AN INTERNATIONAL PERSPECTIVE ON DIGITAL LITERACY

Results from ICILS 2023

Julian Fraillon

Editor

Co-funded by the European Commission

An International Perspective on Digital Literacy

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Researching education, improving learning

The International Association for the Evaluation of Educational Achievement (IEA) is an independent, international cooperative of national research institutions and governmental research agencies. It conducts large-scale comparative studies of educational achievement and other aspects of education, with the aim of gaining in-depth understanding of the effects of policies and practices within and across systems of education.

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Foreword

With today's rapid technological advancement, understanding how well students are prepared for study, work, and life in a digital world has become a question of utmost importance. The International Computer and Information Literacy Study (ICILS), now finalizing its third cycle, addresses this crucial inquiry by investigating students' computer and information literacy (CIL) and computational thinking (CT) skills. As we navigate the complexities of the 21st century, international large-scale assessments (ILSAs) provide imperative data that can help illuminate the ways in which students' learning develops and how it can be improved, and ICILS 2023's results contribute further to this database with its rich data from assessment items and context questionnaires.

Developing digital skills is a key for student success in many aspects of learning, as we also saw demonstrated during the COVID-19 crisis where digitalization helped education to continue in times of global disruptions of schooling and life. However, it should be noted that digital competencies are not replacing traditional learning areas, rather that they open a new field where students need to be competent in today's world.

The International Association for the Evaluation of Educational Achievement (IEA) has been at the forefront of educational research since the 1960s, consistently adding to our understanding of education systems worldwide. Our journey in investigating digital literacy began with the Computers in Education Study (COMPED) in 1987 and evolved into the Second Information Technology in Education Study (SITES) in the late 1990s and early 2000s. These pioneering efforts laid the groundwork for what would become ICILS, reflecting our commitment to adapting our research to the changing educational landscape.

The establishment of ICILS in 2013 marked a significant milestone in our mission to provide comprehensive insights into how students interact with technology and develop essential digital skills. The subsequent cycle in 2018 further expanded this understanding, paving the way for ICILS 2023 to build upon nearly a decade of trend data whilst also providing new, innovative measurements. This longitudinal approach allows us to not only capture the current state of digital literacy but also to track its evolution over time, providing invaluable insights for policymakers and educators alike.

ICILS 2023 builds upon this rich history, offering a unique perspective on the ever-changing landscape of technological innovation and its impact on education. This study encapsulates the broad use of computer technologies across various aspects of daily life—from schools and homes to communities and workplaces—and examines how students investigate, create, participate, and communicate in digital environments. By doing so, ICILS 2023 provides a holistic view of students' digital competencies, going beyond mere technical skills to encompass critical thinking, problem-solving, and effective communication in digital contexts.

The current cycle of ICILS further expands on the optional component of computational thinking, reflecting the growing recognition of these skills as vital for success in a digital world. This addition acknowledges the increasing importance of algorithmic thinking and problem-solving skills in various fields, from computer science to data analysis and beyond. Understanding how computers work helps both to interact with the information presented and to use them effectively. Additionally, this cycle emphasizes new areas of interest related to digital citizenship, acknowledging the increasing opportunities for young people to engage in online civic participation as well as insights into the developing use of AI in schools. This focus on responsible and comprehensive digital navigation is particularly timely, as we witness the growing influence of digital platforms on public discourse and civic engagement.

With 35 education systems participating from all around the world, ICILS 2023 underscores its global relevance and importance. The study aligns closely with UNESCO's Sustainable Development Goals, particularly Goal 4.4, which seek to increase the number of youths with relevant skills for employment. This alignment ensures that ICILS 2023 not only provides valuable data but also contributes directly to global efforts to improve education and employability in the digital age. Furthermore, ICILS data is recognized as an official EU target by the European Council and EU Member States, supporting strategic priorities towards the European Education Area and beyond (2021–2030). This recognition highlights the study's significance in shaping educational policies at both national and supranational levels.

The success of ICILS 2023 is made possible through the collaboration and support of those involved with this ILSA, each playing a crucial role in providing these data. We extend our heartfelt gratitude to the ICILS International Study Center at IEA, as well as IEA's staff, for their hard work and coordination throughout the research process. Their efforts ensure that ICILS maintains the highest standards of methodological rigor and international comparability.

This is further supported by the collaborative engagement of our global network of participants. The expertise of national research coordinators and centers ensures that data collection meets the highest standards of quality. Their work is pivotal in adapting global methodologies to local contexts while still maintaining international comparability. We are also appreciative of all participating countries, schools, teachers, and students whose contributions are invaluable to this endeavor. The dedication and appreciation of the value of this research all contribute to the richness and reliability of the data collected.

We would also like to thank the European Commission, DG EAC, and EACEA for their commitment to funding Erasmus+ and Western Balkan participants in ICILS 2023. This contribution not only enables broader participation but also demonstrates a recognition of the critical importance of digital literacy in fostering economic growth and social cohesion. By supporting the participation of these countries, the European Commission is helping to bridge digital divides and promote inclusive education across the region.

On a global scale, ICILS 2023 results further contribute to important investigations about how young people can effectively navigate and thrive in a digital world, and this in turn can empower stakeholders to make informed decisions that enhance digital literacy education globally. By providing a comprehensive assessment of students' digital competencies and contexts, identifying gaps in digital literacy, and highlighting effective educational practices, ICILS can continue to play a crucial role in shaping the future of education in the digital age.

As we look to the future, we are grateful for all who were involved in the various steps to develop, collect, and analyze the data for ICILS 2023. These will be contributory in ensuring that education systems worldwide are equipped with nonbiased, sound data as they navigate how to meet the challenges and opportunities of the digital era, and to empower the next generation to become not just consumers of digital content, but creative, critical, and responsible digital citizens.

Dirk Hastedt
EXECUTIVE DIRECTOR IEA

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Executive Summary

Julian Fraillon

About the study

The IEA International Computer and Information Literacy Study 2023 (ICILS 2023) investigated students' capacities to use information and communications technology (ICT) productively for a range of different purposes, in ways that go beyond a basic use of ICT. ICILS 2023 builds on the work of previous ICILS cycles conducted in 2013 and 2018, by monitoring the development of these essential digital literacy-related capabilities over time, and by contributing to our understanding of the contexts in which students develop these capabilities, and how these contexts relate to student learning and achievement. With each cycle of ICILS, the study evolves to remain current in an environment of rapidly developing digital technologies.

The first cycle of ICILS in 2013 assessed students' computer and information literacy (CIL) which is defined as 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 & Duckworth, 2024, p. 26), and has an emphasis on students' ability to use computers to collect and manage information and to produce and exchange information. The CIL construct comprises four strands that encompass the skills, knowledge, and understanding assessed by the CIL test instrument: *Understanding computer use*, *Gathering information*, *Producing information*, and *Digital communication*. As part of ICILS 2013, the CIL reporting scale and described proficiency levels were established.

The second cycle of ICILS in 2018 included an international optional assessment of computational thinking (CT) in addition to the core assessment of CIL. Computational thinking is defined as 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" (Duckworth & Fraillon, 2024, p. 38). In ICILS, CT emphasizes "framing solutions to real-world problems in a way that these solutions could be executed by computers...and...implementing and testing solutions using the procedural algorithmic reasoning that underpins programming" (Duckworth & Fraillon, 2024, p. 37). The CT construct comprises two strands that comprise the skills, knowledge, and understanding addressed by the CT assessment: *conceptualizing problems* and *operationalizing solutions*. As part of ICILS 2018, the CT reporting scale was established. In ICILS 2023, the CT reporting scale was confirmed and the CT described proficiency levels were established.

ICILS 2023 provides, across relevant countries, the opportunity to report on trends in student CIL achievement across three assessment cycles since 2013, and on trends in CT achievement across two assessment cycles since 2018.

In addition to measuring variations in CIL and CT among and within countries, ICILS 2023 reports on the relationships between CIL and CT, as well as the relationships between those constructs and students' background characteristics, their access to, and attitudes toward ICT, and their use of ICT both within school, and outside of school.

ICILS 2023 further investigated the broader contexts in which students' CIL and CT develop. ICILS national study centers provided national profiles that provide a sense of the broad national curriculum, policy, and resourcing contexts in which students' CIL and CT are being developed within ICILS countries. Contributing to these national profiles are data collected from school principals and ICT coordinators about the characteristics of schools within countries, including the plans, policies, and resources that are available to students and teachers with respect to CIL and CT teaching and learning. Teachers in schools participating in ICILS provided data about their uses of ICT in their teaching, their attitudes toward the use of ICT in teaching and learning, and their experiences of the implementation of teaching with technology in their schools.

