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International Computer and Information Literacy Study

The International Computer and Information Literacy Study (ICILS) measures international differences in students' computer and information literacy and computational thinking. It is commissioned by the International Association for the Evaluation of Educational Achievement (IEA).

Origins and context

The IEA was founded in 1958. It has evolved from a collective of research bodies into a professional organisation with a secretariat based in Amsterdam, the Netherlands, and a centre devoted to data processing and research based in Hamburg, Germany. Beyond this professional organisation, IEA has over 70 members that are governmental and non-governmental educational research institutions from countries in Africa, Asia, Australasia, Europe, the Middle East and the Americas. Most of the members represent national education systems. IEA also maintains funding and non-funding partnerships (IEA, n.d.-a).[1]

According to IEA's founders, the different education systems across the world together form a kind of educational laboratory, and comparative research into these different systems can reveal important relationships between inputs and outcomes, relationships that would not necessarily be detected if any one system were studied in isolation (IEA, 2014).

IEA studies seek to understand the processes and products of education by administering cognitive assessments and collecting background data to examine the *intended curriculum*, the *implemented curriculum* and the *attained curriculum* (IEA, n.d.-a). The intended curriculum is concerned with the national, social and educational contexts. It covers what is described in curriculum policies and publications, and how the education system is structured to facilitate the learning that is described in these policies and publications. The implemented curriculum is concerned with the school, teacher and classroom contexts. It covers what is actually taught in the classrooms and how it is taught, including the characteristics of the individuals who are teaching. The attained curriculum is concerned with the learning outcomes and characteristics of students. It covers what students learn, what they think about what they learn, and their backgrounds (Mullis & Martin, 2013).

This three-aspect concept of the curriculum has been used in many of the 30 comparative research studies IEA has conducted since its inception.

ICILS builds on previous studies on computer literacy conducted by the IEA. In 1989 and 1992 IEA undertook the Computers in Education Study (COMPED). IEA followed this with the Second Information Technology in Education Study (SITES) in 1998–1999 (Module 1), 2001 (Module 2), and 2006, which assessed the infrastructure, goals, and practices for Information and Communications Technology (ICT) education in twenty-six countries.

Early definitions of computer literacy focussed on operating hardware and software. Whereas ICILS blends technological expertise with information literacy and communication. This includes using the internet to search for and evaluate information (Fraillon, Ainley, Schulz, Duckworth, & Friedman, 2019a).

The first cycle of ICILS was in 2013, with 21 education systems participating. This was then followed up in

1 Some of IEA's recent funding partnerships have been with the European Commission, the Ford Foundation, the Inter-American Development Bank, the United Nations Development Program and the World Bank. Its non-funding partnerships include those with the Educational Testing Service (ETS), UNESCO's International Institute for Educational Planning (IIEP UNESCO), Organization of Ibero-American States (OEI), Partnership for Educational Revitalization in the Americas (PREAL), Programme d'Analyse des Systémes Educatifs CONFEMEN (PASEC), Statistics Canada, the Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ), and the West African Examinations Council (WAEC) (European Commission, 2014; IEA, n.d.-a).

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2018 with 14 education system (12 countries and two benchmarking entities) and a third cycle, ICILS 2023 is in progress.

Purpose

ICILS aims to answer the question – how well are students prepared for study, work, and life in a digital world? It investigates students' ability to use computers to investigate, create and communicate information to participate at home, school, the workplace and the community (IEA, n.d.-b). Additionally, ICILS investigates to what extent, and how, computer technologies are used by students and teachers, along with their associated attitudes. ICILS enables countries to monitor their own national targets regarding students' digital competences, as well as enabling them to compare their performance with other countries. Ultimately, the study provides information to policy-makers so that they can improve computer and information literacy (Fraillon et al., 2019a).

Measurement objectives

The most recent ICILS assessment framework (2018) builds on the conceptual foundation of the previous assessment framework (2013), incorporating developments in technology, education policy and pedagogy, likely to influence computer and information literacy.

