International Computer and Information Literacy Study

Assessment Framework

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ICILS 2013

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Foreword

As an international, nonprofit cooperative of national research institutions and governmental research agencies, the International Association for the Evaluation of Educational Achievement (IEA) has conducted more than 30 large-scale comparative studies in countries around the world. These studies have reported on educational policies, practices, and learning outcomes on a wide range of topics and subject matters. These investigations have proven to be a key resource for monitoring educational quality and progress within individual countries and across a broad international context.

The International Computer and Information Literacy Study (ICILS) follows a series of earlier IEA studies that had, as their particular focus, information and communication technologies (ICT) in education. The first of these, the Computers in Education Study (COMPED), was carried out in 1989 and again in 1992 for the purpose of reporting on the educational use of computers in the context of emerging governmental initiatives to implement ICT in schools. The next series of projects in this area was the Second Information Technology in Education Study (SITES), conducted in 1998–1999 (Module 1), 2001 (Module 2), and 2006. These projects provided an update on the implementation of computer technology resources in schools and their utilization in the teaching process.

The continuing rapid development of computer and other information technologies has transformed the environment in which young people access, create, and share information. Many countries, having recognized the imperative of digital technology in all its forms, acknowledge the need to educate their citizens in the use of these technologies so that they and their society can secure the future economic and social benefits of proficiency in the use of digital technologies. Within this context, many questions relating to the efficacy of instructional programs and how instruction is progressed in the area of digital literacy arise.

ICILS represents the first international comparative study to investigate how students are developing the set of knowledge, understanding, attitudes, dispositions, and skills that comprise computer and information literacy (CIL) in order to participate effectively in the digital age. The aim of ICILS is to report on student achievement by way of an authentic computer-based assessment. In order to help explain variations in CIL outcomes internationally and to inform policymakers on the possible contribution of education systems for digital CIL as an essential skill, ICILS will also capture information about the broader in- and out-of-school contexts in which student proficiency is developed.

This publication, the *ICILS Assessment Framework*, describes the background, constructs, and design of the assessment. The framework development process—as in all IEA studies—was a highly collaborative effort that benefitted from the contributions of a number of individuals and groups involved in the study. The project advisory committee (PAC) and study participants were instrumental in this effort.

International studies of the scale of ICILS require a significant financial commitment from IEA and its partners. In addition to IEA's own resources, critical funding for the study has come from the participation fees of the ICILS countries and from the European Commission Directorate-General for Education and Culture's grant to the European countries participating in the project.

I would like to express my thanks to the team of researchers from the international study center located at the Australian Council for Educational Research (ACER), especially to research director Julian Fraillon, project coordinator John Ainley, and assessment coordinator Wolfram Schulz for their leadership. My special thanks also go to colleagues from the IEA Secretariat in Amsterdam, the Netherlands, and the IEA Data Processing and Research Center in Hamburg, Germany, for their support. I also extend thanks to the staff at SoNET Systems, Melbourne, Australia, involved in developing the software for the computer-based student assessment. Particular thanks go to SoNET's Mike Janic and Stephen Birchall. I also acknowledge the work of Jean Dumais from Statistics Canada, who served as sampling referee.

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ICILS would not be possible without the commitment of the national research coordinators from participating countries. They play a crucial role in the development and implementation of each IEA study by ensuring that it embodies the interests of the broader community of researchers, policymakers, and practitioners.

HANS WAGEMAKER
EXECUTIVE DIRECTOR, IEA

Overview

Purpose of the study

The purpose of the International Computer and Information Literacy Study 2013 (ICILS 2013) is to investigate, in a range of countries, the ways in which young people are developing *computer and information literacy* (CIL) to support their capacity to participate in the digital age. To achieve this aim, the study will assess student achievement through an authentic computer-based assessment of CIL administered to students in their eighth year of schooling. It will also collect and report on analyses of data about student use of computers and other digital devices as well as students' attitudes toward the use of computers and other digital tools.

Some of these data represent outcomes, and others represent aspects of computer use that inform an understanding of the broader context in which CIL is developed in young people. Further contextual information collected during implementation of the student assessment will include background data about the participating students and data from the participating teachers, schools, and education systems about the policies, resources, and pedagogies relating to how CIL is taught and learned.

This study is the first of its kind—in terms of emphasis on students' acquisition of CIL—in international comparative research. It is a response to the increasing use of information and communication technologies (ICT) in modern society and the need for citizens to develop relevant skills in order to participate effectively in the digital age. It also addresses the necessity for policymakers and education systems to have a better understanding of the contexts and outcomes of ICT-related education programs in their countries.

The purpose of the ICILS framework is to articulate the basic structure of the study. It provides a description of the field and the constructs to be measured. It also outlines the design and content of the measurement instruments, sets down the rationale for those designs, and describes how measures generated by those instruments relate to the constructs. In addition, it hypothesizes relations between constructs so as to provide the foundation for some of the analyses that follow. Above all, the framework links ICILS to other work in the field. The contents of this assessment framework combine theory and practice in an explication of "both the 'what' and the 'how'" (Jago, 2009, p. 1) of ICILS.

Background to the study

The past two decades have witnessed the development and pervasive implementation of computer and other information technologies throughout societies around the world. There is consensus that the exchange and transformation of knowledge through information technologies is a feature of modern societies. Information technologies provide the tools for creating, collecting, storing, and using knowledge as well as for communication and collaboration (Kozma, 2003). The development of these technologies has changed not only the environment in which students develop skills for life but also the basis of many occupations and the ways in which various social transactions take place. Knowing about, understanding, and using information technologies has become important for life in modern society, while assessment of these skills has become a component of monitoring student achievement in many education systems. This framework refers to this set of knowledge, understanding, and skills as CIL.

Today, many countries recognize the importance that education and training in ICT has for providing citizens with the necessary skills to access information and participate in transactions through these technologies (Kozma, 2008). According to the United Kingdom's Qualifications and Curriculum Authority (2007), ICT "is an essential skill for life and enables learners to participate in a rapidly changing world" (para. 1). The authors of a report on "E-learning Nordic," a study that explored the impact of ICT on education in Nordic countries, observe that "ICT is seen as an essential cultural technique which can significantly improve the quality of education" (Pedersen et al., 2006, p. 114).

In 2008, under its i2010 strategy, the European Commission reported on 470 digital literacy initiatives in Europe and suggested that digital literacy is "increasingly becoming an essential life competence and the inability to access or use ICT has effectively become a barrier to social integration and personal development" (European Commission, 2008, p. 4). The successor to the i2010 strategy, the Digital Agenda for Europe, included "enhancing digital literacy, inclusion and skills" as one of seven priority areas for action (European Commission, 2013, para. 1) and led to the establishment of a conceptual framework for "benchmarking digital Europe" (European Commission, 2009a). In December 2011, the European Commission launched the DIGICOMP project, setting as its aims the following:

- To *identify* the key components of Digital Competence in terms of the knowledge, skills and attitudes needed to be digitally competent;
- To *develop* Digital Competence descriptors that will feed a conceptual framework/ guidelines that can be validated at European level, taking into account relevant frameworks currently available;
- To *propose* a roadmap for the possible use and revision of a Digital Competence framework and descriptors of Digital Competence for all levels of learners. (Ferrari, 2012, p. 1, emphases original)

Ferrari (2012) explains that digital competence (DC) is "both a requirement and a right of citizens, if they are to be functional in today's society" (p. 3). She identifies, through an analysis of existing digital competence frameworks, seven competence areas: information management; collaboration; communication and sharing; creation of content and knowledge; ethics and responsibility; evaluation and problem solving; and technical operations.

The United States has in place widespread and varied policies designed to encourage the use of ICT in schools (Anderson & Dexter, 2009). In endeavoring to shape their curricula and assessments according to the policy directives, states have generally followed the National Educational Technology Standards established by the International Society for Technology in Education (2007). The US National Education Technology Plan implicitly and explicitly exhorts the development of skills that enable participation in the digital age. Goal 1.1 of the plan stresses that, regardless of the learning domain, "… states should continue to consider the integration of 21st-century competencies and expertise, such as critical thinking, complex problem solving, collaboration, multimedia communication, and technological competencies demonstrated by professionals in various disciplines" (Office of Educational Technology, US Department of Education, 2010, p. *xvi*).

An assessment of technology competency (which includes ICT as one of three areas) is to be included in the US National Assessment of Educational Progress 2014 (WestEd, 2010). The assessment covers proficiency with computers and software learning tools, networking systems and protocols, hand-held digital devices, and other technologies for accessing, creating, and communicating information and for facilitating creative expression. It also identifies five subareas of competency: construction and exchange of ideas and solutions, information research, investigation of problems, acknowledgement of ideas and information, and selection and use of digital tools (Institute of Education Sciences, National Center for Education Statistics, 2012).

Over recent years, a number of countries in Latin America have increased their focus on the use of ICT in classrooms and also introduced one computer to every student in schools (commonly referred to as one-to-one resourcing). Argentina, Brazil, Chile, Peru, and Uruguay are some of the countries that have implemented one-to-one computer policies (see, for example, Ministry of Education of the City of Buenos Aires, 2013; Ministry of Education of Uruguay, 2013; Severin & Capota, 2011; Severin, Santiago, Ibarrarán, Thompson, & Cueto, 2011).

Despite the international context wherein the importance of ICT-related literacies is universally acknowledged and widely regarded as increasing (Blurton, 1999; Kozma, 2003), there is considerable variation among (and even within) countries with regard to explicit ICT curricula, resources, and teaching approaches (Educational Testing Service, 2002; Kozma, 2008; OECD, 2005; Sturman & Sizmur, 2011). In addition to questions stemming from the variety of approaches in which ICT curricula are conceptualized and delivered, there are also questions about the nature of the role that schools and education systems play in supporting the development of ICT-related literacies among young people.

In some countries, young people claim that they learn more about using computers out of school than they do in school (see, for example, Thomson & De Bortoli, 2007). Adults regard the new generation of young people as "digital natives" (Prensky, 2001) who have developed "sophisticated knowledge of and skills with information technologies" as well as learning styles that differ from those of previous generations (Bennett, Maton, & Kervin, 2008, p. 777).

However, various commentators express concern about the value of labeling the new generation this way, and in particular challenge assumptions about the knowledge and skills that these digital natives acquire (see, for example, van den Beemt, 2010). In addition to identifying and discussing the "myths" associated with the notion of digital native, Koutropoulos (2011, p. 531) questions assumptions of homogeneity and pervasiveness, arguing that if we look "at the research … we see that there is no one, monolithic group that we can point to and say that *those are digital natives.* As a matter of fact, the individuals who would fit the stereotype of the digital native appear to be in the minority of the population" (para 36, emphasis original).

Questions are also being raised about the types of ICT use and consequent learning that young people experience, especially when they are away from school. Some scholars query if young people are, indeed, developing through their ICT use the types of ICT-related knowledge, skills, and understandings that can be of significant value in later life. Crook (2008) characterizes the majority of young people's communicative exchanges as "low bandwidth," where the focus is on role allocation and co-operation rather than on genuine collaboration. Selwyn (2009) similarly challenges suppositions about the quality and value of much of young people's self-directed ICT learning, observing that "if anything young people's use of the internet can be described most accurately as involving the passive consumption of knowledge rather than the active creation of content" (p. 372).

Today, the research community and policymakers continue to grapple with issues revolving around the development of digital literacies in young people. Although there is consistent rhetoric about the value of emergent digital literacies in providing positive life outcomes, just how school education can and should contribute to this process is less than clear. ICILS should bring greater clarity to these matters through its systematic investigation of CIL in young people and the ways in which CIL is developed. The development of a uniform research framework and an empirically based set of outcome standards is fundamental to any large-scale crossnational study such as ICILS. The framework and standards described in this document also serve as a means of informing and guiding ICT and CIL policy and thereby help to bring coherence to an area of learning that is of increasing international significance.

The place of CIL in relation to traditional disciplines

In some senses, CIL is analogous to reading literacy in that both are an end and a means in school education. At school, young people may learn to use ICT, and they may also use ICT to learn. Schools use ICT as a basis of instructional delivery systems designed to increase skills and knowledge in other learning areas. They also use ICT as a tool for accessing resources, communicating, analyzing, and conducting simulations. However, education systems also want students to develop ICT skills and knowledge and to understand the role of ICT in learning, work, and society.

The use of ICT in schools for discipline-based and cross-disciplinary areas of instruction and for developing ICT-related skills and understandings has led to two approaches to measuring computer-based achievement. The first involves measuring area-specific achievement of computer use, such as online reading and solving mathematics and science-related problems. This method typically presupposes that ICT achievement is inseparable from subject-based achievement. The second approach—measuring ICT achievement as a discrete learning area—assumes that ICT achievement transcends individual disciplines and comprises a set of knowledge, skills, and understandings that learners can readily adapt and transfer to new contexts.

In line with its broad aim of examining the outcomes of student CIL education across countries, ICILS has adopted the second approach. This approach also taps into the growing interest in the assessment of the ICT literacy-related competencies documented by Erstad (2006, 2010) and is consistent with the approach in other studies of ICT literacy such as the Assessment & Teaching of 21st Century Skills (Griffin, McGaw, & Care, 2012).

The two primary justifications for researching CIL as a means of integrating and transcending individual learning areas are practical and conceptual. At the practical level, ICILS offers the opportunity to capture information on the outcomes of CIL education without restricting CIL to the context of a single learning area. The integration of contexts within CIL provides both efficiency (by collecting data through a single study rather than multiple studies) and removes the effect of variations across studies (such as through population selections, timing of data collection, and variations across the role of CIL within learning areas) that may invalidate any attempts to compare CIL learning outcomes across learning areas. At the conceptual level, CIL-related skills are increasingly being regarded as a broad set of generalizable and transferable knowledge, skills, and understandings that individuals can use to manage the cross-disciplinary commodity that is information.

The possibilities that CIL holds for integrating and processing information are seen to transcend the mere implementation and use of computer technologies within any single learning discipline (see, for example, Amtmann & Poindexter, 2008; Audunson & Nordlie, 2003; Educational Testing Service, 2002; Markauskaite, 2007). It is interest in these facets of CIL that sets ICILS apart from studies that focus solely on assessing online discipline-specific learning, such as online reading, writing, mathematics, and science.

The critical conceptual difference between online assessments of discipline-specific learning areas and an assessment of CIL is that the latter measures students' ability to use computers to manage and communicate information. In discipline-based assessments, the computer is used as a vehicle for students to express their discipline-specific knowledge, understanding, and skills. For example, assessments of online reading focus on students' capacity to make sense of text by locating and interpreting information within the electronic text (see, for example, OECD, 2011). Items may focus on specific details, themes, main ideas, nuance, and authorial purpose and techniques evident in the text. The text is the primary information source and is understood to be deliberately crafted in order to communicate ideas.

CIL-based assessments require students to search for and identify many possible information sources relating to a larger research question or proposition. Receptive tasks relating to students' "reading" of a text in CIL focus on the likely trustworthiness and accuracy of the information and, by necessity, require students to be aware of the role of the text as a means of promoting an author's potential agenda. CIL items do not necessitate the detailed reading of text that computer-based reading items do. In productive tasks, the capacity of students to "read" texts is evident only in the way in which they use the information in those texts to create new "information products".

Criteria relating to information use (that, by inference, relate to students' capacity to make sense of computer-based texts) focus on the ways in which students select and then use (synthesize) the key ideas and information contained in the source texts. The point at which CIL transcends the conventional literacies and computer literacy that underpin it is when computer-based reading of texts combines with the necessity to synthesize and communicate information within a computer-based (hardware and software) context to a particular audience and for a particular purpose.

The difference between CIL and computer-based reading is equally relevant to the learning areas of mathematics and science. In mathematics, for example, students frequently use computer technologies to draw graphs of data or functions or to rotate shapes in three-dimensional space. Items assessing computer-related mathematical literacy might require students to plot multiple functions for the purpose of determining the points at which the graphs of the functions intersect (are "equal") or to rotate a shape in space to determine how it appears from different perspectives. In these cases, students are using computer technology as a tool for demonstrating their understanding of underlying mathematical concepts. Similarly, students may be presented with a table of data and asked to draw a chart in order to include the data in a report. Assessment of this "tool"-based level of computer use from a mathematics perspective would focus on the students' ability to apply the necessary software commands to access the table and then draw the chart (or information product).

However, when students' work is assessed from a CIL perspective, how that work is presented in the information product, for example, with appropriate labeling conventions and sufficient text to explain the place and role of the data in it, would be considered. Thus, from the CIL perspective, the data or chart are information commodities that need to be used for a purpose rather than tools by which to express understanding of mathematical concepts.