The ICILS 2023 CIL and CT assessment instruments used purpose-built applications that reflected standard interface design conventions. The student instruments were delivered on computer, with the majority delivered using internet connections within schools. Where this was not possible, the instruments were delivered offline, either through USB or through a local server. The instruments were developed to represent real-world scenarios with cross-curricular contexts in which CIL and CT achievement could be demonstrated and measured. In the CIL assessment, students completed a range of tasks, including skills-based tasks, information seeking, evaluation and management tasks, and information production tasks using real-world productivity applications (such as presentation, word processing, and design software). In the CT assessment, students completed information-based and planning tasks associated with analyzing problem scenarios and planning solutions, and worked with bespoke block-based coding elements to implement and evaluation algorithmic solutions to problems.

ICILS 2023 was based around research questions that focused on the following for CIL (in all countries) and CT (in countries where CT was also assessed):

- Variations in students' CIL and CT within and across countries in 2023, and in comparison to previous cycles of ICILS
- Aspects of classrooms, schools, and education systems that are related to students' CIL and CT
- Aspects of students' experiences of using ICT, within school and outside of school, that are related to their CIL and CT
- Aspects of students' personal and social backgrounds (such as gender and socioeconomic background) that are related to their CIL and CT
- The relationship between CIL and CT

This report provides detailed information about students' learning achievement in CIL and CT, and with respect to the contexts in which students' CIL and CT learning is taking place within and across ICILS countries. Subsequent ICILS reports are planned to provide more in-depth information relating to themes arising from the ICILS research questions. These include: teaching with and about technology, school leadership for ICT, changes in CIL and CT learning across a decade, equality and the digital divide in CIL and CT, and teacher professional learning and ICT.

Data collection

ICILS 2023 collected data from 132,998 grade 8 (or equivalent) students in 5,299 schools across 34 countries and one benchmarking participant. These student data were augmented by data from 60,835 teachers in those schools, and by contextual data collected from school ICT coordinators, principals, and national research centers. Twenty-four countries, and one benchmarking participant also participated in the optional CT assessment.

Main survey data collection took place in the first half of 2023 for participants in the Northern Hemisphere and the second half of 2023 for participants in the Southern Hemisphere.

ICILS collected data using six instruments (seven in countries that participated in the CT assessment). Students completed the test of CIL, a questionnaire, and (where applicable) the test of CT. Separate questionnaires were completed by teachers, school ICT coordinators, school principals, and staff in national research centers.

Assessing CIL and CT

The ICILS 2023 CIL assessment instrument comprised seven 30-minute assessment modules. Each student completed two of the seven modules. Each CIL module comprised a set of questions and tasks based on a real-world theme and follows a linear narrative structure. Each module has a series of smaller discrete tasks, designed to be able to be completed quickly (usually in less than one minute), and a large authoring task designed to be completed in 10 to 15 minutes. The narrative of each module frames the smaller discrete tasks as a mix of information management and skill execution tasks, that students need to complete in preparation for the large task. In the large tasks, students create information products using productivity applications (such as text editing, website editing, or presentation software). These applications, bespoke developed for ICILS, are designed to reflect contemporary software application conventions, such as the use of recognizable icons associated with typical functions, or common user interface feedback responses to given commands. Four of the CIL modules had been used in ICILS 2018 (and two of these also in 2013) and kept secure. Three new modules were developed for use in ICILS 2023. Data collected from all seven modules were used as the basis of reporting the 2023 CIL results on the ICILS CIL achievement scale.

The CT assessment instrument comprised four 25-minute assessment modules. Each student completed two of the four modules. Each CT module comprised a set of questions and tasks relating to real-world problems that may be addressed with computer-based solutions. The tasks assessed a range of of technical competencies, critical thinking, problem-solving abilities, and evaluation skills. In addition, some tasks included facility for students to create and execute block-based algorithms, designed such that students could demonstrate aspects of computational and algorithmic thinking without the need to learn the syntax or features of a specific programming language. Across the instrument, the content of these tasks reflected the processes of understanding and conceptualizing problems, and executing and evaluating computer-based solutions to those problems. Data collected from all seven modules were used as the basis of reporting the 2023 CT results on the ICILS CT achievement scale.

Collecting data on the contexts in which students develop CIL and CT

The ICILS contextual framework provides a conceptual structure to support the interpretation and analysis of the ICILS data, in particular the data associated with student proficiency in CIL and CT (Rožman et al., 2024). The framework posits that CIL and CT are developed within four levels of influence: the *wider community*, the *school/classroom*, the *home*, and finally the individual characteristics of *the student*. The ICILS context questionnaires aim to collect data relating to each of these four levels of influence.

Contextual data were collected from students using a 30-minute questionnaire. This included questions relating to students' background characteristics, their experience and use of computers and ICT to complete a variety of different tasks in school and out of school, and their attitudes toward the use of computers and ICT.

A 30-minute teacher questionnaire was completed by a random sample of 15 teachers of grade 8 students in each school. The questionnaire collected information about teachers' backgrounds, including their familiarity with ICT. The main focus of the questionnaire was on teachers' perceptions of ICT in schools and their use of ICT in educational activities in their teaching. The questionnaire also includes a small amount of content relating to leadership for technology within the school, and teachers' experiences of professional learning with respect to the use of technology in their teaching.

A 20-minute questionnaire was completed by the designated ICT coordinator in each sampled school. The questionnaire focused on the provision of resources and support (both technical and pedagogical support for teachers) for the use of ICT in teaching in the school. The questionnaire also included questions associated with the implementation of the school vision associated with the use of technology in teaching and learning.

The school principal in each participating school completed a 20-minute questionnaire. This focused on characteristics of the school, and broad policies, procedures, and priorities for ICT in the school. It also included questions relating to the implementation of a school vision associated with the use of technology in teaching and learning. The principal questionnaire collected some information about the impact of the COVID-19 pandemic on teaching and learning in their schools.

As an international option, principals in 12 countries provided information about their responses to the use of generative AI (such as ChatGPT) in their schools, and their perceptions of the likely impact of the use of generative AI on the work of students and teachers. These data are reported in an Addendum to this report.

ICILS 2023 national research coordinators provided information, based on the input of national experts in response to a national contexts survey (NCS). The NCS provided data concerned with contextual factors relating to the structure of the education system and plans and policies with respect to CIL and CT education within countries.

Findings

National contexts for CIL and CT education

Across ICILS countries there exist a broad range of plans, policies, and initiatives that, taken together, show a strong commitment to the development of CIL- and CT-related competencies in schools. CIL tends to have greater emphasis than CT across countries. CIL was reported to be included slightly more than CT in teaching programs at all levels of schooling, and CIL was more frequently reported as compulsory than CT in countries where both were taught at a given education level. There was, however, considerably less emphasis reflected in the reported expectations that CIL and CT skills be assessed in comparison to their emphases in curricula across countries.

Student CIL

Student CIL achievement was described across four levels of increasing sophistication. However, on average across countries, nearly half of students' CIL achievement was below Level 2 proficiency. These students exhibit little more than rudimentary CIL skills, which they may be able to complete under instruction but not independently. Furthermore, they are not demonstrating the ability to make basic judgments about the credibility, relevance, and usefulness of digital information. These are skills that are essential for effective and safe participation in a world where they encounter digital information from myriad diverse sources.

On average across all countries:

- Twenty-four percent of students were working below CIL Level 1, which means they can execute only the most basic and simple commands under explicit instruction.
- Twenty-seven percent of students were working at CIL Level 1, and can use computers to perform routine research and communication tasks under instruction.
- Thirty-four percent of students were working at CIL Level 2, and can use computers with support to complete basic and explicit information gathering and information management tasks.
- Fourteen percent of students were working at Level 3, and demonstrated the capacity to work independently when using computers as information gathering and management tools.
- One percent of students were working at Level 4, and can execute control and evaluative judgment when searching for information and creating information products.

While CIL achievement varied across countries, there was also considerable variation within countries. For example, in the highest achieving countries approximately 30 percent of students demonstrated achievement at or below CIL Level 1 in comparison to between one and six percent at Level 4.

Students' CIL achievement was typically lower in 2023 than in 2018 and 2013, in countries with comparable data across the cycles. This is evident in both reductions in average student CIL scores over time, and a corresponding reduction in the percentage of students achieving CIL Level 2 or higher.

Across countries, students' CIL achievement was typically higher for: female students, students from higher socioeconomic status (SES) backgrounds, students with better access to ICT resources, and students with higher self-confidence to use general computer applications.

Student CT

Student CT achievement was described across four levels of increasing sophistication.