Assessment domains

The core ICILS assessment domain is computer and information literacy (CIL). ICILS 2018 defines CIL as:

> *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. (Fraillon et al., 2019a)*

To ensure that ICILS was applicable across education systems, the CIL assessment framework is not based on curriculum content, but rather learning that crosses curriculum. The CIL assessment domain has four strands, which are the categories that frame the skills and knowledge. Within each category are two aspects, which refer to knowledge, skills, and understandings. Each strand and associated aspect is presented in Table 1.

In ICILS 2018, all countries were offered the option of also assessing computational thinking (CT). This was in response to increased interest from researchers, educators, and policymakers in the importance of CT,

Table 1: Computer and information literacy assessment domain of ICILS 2018

Strand 1 Understanding computer use	Strand 2 Gathering information	Strand 3 Producing information	Strand 4 Digital communication
Aspect 1.1 Foundations of computer use	**Aspect 2.1** Accessing and evaluating information	**Aspect 3.1** Transforming information	**Aspect 4.1** Sharing information
Aspect 1.2 Computer use conventions	**Aspect 2.2** Managing information	**Aspect 3.2** Creating information	**Aspect 4.2** Using information responsibly and safely

Table 2: Computational thinking assessment domain of ICILS 2018

Strand 1 Conceptualising problems	Strand 2 Operationalising solutions
Aspect 1.1 Knowing about and understanding digital systems	**Aspect 2.1** Planning and evaluating solutions
Aspect 1.2 Formulating and analysing problems	**Aspect 2.2** Developing algorithms, programs and interfaces
Aspect 1.3 Collecting and representing relevant data	

who recognised its growing utility (Fraillon et al., 2019a). Computational thinking is defined as:

> *An individual's ability to recognize aspects of real-world problems which are appropriate for computational formulation and to valuate and develop algorithmic solutions to those problems so that the solutions could be operationalized with a computer. (Fraillon et al., 2019a)*

The CT assessment domain comprises of two strands, with one strand containing three aspects and the other two aspects, as shown in Table 2.

ICILS 2018 also investigates how computational thinking is related to computer and information literacy.

The data for both the CIL and CT assessment domains are measured via a computer-based student tests, which consists of questions and tasks set in authentic contexts.

Contextual information

To better understand the variance of outcomes related to students CIL and CT, contextual factors are considered. The contextual factors are distinguished according to the following levels: the individual, home and peer environments, schools and classrooms, and wider community.

The individual level refers to the individual characteristics of the student, which might influence students' CIL related knowledge and skills. This includes the student's age, gender and educational aspirations. It also includes behavioural factors such as students' use of digital devices, and attitudinal factors, such as a student's confidence in using ICT. (Fraillon et al., 2019a)

The home level comprises factors related to the student's background characteristics. This includes: socioeconomic status, language used at home, ethnicity. It also includes the use of ICT in the home and the extent that they have learned about ICT from family and friends. (Fraillon et al., 2019a)

The schools and classrooms level comprises factors related to the instruction students receive, the school culture, and the general school environment. It particularly includes the level of ICT resourcing and the extent the school prioritises its use in learning. Information about teachers is also collected, including their skills and attitudes toward ICT. Due to CIL/CT learning pertaining across curricular, it is not useful to distinguish between the classroom and school level. (Fraillon et al., 2019a)

The wider community level comprises the context in which CIL/CT learning takes place, which encompasses local, regional, national and international contexts. At the local context, remoteness and access to internet facilities is particularly pertinent to CIL/CT learning. The regional and national contexts includes: communication infrastructure, education systems, curricula, and general socio-economic factors. The international context is focused on the general development of ICT, such as the availability of new technology (Fraillon et al., 2019a)

The contextual data is collected via the following instruments: student questionnaire, teacher questionnaire, school ICT coordinator questionnaire, school principal questionnaire, and national contexts survey (completed by staff at ICILS national research centres).

Target population and sampling methodology

The target population of ICILS is students in their eighth year of schooling, so long as the average age of students in this grade is 13.5 years or older (Fraillon et al., 2019a). The appropriate grade for participation is adjusted for education systems based on the target age. A representative sample of this age cohort is identified to participate in the study.