Computer technologies provide two immediate opportunities for computer-based science assessments. One is to use multimedia technology to demonstrate the physical manifestations of a scientific concept (such as color change or precipitation as evidence of a chemical reaction); the second is to provide software that students can use to help conduct investigations, run simulations, and generate data (see OECD, 2010a; Scalise et al., 2011).

The first opportunity provides the advantage of demonstrating complex change without the need for text to describe that change, thereby reducing the reading load. The second opportunity provides a potentially efficient and safe way for students to complete scientific observations from which they can draw conclusions. In a computer-based science assessment, students may be asked, for example, to use simulation software to manipulate independent variables such as sunlight and water, and then to monitor the influence of both on the growth of plants. Here, students would be assessed on their capacity to determine a systematic way in which to manipulate the variables so that they could draw meaningful conclusions about the influence of water and light on plant growth.

As was the case in the examples for reading and mathematics, the focus of science-based CIL is on students' capacity to use scientific information as a commodity rather than as an expression of their understanding of specific science-related concepts. Thus, in the tool-based assessment relating to the effect of sun and water on plant growth, students would not be expected to express understanding of scientific reasoning through the manipulation of variables. Rather, they would be required to follow instructions about what to change (rather than deciding themselves what to change) and might be assessed on their capacity to use the software accurately. They might also be provided with unambiguous experimental data and required to make use of it as part of an integrated information product.

Research questions, participants, and instruments

ICILS aims to investigate the ways in which young people develop CIL to support their capacity to participate in the digital age. The key research questions for the study accordingly concern (1) the contexts in which CIL is developed, and (2) students' proficiency in CIL.

Research questions

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?

Participants

The ICILS target population comprises students in their eighth year of schooling. In most education systems, this is Grade 8, provided that the average age of students in this grade is 13.5 years or above. In education systems where the average age in Grade 8 is below 13.5, Grade 9 is defined as the ICILS target population. Schools with students enrolled in the target grade will be selected randomly proportional to size (PPS). Within each sampled school, 20 students will be randomly selected from among all students enrolled in the target grade.

The population for the ICILS teacher survey is defined as all teachers teaching regular school subjects to the target grade students at each sampled school. It includes only those teachers teaching the target grade students during the testing period and employed at school from the beginning of the school year. Fifteen teachers will be randomly selected from the teacher population at each sampled school.

School-level data will be provided by the principal and ICT coordinator from each sampled school.

Instruments

The following instruments will be administered as part of ICILS.

1) *An international student test* consisting of a computer-based set of authentic questions and tasks designed to measure student computer and information literacy (CIL).
2) *A student questionnaire* consisting of a computer-based set of items measuring student background variables and access to, experience and use of, and familiarity

with ICT at home and at school. The questionnaire will also collect evidence of students' attitudes toward using ICT.

3) *A teacher questionnaire*, administered to selected teachers teaching any subject in the target grade. It will gather information about teacher background variables and use of ICT. The questionnaire includes items that ask teachers to rate their confidence in using computers in their teaching, to state their actual use of computers, and to express their attitudes toward using computers in teaching and learning.
4) *A school principal questionnaire*, administered to the principals of sampled schools and designed to capture school characteristics, the application of ICT in teaching and learning, as well as aspects of the management of ICT at school.
5) *An ICT coordinator questionnaire*, administered to ICT coordinators of sampled schools and designed to capture information on resources and support for ICT at schools.
6) *A national contexts survey*, completed by experts in each country's ICILS national research center. The survey will seek out information on the structure of the education system, the status of CIL-related education in the national curriculum and policies, initiatives and resourcing associated with ICT, and CIL-related education. The data obtained from this survey should provide a description of the contexts for CIL-related education in each country and assist interpretation of the results from the student, school, and teacher questionnaires.

Computer and information literacy framework

Overview

The development and use of terms relating to CIL to describe a range of real-world proficiencies are widely documented in research literature. However, the development of context-specific constructs relating to CIL has led to a proliferation of frequently overlapping and confusing definitions (Bawden, 2001).[1] Paralleling this proliferation is the range of terms and definitions relating to media and critical literacies (Livingstone, Van Couvering, & Thumin, 2008). Similarly, definitions of computer literacy and digital literacy are numerous and overlapping (Tyner, 1998).

Livingstone et al. (2008, p. 104) distinguish between scholarly preferences to achieve the following:

> introduce new terms to characterize these supposedly new skills (e.g., digital literacy, cyber literacy, Internet literacy and network literacy) … [and those that] emphasize the continuities between old and new media and information and communication technologies by extending the term media literacy or literacy in general to encompass a converged concept of media and information literacies.

Scholars who advocate for the latter position argue that the technological advances leading to the increasing range of media contents available on computers (video, audio streaming, and podcasts, for example) support the recognition and assimilation of ICT literacy-related constructs rather than the creation of new terms and constructs that purportedly access a "new" set of technical and cognitive competencies.

One of the conceptual challenges for ICILS has been to decide whether the definition and research construct of CIL should address a new set of competencies or emphasize its connection to existing ones. The decision eventually came down on the side of the second approach. Both definition and construct therefore derive from existing literature on computer-related and information-related literacies but their development took into account two fundamental parameters of ICILS:

1) ICILS targets *school-aged children* (in their eighth year of school); and
2) The assessment would be completed using computers and would focus on computer use.

With these parameters in mind, the ICILS construct explicitly refers to computer literacy, rather than the broader contexts implicit (although not always measured in practice) in constructs relating to digital literacy, ICT literacy, and digital competence (Educational Testing Service, 2002; Janssen & Stoyanov, 2012; Ministerial Council for Education, Early Childhood Development, and Youth Affairs [MCEECDYA], 2008).

1 Virkus (2003), for example, lists terms used synonymously with information literacy. They include "'infoliteracy', 'informacy', 'information empowerment', 'information competence', 'information competency', 'information competencies', 'information literacy skills', 'information literacy and skills', 'skills of information literacy', 'information literacy competence', 'information literacy competencies', 'information competence skills', 'information handling skills', 'information problem solving', 'information problem solving skills', 'information fluency', 'information mediacy' and 'information mastery'...".

In contrast to this practical consideration, the choice to focus on information rather than media literacy reflects a key difference that still exists between the two constructs.

Both information and media literacy typically refer to the capacity to access, analyze, evaluate, and communicate information. What distinguishes the two is that the emphasis in media literacy is primarily on explicitly measuring "understanding" of information as an outcome, whereas the emphasis with respect to information literacy is primarily on the processes of information management (Catts & Lau, 2008; Christ & Potter, 1998; Livingstone et al., 2008; Ofcom, 2006; Peters, 2004). While it is a given that students must understand the information they are dealing with in order to evaluate and use it effectively, explicitly measuring that understanding is rarely the focus with information literacy.

A second area of difference between media and information literacy is in their approach to the concept of information. Traditionally, media literacy has emphasized the range of forms in which information is "packaged," whereas information literacy has focused on static texts (electronic or print). As indicated previously, advances in technology are increasingly blurring this distinction and may eventually render this difference redundant.

Recently, the rapid development of web-based collaborative technologies along with improved internet connectivity in many countries has led to increasing research interest in skills associated with collaboration in learning contexts. Collaboration and collaborative problem-solving are included in conceptualizations informing projects such as Digital Competence (Ferrari, 2012) and 21st Century Skills (see, for example, Ananiadou & Claro, 2009; Partnership for 21st Century Skills, n. d.). Although these conceptualizations are regarded as outside the scope of ICILS, their enabling knowledge, skills, and understandings are not.

ICILS was established to investigate the competencies associated with computer and information literacies as the enabling components of digital competence and 21st Century skills. Despite being developed independently of specific curriculum goals, ICILS does focus on what Lampe et al. (2010) consider should be technology-mediated educational priorities for middle school students. These include finding and synthesizing relevant resources, connecting to people and networks, and knowing how to present and express oneself online in general and through online systems in particular (p. 62).

Defining computer and information literacy

Information literacy constructs developed first through the fields of librarianship and psychology (Bawden, 2001; Church, 1999; Homann, 2003; Marcum, 2002) and are acknowledged as having the following processes in common: identifying information needs, searching for and locating information, and evaluating the quality of information (Catts & Lau, 2008; Livingstone et al., 2008; UNESCO, 2003). Most information literacy constructs (and particularly those developed over the past 10 years) extend these processes to include the ways in which the collected information can be transformed and used to communicate ideas (Catts & Lau, 2008; Peters, 2004).

Computer literacy constructs in education typically focus not on the logical reasoning of programming (or the syntax of programming languages) but rather on declarative and procedural knowledge about computer use, familiarity with computers (including their uses), and, in some cases, attitudes toward computers (Richter, Naumann, & Groeben, 2000; Wilkinson, 2006). With digital technologies now serving as the world's primary information management resources, recent information literacy constructs have adopted and largely subsumed computer literacy constructs (see, for example, Cartelli, 2009). According to various commentators, the global concepts of "knowledge economy" and "information society" are the essential drivers of the ongoing integration of computer and information literacy. Catts and Lau (2008, p. 7), for example, make this observation:

> People can be information literate in the absence of ICT, but the volume and variable quality of digital information, and its role in knowledge societies, has highlighted the need for all people to achieve IL [information literacy] skills. For people to use IL within a knowledge society, both access to information and the capacity to use ICT are prerequisites. IL is, however, a distinct capacity and an integral aspect of adult competencies.

The assumption that information is received, processed, and transmitted underlies CIL constructs. The key difference between explicit information literacy constructs (that still rely on and assume some computer proficiency) and computer literacy constructs appears to be that the latter allocates less importance than the former to the nature and constituent parts of the information processing that happens between reception and transmission. In essence, computer literacy focuses on a more direct path between reception and transmission than does information literacy, which emphasizes the processual steps involved as information is evaluated and transformed (Boekhorst, 2003; Catts & Lau, 2008). Over time, computer literacy and information literacy constructs have converged in the form of information and communication technologies (ICT) literacy and digital literacy. The following definitions of each show this convergence:

- "ICT literacy is using digital technology, communications tools, and/or networks to access, manage, integrate, evaluate, and create information in order to function in a knowledge society" (Educational Testing Service, 2002, p. 2).
- "ICT literacy is the ability of individuals to use ICT appropriately to access, manage and evaluate information, develop new understandings, and communicate with others in order to participate effectively in society" (Ministerial Council on Education, Employment, Training, and Youth Affairs [MCEETYA], 2005, p. 14).
- Digital literacy is "the ability to use digital technology, communications tools, and/or networks to access, manage, integrate, evaluate, and create information in order to function in a knowledge society" (Lemke, 2003, p. 22).

Common to these definitions is the assumption that individuals have the technical skills needed to use the technologies. All three definitions also list very similar sets of information literacy and communication processes. Each furthermore maintains that individuals need to acquire these forms of literacy in order to participate and function effectively in society. Binkley and colleagues' (2012) documentation and synthesis of the operational definitions of ICT literacy that have developed over the past decade provide useful understanding not only of this development but also of how it taps into the construct of CIL used in ICILS.

With reference to both the parameters of ICILS and the literature about ICT-related literacies, we use the following definition of CIL in this framework:

> Computer and information literacy refers to an individual's ability to use computers to investigate, create, and communicate in order to participate effectively at home, at school, in the workplace, and in society.

Within the ambit of the ICILS assessment framework, then, this definition relies on and brings together technical competence (computer literacy) and intellectual capacity (conventional literacies including information literacy) to achieve a highly context-dependent communicative purpose that presupposes and transcends its constituent elements. This view of CIL is congruent with Audunson and Nordlie's (2003) conceptual model of information literacy and is most closely aligned with the ICT literacy construct evident in the first of the three ICT and digital literacy definitions cited previously.

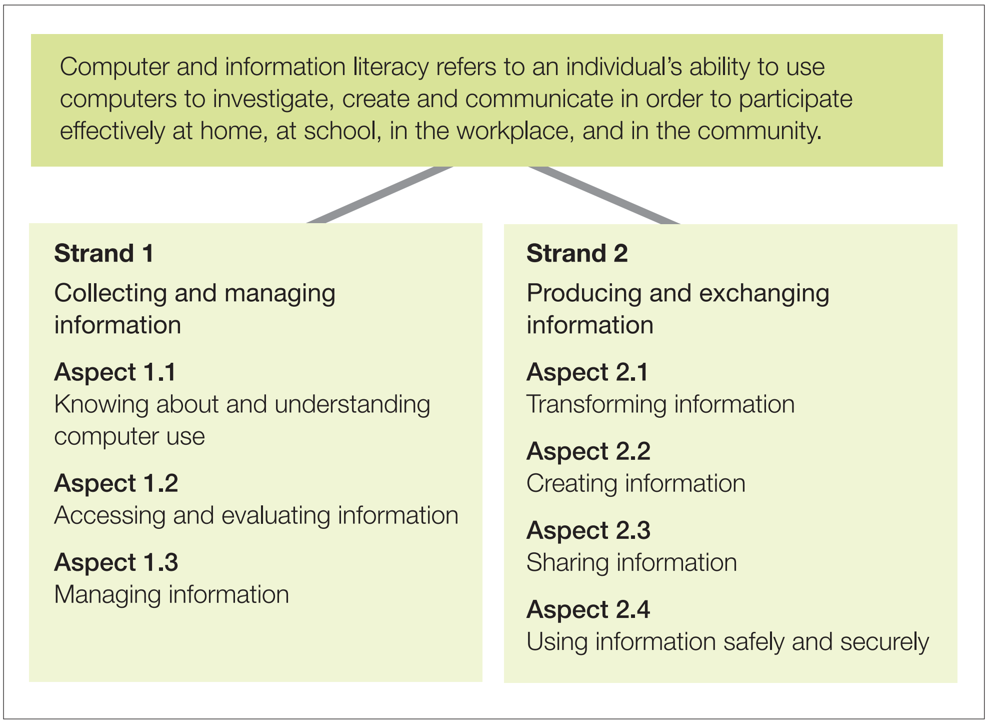
Structure of the computer and information literacy construct

The CIL construct includes the following elements:

- *Strand:* This refers to the overarching conceptual category for framing the skills and knowledge addressed by the CIL instruments.
- *Aspect:* This refers to the specific content category within a strand.

The construct comprises two strands. One strand contains three aspects and the other strand contains four aspects (summarized in Figure 1 and described in detail below). The aspects encompass the set of knowledge, skills, and understandings held in common by the range of definitions of ICT literacy and digital competency discussed previously and also by more recent ones from Ferrari (2012) and the Institute of Education Sciences, National Center for Education Statistics (2012).

Figure 1: Conceptual structure of the CIL framework



The organization of aspects under strands does not presuppose an analytic structure with more than one subscale of CIL achievement. Rather, the two strands reflect the two primary uses of computers as receptive or productive CIL tools. Each aspect belongs to the strand with which it has the greatest, but not necessarily unique, congruence.

Appendix B contains a progress map that details development of the CIL construct. Progress is described in terms of five levels for each of the two strands and includes the descriptors that were formulated on the basis of previous work in the field and supported in the data analyses from the international ICILS field trial. Each level includes a general description of CIL proficiency for that strand and level as well as specific examples of task completion deemed indicative of achievement at that level.

Strands and aspects

Strand 1: Collecting and managing information

Collecting and managing information embraces the receptive and organizational elements of information processing and management, including the fundamental and generic skills and understandings associated with using computers. This strand comprises three aspects:

- Knowing about and understanding computer use;
- Accessing and evaluating information;
- Managing information.

Aspect 1.1: Knowing about and understanding computer use

Knowing about and understanding computer use refers to a person's declarative and procedural knowledge of the generic characteristics and functions of computers. This aspect focuses on the basic technical knowledge and skills that underpin our use of computers in order to work with information. Early constructs of ICT and digital literacies tended to omit this aspect, but this is no longer the case. For example, one of the seven areas of digital competency that Ferrari (2012) proposes is "technical operations," while the Institute of Education Sciences, National Center for Education Statistics (2012), which administers the US's National Assessment of Educational Progress, suggests that "although students are not expected to understand the inner workings of these devices, they should have enough of an understanding of the principles underlying them to appreciate the basics of how they work" (para. 4).

At a declarative level, a person may know that computers use processors and memory to run programs, or that operating systems, wordprocessors, games, and viruses are examples of programs. They may be able to demonstrate knowledge that computers can be connected to and so can "communicate" with one another through networks, and that these can be local or global. They also may understand that the internet is a form of computer network which is run through computers and that websites, blogs, wikis, and all forms of computer software are designed to meet specific purposes.

Procedural knowledge includes knowledge of the software interface conventions that help computer-users make sense of and operate unfamiliar software that adheres to these known interface conventions. Accordingly, at the procedural level, a person may know how to execute basic generic file and software functions such as opening and saving files in given locations, resizing images, copying and pasting text, and identifying file types by their extensions. The procedural knowledge included in Aspect 1.1 is thus limited to basic generic commands that are common across software environments.