On average across all countries:

- Ten percent of students were working below CT Level 1, which means they can only execute the most basic commands under instruction.
- Twenty-four percent of students were working at CT Level 1, and can solve problems in which there is a generally small and functionally independent set of steps. They can logically sequence a small variety of commands, understand, and apply loops for repetitive actions, and ensure conditions are met to direct program flow.
- Thirty-seven percent of students were working at CT Level 2, and can recognize and apply various combinations within limited groups of commands and concepts, including sequencing, conditional logic, and loops, to formulate and solve problems.
- Twenty-three percent of students were working at Level 3, and can engage with problems that include a variety of computational concepts such as simulation, conditional logic, and data interpretation. They can make independent efforts to develop solutions with efficient code.
- Six percent of students were working at Level 4, and can recognize and analyze problems that involve a broad variety of computational concepts and commands. They demonstrate understanding of the relationships between complex problems and sub-problems and can generate mostly precise and efficient solutions.

The variation of CT achievement within countries exceeded the variation of achievement across countries. The difference between the highest and lowest average CT scores across ICILS countries was more than 120 CT scale score points. In contrast, the difference between the lowest performing students (bottom 10%) and the highest performing students (top 10%) was more than 270 CT scale score points in most countries.

Students' average CT did not change significantly between 2018 and 2023 in five of seven countries with comparable date across the two cycles.

On average across countries, the achievement of male students was three scale score points higher than that of female students. While this difference is statistically significant, it is also very small (0.03 of a an international standard deviation). In addition, this pattern was not consistent across countries, with statistically significant differences evident in six countries only. In the remaining 16 countries and the benchmarking participant the differences in average CT achievement between female and male students were not statistically significant.

Across countries, students CT achievement was typically higher for: students from higher socioeconomic status (SES) backgrounds, students with better access to ICT resources, and students with higher self-confidence to use general computer applications.

Students' engagement with ICT

On average across countries, half of the students reported having using digital devices for at least 5 years. In most countries there is a positive association between experience with digital devices and each of CIL and CT achievement. ICT use is prevalent among students, with three out of four students across countries reporting daily ICT use outside school for non-school-related purposes, on school days and on non-school days. In contrast, approximately one-third of students reported using ICT at school for school related purposes on school days.

In addition to students reporting that they use ICT more frequently outside of school than at school, higher proportions of students reported having learned outside of school than in school about aspects of searching for and evaluating digital information.

Within classes, students reported most frequent use of productivity software applications, such as word-processing, presentation software, and computer-based information sources. Students reported less frequent use within classes of more recently developed tools such as simulations and modeling software, interactive digital learning resources (e.g., learning games or apps), multimedia and drawing or graphics tools.

Students reported frequently engaging in academic-media multitasking—the simultaneous engagement in academic tasks (such as studying, reading, or completing assignments) and media-related activities (such as watching TV, browsing the internet, or using social media). On average across countries, about two-thirds of the students revealed they engaged in a range of academic-medial multitasking activities often or very often while doing school work. There was considerable variation in the correlations between academic-media multitasking and CIL achievement across countries. In contrast there was a largely consistent pattern of negative association between academic-media multitasking activities and CT achievement.

Students generally reported that they were confident users of ICT, with more than four out of five students on average reporting that they could complete a range of ICT-related tasks moderately well or very well. Within countries, greater ICT self-efficacy was positively associated with CIL and CT achievement. Students also generally reported having positive opinions their use of ICT and the positive value of ICT in society. Students also reported that they recognized the potential negative influences of ICT on society, thus showing that they were able to simultaneously recognize the potential value and drawbacks of ICT use.

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Chapter 1:

Introduction to the IEA International Computer and Information Literacy Study 2023

Julian Fraillon

1.1 Background

Between the first cycle of IEA's International Computer and Information Literacy Study (ICILS) in 2013 and the third cycle in 2023, the number of individuals using the internet worldwide has increased from an estimated 2.4 billion (35% of the world's population) to 5.4 billion (67% of the world's population) (International Telecommunication Union [ITU], 2024). Across the globe, the use of information communications technologies (ICT) is integrated in all aspects of our daily lives, including education, work, recreation, civil and civic engagement, and socializing. In addition to the ongoing increase in people's access to the internet and digital technologies, the evolution of digital tools serves to amplify the essential value of the development of digital literacy competencies (Council of the European Union, 2018; European Commission, 2021; Gómez, 2021; National Assessment Governing Board [NAGB], 2018). While some of these competencies relate to basic technical skills, they extend well beyond these to include essential skills associated with the critical evaluation of the relevance, accuracy, plausibility, and social consequences of digital information (Vuorikari et al., 2022). In ICILS, this is addressed from the perspective of individuals as consumers and producers of digital information. The recent emergence of generative AI tools and their integration into existing software environments, together with the ease with which individuals can create and publish digital information have served only to heighten the importance of these core skills assessed in ICILS (COMEST, UNESCO, 2019; Ng et al., 2022; Picton & Teravainen, 2017).

The rapid and ongoing increase in the pervasiveness of computer technologies including ICT is a function of the value and efficiency of computers to contribute to solutions for myriad problems. This brings with it the need for innovation and skills that can be used to extend the range of computer-based solutions to problems (see, for example, Cedefop, 2018; Ciarli et al., 2021; OECD, 2022). In ICILS this is reflected in the optional assessment of computational thinking (CT) that was first made available to countries in ICILS 2018.

The importance placed on the need to monitor citizens' ICT-related competencies in an increasingly digital world is evident, for example, in the inclusion of measures of youth and adults' information and communications technologies (ICT) skills in Indicator 4.4.1 of the United Nations (UN) Sustainable Development Goals (UN, 2017). Digital competence is one of the eight key competencies for lifelong learning (European Commission and Directorate-General for Education, Youth, Sport and Culture, 2019). Reflected in the evolution since 2010 of the European Commission Digital Competence Framework for Citizens (DigComp) as the pre-eminent supranational digital skills framework across Europe (European Commission, n.d.). The value of ICILS in contributing to the monitoring of these competencies is manifest in the Resolution on a strategic framework for European cooperation in education and training towards the European Education Area and beyond (2021–2030) (European Commission, 2021), under which the digital skills of grade 8 students will be monitored, using data collected in ICILS.

IEA has been studying the relationship between ICT and educational processes, as well as factors related to the pedagogical use of ICT, since the late-1980s (Pelgrum & Plomp, 2011). IEA's ICILS emerged in response to the increasing value being placed on the use of ICT in modern society and the need for citizens to develop relevant capabilities to participate effectively in a digital world. ICILS also addresses the need for policymakers and education systems to monitor the development of these essential capabilities over time, and to gain a better understanding of the contexts and outcomes of ICT-related education programs in their countries. ICILS continues to evolve with the rapid development of digital technologies and, in particular, digital information sources, tools, and communication platforms.

The assessment framework and instrument content of the first cycle of ICILS were being developed in the early 2000s, at a similar time to the emergence of the social media platforms, collaboration and file sharing platforms, and cloud-based storage platforms that are now fundamental to our engagement with digital technologies. ICILS has needed to remain dynamically connected with ongoing developments in ICT, while continuing to measure the underlying capacities in young people to engage effectively with ICT and to be able to report changes in these capacities over time. In ICILS, this has been achieved through the development of core achievement constructs (CIL and CT) that measure both students' interactions with contemporary ICT platforms, but also students' capacities to evaluate, analyze, and reason about the digital information and digital information tools they are working with. While students' interactions with digital technologies continue to change over time, ICILS measures the knowledge, understanding and critical thinking, evaluation and communication skills that remain central to young people's effective use of technology. Included with these, are young people's understandings of personal and social consequences of their interactions with ICT as consumers and producers of digital information. This approach will continue to be a feature of ICILS, as in future cycles new technologies will emerge, such as generative artificial intelligence agents and tools, and other platforms and tools that may not yet be known about or accessible in the public domain. ICILS will continue to evolve as we transition from what is measured and reported on in this cycle of ICILS (2023) to future cycles in 2028 and beyond.

1.2 Introducing ICILS 2023

The first cycle of ICILS in 2013 (ICILS 2013) assessed students' computer and information literacy (CIL) with an emphasis on students' ability to use computers to collect and manage information and to produce and exchange information. As part of this cycle, the CIL reporting scale and described proficiency levels were established. Computer and information literacy achievement in subsequent cycles of ICILS has continued to be reported against this scale and, with each subsequent ICILS cycle, the scale descriptions have been reviewed and updated to remain consistent with the rapid evolution of ICT platforms and tasks, and as they are included in the student CIL test. In response to growing international interest, the second cycle of ICILS (ICILS 2018) included, as an international option, an assessment of computational thinking (CT) with an emphasis on students' ability to formulate solutions to real-world problems so that those solutions could be operationalized with a computer. As part of this cycle, the CT reporting scale was established and preliminary descriptions of three regions of CT achievement (lower, middle, and upper) were drafted.