The population for the ICILS teacher survey includes all teachers who teach school subjects to the target grade, during the testing period, and have been employed at school from the beginning of the school year (Fraillon et al., 2019a). This population reflects that CIL is often seen as a whole school responsibility, even though there can be designated information technology subjects.

A stratified two-stage probability cluster design is applied. Schools are selected randomly proportional to size (PPS). The IEA, in collaboration with each national research centre, selects the school samples. To identify appropriate schools, the IEA sampling team asks national centres to provide a list of schools with students enrolled in the target grade, which is checked for plausibility against official statistics. (Meinck, 2019)

Within each sampled school, a minimum of 20 students are randomly selected from among all students enrolled in the target grade, and up to 15 teachers. In each participating education system, 150 schools are selected with a sample size of about 3,000 students. (Meinck, 2019)

Some participating countries/benchmarking entities sample more than 20 students per sampled school, either to obtain a larger student sample or to enable the better estimation of school-level effects. A participating country/benchmarking entity may also be required to sample more than 150 schools if the standard class size is particularly small or if high levels of non-response are expected (Meinck, 2019).

The inclusion of all participants included in the target population is encouraged, participants are permitted to

reduce the population coverage by making school-level and student-level exclusions for political, organisational and operational reasons, providing these exclusions do not exceed set limits.

Assessment administration

The Australian Council for Educational Research (ACER) serves as the ICILS international study centre. ACER is responsible for designing and implementing the study, cooperating with the IEA and the national centres of participating countries (IEA, n.d.-b).

As the assessment is focussed on computer use, it is conducted using computers. The teacher and school questionnaires are available in paper and digital formats. Providing and collecting the questionnaires from students is the responsibility of the test administrators, who manages the activities on the day of test. (Jung & Carstens, 2019)

Within a participating country/benchmarking entity, after schools have been sampled, the national research centre is responsible for identifying and training school coordinators. The school coordinators are tasked with providing the national research centre with information for within-school sampling of classes; identifying and training test administrators; organising the time and place for test administration; distributing instrument and maintaining the security of assessment materials. Both the school coordinators and the test administrators are supported in their work by manuals that are developed by the ICILS International Study Centre (Jung & Carstens, 2019).

Since ICILS is a comparative international survey, the assessment must be standardised across countries/ benchmarking entities. Guides are provided to countries/benchmarking entities in translating and adapting test items from the source language to the target language(s). The translations are externally reviewed, with the verification process overseen by the IEA in collaboration with the ICILS international study centre. After translation and verification, participating countries/benchmarking entities are expected to follow further standard, internationally agreed-upon procedures to complete the preparation of their materials (Ebbs & Friedman, 2019).

In addition to the preparation of online test materials, other assessment activities, including test administration, scoring, and data entry and processing, must also be standardised as much as possible. To achieve this, ICILS has developed and documented procedures, protocols, software and training, and also initiated an independent quality assurance program (Koršnáková & Ebbs, 2019).

Reporting and dissemination

ICILS results are reported in international reports prepared by ACER. Reports include separate chapters on background information about the study, the assessment results, analysis of contextual data and reflections about the study. (Fraillon, Ainley, Schulz, Duckworth, & Friedman, 2019b)

The means and distributions of student achievement of participating countries/benchmarking entities are reported on. The proficiency that students showed in the test of CIL is reported on a scale with a mean of 500, which is divided into proficiency levels: "below level 1" (less than 407 score points), "level 1" (407 to 492 score points), "level 2" (492 to 576 score points), "level 3" (from 576 to 661 score points) "level 4" (661 score points and more). The higher the level, the more advanced the proficiency. In 2018, computational thinking was reported in three proficiency bands. Students scoring within a given level have correctly answered at least half of the items that are mapped to that level of difficulty. (European Commission, 2014)

The ICILS scale levels are also as detailed proficiency descriptions. These descriptions of what scale levels mean in terms of knowledge and skills are developed by the ICILS International Study Center, along with the item review experts through data analysis and conceptual analysis of the assessment items.