Aspect 1.2: Accessing and evaluating information

Accessing and evaluating information refers to the investigative processes that enable a person to find, retrieve, and make judgments about the relevance, integrity, and usefulness of computer-based information. The proliferation of information sources that use the internet as a communication medium means that users are required to filter the vast array of information to which they gain access before they can make use of it. However, the process of filtering in combination with the increasing intuitiveness of computer-based information search programs[2] is producing an ever greater integration of the processes of accessing and evaluating information. For this reason, accessing information and evaluating information are regarded as sufficiently integrated to warrant their inclusion as a single aspect, rather than separate aspects, of the CIL construct.

The importance of accessing and evaluating information is also a direct result of the increasing quantity and range of available unfiltered computer-based (and delivered) information. Computer-based information is not only increasing in volume, but also constantly changing. While accessing information and evaluating information are rooted in conventional literacies, the dynamic multimedia and multimodal nature of computer-based information means that the processes of accessing and evaluating that contribute to the CIL construct are different from those that relate only to conventional literacies. The dynamic context of computer-based information therefore necessitates the use of an amalgam of a range of skills (i.e., those typically associated with digital and media literacies) that differ from and are broader than the range employed with conventional literacies.

Examples of tasks that provide evidence of an individual's ability to access and evaluate computer-based information include the following:

- Selecting information from within a website or file list that is relevant to a particular topic;
- Describing and explaining the functions and parameters of different computer-based information search programs;
- Suggesting strategies for searching for information and/or adjusting the parameters of searches to target information better;
- Recognizing and explaining characteristics of computer-based information (such as hyperbole and unsubstantiated claims) that detract from its credibility;
- Recognizing that published information can have a hidden agenda; and
- Suggesting and implementing strategies to verify the veracity of information (such as cross-checking information from multiple sources).

Aspect 1.3: Managing information

Managing information refers to the capacity of individuals to work with computer-based information. The process includes ability to adopt and adapt information classification and organization schemes in order to arrange and store information so that it can be used or reused efficiently. Managing information differs from Aspect 1.1 (knowing and understanding computers) because it relates to making decisions about the way information is used, rather than to simply knowing or demonstrating that it can be used.

2 These include search engines that tailor search results to individual searchers based on location, previous search behavior, and even the internet-use behavior of "friends" in a social network.

Managing information also differs from Aspect 1.2 (accessing and evaluating information) in that it relates to the ability to manage information in an environment where users have some control over the organization and structure of the information. Hence, for example, searching for a file that exists within a constrained file structure involves managing rather than accessing and evaluating information because it requires users to work with the known attributes of the closed file system rather than determine the likely searchable properties of an information product that would enable them to focus their search.

Computer and information literacy, as manifest in this aspect of the domain, thus refers to the ability to manage information by, for example:

- Creating a file structure in a directory according to given parameters;
- Sorting or filtering information on an internet database; and
- Recognizing the most efficient data structure for a given purpose within a simple database.

Strand 2: Producing and exchanging information

This strand, which focuses on using computers as productive tools for thinking, creating, and communicating, has four aspects:

- Transforming information;
- Creating information;
- Sharing information;
- Using information safely and securely.

Aspect 2.1: Transforming information

Transforming information refers to a person's ability to use computers to change how information is presented so that it is clearer for specific audiences and purposes. This process typically involves using the formatting, graphics, and multimedia potential of computers to enhance the communicative effect or efficacy of (frequently text-based or numerical) information.

The CIL manifest in this aspect of the domain refers to the ability to transform information by, for example:

- Reformatting the titles in a document or presentation so as to enhance the flow of information;
- Using, modifying, or creating images to supplement or replace text in a document (such as with a flow chart or diagram);
- Creating a chart to represent a table of data;
- Transferring data (such as temperature or velocity data) from a data-logger and displaying it in ways that illustrate patterns of change; and
- Creating a short animated sequence of images to illustrate a sequence of events.

Aspect 2.2: Creating information

Creating information refers to a person's ability to use computers to design and generate information products for specified purposes and audiences. These original products may be entirely new or may build upon a given set of information to generate new understandings.

The CIL manifest in this aspect of the domain therefore refers to the ability to create information by, for example:

- Using a simple graphics program to design a birthday card;
- Designing and writing a presentation that explains the key elements of an historical event; and
- Using a given set of information to make recommendations in a report that integrates text, data, and graphics.

Typically, the quality of information creation relates to how the information content is structured (whether or not the flow of ideas is logical and easy to understand) and the way in which layout and design features (such as images and formatting) are used to support understanding of the information produced. Even though information design and layout design are executed together in an information product, they are typically conceptualized and assessed as discrete elements of creating information.

Aspect 2.3: Sharing information

Sharing information refers to a person's understanding of how computers are and can be used, as well as his or her ability to use computers to communicate and exchange information with others. Sharing information focuses on a person's knowledge and understanding of a range of computer-based communication platforms, such as email, wikis, blogs, instant messaging, sharing media, and social networking websites. Given the rapidly changing nature of this area, Aspect 2.3 focuses on knowledge and understanding of information-based social conventions and, at the higher end of the achievement spectrum, the social impact of sharing information through computer-based communication media.

The CIL manifest in this aspect of the domain accordingly refers to a person's ability to share information by, for example:

- Recognizing some key differences between computer-based communication media;
- Using software to disseminate information (such as attaching a file to an email or adding or editing an entry in a wiki);
- Evaluating the appropriateness of information in a given context;
- Evaluating the best communication platform for a particular communicative purpose; and
- Creating or modifying information products to suit a specified audience or purpose.

Aspect 2.4: Using information safely and securely

Using information safely and securely refers to a person's understanding of the legal and ethical issues of computer-based communication from the perspectives of both the publisher and the consumer. Internet-based communication platforms increasingly are providing the facility for users to share information. With this facility comes the potential for misuse, particularly when dealing with personal information. Using information safely and securely also includes risk identification and prevention as well as the parameters of appropriate conduct. It furthermore focuses on the responsibility of users to maintain a certain level of technical computer security, such as using strong passwords, keeping virus software up to date, and not submitting private information to unknown publishers.

Current issues relating to this aspect include but are not limited to:

- Identity theft;
- Unauthorized access and impersonation;
- Identity concealment;
- Phishing;
- Malicious software distribution;
- Automatic collection of internet usage data;
- Provision and use of personal information; and
- Copyright restrictions for various media published on the internet.

This aspect can be applied to both strands of the CIL construct depending on whether it is demonstrated in a receptive or a productive context. ICILS places it in Strand 2 because, within the ICILS assessment context, safe and secure use is most frequently demonstrated when users actively produce or exchange information.

The CIL manifest in this aspect of the domain relates to the proficiency to, for example:

- Identify the strongest of a given set of passwords;
- Explain the consequence(s) of making personal information publicly available;
- Suggest ways to protect private information;
- Understand how internet advertising targets users; and
- Explain the techniques used in a phishing email scam.

Contextual framework

Overview

This section describes the contextual information collected during ICILS in order to aid understanding of variation in students' computer and information literacy (CIL). We provide a classification of factors that accords with the multilevel structure inherent in the process of student learning, and consider the relationship of these factors to the learning process (antecedents or processes). We also list the different kinds of variables that will be collected via the different ICILS contextual instruments and briefly outline prior findings from educational research in order to explain why these variables are included in ICILS.

Classification of contextual factors

When studying student outcomes related to CIL, it is important to set these in the context of the different factors influencing them. Students acquire competencies in this area through a variety of activities and experiences at the different levels of their education and through different processes in school and out of school. It is also likely, as Ainley, Enger, and Searle (2009) argue, that students' out-of-school experiences of using ICT influence their learning approaches in school. Contextual variables can also be classified according to their measurement characteristics, namely, factual (e.g., age), attitudinal (e.g., enjoyment of computer use), and behavioral (e.g., frequency of computer use).

Different conceptual frameworks for analyzing educational outcomes frequently point out the multilevel structure inherent in the processes that influence student learning (see, for example, Scheerens, 1990; Scheerens & Bosker, 1997; Schulz, Fraillon, Ainley, Losito, & Kerr, 2008; Travers, Garden, & Rosier, 1989; and Travers & Westbury, 1989). The learning of individual students is set in the overlapping contexts of school learning and out-of-school learning, both of which are embedded in the context of the wider community that comprises local, national, supranational, and international contexts. The contextual framework of ICILS therefore distinguishes the following levels:

- *The individual:* This context includes the characteristics of the learner, the processes of learning, and the learner's level of CIL.
- *Home environment:* This context relates to a student's background characteristics, especially in terms of the learning processes associated with family, home, and other immediate out-of-school contexts.
- *Schools and classroom:* This context encompasses all school-related factors. Given the crosscurricular nature of CIL learning, it is not useful to distinguish between classroom level and school level.
- *Wider community:* This level describes the wider context in which CIL learning takes place. It comprises local community contexts (e.g., remoteness and access to internet facilities) as well as characteristics of the education system and country. It also encompasses the global context, a factor widely enhanced by access to the world wide web.

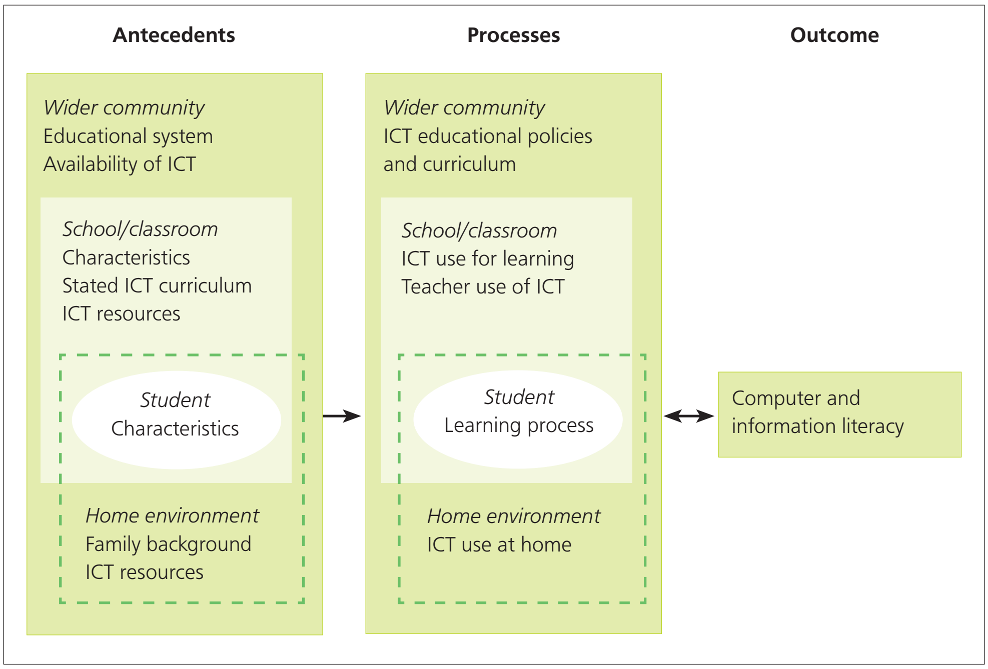
The status of contextual factors within the learning process is also important. Factors can be classified either as antecedents or processes.

- *Antecedents* are exogenous factors that condition the ways in which CIL learning takes place. They are contextual factors that are not directly influenced by learning-process variables or outcomes. It is important to recognize that antecedent variables are level-specific and may be influenced by antecedents and processes found at higher levels. Variables such as the socioeconomic status of the student's family and the school intake along with home resources fall into this category.
- *Processes* are those factors that directly influence CIL learning. They are constrained by antecedent factors and factors found at higher levels. This category contains variables such as opportunities for CIL learning during class, teacher attitudes toward using ICT for study tasks, and students' use of computers at home.

Both antecedents and processes need to be taken into account when explaining variation in CIL learning outcomes. Whereas antecedent factors shape and constrain the development of CIL, process factors can be influenced by the level of (existing) CIL learning. For example, the level and scope of classroom exercises using ICT generally depend on the existing CIL-related proficiency of the students.

Figure 2 illustrates the basic classification of antecedent and process-related contextual factors in their relationship with CIL outcomes located at the different levels. Each type of factor at each level is accompanied by examples of variables that have the potential to influence learning processes and outcomes. The double-headed arrow in the figure between the process-related factors and outcome emphasizes the possibility of feedback between learning process and learning outcome. The single-headed arrow between antecedents and processes, in turn, indicates the assumption within the ICILS contextual framework of a unidirectional association at each contextual level.

Figure 2: Contexts for CIL learning and learning outcomes



Reference to this general conceptual framework enables us to locate potential contextual factors on a two-by-four grid where antecedents and processes constitute the columns and the four levels the rows. Table 1 shows examples in each of these cells of the contextual variables collected by the ICILS instruments. The student questionnaire will collect data on contextual factors pertaining to the level of the individual student and his or her home context. The teacher, school principal, and ICT coordinator questionnaires are designed to locate contextual factors associated with the school/classroom level, while the national contexts survey and other available sources (e.g., published statistics) will gather contextual data at the level of the wider community.

Table 1: Mapping of ICILS context variables to framework grid

Level of ...	Antecedents	Processes
Wider community	NCS & other sources: Structure of education Accessibilty of ICT	NCS & other sources: Role of ICT in curriculum
School/classroom	PrQ, ICQ, & TQ: School characteristics ICT resources	PrQ, ICQ, & TQ: ICT use in teaching
Student	StQ: Gender Age	StQ: ICT activities Use of ICT
Home environment	StQ: Parent SES ICT resources	StQ: Learning about ICT at home

Key: NCS = national contexts survey; PrQ = principal questionnaire; ICQ = ICT coordinator questionnaire; TQ = teacher questionnaire; StQ = student questionnaire.

Contextual levels and variables

The wider-community context

The different levels of this context all have the potential to affect student learning at school or at home. Conceptually, this context has several levels:

- *Local communities*, where remoteness and lack of stable and fast internet connections may affect conditions for ICT use;
- *Regional and national contexts*, where communication infrastructure, educational structures, curricula, and general economic/social factors may be of importance; and
- *Supranational or even international contexts*, where a long-term perspective brings in, for example, factors such as the general advance of ICT globally.

The most important factors potentially explaining variation in CIL are located at the national level (or subnational level in those instances of subregions participating in the study). There is evidence of broad differences in terms of access to digital technology among countries across Europe as well as more broadly across the world (Korte & Husig, 2006; OECD, 2005). There is also evidence that, in recent years, a number of countries have invested in ICT infrastructure that will increase access to broadband internet within schools and homes or increase hardware access in schools. These countries include Australia, Canada, Estonia, Israel, New Zealand, Portugal, and the Republic of Korea (Bakia, Murphy, Anderson, & Trinidad, 2011).

Variables that describe the contexts of education systems will be collected from published sources as well as through the ICILS national contexts survey. Typically, published sources provide information about antecedent country-context variables while the national contexts survey will deliver data on antecedent and process variables at the level of and with respect to the education system.

More specifically, the national contexts survey is designed to collect systemic data on the following:

- Education policy and practice in CIL education (including curriculum approaches to CIL);
- Policies and practices for developing the CIL expertise of teachers; and
- Current debates on and reforms to the implementation of digital technology in schools (including approaches to the assessment of CIL and the provision of ICT resources in schools).

Data pertaining to factors such as the structure of education systems and national curriculum orientations will also be captured so that they can be taken into account during interpretation of ICILS results.

Antecedent variables at the level of the wider community

International comparative research shows relatively strong associations between the general socioeconomic development of countries and student learning outcomes. ICILS will therefore select national (and where appropriate possible subnational) indicators of general human development status regularly reported by the United Nations Development Programme (UNDP, 2009). Examples of these indicators are gross domestic product per capita, access to education, and health statistics.

Given ICILS' focus on students' CIL, it is important to take into account the general availability of and infrastructure for ICT. To this end, ICILS will collect, with the aim of describing the general ICT-related resources at the national level, information from published sources relating to variables such as the number of internet hosts.

One example of a published source of data regarding national contexts is the ICT Development Index (IDI), developed by the International Telecommunications Union (2012). The IDI combines 11 indicators into a single measure that can be used as an index of ICT development for 154 countries or used as separate indicators. Another is the Networked Readiness Index (see, for example, Dutta & Mia, 2011).

Data from a range of international surveys show that the provision of ICT resources in schools varies widely across countries (see, for example, Anderson & Ainley, 2010; Pelgrum & Doornekamp, 2009). In order to obtain information related to the general ICT resourcing of schools, the ICILS national contexts survey will collect data on school-based ICT infrastructure, hardware, and software, as well as policy expectations regarding these provisions.