The CIL and CT achievement scales each comprise two key elements. The first is the measurement metric, established in 2013 for CIL and in 2018 for CT. These metrics have remained consistent across ICILS cycles. CIL scale scores can be directly compared across the three ICILS, and CT scale scores can be directly compared between 2018 and 2023. The second element of each scale are the levels of achievement or proficiency levels. While the scale metrics have remained unchanged across cycles, with each new ICILS assessment cycle, the descriptions of achievement across the scale levels are reviewed and revised for clarity, and to reflect changes in the CIL and CT assessment content. For CIL, the level boundaries established in 2013 have remained unchanged, and the text of the level descriptors and examples of achievement has been updated with each subsequent assessment cycle (see Chapter 3 for more details). For CIL, both the scale scores and percentages of students achieving each level on the scale can be directly compared across all three ICILS cycles. Direct comparisons will also be possible with future cycles of ICILS.

Because of the relatively small amount of CT assessment content in ICILS 2018, preliminary draft regions rather than proficiency levels were described against the CT scale. As part of ICILS 2023, we used the larger amount of available CT assessment content to formalize descriptions of levels of CT proficiency by revising both the boundaries on the scale, and the descriptions of the levels within those boundaries. This process established the four-level ICILS CT described achievement scale that replaces the preliminary draft regions reported in ICILS 2018 (see Chapter 4 for more details). The percentages of students achieving each preliminary draft region in ICILS 2018 cannot be directly compared to the percentages of students achieving each level of the CT scale in 2023. However, the CT scale scores are directly comparable between ICILS 2018 and 2023 and with future cycles of ICILS. Direct comparison of the percentages of students achieving each CT level will be possible between ICILS 2023 and future ICILS cycles.

ICILS 2023 includes both the core assessment of CIL and the optional assessment of CT. ICILS 2023 provides, across relevant countries, the opportunity to report on trends in student CIL achievement across 10 years and across three assessment cycles since ICILS 2013. As part of ICILS 2023, a described CT achievement scale has been established (replacing the previously drafted preliminary described regions) with descriptions of CT proficiency across four levels (see Chapter 4 for further details). The updated scale description was planned and made possible by including a larger amount of CT test content in ICILS 2023 in comparison to 2018. Despite this change in scale description, student CT achievement in ICILS 2023 is reported on the CT reporting scale established in 2018 and, consequently for relevant countries, ICILS 2023 provides the opportunity to measure changes in student CT achievement scale scores between 2018 and 2023. The CT measurement scale established in 2018 and the four-level description of the scale established in 2023 will continue to be used in future cycles of ICILS.

This report presents research outcomes at the international level of analyses of data collected in the ICILS main survey in 2023. The focus of this report is on CIL and CT achievement of lower secondary school students, with reference to the contexts in which these competencies have been and are being developed. Thirty-four countries and one benchmarking participant took part in the core assessment of CIL in ICILS 2023, and twenty-four countries also took part in the optional assessment of CT (Table 1.1).

Table 1.1: ICILS 2023 participating countries

Austria (CIL&CT)	Germany (CIL&CT)	Oman (CIL)
Azerbaijan (CIL)	Greece (CIL)	Portugal (CIL&CT)
Belgium (Flemish) (CIL&CT)	Hungary (CIL)	Romania (CIL)
Bosnia and Herzegovina (CIL)	Italy (CIL&CT)	Serbia (CIL&CT)
Chile[1] (CIL)	Kazakhstan (CIL)	Slovak Republic (CIL&CT)
Chinese Taipei (CIL&CT)	Korea (Rep. of) (CIL&CT)	Slovenia (CIL&CT)
Croatia (CIL&CT)	Kosovo (CIL)	Spain (CIL)
Cyprus (CIL)	Latvia (CIL&CT)	Sweden (CIL&CT)
Czech Republic (CIL&CT)	Luxembourg (CIL&CT)	United States (CIL&CT)
Denmark (CIL&CT)	Malta (CIL&CT)	Uruguay (CIL&CT)
Finland (CIL&CT)	Netherlands[2] (CIL&CT)	
France (CIL&CT)	Norway (CIL&CT)	
Benchmarking participant		
North Rhine-Westphalia (Germany) (CIL &CT)		

1 Due to issues with the ICILS main survey data collection in 2023 in Chile, data from Chilean schools are not included in this report. An additional data collection exercise has subsequently been conducted to support the reporting of national data within Chile.
2 Due to issues with the ICILS main survey data collection in 2023 in the Netherlands, data collected from schools in the Netherlands are not included in this report. Selected data from the Netherlands are provided as an appendix.

Purposes of ICILS 2023

The primary purpose of ICILS 2023 is to assess empirically students' capacities to use ICT productively for a range of different purposes, in ways that go beyond a basic use of ICT. From the ICILS perspective, the productive use of ICT includes, but extends beyond, the ability to execute technical skills associated with ICT use. An important focus of ICILS is on young people's critical reasoning capacities as information consumers, information producers, and problem solvers.

In addition to measuring variations in CIL and CT among and within countries, ICILS 2023 reports on the relationships between CIL and CT, as well as the relationships between those constructs and students' background characteristics, their access to, and experiences with, using ICT technology both in and outside of school.

ICILS 2023 further investigates the broader contexts in which students' CIL and CT develop. We collected data from ICILS national centers that help to develop national profiles that provide a sense of the broad national curriculum, policy, and resourcing contexts in which students' CIL and CT are being developed within ICILS countries. Contributing to these national profiles are data collected from school principals and ICT coordinators about characteristics of schools within countries, including the plans, policies, and resources that are available to students and teachers with respect to CIL and CT teaching and learning.

With respect to within school contexts that may be associated with students' CIL and CT learning, data were collected to investigate students' and teachers' experiences of working with ICT, both specifically with reference to CIL and CT, but also more generally. Teachers' reports of their approaches to teaching with and about technology constitute an area of explicit additional focus in ICILS 2023, compared to previous cycles. ICILS 2023 collects data relating to the specific pedagogical approaches and strategies that teachers employ, to incorporate technology both as a tool for teaching and learning and as a subject of instruction. This is supplemented by students' reports on their experiences of learning about CIL and CT at school, and about their uses of ICT in their schoolwork more generally. An additional focus of ICILS 2023 has been the approach to leadership for technology use within schools. School principals, ICT coordinators, and teachers have provided data on this new area, as well as on teachers' experiences and opportunities to engage in professional learning with respect to technology use in teaching.

Previous cycles of ICILS have reported that students used ICT more frequently outside of school than in school, and also more often for non-school-related purposes (Fraillon et al., 2014, 2020). The out-of-of school contexts in which students CIL and CT develop, as well as students' perceptions of where they believe they are learning about CIL and CT are investigated again in ICILS 2023; as are students' confidence to use ICT, and their attitudes towards ICT in their own lives and more generally for society.

In addition to collecting and reporting data on the specific research questions and themes of ICILS, a key purpose of ICILS is to provide a rich database that meets IEA's exacting standards. This database, available to the research and policy-making communities, can be used to enhance our understanding of students' learning of CIL and CT. Furthermore, it can help identify factors that contribute to realization of our collective ambition of continuous improvement of the quality of teaching and learning of CIL and CT in schools.

The COVID-19 pandemic and ICILS 2023

Work on ICILS 2023 began in 2018, with instrument preparation and assessment framework development beginning in 2019. The first meeting of ICILS National Research Coordinators took place in March 2020, coinciding with the early phases of the COVID-19 pandemic and the closure of many national borders and lockdowns occurring within ICILS countries. Schools had largely reopened for face-to-face teaching across ICILS countries by the time of data collection in the ICILS 2023 field trial and main survey, although there were of course considerable operational challenges within countries as preparations for data collection were being made during the height of the pandemic. The disruptions to schooling associated with the COVID-19 pandemic took place between main survey data collections in ICILS 2018 and ICILS 2023. Details of the extent of school closures, transitions to digitally support remote learning, and school principals' beliefs about the impact of the pandemic on aspects of teaching and learning in ICILS 2023 countries are provided in Chapter 2. While it is not possible to estimate the impact of the experience of the pandemic on ICILS 2023 results, decreases in achievement measured in cycles spanning the pandemic have been reported in international large-scale assessments including: the IEA Progress in Reading Literacy Study (PIRLS) (Mullis et al., 2023), the IEA International Civics and Citizenship Education Study (ICCS) (Schulz et al., 2023), and the OECD Programme for International Student Assessment (PISA) (Jakubowski et al., 2024; OECD, 2023). The experience of the pandemic varied across ICILS countries, but should be considered when interpreting the results presented in this international report.