ICILS international reports, technical reports, assessment frameworks and other documentation for all cycles can be downloaded from the IEA website.[2] The international databases for all cycles, and user guides – along with the IEA IDB Analyser software application, which facilitates the analysis and visualisation of data – can also be downloaded from the IEA website.[3]

Influence

ICILS was developed in response to the increasing use of ICT in modern society, and the need for people to have the capabilities necessary to participate effectively in a digital world (Fraillon et al., 2019b). ICILS can support countries develop and achieve national targets regarding students' digital competence, via monitoring students digital competence and comparing results across countries.

A particular example of ICILS influence has been the use of ICILS results by the European Commission (EC). The EC has stated that ICILS is a valuable source of evidence and information to inform policy dialogue between the EC and Member States (European Commission, 2014). Furthermore, the

2 https://www.iea.nl/studies/iea/icils/2018#section-559

3 https://www.iea.nl/data-tools/repository/icils

EC acknowledges that ICILS will inform European digital education working groups, the 2020 Education and Training strategy and be used to develop frameworks for digital competencies in education (European Commission, 2014).

Based on findings from ICILS 2013, the EC affirmed that increased policy efforts are required to encourage teachers to use ICT in their teaching practices (European Commission, 2014). In achieving this, the EC recommended providing targeted professional development for teachers related to integrating ICT in pedagogy. The EC also recommended reforming institutional structures to encourage more collaboration amongst teachers (European Commission, 2014). The EC will continue to use ICILS to monitor progress in digital competence and to inform policy development.

References

Ebbs, D., & Friedman, T. (2019). Translation and Verification of ICILS 2013 Instruments. In J. Fraillon, J. Ainley, W. Schulz, D. Duckworth, & T. Friedman (Eds.), ICILS 2013 Technical Report. Amsterdam, The Netherlands: The International Association for the Evaluation of Educational Achievement.

European Commission. (2014). *The International Computer and Information Literacy Study (ICILS): Main findings and implications for education policies in Europe*. Retrieved from

Fraillon, J., Ainley, J., Schulz, W., Duckworth, D., & Friedman, T. (2019a). *IEA International Computer and Information Literacy Study 2018: Assessment Framework*. Retrieved from Amsterdam, The Netherlands:

Fraillon, J., Ainley, J., Schulz, W., Duckworth, D., & Friedman, T. (2019b). *Preparing for Life in a Digital World: IEA International Computer and Information Literacy Study 2018 International Report*. Retrieved from Amsterdam, The Netherlands:

IEA. (2014). IEA: Brief history. Retrieved from http://www.iea.nl/brief_history.html

IEA. (n.d.-a). *About Us [Pamphlet]*. Retrieved from http://www.iea.nl/fileadmin/user_upload/IEA_Documents/IEA_Brochure.pdf

IEA. (n.d.-b). ICILS. Retrieved from https://www.iea.nl/studies/iea/icils

Jung, M., & Carstens, R. (2019). ICILS Field Operations. In J. Fraillon, J. Ainley, W. Schulz, D. Duckworth, & T. Friedman (Eds.), *ICILS 2013 Technical Report*. Amsterdam, The Netherlands: The International Association for the Evaluation of Educational Achievement.

Koršnáková, P., & Ebbs, D. (2019). Quality Assurance of the ICILS Data Collection. In J. Fraillon, J. Ainley, W. Schulz, D. Duckworth, & T. Friedman (Eds.), *ICILS 2013 Technical Report*. Amsterdam, The Netherlands: The International Association for the Evaluation of Educational Achievement.

Meinck, S. (2019). Sampling Design and Implementation In J. Fraillon, J. Ainley, W. Schulz, D. Duckworth, & T. Friedman (Eds.), *ICILS 2013 Technical Report*. Amsterdam, The Netherlands: The International Association for the Evaluation of Educational Achievement.

Mullis, I. V. S., & Martin, M. O. (Eds.). (2013). *TIMSS 2015 Assessment Frameworks*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College and International Association for the Evaluation of Educational Achievement (IEA).