These data comprise system-level variables such as the number of computers per student, computers per teacher, internet connectivity (coverage and speed), software licensing arrangements, and the availability of digital curriculum resources. Analysis of this information will support evaluation of the premise that students in those schools with the highest levels of digital resourcing will have greater experience of and access to the use of CIL and consequently develop higher levels of CIL.

The national contexts survey will also gather data about a range of other characteristics of the education systems participating in ICILS. System-level variables related to this aspect include length of schooling, age-grade profiles, educational finance, and the structure of school education (e.g., study programs, public/private management), as well as the autonomy of educational providers.

Process-related variables

The process-related variables on CIL-related education policy that will be collected by the national contexts survey include the following:

- The definition of and the priority that each country gives to CIL education in its educational policy and provision;
- The name of and national or official definition given to CIL education;
- The place of CIL education in educational reforms;
- The main aims and goals of CIL education; and
- The influence of different institutions or groups on decisions relating to those goals and aims.

Because the ICILS contextual framework references policies and practices developed as outcomes of earlier large-scale surveys of ICT in education, ICILS also takes into account the process-related data in these studies' reports and databases. The studies include IEA's Second Information Technology in Education Study (SITES) (Plomp, Anderson, Law, & Quale, 2009), the European Commission's Indicators of ICT in Primary and Secondary Education (European Commission, 2009b), and the International Experiences with Technology in Education survey, which covered policies and experiences in 21 countries (Bakia et al., 2011).

The information from these studies shows that countries take different approaches to the implementation of CIL education in their curricula. Some education systems include it as a subject within the curriculum, whereas others include it by integrating it into other subjects. The explicitness with which countries describe their CIL curricula and the learning outcomes they want from them also vary across education systems. Some have very explicit curricula regarding CIL education and its expected learning outcomes; others describe CIL education as an "implicit" curriculum that weaves through the curriculum documents for other learning areas.

In order to build on what is already known, the national contexts survey will gather data on the inclusion of CIL education (as a separate subject, integrated into different subjects, or as a crosscurricular approach) in the formal curriculum at different stages of schooling and in different study programs. It will also capture the nomenclature for CIL-related curriculum subjects and whether they are compulsory or optional in each program of study. Specific questions regarding the target grade in terms of curriculum emphasis and the amount of instructional time given to CIL education will also be asked.

Another important process-related variable at the system level is the development of teacher expertise in CIL (Charalambos & Glass, 2007; Law, Pelgrum, & Plomp, 2008). Teacher education programs often provide aspiring teachers with opportunities to develop CIL-related competencies. To aid assessment of the variety of different approaches to teacher education in the field, the national contexts survey will gather (where applicable) data on CIL requirements for becoming a teacher, licensing or certification procedures for teachers, and the backgrounds of CIL teachers. The survey will also seek out information on the extent to which CIL education is part of preservice or initial teacher education, on the availability of inservice or continuing professional development for CIL education, on the providers of these activities, and on expectations for teachers' ongoing learning about developments in CIL education.

Over the past few decades, many countries have undertaken educational reforms involving the introduction of digital technology.[3] A key feature of most national plans over the most recent decade is that they aspire to use ICT to transform patterns of learning and teaching and to develop capabilities useful within modern economies, rather than simply improve existing practice. However, countries differ in the extent to which they have introduced, or are introducing, digital technology into school education. There is also considerable variation in the level of priority given to this development, including the development of curriculum resources in the form of digital learning objects. The same can be said with respect to whether and how education systems assess CIL and whether they use ICT to assess other disciplines. The national contexts survey will therefore gather data about the priorities accorded to these digital developments and the nature of the debates surrounding them.

School/classroom context

Any study of students' acquisition of CIL must acknowledge the key role that school and classroom contexts play in that acquisition. Use of ICT is increasingly becoming standard practice in education and is therefore an important part of preparing young people for participation in modern society. Factors associated with the school and classroom context will be collected through the teacher, school principal, and ICT coordinator questionnaires. In addition, the student questionnaire includes some questions gauging student perceptions about classroom practices related to ICT. Even though ICILS will not attempt to investigate the relationship between ICT use in schools or classrooms and achievement in academic learning areas such as language, mathematics, or science, it is of interest to note the suggestion of positive associations with achievement evident in the results of a recent meta-analysis conducted by Tamin, Bernard, Borokhovski, Abrami, and Schmid (2011).

Antecedent variables at the school/classroom level

In line with the need to take basic school characteristics into account when investigating variations in CIL, the questionnaire given to each school principal will collect information on student enrolment, teachers, the range of grades, and the location of each participating school. It will also collect data on school (public or private) management. Because, as noted earlier, we can regard ICT-related resources at school as a key context factor when studying students' CIL, the school principal questionnaire will furthermore ask who, in the school, assumes responsibilities for the acquisition of ICT resources.

The ICILS questionnaire for each school's ICT coordinator includes questions on the availability of school-owned computing devices at school, their location within the school, how many students have access to them, which computer operating system the school mainly uses, and the number of years the school has been using ICT. The

3 Two national plans for ICT in education are those of the United States (U.S. Department of Education, 2010) and Portugal (Ministry of Education of Portugal's *Plano Technólogico Educação* 2007, cited in Bakia, et al., 2011).

instrument will also collect data on the support the school provides for ICT use in teaching and learning in terms of personnel and technology or software resources. It additionally includes a question measuring the coordinator's perceptions of the adequacy of the ICT on hand for learning and teaching at school.

The background and experiences of teaching staff have the potential to influence the acquisition of student CIL. Results from SITES 2006 indicated that teachers are more likely to use ICT in their teaching when they have higher levels of self-confidence in using ICT in general (Law et al., 2008). SITES 2006 also indicated that, in most of the participating countries, ICT is more frequently used in science teaching than in mathematics teaching.

The ICILS teacher questionnaire will therefore collect information on the general professional background of teaching staff (such as age, gender, subject taught at school) and on their ICT experience (number of years using ICT for teaching purposes, general use of computers at different locations, participation in ICT-related professional development activities, and perceived self-confidence in using ICT for different tasks). Teachers will also be asked to give their views on the positive and negative consequences of using ICT for teaching and learning, and to identify any factors that they think impede the use of ICT for teaching and learning at their school.

SITES 2006 findings suggest that ICT use by science and mathematics teachers is influenced by the school principal's views about its value, as well as the ICT-related support teachers have at hand (Law et al., 2008). Findings also indicate that ICT-related teaching and learning can be constrained or facilitated by the school's stated curriculum and its policies with regard to ICT. The ICILS school principal questionnaire will therefore collect data on the following factors:

- The extent to which the school has policies and procedures relating to ICT use;
- The extent to which the school prioritizes ICT acquisition and resourcing;
- Perception of the importance ascribed to ICT use in teaching at the school;
- School-level expectations for teachers' knowledge of and skills in using ICT; and
- The extent to which teachers participate in ICT-related professional development.

Process-related variables at the school/classroom level

The emergence of ICT in school education has been seen for some time as having the potential to influence teaching and learning processes by enabling wider access to a range of resources, allowing greater power to analyze and transform information, and providing enhanced capacities to present information in different forms. However, the evolution of greater interactivity in more recent technologies (sometimes referred to as Web 2.0) has expanded these possibilities considerably (Greenhow, Robelia, & Hughes, 2009). These developments have led to claims by some scholars that it is now possible for students to participate in extended projects that help them develop sophisticated concepts and skills through the use of simulation and visualization tools (Dede, 2007). Commentators also argue that students can collaborate in developing learning experiences, generating knowledge, and sharing perspectives on experiences with other students.

The aforementioned large-scale crossnational studies also show that schools and classrooms vary in the extent to which teachers use ICT in teaching. Burbules (2007) argues that although e-learning technologies have the potential to bring transformative effects to classrooms, their implementation has been, for various reasons, surprisingly limited (see also Cuban, 2001). The ICILS teacher questionnaire accordingly asks teachers to consider one of their classes (specified in the questionnaire) and to identify (where applicable) the types of ICT applications used in that class, the type of and extent to which ICT is used as part of teaching practices and for particular learning activities in that class, and the emphasis placed on developing ICT-based student capabilities. The questionnaire also asks teachers about their perceptions of whether and how ICT is used as part of collaborative teaching and learning at their school.

Actual student use of ICT in the learning process is another important factor. A segment of the teacher questionnaire therefore asks teachers to report on student involvement in different learning activities involving ICT use. The student questionnaire also asks students to report on how often they use computers at school, their use of computers for different school-related purposes, and the frequency with which they use ICT in their learning of different subjects.

Home context

Antecedent variables related to the home environment

The influence of student home background on students' acquisition of knowledge has been shown in many studies, and there is evidence that home background also influences the learning of ICT skills (MCEECDYA, 2010; Nasah, DaCosta, Kinsell, & Seok, 2010). Factors that have been shown to be associated include parental socioeconomic status, language used at home, ethnicity, and whether or not the student and/or his or her parents have an immigrant background.

A large body of literature shows the influence of students' socioeconomic background on student achievement in a variety of learning areas (see, for example, Saha, 1997; Sirin, 2005; Woessmann, 2004). To assess the socioeconomic status of the students' parents, the ICILS student questionnaire includes questions on the highest educational levels of parents, their occupations, and the number of books at home.

In the questionnaire, highest educational levels achieved by the student's mother and father are defined in accordance with the International Standard Classification of Education (ISCED) (UNESCO, 2006). The occupation of each parent will be recorded through open-ended questions, with occupations classified according to the International Standard Classification of Occupations (ISCO) framework (International Labour Organisation, 2007) and then scored using the International Socio-economic Index (SEI) of occupational status (Ganzeboom, de Graaf, & Treiman, 1992). Home literacy resources will be measured through a question asking students to report the approximate number of books at home.

There is evidence from many countries of considerable disparities in students' access to digital resources in homes, and researchers and commentators claim that these disparities affect the opportunities that students have to develop the capabilities required for living in modern societies (Warschauer & Matuchniak, 2010). ICILS therefore will gather information about the digital resources in students' homes and examine the relationship between resource levels and CIL.

Many studies have found that the cultural and language background of students can be associated with their educational performance (see, for example, Elley, 1992; Kao, 2004; Kao & Thompson, 2003; Stanat & Christinsen, 2006). To measure these aspects of student background, the ICILS student questionnaire includes questions about students' and parents' country of birth as well as about which language is spoken most frequently at home.

Process-related variables related to the home environment

Home environment factors that potentially influence the learning process include the use of ICT in the home context and learning through interaction with family members. The student questionnaire therefore includes questions about the extent to which students have learned about different aspects of ICT use from family and/or friends and how often they use computers at home in general.

Individual context

Antecedent variables at the individual level

Antecedent variables at the level of the individual student consist of basic background characteristics that may influence students' CIL-related knowledge and skills. Relevant factors in this category are age, gender, and educational aspirations.

Although students' knowledge and skills generally increase with age, various researchers who have collected crossnational data from students in the same grade within an education system have found a negative association between age and achievement in some countries. However, as Schulz, Ainley, Fraillon, Kerr, and Losito (2010), amongst others, explain, the underlying cause for this finding tends to be retention and progression policies that lead to the older students in the same grade being those with the lower achievement.

Studies on educational achievement in numerous learning areas have found considerable gender-based differences. In particular, crossnational research on reading literacy has shown larger gender differences in favor of females (Mullis, Martin, Kennedy, & Foy, 2007; OECD, 2010b). Males have traditionally tended to be somewhat more proficient in mathematics and science, but there is some evidence of a declining gender gap in these learning areas (Mullis, Martin, & Foy, 2008; OECD, 2010b). Recent data from two cycles of an Australian assessment of ICT literacy in 2008 and 2011 show significantly higher levels of achievement for females when compared to male students (Australian Curriculum, Assessment, and Reporting Authority [ACARA], 2012; MCEECDYA, 2008).

Individual aspirations with regard to education are a further variable that should be taken into account during any analysis of variation in students' CIL. The ICILS student questionnaire includes a question that asks students to state which level of educational qualification they expect to reach in the future. During analysis of students' answers to this question, categories for this variable will be defined according to the international classification of educational qualifications (ISCED) (UNESCO, 2006) and adapted to national contexts.

Process-related variables at the individual level

These variables consist of attitudinal as well as behavioral factors. Self-beliefs regarding proficiency in using ICT are often viewed as central to the process of learning and are likely to have a reciprocal association with knowledge and skills as well as with the use of ICT applications. It is also important to include student perceptions about responsible and appropriate use of ICT. These perceptions can be seen as intended learning outcomes from teaching CIL. Behavioral variables also relate to using ICT for different purposes and needs, especially in terms of the potential that frequent and varied use of these tools has for facilitating student learning.

The student questionnaire includes items designed to measure the extent to which students express confidence in doing a range of ICT-related tasks. According to Bandura (1993), students' confidence in their ability to carry out specific tasks in an area (self-efficacy) is strongly associated with their performance as well as perseverance, emotions, and later study or career choices. Moos and Azevedo (2009) concluded from their review of research on computer self-efficacy that this variable plays an integral role in learning in computer-based learning environments. The two authors examined factors related to computer self-efficacy and the relationships between computer self-efficacy, learning outcomes, and learning processes. They found a number of positive associations between behavioral and psychological factors and computer self-efficacy. A particular finding was that students who receive behavioral modeling report significantly higher computer self-efficacy than do students taught by more traditional instruction methods.

A related construct is students' self-concept, which reflects students' global judgments about how they perceive their ability to cope with a certain learning area (Branden, 1994; Marsh & Shavelson, 1985). Self-perception has been the basis of several international studies of students' confidence in using ICT (e.g., OECD, 2005). In those studies, overall self-confidence was structured around self-confidence in performing routine tasks, internet tasks, and high-level tasks. The scales used in the studies indicated substantial differences across countries as well as among students in the association between students' self-confidence and the extent and nature of students' experience of ICT. The studies also showed that males tended to express higher levels of self-confidence in using ICT than did females. Findings such as these led to items designed to measure how students rate their ability to cope with computer technology being included in the ICILS student questionnaire.

Enjoyment of a learning area has the potential to facilitate the acquisition of knowledge and skills (Pekrun, Goetz, Titz, & Perry, 2002). Dede, Ketelhut, Clarke, Nelson, and Bowman (2005) observed from their study of an ICT-based project which utilized graphical multiuser virtual environments that both students and teachers were highly engaged, student attendance improved, disruptive behavior dropped, and interesting patterns emerged about which students do best under various teaching conditions. The ICILS student questionnaire will gather data on students' enjoyment of ICT learning by including a question in which students rate their agreement with statements reflecting enjoyment of computing and information technology tasks.

Applying ICT for different purposes on a regular basis has considerable potential to increase knowledge and skills in this area (see, for example, ACARA 2012; Fletcher, Schaffhauser, & Levin, 2012). The ICILS student questionnaire consequently includes questions about the frequency of using different ICT applications, using the internet for social communication, and using ICT for recreational activities.

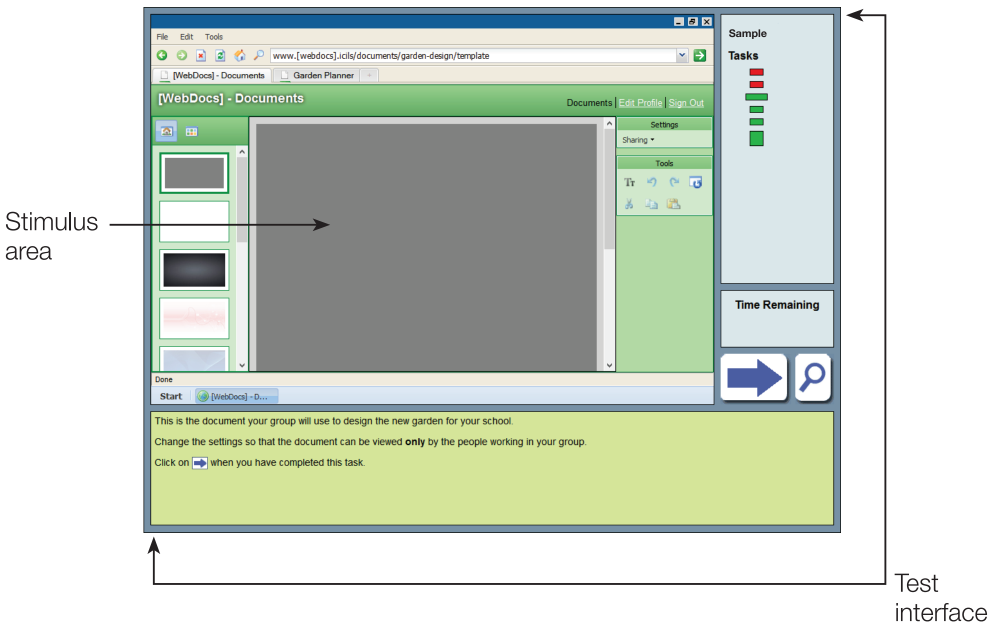
Assessment design

The ICILS test design

Computer-based testing environment

The ICILS test is designed to provide students with an authentic computer-based assessment experience, balanced with the necessary contextual and functional restrictions to ensure that the tests are delivered in a uniform and fair way. In order to maximize the authenticity of the assessment experience, the instrument uses a combination of purpose-built applications and existing live software. Students need to be able to both navigate the mechanics of the test and complete the questions and tasks presented to them. Consequently, the test environment comprises two functional spaces: the test interface and the stimulus area, as illustrated in Figure 3.

