Eighth Graders’ Competency in Computer and Information Literacy and Computational Thinking - Key Findings from ICILS 2018 (Supplement)

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This document appears as supplementary material in connection with the Luxembourg National Education Report 2021 – specifically as a translation of the following article:

Computer- und informationsbezogene Kompetenzen (CIL) und Kompetenzen im informatischen Denken (CT) von Achtklässler*innen. Zentrale Ergebnisse der ICILS 2018
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Suggested citation for this document:
Boualam, R., Lomos, C., & Fischbach, A. (2022). *Eighth Graders’ Competency in Computer and Information Literacy and Computational Thinking - Key Findings from ICILS 2018 (Supplement)*. Luxembourg Centre for Educational Testing (LUCET) & Service de la Recherche et de l’Innovation pédagogiques (SCRIPT). https://doi.org/10.48746/BB2021LU-EN-26

The "Luxembourg National Education Report 2021" is published in German and French and can be accessed at the following link:

www.bildungsbericht.lu

Eighth Graders' Competency in Computer and Information Literacy and Computational Thinking

Key Findings from the ICILS 2018

Abstract

In spring 2018, Luxembourg participated for the first time in the ICILS study (International Computer and Information Literacy Study) conducted by the International Association for the Evaluation of Educational Achievement (IEA). In the present chapter, we focus on the key ICILS 2018 results for Luxembourg's students. Specifically, we place the national ICILS performance in an international comparison, and analyze national differences in levels of competency due to student characteristics such as gender, and socio-cultural and socio-economic background. Moreover, we investigate differences in competency related to educational tracks in Luxembourg. From a perspective of student proficiency, the principal conclusions from Luxembourg's first participation in the ICILS are fourfold: (1) For competency in Computer and Information Literacy (CIL) as well as in Computational Thinking (CT), eighth grade students from Luxembourg perform well below the study's international average. (2) Computer and information literacy and computational thinking performance in Luxembourg are substantially influenced by students' background characteristics, and most notably by their socio-economic background. (3) Differences in CIL and CT levels between academic tracks are substantial, and always in favor of the more prestigious track(s). (4) Girls outperform boys in computer and information literacy. In sum, Luxembourg's first participation in the ICILS mirrors old conclusions, but for new competencies.

1. The International Computer and Information Literacy Study (ICILS)

In spring 2018, Luxembourg participated for the first time in the International Computer and Information Literacy Study (ICILS) conducted by the IEA, the International Association for the Evaluation of Educational Achievement (Fraillon, Ainley, Schulz, Friedman, & Duckworth, 2019). At the heart of this large-scale assessment study lie standardized tests of eighth graders' Computer and Information Literacy and Computational Thinking competency (Fraillon, Ainley, Schulz, Duckworth, & Friedman, 2019). Computer and Information

Literacy[1] (CIL) is defined as an individual's ability to use computers to investigate, create, and communicate information in order to participate effectively at home, at school, in the workplace, and in society. CIL comprises four sub-areas: understanding computer use, gathering information, producing information, and digital communication.

The competence area of Computational Thinking refers to an individual's ability to recognize aspects of real-world problems that are appropriate for computational formulation, and to evaluate and develop algorithmic solutions to those problems so that the solutions could be operationalized with a computer. CT comprises two sub-areas: conceptualizing problems and operationalizing solutions.

Educational systems and schools are the cornerstone of the digital transition, as they are responsible for training and educating pupils and students in new digital skills for future job profiles. The necessary learning will not be possible without a mastery of IT tools, hence the relevant choice of the ICILS study to measure competence in Computer and Information Literacy. The evaluation of computer thinking is also important, because it measures the ability of students to identify and solve a problem using algorithms. As a computer cannot function on its own, the development of computer thinking for the automation of solutions to new challenges will enable societies and economies to benefit fully from new discoveries and innovations.

The importance and interest in mastering these two new skills has been further amplified as a result of the COVID-19 pandemic. Indeed, the crisis has forced everyone to make intensive, increased, and unprecedented use of communication and information technologies (ICTs), making the level of ICT skills—more so for computer and information literacy than for computational thinking—a key factor in the ability to adapt to this sudden change. Clearly, this health crisis has been an accelerator for the transition to a digital age that has become inevitable.

The ICILS 2018 encompasses individual student data from 46,561 eight graders (or equivalent) from 2,226 schools, located in twelve countries (and two additional benchmarking regions). The student data is complemented by data from 26,530 teachers from the respective schools, as well as by contextual data collected from the schools' ICT coordinators, school principals, and national policymakers. Eight of the participating countries, including Luxembourg, participated in the optional computational thinking competence test. Luxembourg participated

[1] For a detailed description of the two test domains and more information on the proficiency and competence levels, please see the IEA's ICILS 2018 report at: https://www.iea.nl/publications/study-reports/preparing-life-digital-world

with an entire cohort of eighth graders (children aged 13 to 14), amounting to 5,401 students from 38 schools. The fully representative national student data is complemented by data for 494 teachers from 28 schools.