Generative AI and ICILS 2023

The ICILS main survey instruments were finalized and released to countries in November 2022, around the same time as the launch of ChatGPT on 30 November 2022. The immediate and rapid uptake in use of ChatGPT and other generative AI tools that followed, resulted in us deciding to develop a late optional addition to ICILS 2023. This decision was made in June, 2023, after the main ICILS data collection had been completed in Northern Hemisphere countries and before it had begun in Southern Hemisphere countries. The decision to include this content at such a late stage of the study, and outside the conventional development practices of the study, was taken to address the otherwise unforeseen, but significant and rapid change in the use of this new technology in education. We felt that it would be remiss of ICILS 2023 not to offer countries the opportunity to collect some baseline data at the beginning of this potentially significant period of development in the use of generative AI technology in schools. However, we were also aware that data collection would not be feasible in all countries.[3]

The additional data collection took the form of a set of questions for school principals about the introduction of generative AI tools (such as ChatGPT) in their schools, and principals' beliefs about the potential impact of the use of generative AI tools on the work of teachers and students. The decision to limit data collection to school principals was made primarily to minimize the operational burden on countries. Principals across 12 ICILS countries completed the optional questions. The corresponding data are reported as an addendum to this report (see Addendum).

Purpose of this report and subsequent reports using ICILS international data

This report provides detailed information about students' learning achievement in CIL and CT, and with respect to the contexts in which students' CIL and CT learning is taking place within and across ICILS countries. The report aims to provide readers with a deep understanding of CIL and CT achievement, as measured in ICILS, and with information about the key characteristics of learning growth in each domain. The report also aims to provide insights into national contexts of CIL and CT education, and into student-level experiences of using ICT, their attitudes with respect to ICT use, and the associations between aspects of students' backgrounds and ICT experiences and their CIL and CT achievement.

Subsequent ICILS reports are planned relating to themes and questions that are central to ICILS. These reports will use ICILS data from ICILS 2023 and, where relevant, data from previous cycles of ICILS to address themes including:

- Teaching with and about technology
- School leadership for ICT
- Changes in CIL and CT learning across a decade
- Equity and the digital divide in CIL and CT
- Teacher professional learning and ICT

3 Factors such as staffing and financial resources, contractual agreements and obligations, approval processes, operational procedures, and predetermined timelines, affected the feasibility of the additional data collection across ICILS countries.

1.3 ICILS 2023 research questions

ICILS aims to investigate the extent of CIL and CT among grade 8 students and to examine how these learning outcomes are associated with students' backgrounds, developed attributes, experiences with using computer technologies, and learning about computer technologies.

The core student achievement measure of ICILS is CIL. Computational thinking is available as an optional additional measure. As a consequence, two sets of ICILS research questions (RQ) are presented relating to these two outcome measures, and the contexts in which CIL and CT are developed.

CIL

RQ CIL 1 What variations exist in students' CIL within and across countries?

RQ CIL 2 How is CIL education implemented across countries, and what aspects of schools and countries are related to students' CIL?

Following are some of the aspects of schools and education systems that could potentially be related to students' CIL:

(a) General approaches and priorities accorded to CIL education at system and school level

(b) School coordination and collaboration regarding the use of ICT in teaching

(c) School and teaching practices regarding the use of technologies in students' CIL

(d) Teacher proficiency in, attitudes towards, and experience with using computers

(e) ICT resources in schools

(f) Teacher professional development

(g) School leadership for technology

RQ CIL 3 How has CIL changed since ICILS 2013?

RQ CIL 4 What aspects of students' personal and social backgrounds (such as gender and socioeconomic background) are related to students' CIL?

RQ CIL 5 What are the relationships between students' levels of access to, familiarity with, and self-reported proficiency in using computers and their CIL?

CT

The proposed research questions relating to CT closely reflect those proposed for CIL. Analyses include data from those countries participating in the international option assessing students' CT.

RQ CT 1 What variations exist in students' CT within and across countries?

RQ CT 2 How is CT education implemented across countries, and what aspects of schools and countries are related to students' CT?

RQ CT 3 How has CT changed since ICILS 2018?

RQ CT 4 What aspects of students' personal and social backgrounds (such as gender and socioeconomic background) are related to students' CT?

RQ CT 5 What are the relationships between students' levels of access to, familiarity with, and self-reported proficiency in using computers and their CT?

RQ CT 6 What is the association between students' CIL and CT, and how has this changed since 2018?

1.4 The ICILS assessment framework

The contents and high-level operational procedures of ICILS 2023 are instantiated in the ICILS 2023 assessment framework (Fraillon & Rožman, 2024). The core of the assessment framework "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" (Fraillon et al., 2024, p. 2).

The assessment framework includes the following sections that provide detailed information which may help understanding and interpretation of the findings presented in this report.

- Introduction: This includes details of the background and rationale for ICILS, an overview of policy developments and programs with respect to CIL and CT within selected ICILS countries, uses of ICILS data, and high-level information about the ICILS study design.
- The CIL framework defines and explains the structure and content of the CIL construct measured and addressed through the CIL test.
- The CT framework defines and explains the structure and content of the CT construct measured and addressed through the CT test.
- The contextual framework maps the context factors as they are anticipated to influence and explain variation in CIL and CT.
- The ICILS achievement and questionnaire instruments are described and explained with details of their structure, content, and the computer-based delivery environment.

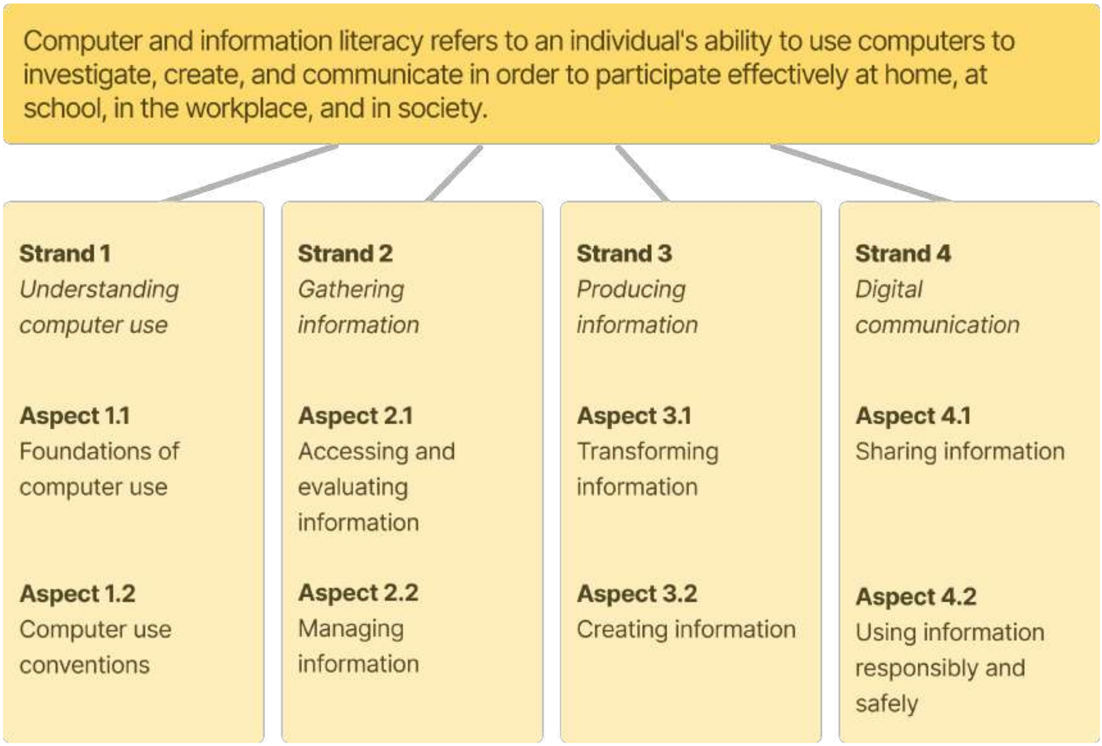
Following are summary extracts of key aspects of the CIL framework, the CT framework and the contextual framework that were used as the basis for developing the ICILS assessments of CIL and CT and contextual questionnaires.

The CIL framework

The ICILS definition of CIL (see Figure 1.1) was established for use in ICILS 2013 and has been maintained for use in ICILS 2018 and 2023. The 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" (Fraillon & Duckworth, 2024, p. 26).

The structure of the CIL construct comprises four strands that encompass the skills, knowledge, and understanding assessed by the CIL test instrument: *understanding computer use*, *gathering information*, *producing information*, and *digital communication* (Figure 1.1).

Figure 1.1: ICILS 2023 CIL construct



Understanding computer use refers to the fundamental technical knowledge and skills that underpin the operational use of computers as tools for working with information. This includes a person's knowledge and understanding of the generic characteristics and functions of computers. Understanding computer use comprises two aspects:

- *Foundations of computer use* includes the knowledge and understanding of the principles underlying the function of computers, rather than the technical detail of exactly how they work. This knowledge and understanding underpins effective and efficient computer use, including troubleshooting basic technical problems.
- *Computer use conventions* include the knowledge and use of software interface conventions that help users make sense of and operate software. This knowledge supports the efficient use of applications including the use of devices or applications that are unfamiliar to the user (Fraillon & Duckworth, 2024, pp. 28–29).