Figure 3: Test environment comprised of two functional spaces



Test interface

The test interface serves two purposes. Firstly, it provides information about the test (such as test progress, time remaining, and the text for a question or instructions for a task). Secondly, it provides navigation controls that allow the participant to move between test questions and tasks in much the same way that students would engage with other computer-delivered assessments in another discipline.

Stimulus area

The stimulus area is a space that contains either noninteractive content, such as an image of a login screen for a website, or interactive content, such as electronic texts or live software applications.

The ICILS test instrument

The ICILS test instrument consists of questions and tasks that are delivered in 30-minute modules. In total, there are four test modules, and each participant completes two modules. This rotated module design was chosen to allow for a large number of test items (covering the breadth of the CIL framework and a range of difficulties) to be included in the instrument without the need for each individual student to complete more than two test modules within the allocated time of 60 minutes.

Test modules

A test module is a set of linked questions and tasks contextualized by an authentic theme and driven by a plausible narrative. Each module has a series of five to eight smaller tasks, each of which typically takes students less than one minute to complete, and each of which leads up to a single large task. The large tasks typically take 15 to 20 minutes to complete. The module themes were selected and tasks developed in accordance with the aims of being engaging and relevant to students and of preventing prior content knowledge from privileging subgroups of students.

Table 2 shows the delivery design of the test modules. The design is a fully balanced rotated design comprising 12 different module combinations. Module combinations are randomly assigned to sampled students so that an approximately equal number of students responds to each set within each national sample. The student questionnaire takes 20 minutes to complete and is administered after completion of the second test module. In order to show the entire assessment sequence for each module combination, we have included the student questionnaire in the fourth column of Table 2.

Table 2: Balanced module rotation for student instruments

Module Combination	First Module (30 minutes)	Second Module (30 minutes)	Student Questionnaire (20 minutes)
1	A	B	S
2	A	C	S
3	A	D	S
4	B	C	S
5	B	A	S
6	B	D	S
7	C	A	S
8	C	B	S
9	C	D	S
10	D	A	S
11	D	B	S
12	D	C	S

Types of assessment task

The computer-based assessment of CIL contains three types of task that are integrated in a single testing environment. This section contains details of each of these tasks with illustrative examples.[4] The examples are taken from a module based on the idea of

4 At the time of publication of this framework, all ICILS test tasks are secure. The illustrative examples have been created for use in this framework to accurately represent the types of task formats and content materials used in ICILS.

students working with a group of collaborators to plan the design of a new garden area in their school. The ultimate aim of the module is for students to prepare an information sheet that explains and engenders support for their garden design in the hope that their classmates will vote to have the design used. Creating the information sheet is the large task in the module. The contexts and stimulus materials in the example tasks all relate to the gardening/garden design theme of the module.

Task Type 1: Information-based response tasks

Information-based response tasks use computer technology to deliver pencil-and-paper-like questions in a slightly richer form than in paper-based methods. The stimulus material is typically a noninteractive representation of a computer-based problem or information source. The response formats for these tasks may be multiple-choice, constructed-response, or drag-and-drop ones that use the technology only to display the stimulus material and record participant responses. In these tasks, the computer-based environment is used to capture evidence of students' knowledge and understanding of CIL independently of students using anything beyond the most basic skills required to record a response.

Figures 4 and 5 present two example tasks (shown as Example Tasks 1 and 2) and are accompanied with a brief discussion that illustrates the information-based response task format. Example Task 1 requires students to examine four organizational-structure diagrams for a website and to select the structure that best suits a given set of six pages of content. It relates to Aspect 1.3 (managing information) of the CIL construct. Example Task 2 requires students to read a noninteractive web-page (in this case, with entries from a web-based forum) and to respond using free text in a text entry box in the lower (pale green) section of the test interface.

Figure 4: Example Task 1 (multiple-choice task)

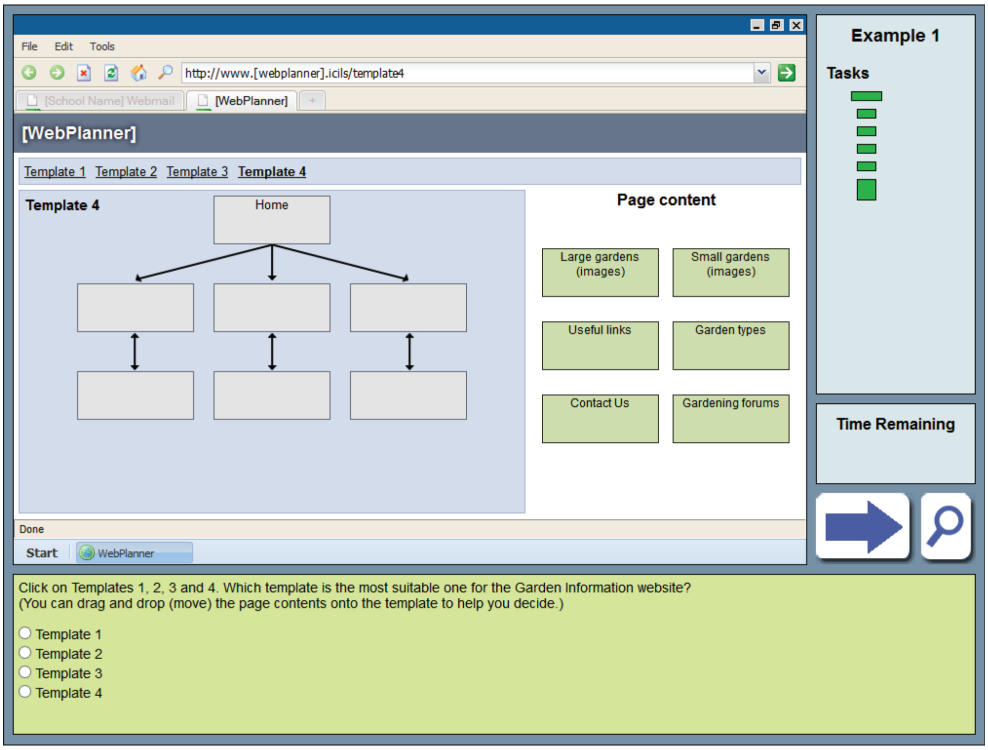
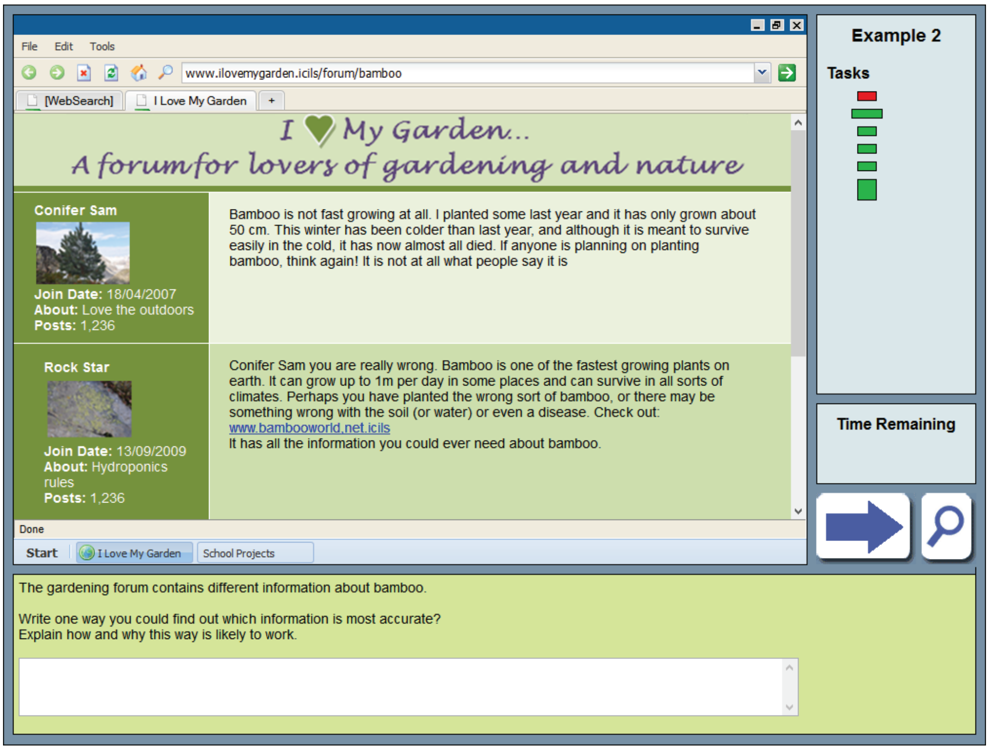


Figure 5: Example Task 2 (open-response task)



The dynamic computer-based environment in Example Task 1 (Figure 4) enables students to view each of the four website structures in turn. The stimulus could also be presented in a static form (i.e., showing all four diagrams together) in a pencil-and-paper test. The simplest multiple-choice tasks in ICILS could also be presented in an equivalent form on paper.

However, because Example Task 1 allows students to drag and drop the web-page contents into each organizational-structure template and thereby "try out" the different information structures in order to support their choice of the best structure, the computer-based stimulus facet of this task extends beyond what could be made easily available in a pencil-and-paper format. The task then enables students to provide their answer through a conventional multiple-choice format (shown in the light-green lower area of the test interface), with one correct response that can be automatically scored.

While the drag and drop functionality in Example Task 1 serves as an aid to determine the correct response, in other ICILS tasks this functionality serves as a method for recording student responses. The ICILS assessment uses the drag-and-drop task format whenever students are required to classify information into groups or to match objects or concepts according to their characteristics.

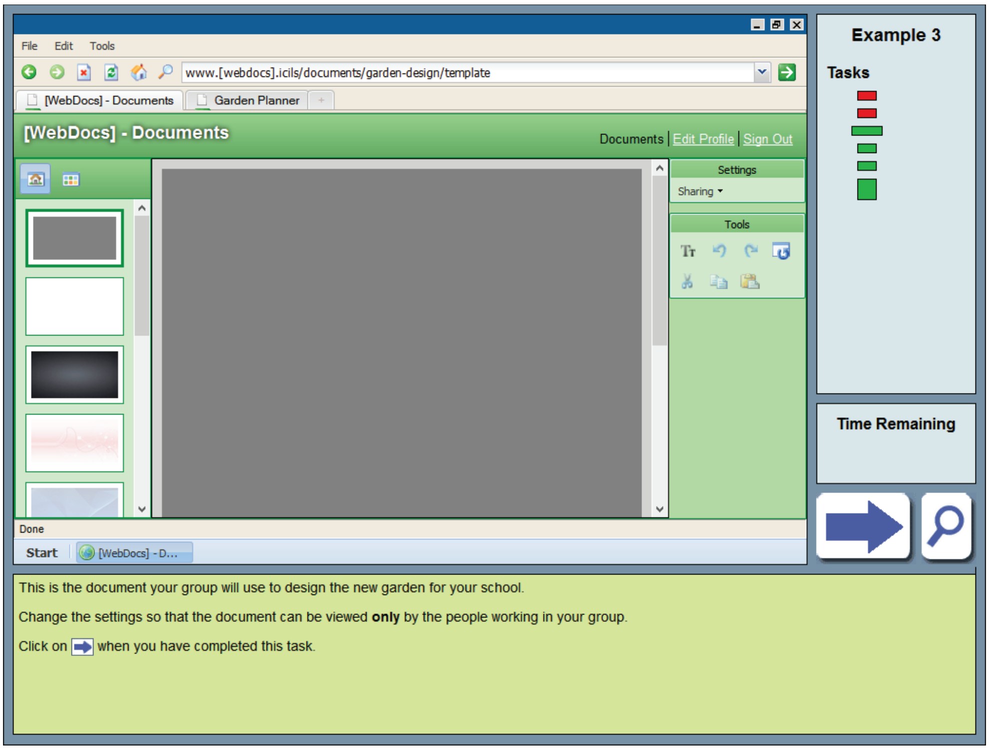
The stimulus material in Example Task 2 (reading web-based material) contains conflicting information presented as two posts on the forum. The task is presented to students as an example of conflicting information and therefore as a vehicle enabling them to see that the accuracy of the web-based information may need to be evaluated. Example Task 2 relates to Aspect 1.2 (accessing and evaluating information) of the CIL construct. Responses to this task are recorded as text fields and scored by scorers according to a pre-defined scoring guide.

Task Type 2: Skills tasks

Skills tasks require students to use interactive simulations of generic software or universal applications to complete an action. These may be single-action tasks (such as copying, pasting, or opening a web-browser) or may contain a sequence of steps (such as "Save As" with a specific file name, or navigation through a menu structure). The tasks allow for all possible "correct" responses to be undertaken and are recorded by the testing software. All that some skills tasks require students to do is to execute given software commands, while others require students to execute commands along with some information processing. Skills tasks are scored automatically.

The ICILS student test contains linear and nonlinear skills tasks. A linear skills task may be as simple as executing a single command (such as opening a file from the desktop), or requiring more than one step to complete the task. All appropriate methods of executing a command (e.g., using the mouse, pull-down menus, or keyboard shortcuts) are scored as equivalent and correct. Linear skills tasks that require the execution of more than one command can only be completed correctly if the commands are executed in a necessary prescribed sequence. For example, if students are instructed to copy and paste an image, they would first need to select the image and then execute the copy and paste commands in that order. Responses are automatically detected and scored once participants have reached an "endpoint" to a task. Figure 6, containing Example Task 3, illustrates a linear skills task.

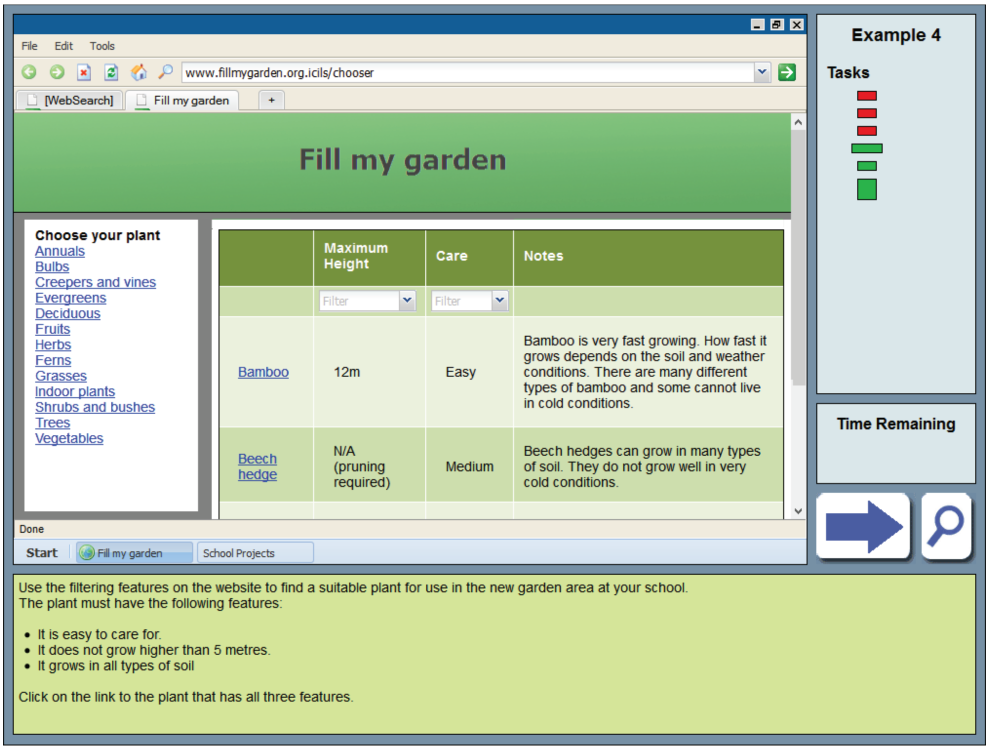
Figure 6: Example Task 3 (linear skills task)



Example Task 3 requires students to change the settings for a document in a collaborative workspace in order to restrict viewing access to specified people. Students must first click on the settings/sharing menu link and then make changes within a dialogue box to restrict the file sharing to their group. Example Task 3 relates to Aspect 1.1 (understanding computer use) of the CIL construct.