The present chapter focuses on the key ICILS 2018 results for Luxembourg students. A second chapter in the National Education Report further analyzes the national ICILS results, but this time from the teachers' perspective (see Lomos et al. in this volume).

2. Luxembourg's Students in International Comparison

Figures 1 and 2 show the participating countries' mean competency scores for computer and information literacy and computational thinking. Both competency tests share a metric with a mean of 500 points and a standard deviation of 100 points (see Fraillon, Ainley, Schulz, Duckworth, & Friedman, 2019). With 482 points for computer and information literacy, and 460 points for computational thinking, Luxembourg scores substantially below the ICILS 2018 average score.

--insert Figure 1 and Figure 2--

3. Competency Differences due to Student Characteristics

In Luxembourg—as in most countries—student performance is (highly) influenced by the relevant characteristics, such as gender, and socio-cultural and socio-economic background (e.g., Muller et al., 2015; Boehm et al., 2016; Hadjar et al., 2015, 2018; Hornung et al., 2013; Ugen et al., 2010). In all the participating countries, girls outperform boys in computer and information literacy; in Luxembourg, they do so by 23 points. By comparison, in computational thinking, boys outperform girls in almost all the countries. In Luxembourg, boys lead by six points in computational thinking. In all the countries, and on both competencies, natives outperform immigrants; this is thus also the case for Luxembourg. Similar findings apply to the differences between students from more and less privileged households: in Luxembourg, as well as in all the other countries, students with a higher socio-economic background systematically outperform their less privileged peers (Karpiński, Biagi, & Di Pietro, 2021).

In order to disentangle the influence of these various student characteristics and investigate which variable is most defining of students' computer and information literacy and computational thinking competencies in Luxembourg, we performed statistical regression analyses on the Luxembourg ICILS data. In other words, we regressed computer and information literacy and computational thinking scores (separately) on student gender (girls vs. boys), immigration background[2] (natives vs. non-natives), and socio-economic background (upper quartile vs. lower quartile of the highest household ISEI, in line with Ganzeboom, 2010).

Figures 3 and 4 show the results. We see that for both competencies, if all three variables (i.e., gender, socio-cultural background, and socio-economic background) are considered, the socio-economic context is the factor that has the greatest effect on student performance. For computer and information literacy, a student from a privileged background will score on average 63 points more than a student from a disadvantaged background. This difference is even greater for the computational thinking competency, at 85 points (i.e., almost one standard deviation). When socio-economic status and gender are statistically controlled for, natives outperform their peers who have an immigration background, by on average 14 points for computer and information literacy, and eight points for computational thinking. Lastly, even when controlling for socio-cultural and socio-economic background, girls retain a 23 points advantage over boys for computer and information literacy, and boys still outperform girls by five points for computational thinking.

--insert Figure 3 and Figure 4—

4. Competency Differences between Educational Tracks

Similar to many other countries, Luxembourg has a performance tracked secondary school system (e.g., Keller et al., 2013, 2015). On average, students in the classical track (ESC) obtain computer and information literacy and computational thinking scores above the international average of 500 points (see Figures 5 and 6). Students in the general/technical stream (ESG) score below the 500 points international mean on average for both competencies. They also obtain on average 65 points less than students in the ESC stream for computer and information literacy, and 83 points less for computational thinking. At 78 points for computer and information literacy and 78 for computational thinking, the gap is even larger between ESG students and students in the preparatory stream (PREP). Moreover, the latter average is 118

[2] Please note that we performed the same analyses based on the language spoken at home (Luxembourgish vs. other) instead of immigration background. The results were very similar.

points for computer and information literacy and 150 for computational thinking (i.e., 1.5 standard deviations) lower than the international average for the participating countries.

- insert Figure 5 and Figure 6 --

5. New Study, New Competencies, Old Conclusions

From the perspective of students' proficiency, the principal conclusions from Luxembourg's first participation in the ICILS 2018 are fourfold: (1) For competency in computer and information literacy and in computational thinking, eighth graders from Luxembourg perform below the study's international average. (2) Computer and information literacy and computational thinking performance in Luxembourg are substantially influenced by the students' background characteristics, and most notably by their socio-economic background. (3) Differences between academic tracks in terms of computer and information literacy and computational thinking are substantial, and always in favor of the more prestigious tracks. (4) Girls outperform boys in computer and information literacy, whereas boys outperform girls in computational thinking.