Gathering information embraces the receptive and organizational elements of information processing and management. Gathering information comprises two aspects:

- *Accessing and evaluating information* refers to the combined investigative processes that enable a person to find, retrieve, and make judgments about the relevance, integrity, and usefulness of computer-based information. This information is not only increasing in volume but is also evolving with advances in technologies such as the capacity of AI to generate digital content. One consequent challenge is for information seekers to filter information to identify what is relevant, credible, and ultimately useful.
- *Managing information* involves understanding and applying techniques and tools to handle, organize, store, and protect computer-based information. The process of managing information includes the ability to adopt and adapt different classification and organization schemes. These schemes enable users to arrange and store information systematically, ensuring that it can be

accessed, used, or reused efficiently (Fraillon & Duckworth, 2024, pp. 29–30).

Producing information focuses on using computers as productive tools for thinking and creating. Producing information comprises two aspects:

- *Transforming information* refers to a person's ability to use computers to modify and present information in a way that enhances its clarity and communicative efficacy for specific audiences and purposes. The process of transforming information is more than merely changing the appearance of the content of information. Guided by an understanding of the audience and purpose of a communication, this process involves thoughtful selection and integration of the formatting, graphical, and multimedia capabilities of software applications to augment the communicative impact of information that might otherwise be presented as plain text or data.
- *Creating information* refers to a person's ability to use computers to design and generate information products tailored to specified purposes and audiences. These original products may involve the creation of entirely new content or may expand upon existing content to generate new understandings. Typically, the quality of information created relates to how the 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 together to support the viewer's understanding of the emergent information product (Fraillon & Duckworth, 2024, pp. 30–31).

Digital communication encompasses the competencies associated with information sharing through various online platforms, such as instant messaging, social media, and other public or private community forums together with the social, legal, and ethical responsibilities that entail sharing information with others. This strand also includes the implementation of strategies and mechanisms to protect against the misuse of communication tools and personal information by others. Digital communication comprises two aspects:

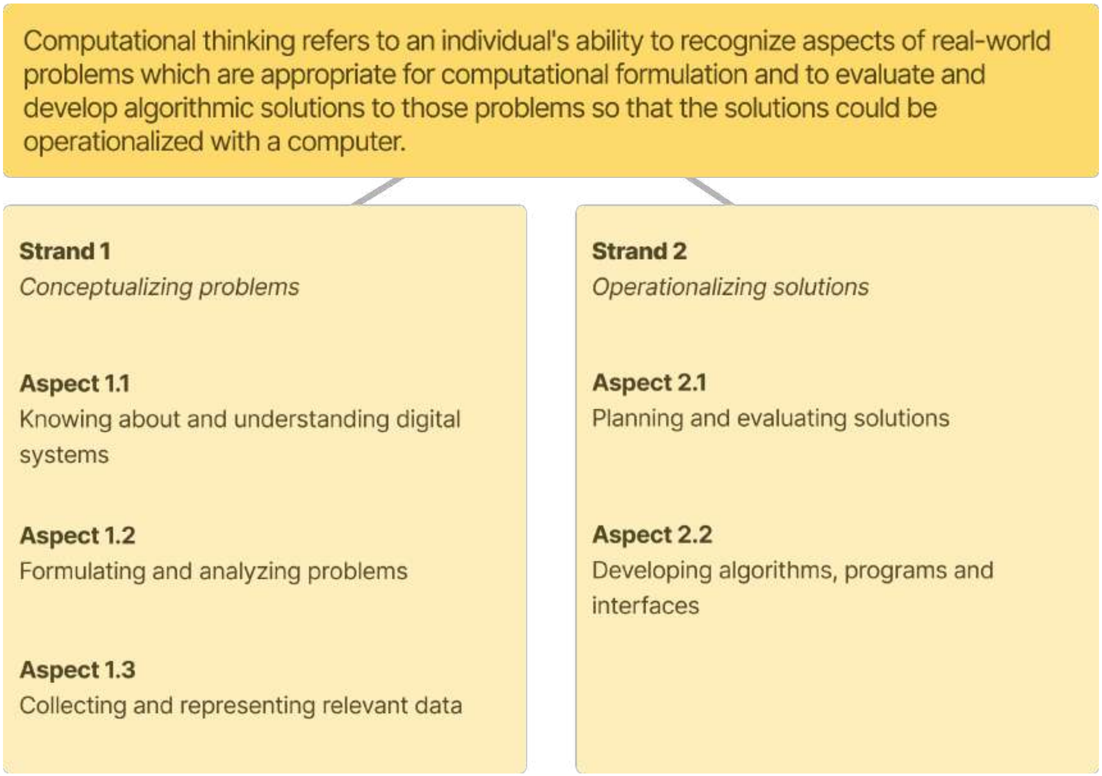
- *Sharing information* refers to a person's knowledge and understanding of how computers are used and can be used, as well as his or her ability to use computers to exchange information with others. This includes knowledge and understanding of the conventions established by a range of computer-based communication platforms such as: email, instant messaging, blogs, wikis, media sharing platforms, and social media networks.
- *Using information responsibly and safely* refers to a person's understanding of the legal and ethical issues of computer-based communication from the perspectives of both a content creator and an information consumer. As both consumers and creators of content, individuals bear a significant responsibility to exercise respectful discretion and to critically evaluate information when sharing it with others. Using information responsibly and safely hence includes risk identification and prevention, as well as the parameters of appropriate conduct (Fraillon & Duckworth, 2024, pp. 31–32).

The CT framework

The ICILS definition of CT (see Figure 1.2) was established for use in ICILS 2018 and has been maintained for use in ICILS 2023. The definition is consistent with conceptualizations of CT as a problem solving approach in which problems and their solutions are "framed in a manner suitable for algorithmic and step-by-step solutions that can be executed by a computer" (Duckworth & Fraillon, 2024a, p. 38).

The structure of the CT construct comprises two strands that comprise the skills, knowledge, and understanding addressed by the CT assessment: *conceptualizing problems* and *operationalizing solutions* (Figure 1.2).

Figure 1.2: ICILS 2023 CT construct



Conceptualizing problems acknowledges that, before solutions can be developed, problems must first be understood and framed in a way that allows algorithmic or systems thinking to assist in the process of developing solutions. Conceptualizing problems comprises three aspects:

- *Knowing about and understanding digital systems* refers to a person's ability to identify and describe the properties of systems by observing the interaction of the components within a system. Systems thinking is used when individuals conceptualize the use of computers to solve real-world problems, which is fundamental to CT. In the context of ICILS, digital systems thinking can be applied to describe the actions of both solely digital systems (such as those within a computer application), or physical systems (such as filling a glass with water from a tap), in such a way that these actions could later be controlled by a computer program.
- *Formulating and analyzing problems* includes the decomposition of a problem into smaller manageable parts and specifying and systematizing the characteristics of the task so that a computational solution can be developed (formulating problems); and making connections between the properties of, and solutions to, previously experienced and new problems to establish a conceptual framework to underpin the process of breaking down a large problem into a set of smaller, more manageable parts (analyzing problems).
- *Collecting and representing relevant data* is underpinned by knowledge and understanding of the characteristics of the data and of the mechanisms available to collect, organize, and represent these data for analysis. This could involve creating or using a simulation of a complex system to produce data that may show patterns or characteristics of behavior that are otherwise not clear when viewed from an abstract system level (Duckworth & Fraillon, 2024a, pp. 39–40).

Operationalizing solutions comprises the processes associated with creating, implementing, and evaluating computer-based system responses to real-world problems. It includes the iterative processes of planning for, implementing, testing, and evaluating algorithmic solutions. Operationalizing solutions comprises two aspects:

- *Planning and evaluating solutions* includes establishing the parameters of a system, including the development of functional specifications or requirements relating to the needs of users and desired outcomes, and with a view to designing and implementing the key features of a solution (planning solutions). It also includes the ability to make critical judgments about the quality of computational artifacts (such as algorithms, code, programs, user interface designs, or systems), against criteria based on a given model of standards and efficiency (evaluating solutions). These two processes are combined in a single aspect because they are iteratively connected to the process of developing algorithms and programs.
- *Developing algorithms, programs, and interfaces* focuses on the logical reasoning that underpins the development of algorithms (and code) to solve problems. In ICILS this is operationalized in a way to avoid students needing to know the syntax of, or features of a specific coding language. Creating interfaces relates to the intersection between users and the system. This may relate to development of the user interface elements in an application including implementation of specifications for dynamic interfaces that respond to user input (Duckworth & Fraillon, 2024a, p. 41).

The contextual framework

The contextual framework describes information collected as part of ICILS 2023 to aid understanding of variations in CIL and CT. The framework reflects the perspective that student learning of CIL and CT takes place within a multilevel structure. "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" (Rožman et al., 2024, p. 45).