Nonlinear skills tasks require students to execute a software command (or reach a desired outcome) by executing subcommands in a number of different sequences. Example Task 4, presented in Figure 7, illustrates a nonlinear skills task. This task requires students to use the filtering functions of a web-based database and to interpret some simple text in order to locate an object (a plant) that matches a given set of characteristics. The task is thus an example of a nonlinear skills task that requires information-processing skills and relates to Aspect 1.3 (managing information) of the CIL construct. The web-based database contains too many objects for a student to search manually with ease. As such, the automatic scoring gives the highest level of credit to students who make use of the filtering functions (in any order) to support their search. Students who identify the correct task without using the filters receive less credit.

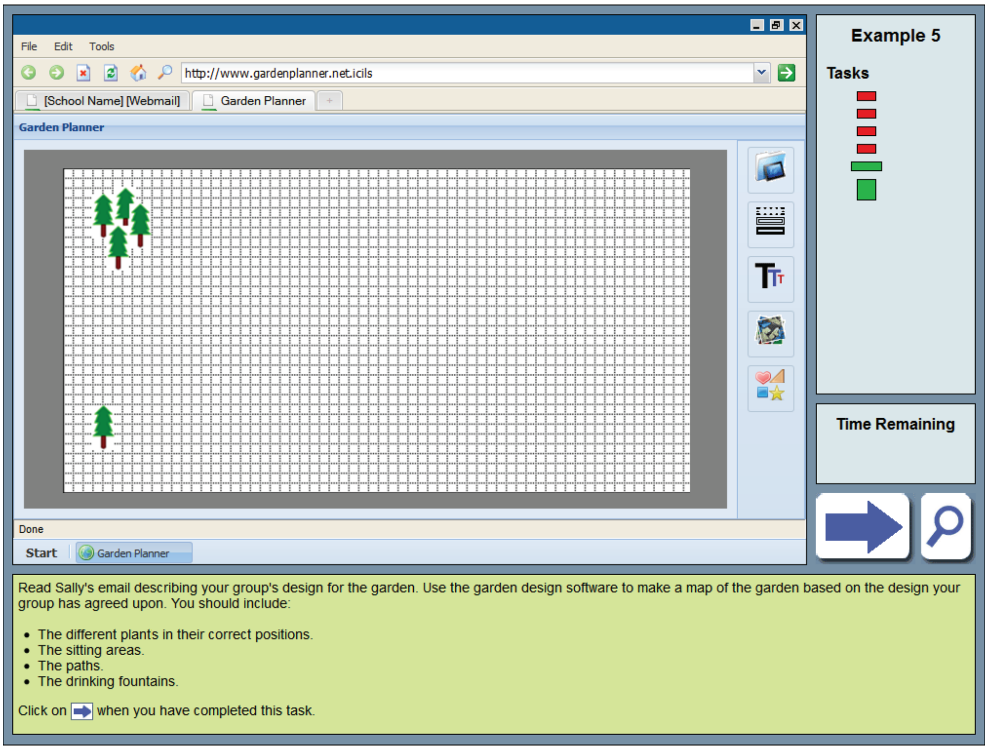
Figure 7: Example Task 4 (nonlinear skills task)



Task Type 3: Authoring tasks

Authoring tasks require students to modify and create information products using authentic computer software applications. The applications, purpose-built for ICILS, adhere to software application conventions, such as the use of standard icons, or typical response types to given commands. This approach may require students to use multiple applications concurrently (such as email applications, web-pages, spreadsheets, and wordprocessing or multimedia software) as one typically does when using computer software to perform authentic, complex tasks. Each student's work is automatically saved as an information product file for subsequent assessment by scorers according to a prescribed set of criteria. Example Task 5 (Figure 8) illustrates a simple authoring task.

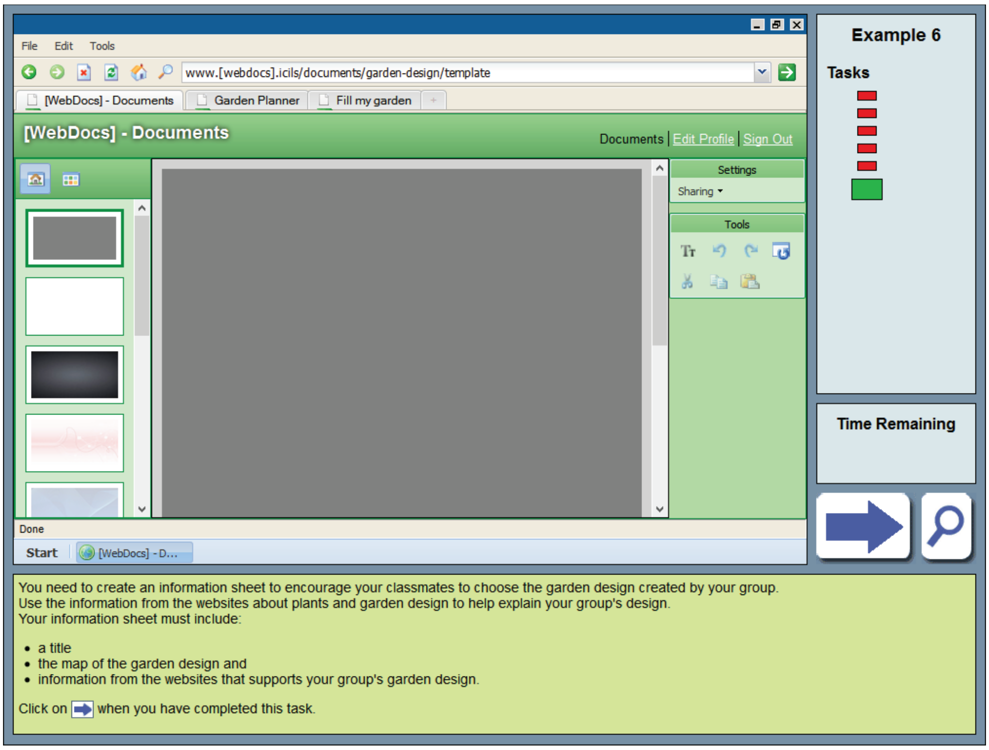
Figure 8: Example Task 5 (simple authoring task)



Example Task 5 requires students to use some simple map-drawing software to create a garden design plan that represents the text describing the plan. It relates to Aspect 2.1 (transforming information) of the CIL construct. The task is a simple authoring task because it asks students to use only the instructions and one piece of software (the mapping software) to complete the task. It is also simple because there is a relatively narrow range of "correct" ways in which the student can draw the garden design to match the text specifications. The task is manually scored according to the accuracy with which the different specified elements of the garden design are shown in the diagram.

The complex authoring task (Task 6) illustrated in Figure 9 requires students to use information from a range of electronic sources to create an information sheet that explains and promotes their garden design. The stimulus is nonlinear, fully interactive, and behaves intuitively. Students can tab between concurrent applications such as the web-browser and presentation software. They can copy and paste text and images between applications and can use the software to design the information sheet. The final information product is saved, stored, and then scored against a set of criteria. The scoring criteria can be categorized as relating to students' use of (1) the software features and (2) the available information.

Figure 9: Example Task 6 (complex authoring task)



Criteria relating to students' use of software features can include ability to use color, text formatting, and general page layout. These criteria typically have an internal hierarchy based on the degree to which the software features are used to support or even enhance the communicative effect of the information product. Criteria relating to students' use of information can also include students' adaptation of information, the relevance (and accuracy) of information selected for and used in the information product, and the appropriateness of selected information for the target audience. Note, though, that the use of information is only assessed with respect to students' use of the information provided to them for use in the module.

The highest level of credit is given to student work that demonstrates ability to use the software features to enhance the communicative effect of the information product. The lowest level of credit is given to pieces of work that show no application of the relevant software feature, or uncontrolled use (such as extremely poor color contrast or overlapping text) that inhibits comprehension of the product. The range of criteria available to evaluate Example Task 6 means that the single task allows for students providing evidence of achievement relating to Aspects 2.1 (transforming information), 2.2 (creating information), and 2.3 (sharing information) of the CIL construct.

Mapping test items to the CIL framework

The test items that comprise the assessment modules are based on the strands and constituent aspects in the assessment framework described earlier. The CIL framework is central to the process of instrument development because it provides a theoretical underpinning for the assessment and a means of describing its content. Table 3 shows the mapping of the test items to the two assessment strands, the constituent aspects, and their levels in the CIL framework.

Table 3: Mapping test items to the CIL framework

CIL Aspect	Total (Items)	Total (Score Points)
Strand 1: Collecting and managing information		
Aspect 1.1: Knowing about and understanding computer use	12	12
Aspect 1.2: Accessing and evaluating information	10	14
Aspect 1.3: Managing information	5	6
Total (Strand 1)	27	32
Strand 2: Producing and exchanging information		
Aspect 2.1: Transforming information	16	23
Aspect 2.2: Creating information	15	23
Aspect 2.3: Sharing information	8	12
Aspect 2.4: Using information securely and safely	14	15
Total (Strand 2)	53	73

We can see from Table 3 that about twice as many items and score points relate to Strand 2 than relate to Strand 1 of the CIL construct. The main reason for this is that the large tasks at the end of each module focus on students' creation of an information product and therefore require each of these tasks to be assessed via multiple criteria with multiple score categories. Assessment of the large tasks focuses on Aspects 2.1 and 2.2, and together these contribute the largest number of associated score points across the four test modules.

The test design of ICILS was not planned to assess equal proportions of all aspects of the CIL construct, but rather to ensure some coverage of all aspects as part of an authentic set of assessment activities in context. The balance of items and score points relating to the different aspects of the CIL construct reflects the balance of time that students are expected to spend completing the different tasks.

The ICILS student questionnaire and context instruments

Student questionnaire

The student questionnaire has been designed primarily to collect data that address Research Questions 3 and 4.

- 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?
- What aspects of students' personal and social backgrounds (such as gender, socioeconomic background, and language background) are related to computer and information literacy?

ICILS will use the data gathered from the student questionnaire for two purposes. Firstly, these data will be used in analyses that examine the relationships between student-level factors and measured CIL. Secondly, these data will be used to provide descriptive information about patterns of computer access and use across and within countries.

The student questionnaire is designed to collect indices of student and home background, namely:

- Age (in years);
- Gender;
- Expected highest level of educational qualifications;
- Immigration background;
- Language used at home (test language or others);
- Mother's and father's highest occupational status;
- Mother's and father's highest level of education;
- Home literacy (number of books at home);
- ICT resources at home; and
- Experience with ICT.

The student questionnaire thus contains questions that will derive indices on students' ICT use and students' attitudes toward ICT:

- Use of computer applications (frequency);
- Use of ICT for social communication (frequency);
- Use of ICT for exchanging information (frequency);
- Use of ICT for recreational purposes (frequency);
- Use of ICT for school-related purposes (frequency);
- Use of ICT in school subject lessons (frequency);
- Reports on learning ICT tasks at school;

- ICT self-efficacy;
- Interest and enjoyment of computer use; and
- Self-concept as related to computer use.

Teacher questionnaire

This questionnaire is concerned with information about teachers' perceptions of ICT in schools and the use that teachers make of ICT in educational activities during their teaching. Together with the questionnaires completed by the school principal and the ICT coordinator, this questionnaire will collect data that address Research Question 2:

> What aspects of schools and education systems are related to student achievement in CIL?

The assumption underlying this question is that the extent to which and the ways in which ICT is used in schools influence the development of students' CIL. Information from the teacher questionnaire will also be used to describe the use of ICT in pedagogy within and across countries and within and across major teaching areas. It will not be possible, within the scope of ICILS, to link teacher-based information to individual students. Rather, this information will be used to generate school-level indicators that will be used, along with student-based data, in two-level multiple regression analyses.

The population for the ICILS teacher survey is defined as all teachers teaching regular school subjects to the students in the target grade (generally Grade 8) at each sampled school. Fifteen teachers will be selected at random from all teachers teaching the target grade at each sampled school.[5] This cluster size is required in order to produce:

- School-level estimates with sufficient precision to be used in analyses that examine associations with student outcomes; and
- Population estimates with a precision level similar to the levels generated from the student data.

The teacher questionnaire consists of questions regarding teachers' background, teachers' familiarity with ICT, their use of ICT when teaching a reference class, and their perceptions of ICT provision and use at school. Teachers will also be asked about their experience of learning to use ICT in teaching.

The teacher questionnaire is therefore designed to generate the following indices about teachers':

- CIL self-efficacy;
- Use of ICT tools in class;
- Reports on student engagement in learning activities with ICT;
- Reports on use of ICT in teaching and learning practices;
- Perceptions of emphasis on ICT skills development in class;
- Positive views regarding the use of ICT in teaching and learning;
- Negative views regarding the use of ICT in teaching and learning;
- Perceptions of impediments to ICT use at school;

5 In small schools, this will mean all teachers of Grade 8 students.

- Participation in ICT professional development; and
- Perceptions of collaborations involving ICT use.

School questionnaires

ICILS has two school questionnaires, each of which complements the other: a principal questionnaire and an ICT coordinator questionnaire. While ICILS intends each questionnaire to be completed by different people in each school, ICILS does provide for the possibility that both may be completed by the same person in a small school where there is no identifiable ICT coordinator.

Principal questionnaire

The principal questionnaire is designed primarily to collect data that address Research Question 2:

> What aspects of schools and education systems are related to student achievement in CIL?

The assumption underlying this research question is that the extent to which and the manner in which ICT is used in schools influence the development of students' CIL. It is expected that principals will provide important perspectives on school practices and policies regarding the pedagogical use of ICT. Another purpose of the principal questionnaire is to collect data that will contribute to a description of the contexts within which ICT is used for pedagogical purposes both in and across the countries participating in ICILS. The ICILS principal questionnaire therefore covers these areas:

- Characteristics of the principal, including his or her use of ICT;
- School characteristics (number of enrolments, range of grades taught, characteristics of the school location, ratio of female to male enrolments);
- Management of ICT in the school;
- Encouragement of ICT use in teaching and learning;
- The school's pedagogical orientations; and
- Provision within the school for professional development in "operating" ICT tools and using ICT for pedagogical purposes.

The questionnaire items are therefore designed to generate the following indices:

- School principals' use of computers for school-related purposes (frequency);
- School size (student enrolment);
- Student–teacher ratio;
- School management (public/private);
- School principals' perceptions of the importance of ICT use at school;
- School principals' reports on expectations of teachers' ICT skills;
- School principals' reports on ICT policies and procedures;
- School principals' reports on teachers' professional development for ICT use; and
- School principals' reports on school priorities for ICT use in teaching and learning.

ICT coordinator questionnaire

The ICT coordinator questionnaire has been designed primarily to collect data that address Research Question 2:

> What aspects of schools and education systems are related to student achievement in CIL?

The assumption underlying Research Question 2 is that the extent to which and the manner in which ICT is used in schools influence the development of students' CIL. It is anticipated that the ICT coordinator will provide important perspectives on school practices and policies regarding the pedagogical use of ICT. An additional purpose for the questionnaire is to provide data that will contribute to a description of the contexts within which ICT is used for pedagogy within and across countries.

The ICT coordinator questionnaire will therefore collect data on the following:

- ICT resources (numbers of computers of different types, availability of computers for student use, availability of other ICT devices, availability of digital learning resources, and networking and internet connectivity);
- ICT use in the school (provision of specialist teaching in ICT, emphasis in curriculum areas, learning management systems, and school administration); and
- ICT technical support (maintenance provision and support for managing resources); and
- Provision for ICT-related professional development at school.

The questions in the ICT coordinator questionnaire are therefore designed to generate two indices:

- The computer–student ratio in the participating schools; and
- The quality of ICT resources in these schools.

National contexts survey

The intention behind the national contexts survey is to collect data that address Research Question 2:

> What aspects of schools and education systems are related to student achievement in CIL?

The assumption underlying this question is that the opportunities students have to use ICT will have an impact on their opportunities to learn about CIL and therefore on the development of their CIL.

Data from the national contexts survey will be used to generate CIL-education profiles in the participating countries. The survey is also designed to provide data on contextual factors, such as the structure of the education system and education policy. This information will facilitate the analysis of differences in CIL education across countries. More specifically, data from the national contexts survey will be used for three broad purposes:

- To generate systematic descriptions of ICT-related policy and practice in school education across the ICILS countries;

- To provide the bases for system-level analyses of differences in CIL across the ICILS countries; and
- To provide systematic data that researchers and other stakeholders can use as a basis for interpreting crossnational differences in the patterns of relationships among factors related to CIL achievement.

Finally, information obtained from the national contexts survey will also be used to supplement the following types of data pertaining to education systems:

- General approaches to the use of ICT in schools;
- Approaches to the development of CIL in schools;
- Availability of and access to ICT resources in schools; and
- The extent to which ICT in teaching and learning is encouraged.