For the informed reader, the three first aforementioned conclusions may not be very surprising. In fact, the principal conclusions from the ICILS 2018 are perfectly aligned with the principal conclusions that can be drawn from the general, by now two decades strong, empirical body of knowledge on the national education system (Fischbach et al., 2016; Martin et al., 2013, 2015b). In other words, Luxembourg's performance—or rather underperformance—in computer and information literacy and computational thinking is perfectly aligned with the picture drawn by the OECD's Programme for International Student Assessment (e.g., SCRIPT & LUCET, 2016; OECD, 2019) and/or the National School Monitoring Programme Épreuves Standardisées (e.g., Martin et al., 2015a; https://dashboard.epstan.lu/) for more "classical" academic competencies, such as mathematics, reading, or scientific literacy. The dramatic systematic inequalities—mainly due to students' socio-economic background—are also nothing new, nor are the considerable track differences. It goes without saying that the systematic underperformance, as well as the track differences, could be largely explained by the substantial socio-economic disparities (Boualam, 2020).

In reality, computer and information literacy and computational thinking were barely (if at all) present in the pre-ICILS national curriculum (Fraillon, Ainley, Schulz, Duckworth, & Friedman, 2019). One could and should not expect top-notch computer and information literacy and/or computational thinking skills from Luxembourg's students if nobody has taught them these skills. The country's infrastructure with respect to ICT is better than the international average, not to say excellent—which is among the conclusions of the ICILS—but that alone is apparently, and unsurprisingly, not a sufficient condition for the development of strong computer and information literacy and computational thinking competency. That said, ICT was not completely absent in the pre-ICILS national curriculum. ICT courses did—and still do—exist, but primarily in the general/technical stream (ESG). Consequently, one could have expected a different pattern (as opposed to the more traditional disciplines: e.g., Keller et al., 2013, 2015) when comparing educational tracks regarding computer and information literacy and computational thinking outcomes.

Our last conclusion may be the most interesting one. In the entire empirical body of knowledge about national education, girls never systematically outperform boys in any of the so-called STEM (science, technology, engineering, and mathematics) fields (see e.g., Hornung et al., 2013). Although the relative success of girls in the 2018 ICILS's computer and information literacy assessment is not a Luxembourg specificity,[3] it nonetheless calls for a deeper investigation on a national level, as we might be able to capitalize on this success in STEM education in general, and in ITC education in particular.

To conclude, from the perspective of students' proficiency, Luxembourg's first participation in the ICILS confirms old conclusions, but for new competencies. Importantly, the ICILS 2018 also represents an ideal baseline to monitor and evaluate the recent post-ICILS 2018 efforts to introduce ITC in the national curriculum.

[3] A part of the explanation may lie in the CIL assessment itself, which was more text heavy than the CT test (https://www.iea.nl/publications/study-reports/preparing-life-digital-world).

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Fig*. *1*. *Average CIL scores per country

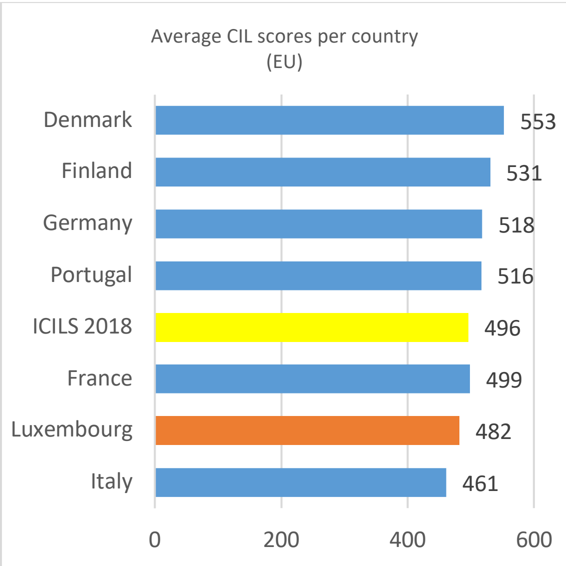
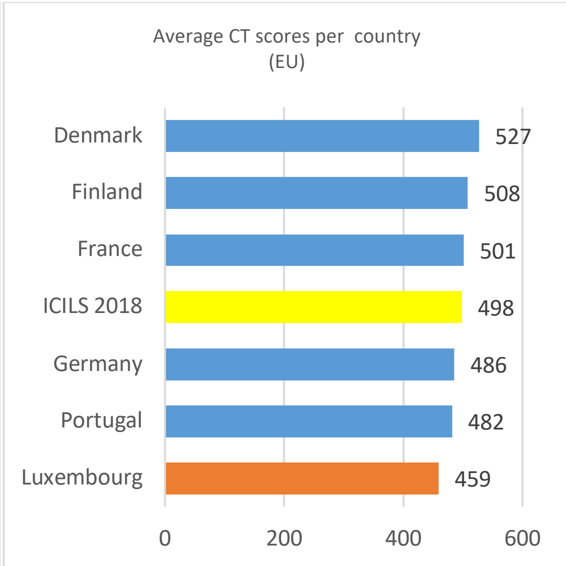


Fig*. *2*. *Average CT scores per country



Notes: For reasons of relevance and comparability, we present the scores obtained by the European countries. The average score in yellow refers to all participating countries in the ICILS 2018.