As was the case for the two previous cycles of ICILS, the contextual framework distinguished four overlapping contextual levels in which student CIL and CT learning takes place: *the wider community; schools and classrooms; the home environment;* and *the individual* (see Figure 1.3).

The status of contextual factors within the learning process was also classified and considered within the ICILS contextual framework. *Antecedents* are exogenous factors that condition the ways in which CIL/CT learning takes place. They are contextual factors that are not directly influenced by learning process variables or outcomes. *Processes* are those factors that directly influence CIL/CT learning.

Antecedent variables are level specific and may be influenced by antecedents and processes found at higher levels. For example, the availability of ICT resources in schools/classrooms (a school/classroom antecedent) is likely to be influenced by ICT education policies at the level of the education system (a wider community antecedent). Similarly, process variables may be constrained by antecedent factors and factors found at higher levels. This category contains variables such as opportunities for CIL/CT learning during class. There is the potential for reciprocal relationships between learning processes and learning outcomes (e.g., students' CIL and CT outcomes are influenced by teaching and learning programs, but students' experiences of teaching and learning programs are affected by their CIL and CT abilities).The implementation of, or desire to implement specific learning processes may result in policy changes and the provision of resources to schools. However, this does not represent the learning processes influencing the antecedent conditions, rather it reflects the necessity of given antecedent conditions to enable the implementation of given process. The ICILS contextual framework assumes a unidirectional influence of antecedents on learning processes. The unidirectional or reciprocal assumed natures of influence are illustrated by single- and double-headed arrows in Figure 1.3.

Reference to this conceptual framework enabled us to show potential contextual factors on a two-by-four grid, where antecedents and processes constitute the columns and the four contextual levels constitute the rows. The information collected by the ICILS contextual questionnaires can then be classified and mapped according to these classifications (see Table 1.2).

Figure 1.3: Contexts for ICILS 2023 CIL/CT outcomes

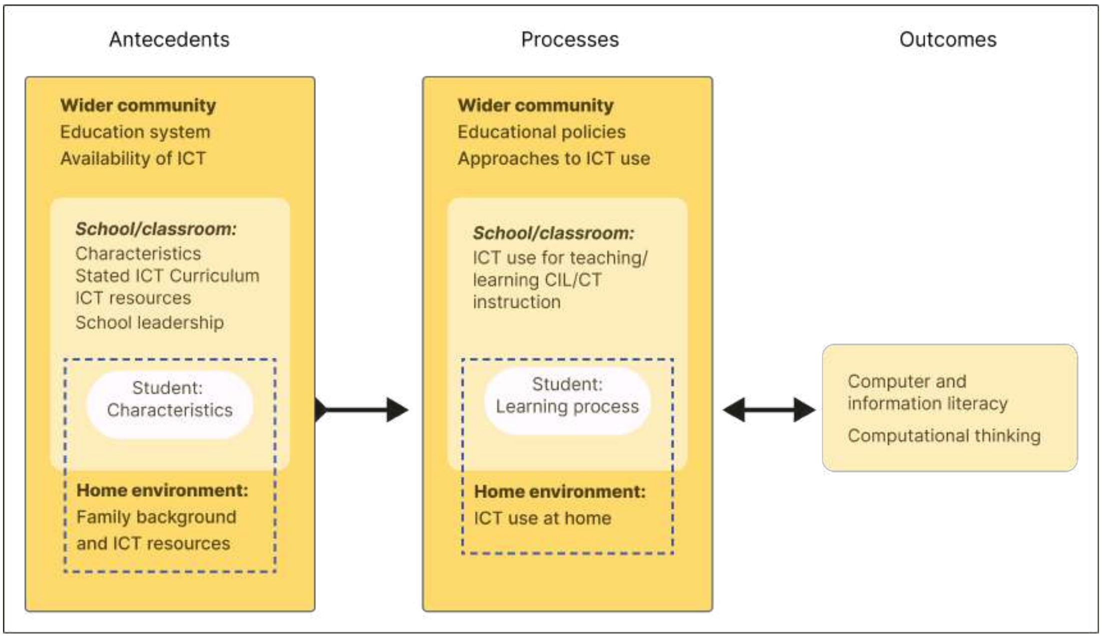


Table 1.2: Mapping of variables to contextual framework (examples)

Context level	Antecedents	Processes
Wider community	**Example antecedents** Structure of education Availability of ICT **Data sources** NCS, PQ, ICQ, and other sources	**Example processes** Role of ICT in curriculum Approaches to ICT use **Data sources** NCS, PQ, ICQ, and other sources
School/classroom	**Example antecedents** School characteristics ICT resources School leadership **Data sources** PQ, ICQ, and TQ	**Example processes** ICT use in teaching and learning CIL/CT instruction **Data sources** PQ, ICQ, TQ, and StQ
Student	**Example antecedents** Gender Age **Data source** StQ	**Example processes** ICT activities Use of ICT CIL/CT **Data source** StQ
Home environment	**Example antecedents** Parent socioeconomic status ICT resources **Data source** StQ	**Example processes** Learning about ICT at home **Data source** StQ

Data sources: NCS = national contexts survey; PQ = principal questionnaire; ICQ = ICT coordinator questionnaire; TQ = teacher questionnaire; StQ = student questionnaire.

The student questionnaire collected data on contextual factors pertaining to the level of the individual student and their home context. The teacher, school principal, and ICT coordinator questionnaires were designed to gather information about contextual factors associated with the school/classroom level. In addition, the national contexts survey (NCS) and other available sources (e.g., published statistics), were used to provide national contextual data to support interpretation of the data collected from students, teachers, ICT coordinators, and principals.

1.5 ICILS instruments

In ICILS 2023, all students completed the test of CIL and the student questionnaire. Where applicable, students then completed the test of CT. Separate questionnaires were completed by teachers, ICT coordinators, school principals, and staff in national research centers. All ICILS instruments were delivered on computer.

The ICILS 2023 CIL and CT test instruments were designed to provide students with an authentic computer-based assessment experience in a uniform way. ICILS 2023 used a customized assessment platform to deliver the test and questionnaire content to students, in a seamless integrated environment. The ICILS student instruments could be delivered online using the internet, or offline using either USB drives (one per student computer) or through a local server within schools. The majority of students completed the tests online. All other ICILS questionnaires were delivered online only.

The student test instruments used purpose-built applications that followed standard interface design conventions. In the CIL test, students completed a range of tasks including conventional multiple-choice and short text responses, as well as skills-based tasks using desktop productivity software applications (such as word processors or presentation software) and web content. In the CT assessment, students completed a range of tasks including conventional multiple-choice, drag and drop, and short text responses, as well as tasks that involved block-based coding with bespoke configured displays of output. The purpose-built applications were designed to be consistent with the applications that could reasonably be expected to be within the realm of students' typical experience of computer use.

CIL test design

The CIL test instrument comprised a set of seven 30-minute test modules. Each student completed two modules that were delivered in a fully balanced randomized design.

Each CIL module comprised a sequence of tasks contextualized by a real-world theme, and driven by a plausible narrative. Each module included a series of smaller tasks which typically took students less than one minute to complete, and each of which contributed to the development of contextual knowledge that underpinned work on a single large task. The large tasks typically took 15 to 20 minutes to complete and involved the development of an information product (such as a presentation, information sheet, website, or social media post) that made use of information and resources managed by students in the lead-up tasks. Chapter 3 and the ICILS 2023 assessment framework (Duckworth & Fraillon, 2024b) provide detailed information about the CIL tasks and modules.

Four CIL test modules (two first used in ICILS 2013 and two first used in ICILS 2018) were kept secure across cycles. Three new CIL test modules were developed for use in ICILS 2023, in order to accommodate contemporary themes and software environments. Data collected from these seven modules were used as the basis for reporting ICILS 2023 CIL results on the ICILS CIL achievement scale, established in 2013. The rotated module design enabled the instrument to contain, and consequently report on achievement against, a larger amount of content (covering the breadth of the CIL framework and a range of difficulties) than any single student could reasonably complete in 60 minutes.

CT test design

The CT test instrument comprised four 25-minute test modules. Each student completed two modules that were delivered in a fully balanced randomized design. Each of the four modules had a unifying central theme and a sequence of tasks related to that theme. Unlike the CIL modules, the CT modules did not include large information authoring tasks.

Within the CT modules there were tasks developed to assess content associated with each of the two strands of the CT construct (conceptualizing problems and operationalizing solutions). The tasks focusing on conceptualizing problems related to aspects of planning the development of computer-based solutions to tasks. These included visual representations of data simulating real-world situations and representations that can support the operational logic of code-based solutions (such flow charts and decision trees). The tasks focusing on operationalizing solutions typically included a block-based coding environment with a form of visual display of the outcomes of executing (running) the code. The block-based coding environment adhered to the conventions of such environments. However, in some cases, predefined custom function blocks with plain language labels indicating their functions were included to simplify complex code structures. Additionally, for each task, a custom visual display was designed to represent the output of executed code. This customization allowed students to focus on fundamental code operations and algorithmic thinking. Chapter 4 and the ICILS 2023 assessment framework (Duckworth & Fraillon, 2024b) provide detailed information about the CT tasks and modules.