APPENDIX A:

Organizations and individuals involved in ICILS

International study center

The international study center is located at the Australian Council for Educational Research (ACER) and serves as the international study center for ICILS. Center staff at ACER were responsible for designing and implementing the study in close cooperation with the IEA Data Processing and Research Center (DPC) in Hamburg, Germany, and the IEA secretariat in Amsterdam, the Netherlands.

Staff at ACER

Julian Fraillon, *research director*
John Ainley, *project coordinator*
Wolfram Schulz, *assessment coordinator*
Tim Friedman, *project researcher*
Daniel Duckworth, *test development*
Karin Hohlfeld, *test development*
Eveline Gebhardt, *data analyst*

International Association for the Evaluation of Educational Achievement (IEA)

IEA provides overall support in coordinating ICILS. The IEA secretariat in Amsterdam, the Netherlands, is responsible for membership, translation verification, and quality control monitoring. The IEA Data Processing and Research Center (DPC) in Hamburg, Germany, is mainly responsible for sampling procedures and the processing of ICILS data.

Staff at the IEA Secretariat

Hans Wagemaker, *executive director*
Paulína Koršňáková, *senior professional officer and researcher*
Barbara Malak, *manager membership relations*
David Ebbs, *research officer (translation verification)*
Alana Yu, *publications officer*
Jur Hartenberg, *financial manager*
Isabelle Gemin, *financial assistant*

Staff at the IEA Data Processing and Research Center (DPC)

Dirk Hastedt, *co-director*
Ralph Carstens, *co-project manager*
Michael Jung, *co-project manager*
Sabine Meinck, *researcher (sampling)*

SoNET Systems

SoNET Systems was responsible for developing the software systems underpinning the computer-based student assessment instruments. This work included development of the test and questionnaire items, the assessment delivery system, and the web-based translation, scoring, and data-management modules.

Staff at SoNET Systems

Mike Janic, *managing director*
Stephen Birchall, *general manager of software development*
Erhan Halil, *senior analyst programmer*
Rakshit Shingala, *analyst programmer*
Stephen Ainley, *quality assurance*
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PAC has, from the beginning of the project, advised the international study center and its partner institutions during regular meetings.

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Jean Dumais from Statistics Canada in Ottawa is the sampling referee for the study. He has provided invaluable advice on all sampling-related aspects of the study.

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The national research coordinators (NRCs) played a crucial role in the development of the project. They provided policy- and content-oriented advice on the development of the instruments and are responsible for the implementation of ICILS in the participating countries.

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APPENDIX B:

Hypothetical progress map for CIL

The ICILS research team developed the following hypothetical progress map for CIL in order to achieve the following:

1) Support readers' understanding of the nature of the contents of the CIL construct operationalized through the ICILS student test; and
2) Support readers' understanding of how progress in CIL achievement has been conceptualized for the purpose of framing ICILS and developing the CIL test instrument.

The levels and broad nature of progress described in the progress map are based on an empirically derived map of ICT literacy progress established using data from over 6,000 Grade 6 and Grade 10 students who completed module-based assessment tasks underpinned by a similar assessment design to that of ICILS (see Australian Curriculum, Assessment, and Reporting Authority, 2012). The contents of the progress map have been adapted to represent the two strands and to include examples of task types that reflect the aspects of the CIL construct.

The empirical student achievement data, together with the contents of the ICILS student test, are used here in order to describe the empirically based CIL achievement scale that will be used after the ICILS data collection in 2013.

Hypothetical progress map for CIL

Level	Strand 1: Collecting and managing information	Strand 2: Producing and exchanging information
5	Students working at Level 5 evaluate the credibility of information from electronic sources and select the most relevant information to use for specific communicative purposes. They create structures for simple databases and file-management systems and evaluate the efficacy of simple data structures. Thus, students working at Level 5 can, for example: • Select and include information from electronic resources in an information product to suit an explicit communicative purpose; • Explain how the features of a web-based text such as hyperbole or extreme bias contribute to the credibility of the text; • Identify some of the frequent "hooks" used in phishing and other common web-based deceptions such as unsubstantiated requests for information, or extraordinary claims or offers; • Apply specialized software and file-management functions such as using the history function on a web-browser to return to a previously visited page or sorting data in a spreadsheet according to a specified criterion; • Specify field parameters that can be used to organize data relevant to their content; • Suggest ways an existing database or file system could be reorganized to make it more efficient.	Students working at Level 5 create information products that show evidence of planning and technical competence. They use software features to reshape and present information consistent with presentation conventions. They design information products that combine different elements and accurately represent their source data. They use available software features to enhance the appearance of their information products. Students show awareness of the power of information and the contexts in which information sharing can be socially constructive or destructive. Thus, students working at Level 5 can, for example: • Create an information product in which the information flow is clear and logical and the tone and style are consistent and appropriate for a specified audience; • Use graphics and text-software-editing features such as font formats, color, and animations consistently within an information product to suit a specified audience; • Create tables and charts that accurately represent data and include them in an information product with text that refers to their contents; • Give examples of social contexts in which information can be used to disseminate socially significant information; • Explain how communication networks can be used to promulgate misinformation and suggest ways of protecting against these actions.

Hypothetical progress map for CIL (contd.)

Level	Strand 1: Collecting and managing information	Strand 2: Producing and exchanging information
4	Students working at Level 4 generate well-targeted searches for electronic information sources, select relevant information from within sources to meet a specific purpose, and suggest strategies for checking the veracity of information sources. They recognize and make use of metadata when retrieving and managing files. Thus, students working at Level 4 can, for example: • Independently select and use appropriate software and/or hardware to suit specific tasks, purposes, and social contexts; • Independently modify the settings for an individual task using a peripheral device, such as a printer that can print on both sides of a page; • Suggest ways that the veracity of web-based information can be confirmed; • Use fields that provide the identifying characteristics of data needed to search, sort, and retrieve information from within a database (such as an electronic media manager or a web-based catalogue); • Identify the features/uses of common file types according to their extensions (such as .doc, .xls, .gif.); • Generate searches that target relevant resources for a specified purpose; • Select sections relevant to a given purpose from within electronic resources.	Students working at Level 4 create information products with simple linear structures and use software commands to edit and reformat information products in ways that demonstrate some consideration of audience and communicative purpose. They create information products in which the flow of information is clear and the tone is controlled to suit a specified audience. They recognize that shared information can be tailored to suit and can have different effects on different audiences. They also recognize that there are risks associated with sharing information with others, and can suggest ways of minimizing these risks. Thus, students working at Level 4 can, for example: • Select and apply graphics and text-software-editing features such as font formats, color, and image placement consistently across a simple information product; • Combine mixed-media resources such as graphics, text, audio, and video; • Use software to draw graphs of tables of data to demonstrate patterns; • Create a flow chart to represent a decisionmaking system; • Identify security risks associated with internet data and explain the importance of respecting and protecting the intellectual property rights of authors; • Suggest ways of using software to present a given set of information for different audiences; • Suggest the different potential size and breadth of an audience for information presented using different electronic communication systems; • Identify ways of minimizing undesirable access or use of electronically shared information, and use software options and parameters to restrict access or limit use.

Hypothetical progress map for CIL (contd.)

Level	Strand 1: Collecting and managing information	Strand 2: Producing and exchanging information
3	Students working at Level 3 demonstrate some autonomy when using computers as information-gathering and management tools. They generate simple general search questions and select the best information source to meet a specific purpose. They retrieve information from given electronic sources to answer specific concrete questions and manage files effectively within simple organizational structures. Thus, students working at Level 3 can, for example: • Recognize the role of the server and clients on a computer network; • Retrieve information from a database such as a library catalogue; • Recognize the purpose of including usernames and passwords to access files on shared networks; • Create a meaningful organizational system for a set of files based on their type and/or content; • Recognize the key features of an “operating system”; • Recognize the difference between the “save” and “save as” commands; • Identify that two different search terms relating to the same topic can result in different numbers of “matches” on a search engine.	Students working at Level 3 assemble information in a provided simple linear order to create information products. They follow instructions to use conventionally recognized software commands to edit and reformat information products. They recognize that communication with ICT has responsibilities for users and offers the potential for misuse. Thus, students working at Level 3 can, for example: • Use graphics and text-software-editing features to manipulate aspects such as color, image size, and placement in simple information products; • Apply templates or styles, when instructed, to improve the appearance and layout of documents and text; • Assemble a liner sequence of video clips with simple transitions; • Apply simple animations to objects to demonstrate a process or dynamic action; • Suggest different contexts in which different electronic communications systems may be most appropriate; • Identify some of the responsibilities of contributors to collaborative online projects or information resources such as wikis and review sites; • Recognize the potential for ICT misuse through information sharing and communications networks such as plagiarism and deliberate identity concealment as well as suggest measures to protect against them.

Hypothetical progress map for CIL (contd.)

Level	Strand 1: Collecting and managing information	Strand 2: Producing and exchanging information
2	Students working at Level 2 use computers as tools to complete very basic and explicit information-gathering and management tasks. They locate simple, explicit information from within a given electronic source, recognize common computer conventions, and demonstrate basic knowledge of how computers function as tools. Thus, students working at Level 2 can, for example: • Recognize that file extensions such as .txt or .gif represent the type of information stored in a file; • Add a web-page to a list of favorites (bookmarks) in a web-browser; • Recognize that computers "run" programs that can be used to complete a range of functions; • Click on buttons in a web-page that have links to explicitly stated information; • Recognize that information in a working document can only be retrieved if the file is "saved;" • Recognize that individual files must each have a different name when saved to the same location in a directory tree; • Move a file from one folder to another in a simple directory tree; • Select the most relevant search term from a set of possible terms.	Students working at Level 2 use computers to add content to and make simple changes to existing information products when instructed. They edit information products and create products that show limited consistency of design and information management. Students identify the efficiency of immediate communication with multiple parties using communications software and recognize common communications conventions. Thus, students working at Level 2 can, for example: • Make changes to some presentation elements in an information product; • Apply simple software reformatting functions such as copying and pasting information across columns in a spreadsheet; • Use a drawing tool to copy and repeat design elements and create patterns; • Send emails to groups of users or establish "friends" on a social networking site; • Recognize differences between the To, Cc and BCc functions in email, or different classifications of "friends" on social networking software; • Recognize appropriate email greetings and sign-offs when communicating with different people.

Hypothetical progress map for CIL (contd.)

Level	Strand 1: Collecting and managing information	Strand 2: Producing and exchanging information
1	Students working at Level 1 demonstrate a functional working knowledge of computers as tools to complete tasks. They implement the most commonly used file-management and software commands when instructed. They recognize the most commonly used ICT terminology and functions. Thus, students working at Level 1 can, for example: • Apply basic file and computer management functions such as opening and dragging and dropping files on the desktop; • Apply generic software commands such as the "save as" and "paste" function or select all the text on a page; • Recognize basic computer use conventions such as identifying the main parts of a computer and that the "shut-down" command is a safe way to turn off a computer; • Recognize different types of commonly used software such as wordprocessors, internet search engines, and web-browsers; • Recognize the function of some computer peripheral devices such as USB drives, DVD drivers, and printers.	Students working at Level 1 perform basic communication tasks using computers and software. They recognize different software communications systems and can compile text and messages using the most basic features of these systems. Thus, students working at Level 1 can, for example: • Apply graphics-manipulation-software features such as adding and moving predefined shapes to reproduce the basic attributes of a simple image; • Apply commonly used text formatting commands such as "bold" or "italic" to modify the appearance of fonts; • Recognize the difference between communication systems such as email, instant messaging, blogs, and social networking software; • Prepare an email by inserting an address and subject; • Identify that the appearance and layout of text and graphics can influence the communicative efficacy of an electronic text.

References

Ainley, J., Enger, L., & Searle, D. (2009). Students in a digital age: Implications for teaching and learning. In J. Voogt and G. Knezek (Eds.), I*nternational handbook of information technology in primary and secondary education* (pp. 63–80). Heidelberg, Germany: Springer.

Amtmann, R., & Poindexter, S. (2008). Literacy in information and communication technology: Standards and practices of secondary schools. *The International Journal of Learning*, *15*(5), 281–290.

Ananiadou, K., & Claro, M. (2009). *21st century skills and competences for new millennium learners in OECD countries* (OECD Education Working Papers, No. 41). Paris, France: OECD Publishing.

Anderson, R., & Ainley, J. (2010). Technology and learning: Access in schools around the world. In B. McGaw, E. Baker, & P. Peterson (Eds.), *International encyclopaedia of education* (3rd ed., pp. 21–33). Amsterdam, the Netherlands: Elsevier.

Anderson, R., & Dexter, S. (2009). National policies and practices in ICT in education: United States of America. In T. Plomp, R. Anderson, N. Law, & A. Quale (Eds.), *Cross-national information and communication technology policies and practices in education* (2nd ed., pp. 697–715). Charlotte, NC: Information Age Publishing.

Audunson, R., & Nordlie, R. (2003). Information literacy: The case or non-case of Norway? *Library Review*, *52*(7), 319–325.

Australian Curriculum, Assessment, and Reporting Authority (ACARA). (2012). *National Assessment Program—ICT literacy: Years 6 & 10 report*. Sydney, NSW, Australia: Author.

Bakia, M., Murphy, R., Anderson, K., & Trinidad, G. E. (2011). *International experiences with technology in education: Final report*. Washington, DC: U.S. Department of Education.

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist*, *28*(2), 117–148.

Bawden, D. (2001). Information and digital literacies: A review of concepts. *Journal of Documentation*, *57*(2), 218–259.

Bennett, S., Maton, K., & Kervin, L. (2008). The "digital natives" debate: A critical review of the evidence. *British Journal of Educational Technology*, *39*(5), 775–786.

Binkley, M., Erstad, E., Herman, J., Raizen, S., Ripley, M., Miller-Ricci, M., & Rumble, M. (2012). Defining 21st century skills. In P. Griffin, B. McGaw, and E. Care (Eds.), *Assessment and teaching of 21st century skills* (pp. 17–66). Dordrecht, the Netherlands: Springer.

Blurton, C. (1999). *New directions in ICT use in education*. Paris, France: UNESCO.

Boekhorst, A. K. (2003). Becoming information literate in the Netherlands. *Library Review*, *52*(7), 298–309.

Branden, N. (1994). *The six pillars of self-esteem*. New York, NY: Bantam Books.

Burbules, N. (2007). E-lessons learned. *National Society for the Study of Education 2007 Yearbook*, *106*(2), 207–216.

Cartelli, A. (2009). Frameworks for digital literacy and digital competence assessment. In D. Remenyi (Ed.), *Proceedings of the 8th European Conference on e-Learning* (ECEL 2009) (pp. 116–123). Bari, Italy: University of Bari.

Catts, R., & Lau, J. (2008). *Towards information literacy indicators*. Paris, France: UNESCO.

Charalambos, V., & Glass, G. (2007). Teacher professional development and ICT: Strategies and models. *National Society for the Study of Education 2007 Yearbook*, *106*(2), 87–102.

Christ, W. G., & Potter, W. J. (1998). Media literacy: Symposium. *Journal of Communication*, *48*(1), pp. 5–15.

Church, A. (1999). The human–computer interface and information literacy: Some basics and beyond. *Information Technology and Libraries*, *18*(1), 3–21.

Crook, C. (2008). Theories of formal and informal learning in the world of Web 2.0. In S. Livingstone (Ed.), *Theorising the benefits of new technology for youth* (pp. 30–37). Oxford, UK: Oxford University Press.

Cuban, L. (2001). *Oversold and underused: Computers in the classroom*. Cambridge, MA: Harvard University Press.

Dede, C. (2007). Reinventing the role of information and communications technologies in education. *National Society for the Study of Education 2007 Yearbook*, *106*(2), 11–38.

Dede, C., Ketelhut, D. J., Clarke, J., Nelson, B., & Bowman, C. (2005). *Students' motivation and learning of science in a multi-user virtual environment*. Paper presented at the 2009 annual meeting of the American Educational Research Association, Montréal, Québec, Canada.

Dutta, S., & Mia, I. (Eds.). (2011). *The global information technology report 2010: 2011 transformations 2.0*. Geneva, Switzerland: World Economic Forum.

Educational Testing Service (ETS). (2002). *Digital transformation: A framework for ICT literacy*. Princeton, NJ: Author. Available online at http://www.ets.org/Media/Tests/Information_and_Communication_Technology_Literacy/ictreport.pdf

Elley, W. B. (1992). *How in the world do students read?* The Hague, the Netherlands: International Association for the Evaluation of Educational Achievement (IEA).

Erstad, O. (2006). A new direction? Digital literacy, student participation and curriculum reform in Norway. *Education and Information Technologies*, *11*(3/4), 415–429.