Fig*. *3*. *Cumulative effect of gender, immigration and socio-economic background on CIL

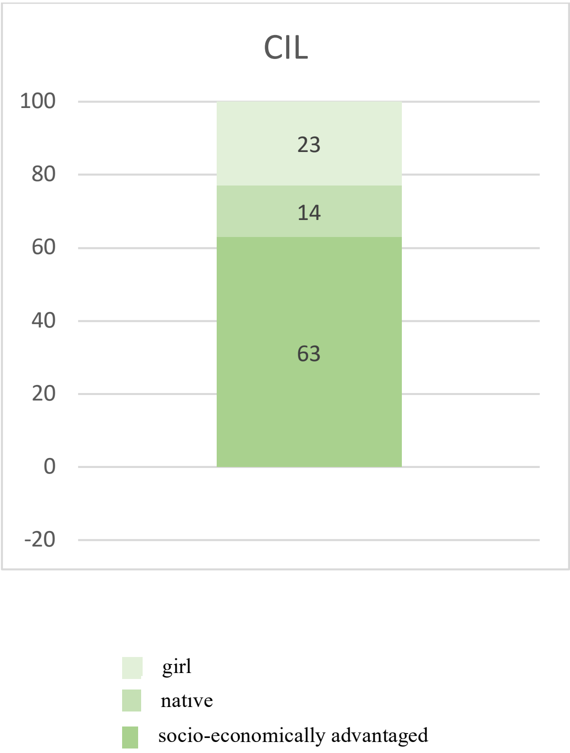


Fig*. *4*. *Cumulative effect of gender, immigration and socio-economic background on CT

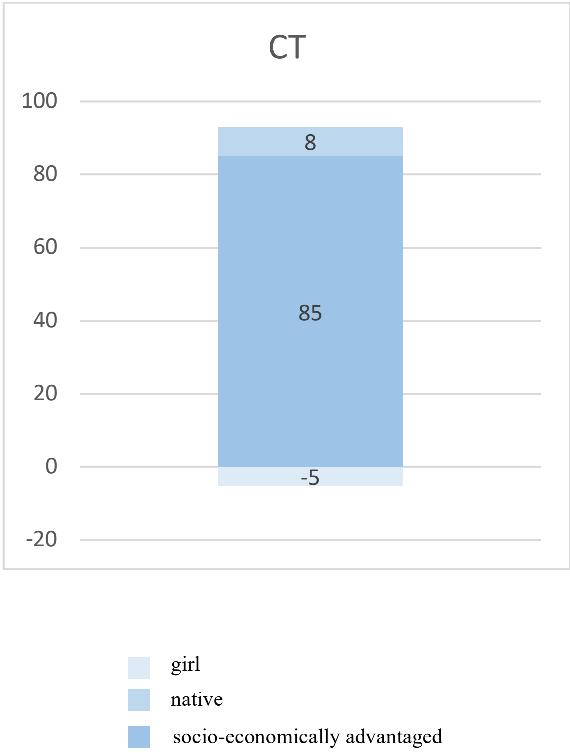


Fig. 5. *Average* ***CIL*** *scores by educational track*

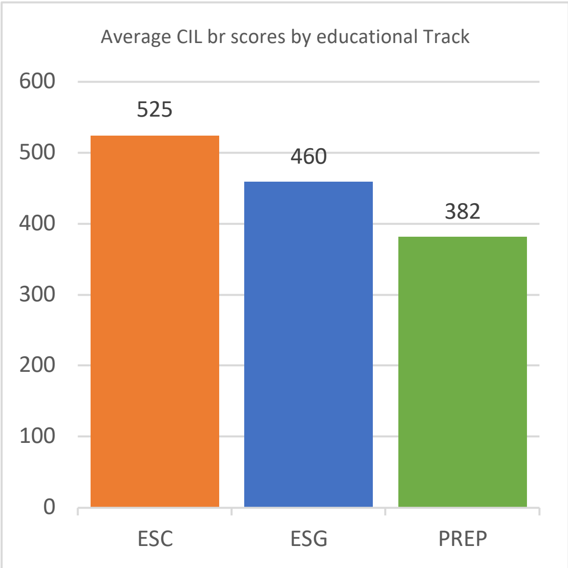


Fig. 6. *Average* ***CT*** *scores by educational track*