Erstad, O. (2010). Conceptions of technology literacy and fluency. In P. Peterson, E. Baker, & B. McGaw (Eds.), *International encyclopedia of education* (3rd ed., pp. 31–41). Oxford, UK: Elsevier.

European Commission. (2008). *Digital Literacy European Commission working paper and recommendations from Digital Literacy High-Level Expert Group*. Brussels, Belgium: Author. Retrieved from http://www.ifap.ru/library/book386.pdf

European Commission. (2009a). *Indicators of ICT in primary and secondary education (IIPSE)*. Brussels, Belgium: Author.

European Commission. (2009b). *Benchmarking digital Europe 2011–2015: A conceptual framework*. Brussels, Belgium: Author.

European Commission. (2013). *Digital agenda for Europe: A Europe 2020 initiative*. Brussels, Belgium: Author. Retrieved from http://ec.europa.eu/digital-agenda/en/our-goals/pillar-vi-enhancing-digital-literacy-skills-and-inclusion

Ferrari, A. (2012). *Digital competence in practice: An analysis of frameworks*. Seville, Spain: Institute for Prospective Technological Studies, European Commission. Retrieved from http://www.ifap.ru/library/book522.pdf

Fletcher, G., Schaffhauser, D., & Levin, D. (2012). *Out of print: Reimagining the K–12 textbook in a digital age*. Washington, DC: State Educational Technology Directors Association (SETDA).

Ganzeboom, H. B. G., de Graaf, P. M., & Treiman, D. J. (1992). A standard international socioeconomic index of occupational status. *Social Science Research*, *21*(1), 1–56.

Greenhow, C., Robelia, B., & Hughes, J. (2009). Learning, teaching, and scholarship in a digital age: Web 2.0 and classroom research. What path should we take now? *Educational Researcher*, *38*(4), 246–259.

Griffin, P., McGaw, B., & Care, E. (2012). *Assessment & teaching of 21st century skills*. Dordrecht, the Netherlands: Springer.

Homann, B. (2003). German libraries at the starting line for the new task of teaching information literacy. *Library Review*, *52*(7), 310–318.

Institute of Education Sciences, National Center for Education Statistics. (2012). *National Assessment of Educational Progress (NAEP) technology and engineering literacy (TEL) assessment*. Washington, DC: Author. Retrieved from http://nces.ed.gov/nationsreportcard/tel/

International Labour Organisation (ILO). (2007). *International Standard Classification of Occupations: ISCO-2008*. Geneva, Switzerland: Author.

International Society for Technology in Education (ISTE). (2007). *National educational technology standards for students* (2nd ed.). Eugene, OR: Author.

International Telecommunications Union. (2012). *Measuring the information society*. Geneva, Switzerland: Author.

Jago, C. (2009). *A history of NAEP assessment frameworks*. Washington, DC: National Assessment Governing Board (ERIC Document Reproduction Service No. ED509382). Available online at http://www.nagb.org/content/nagb/assets/documents/who-we-are/20-anniversary/jago-frameworks-formatted.pdf

Janssen, J., & Stoyanov, S. (2012). *Online consultation on experts' views on digital competence*. Seville, Spain: European Commission Joint Research Centre.

Kao, G. (2004). Social capital and its relevance to minority and immigrant populations. *Sociology of Education*, *77*, 172–183.

Kao, G., & Thompson, J. S. (2003). Racial and ethnic stratification in educational achievement and attainment. *Annual Review of Sociology*, *29*, 417–442.

Korte, W., & Husig, T. (2006). *Benchmarking access and use of ICT in European schools 2006*. Bonn, Germany: Empirica Association for Communications and Technology Research. Retrieved from www.empirica.com/publikationen/documents/No08-2006_learnInd.pdf

Koutropoulos, A. (2011). Digital natives: Ten years after. *MERLOT Journal of Online Learning and Teaching*, *7*(4). Available online at http://jolt.merlot.org/vol7no4/koutropoulos_1211.htm

Kozma, R. (Ed.). (2003). *Technology, innovation, and educational change: A global perspective*. Eugene, OR: International Society for Technology in Education (ISTE).

Kozma, R. (2008). Comparative analyses of policies for ICT in education. In J. Voogt & G. Knezek (Eds.), *International handbook of information technology in education* (pp. 1083–1096). Berlin, Germany: Springer Science.

Lampe, C., Resnick, P., Forte, A., Yardi, S., Rotman, D., Marshall, T., & Lutters, W. (2010). Educational priorities for technology-mediated social participation. *IEEE Computer*, *43*(11), 60–67.

Law, N., Pelgrum, W., & Plomp, T. (2008). *Pedagogy and ICT use in schools around the world: Findings from the IEA SITES 2006 Study*. Hong Kong SAR: Comparative Education Research Centre, University of Hong Kong.

Lemke, C. (2003). Standards for a modern world: Preparing students for their future. *Learning and Leading with Technology*, *31*(1), 6–9.

Livingstone, S., Van Couvering, E., & Thumim, N. (2008). Converging traditions of research on media and information literacies. In J. Corio, M. Knobel, C. Lankshear, and D. Leu (Eds.), *Handbook of research on new literacies* (pp. 103–132). New York, NY: Lawrence Erlbaum Associates.

Marcum, J. (2002). Rethinking information literacy. *Library Quarterly*, *72*(1), 1–26.

Markauskaite, L. (2007). Exploring the structure of trainee teachers' ICT literacy: The main components of, and relationships between, general cognitive and technical capabilities. *Education Technology Research Development*, *55*(6), 547–572.

Marsh, H., & Shavelson, R. (1985). Self concept: Its multifaceted hierarchical nature. *Educational Psychologist*, *20*(3), 107–123.

Ministerial Council for Education, Early Childhood Development, and Youth Affairs (MCEECDYA). (2008). *National assessment program: ICT literacy Years 6 & 10 report 2008*. Carlton South, VIC, Australia: Curriculum Corporation. (ERIC Document ED534805)

Ministerial Council on Education, Employment, Training, and Youth Affairs (MCEETYA). (2005). *National assessment program: ICT literacy Years 6 and 10 report*. Carlton South, VIC, Australia: Curriculum Corporation. Available online at http://www.nap.edu.au/verve/_resources/2005_ICTL_Public_Report.pdf

Ministry of Education of the City of Buenos Aires. (2013). *El plan S@rmiento*. Buenos Aires, Argentina: Author. Retrieved from http://sarmientoba.buenosaires.gob.ar/?menu_id=34179 (in Spanish).

Ministry of Education of Uruguay. (2013). *Plan Ceibal* [website]. Retrieved from www.ceibal.org.uy (in Spanish).

Moos, D., & Azevedo, R. (2009). Learning with computer-based learning environments: A literature review of computer self-efficacy. *Review of Educational Research*, *79*(2), 576–600.

Mullis, I., Martin, M., & Foy, P. (2008). *TIMSS 2007 international mathematics report. Findings from IEA's Trends in International Mathematics and Science Study at the fourth and eighth grades.* Chestnut Hill, MA: Boston College.

Mullis, I., Martin, M., Kennedy, A., & Foy P. (2007). *PIRLS 2006 international report: IEA's Progress in International Reading Literacy Study in primary schools in 40 countries.* Chestnut Hill, MA: Boston College.

Nasah, A., DaCosta, B., Kinsell, C., & Seok, S. (2010). The digital literacy debate: An investigation of digital propensity and information and communication technology. *Educational Technology Research and Development*, *58*(5), 531–555.

Ofcom. (2006). *Media literacy audit: Report on media literacy amongst children.* London, UK: Author.

Office of Educational Technology, US Department of Education. (2010). *Transforming American education: Learning powered by technology (US National Education Technology Plan 2010).* Washington, DC: Author. Available online at http://www.ed.gov/sites/default/files/netp2010.pdf

Organisation for Economic Co-operation and Development (OECD). (2005). *Are students ready for a technological world? What PISA studies tell us.* Paris, France: Author.

Organisation for Economic Co-operation and Development (OECD). (2010a). *PISA computer-based assessment of student skills in science.* Paris, France: OECD Publications.

Organisation for Economic Co-operation and Development. (2010b). *PISA 2009 results: What students know and can do.* Paris, France: OECD Publications.

Organisation for Economic Co-operation and Development (OECD). (2011). *PISA 2009 results: Students on line: Vol. 6. Digital technologies and performance.* Paris: OECD Publications.

Partnership for 21st Century Skills. (n. d.). *Partnership for 21st century skills: A framework for 21st century learning.* Washington, DC: Author. Retrieved from http://www.p21.org/

Pedersen, S. G., Malmberg, P., Christensen, A. J., Pedersen, M., Nipper, S., Græm, C. D., & Norrgård, J. (Eds.). (2006). *E-learning Nordic 2006: The impact of ICT on education.* Copenhagen, Denmark: Ramboll Management. Available online at http://www.oph.fi/download/47637_eLearning_Nordic_English.pdf

Pekrun, R., Goetz, T., Titz, W., & Perry, R. P. (2002). Academic emotions in students' self-regulated learning and achievement: A program of qualitative and quantitative research. *Educational Psychologist*, *37*(2), 91–105.

Pelgrum, W. J., & Doornekamp, B. D. (2009). *Indicators on ICT in primary and secondary education.* Brussels, Belgium: European Commission, Directorate General Education and Culture. (IIPSE: EACEA-2007-3278/001-001)

Peters, J. (2004). *Learning outcomes and information literacy.* London, UK: Society of College, National and University Libraries.

Plomp, T., Anderson, R. E., Law, N., & Quale, A. (Eds.). (2009). *Cross national policies and practices on information and communication technology in education* (2nd ed.). Greenwich, CT: Information Age Publishing.

Prensky, M. (2001). Digital natives, digital immigrants Part 1. *On the Horizon*, *9*(5), 1–6.

Qualifications and Curriculum Authority. (2007). *About information and communication technology: Assessment guidance.* London, UK: Author. Retrieved from http://web.archive.org/web/20040815054520/http://www.qca.org.uk/7889.html

Richter, T., Naumann, J., & Groeben, N. (2000). The Computer Literacy Inventory (INCOBI): An instrument for the assessment of computer literacy and attitudes toward the computer in university students of the humanities and the social sciences. *Psychologie in Erziehung und Unterricht*, *48*(1), 1–13.

Saha, L. J. (1997). Introduction: The centrality of the family in educational processes. In L. J. Saha (Ed.), *International encyclopedia of the sociology of education* (pp. 587–588). Oxford/New York/ Tokyo: Elsevier.

Scalise, K., Timms, M., Moorjani, A., Clark, L., Holtermann, K., & Irvin, P. S. (2011). Student learning in science simulations: Design features that promote learning gains. *Journal of Research in Science Teaching*, *48*(9), 1050–1078.

Scheerens, J. (1990). School effectiveness and the development of process indicators of school functioning. *School Effectiveness and School Improvement*, *1*(1), 61–80.

Scheerens, J., & Bosker, R. J. (1997). *The foundations of educational effectiveness*. Oxford, UK: Pergamon.

Schulz, W., Ainley, J., Fraillon, J., Kerr, D., & Losito, B. (2010). *ICCS 2009 international report: Civic knowledge, attitudes, and engagement among lower-secondary school students in 38 countries*. Amsterdam, the Netherlands: International Association for the Evaluation of Educational Achievement (IEA).

Schulz, W., Fraillon, J., Ainley, J., Losito, B., & Kerr, D. (2008). *International Civic and Citizenship Education Study assessment framework*. Amsterdam, the Netherlands: International Association for the Evaluation of Educational Achievement (IEA).

Selwyn, N. (2009). The digital native: Myth and reality. *Aslib Proceedings: New Information Perspectives*, *61*(4), 364–379.

Severin, E., & Capota, C. (2011). *Modelos uno a uno en América Latina y el Caribe*: *Notas técnicas* [One to one models in Latin America and the Caribbean: Technical notes]. Washington, DC: Banco Interamericano de Desarrollo. Retrieved from https://docs.google.com/file/d/0B4s6u5p7MmBDMTRkYjA0NGYtZWZlNS00NDJjLTk1NGYtZTQ0MjdjOWRjNDYx/edit?hl=es

Severin, E., Santiago, A., Ibarrarán, P., Thompson, J., & Cueto, S. (2011). *Evaluación del programa "Una laptop por niño" en Perú: Resultados y perspectivas. Aporte n°13, diciembr*e [Evaluation of "One laptop per child" in Peru: Results and perspectives. Contribution No. 13, December]. Washington, DC: Banco Interamericano de Desarrollo. Retrieved from http://idbdocs.adb.org/wsdocs/getdocument.aspx?docnum=36750488

Sirin, S. R. (2005). Socioeconomic status and academic achievement: A meta-analytic review of research. *Review of Educational Research*, *75*(3), 417–453.

Stanat, P., & Christensen, G. (2006). *Where immigrant students succeed: A comparative review of performance and engagement in PISA 2003*. Paris, France: OECD Publications.

Sturman, L., and Sizmur, J. (2011). *International comparison of computing in schools*. Slough, UK: National Foundation for Educational Research (NFER).

Tamin, R., Bernard, R., Borokhovski, E., Abrami, P., & Schmid, R. (2011). What forty years of research says about the impact of technology on learning: A second-order meta-analysis and validation study. *Review of Educational Research*, *81*(1), 4–28.

Thomson, S., & De Bortoli, L. (2007). *PISA 2003: ICT use and familiarity at school and home* (ACER Research Monograph No. 62). Melbourne, VIC, Australia: Australian Council for Educational Research (ACER).

Travers, K. J., Garden, R. A., & Rosier, M. (1989). Introduction to the study. In D. F. Robitaille & R. A. Garden (Eds.), *The IEA Study of Mathematics II: Contexts and outcomes of school mathematics curricula*. Oxford, UK: Pergamon Press.

Travers, K. J., & Westbury, I. (1989). *The IEA Study of Mathematics I: Analysis of mathematics curricula*. Oxford, UK: Pergamon Press.

Tyner, K. (1998). *Literacy in a digital world: Teaching and learning in the age of information*. Mahwah, NJ: Lawrence Erlbaum Associates.

United Nations Development Programme (UNDP). (2009). *Indicators: Human development report 2009.* New York, NY: Author. Retrieved from http://hdrstats.undp.org/en/indicators

United Nations Education Scientific and Cultural Organisation (UNESCO). (2003). *The Prague Declaration: Towards an information literate society*. Paris, France: Author.

United Nations Education, Scientific and Cultural Organisation (UNESCO). (2006). *ISCED 1997: International standard classification of education* (rev. ed.). Paris, France: UNESCO-UIS.

U.S. Department of Education. (2010). *National Education Technology Plan*. Washington, DC: Author. Available online at http://www.ed.gov/technology/netp-2010

van den Beemt, A. (2010). *Interactive media practices of young people: Origins, motives, background and patterns.* Oesterwijk, the Netherlands: Uitgeverij BOXPress. Retrieved from http://igitur-archive.library.uu.nl/dissertations/2010-1118-200300/beemt.pdf

Virkus, S. (2003). Information literacy in Europe: A literature review. *Information Research: An International Electronic Journal*, *8*(4), 329–345. Available online at http://informationr.net/ir/8-4/paper159.html

Warschauer, M., & Matuchniak, T. (2010). New technology and digital worlds: Analyzing evidence of equity in access, use, and outcomes. *Review of Research in Education*, *34*, 179–225.

WestEd. (2010). *Technology and engineering literacy framework for the 2014 National Assessment of Educational Progress pre-publication edition.* Retrieved from http://www.edgateway.net/cs/naepsci/download/lib/249/prepub_naep_tel_framework.pdf?x-r=pcfile_d

Wilkinson, K. (2006). Students' computer literacy: Perception versus reality. *Delta Pi Epsilon Journal*, *48*(2), 108–120.

Woessmann, L. (2004). *How equal are educational opportunities? Family background and student achievement in Europe and the United States* (IZA Discussion Papers 1284). Bonn, Germany: Institute for the Study of Labor (IZA).

ICILS 2013

This document outlines the framework and assessment design for the International Computer and Information Literacy Study (ICILS) sponsored by the International Association for the Evaluation of Educational Achievement (IEA). Over the past 50 years, IEA has conducted comparative research studies focusing on educational policies, practices, and outcomes in more than 80 countries.

Information technologies are a pervasive feature of modern societies. Knowing about, and knowing how to use, these technologies have become essentials of the modern era. The purpose of ICILS is to investigate, in a range of countries, the ways in which young people are developing computer and information literacy (CIL) to support their capacity to function in the digital age. This document defines the knowledge, understanding, and skills that make up CIL, postulates aspects of the contexts in which CIL develops in young people, and embeds these in a conceptual framework which underpins the ICILS study design. This document also outlines innovative and authentic computer-based assessment methods which are used in the study.

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