Two CT test modules were kept secure from ICILS 2018 and two new CT test modules were developed for use in ICILS 2023. Data collected from these four modules were used as the basis for reporting ICILS 2023 CT results on the ICILS CT achievement scale established in 2018. The rotated module design enabled the instrument to contain, and consequently report on achievement against, a larger amount of content (covering the breadth of the CT framework and a range of difficulties) than any single student could reasonably complete in 50 minutes.

In countries participating in the ICILS 2023 CT option, students completed both CT modules after having finished both the CIL test and student questionnaire.

International student questionnaire

A 30-minute international student questionnaire was completed on computer by students following completion of the CIL assessment. It included questions relating to students' background characteristics, their experience and use of computers and ICT to complete a variety of different tasks in school and out of school, and their attitudes toward the use of computers and ICT.

Teacher and school questionnaires

Three instruments were designed to gather information from and about teachers and schools:

- A 30-minute teacher questionnaire: This was designed to be completed by a random sample of 15 teachers of grade 8 students in each sampled school. The teacher questionnaire collected information about teachers' backgrounds, including their familiarity with ICT. The main focus of the questionnaire was on teachers' perceptions of ICT in schools and their use of ICT in educational activities in their teaching. The questionnaire also includes a small amount of content relating to leadership for technology within the school, and teachers' experiences of professional learning with respect to the use of technology in their teaching.
- A 20-minute ICT coordinator questionnaire: This was designed to be completed by the designated ICT coordinator in each sampled school. The questionnaire focused on the provision of resources and support (both technical and pedagogical support for teachers) for the use of ICT in teaching in the school. The questionnaire also included questions associated with the implementation of the school vision associated with the use of technology in teaching and learning.
- A 20-minute principal questionnaire: This questionnaire focused on characteristics of the school, and broad policies, procedures, and priorities for ICT in the school. It also included questions relating to the implementation of a school vision associated with the use of technology in teaching and learning. The principal questionnaire collected some information about the impact of the COVID-19 pandemic on teaching and learning in their schools. As an international option,

principals in 12 countries provided information about their responses to the use of generative AI (such as ChatGPT) in their schools, and their perceptions of the likely impact of the use of generative AI on the work of students and teachers.

National contexts survey

ICILS 2023 national research coordinators provided information, based on the input of national experts in response to a national contexts survey (NCS). The NCS provided data concerned with contextual factors relating to the structure of the education system and plans and policies with respect to CIL and CT education within countries.

1.6 Participating countries, populations, sample design, and achieved samples

Participating countries or education systems

Thirty four countries and one benchmarking participant took part in ICILS 2023 (see Table 1.1).

Benchmarking participants are education systems within countries. The German state of North Rhine-Westphalia took part as a benchmarking participant in addition to the participation of the country of Germany. Additional schools were sampled in North Rhine-Westphalia to enable accurate reporting of data representing that entity. Data collected from North Rhine-Westphalia also contributed to the data reported for Germany as a whole.

This report includes student data from the 32 countries and the benchmarking participant North-Rhine Westphalia (Germany) that met the student sample participation requirements. The ICILS 2023 averages are calculated using data from the 31 countries that met the ICILS sampling participation requirements. For brevity, when describing student data in this report, the term 'countries' refers to the 31 countries that met the ICILS sampling participation requirements plus the benchmarking participant.

Administration periods

The ICILS 2023 main survey data collection took place in the first half of 2023 in for participants in the Northern Hemisphere and in the second half of 2023 for participants in the Southern Hemisphere. In Romania data collection took place in the second half of 2023 even though it was a Northern Hemisphere participant.

Population definitions

The ICILS student population was defined as students in grade 8 (typically about 14 years of age in most countries), provided that the average age of students in this grade was at least 13.5 years at the time of the assessment.

The population for the ICILS teacher survey was defined as consisting of all teachers teaching regular school subjects to the students in the target grade at each sampled school. It included only those teachers who were teaching the target grade during the testing period and who had been employed at the school since the beginning of the school year.

The principal and ICT coordinator in each sampled school also completed a questionnaire. The ICT coordinator was defined as the person with designated responsibility for ICT in the school, who would also know about and have access to information about ICT resources (including computers), pedagogical practices that use ICT, and support for the use of ICT in teaching and learning within the school. School coordinators in consultation with the school principal had the responsibility for identifying the person who was best placed to complete the ICT coordinator questionnaire. If there was no person with designated responsibility for ICT in a given school, the questionnaire was to be completed by the principal or deputy-principal.

Sample design

Schools

The samples were designed as two-stage cluster samples. During the first stage of sampling, schools with enrolled students at the target grade were randomly selected with a probability proportional to size as measured by the number of students enrolled in a school. The numbers required in the sample to achieve the necessary precision were estimated on the basis of national characteristics. However, as a guide, each country was instructed to plan for a minimum sample size of 150 schools except in very small education systems where all schools were included in the survey. Students and teachers were then sampled from within the schools sampled at the first stage.

Students

Within each school, one class was randomly sampled from all the classes at the target grade. All students within each sampled class were then invited to participate.

Teachers

In schools with more than 20 teachers at the target grade (grade 8 or equivalent), 15 teachers of these teachers were to be selected at random to participate. In schools with 20 or fewer teachers at the target grade, all teachers teaching the target grade were invited to participate.

This teacher sampling practice has been a feature of all cycles of ICILS. In each of ICILS 2013 (Fraillon et al., 2014), 2018 (Fraillon et al., 2020) and again in ICILS 2023 (see Chapter 2), we have observed across countries that CIL, and since 2018, CT, are taught both as part of individual specialized computing subjects as well as being integrated within the teaching of other subjects, such as language arts, mathematics, and science.

The intention in ICILS has been to collect teacher data from across the target grade in each school, rather than to link the teacher information to specific classes. This approach reflects the cross-curricular nature of CIL and CT education in many education systems and schools. By collecting these data, ICILS can generate school- and system-level aggregates that reflect the cross-curriculum approach often featured in CIL and CT education. Furthermore, in countries where CIL and/or CT are not taught as standalone subject, it would not be feasible to link teacher information to specific classes within schools.

Participation requirements and reporting

The participation rates required for each country were 85 percent of the selected schools and 85 percent of the selected students within the participating schools, or a weighted overall participation rate of 75 percent. The same criteria were applied to the teacher sample, but the coverage was judged independently of those for the student sample.

In the tables in this report, we use annotations to identify those countries that met these response rates only after using replacement schools. Countries that did not meet the response rates, even after replacement, are reported separately below the main section of each table. Countries in which the overall sampling participation of students or teachers was less than 50 percent (student and teacher participation was adjudicated separately) have not been included in the relevant tables in this report. Appendix A documents sampling information and participation rates for each country.

Achieved samples

ICILS 2023 collected data from 132,889 grade 8 (or equivalent) students, 132,652 completed the CIL assessment and 85,240 completed the CT assessment.[4] These students were from 5,299 schools in

4 While it was intended that all students who participated in ICILS completed both the CIL test and the student questionnaire, a relatively small number of students completed either the questionnaire only, or the questionnaire and the optional CT assessment without completing the CIL assessment. This is reflected in the difference between the total number of students who participated in ICILS and the number that completed the CIL assessment.

34 countries and one benchmarking participant. These student data were augmented by data from 60,835 teachers in the sampled schools, and by contextual data collected from school ICT coordinators, principals, and national research centers.

The sampling participation requirements for students were satisfied or nearly satisfied in 31 of the 34 participating countries, (and in the benchmarking participant North Rhine-Westphalia (Germany)), and student data from these participants are reported in the main section of the reporting tables. The sampling participation requirements were satisfied or nearly satisfied in 17 of the 34 participating countries (and in the benchmarking participant North Rhine-Westphalia (Germany)), and teacher data from these participants can be reported in the main section of the reporting tables, and will be in subsequent ICILS reports that report on data collected from teachers.

As described by the United Nations High Commissioner for Refugees (UNHCR) "[t]he Russian invasion of Ukraine and full-scale war has caused the world's fastest-growing displacement crisis since the Second World War" (UNHCR, n.d.), and at the end of 2022 had resulted in an estimated 5.7 million asylum seekers across Europe (UNHCR, n.d.). Ukrainian refugee students were part of the student population in ICILS countries. However, these students were eligible to be excluded from participation in the study because they had experienced less than 1 year of instruction in the language of testing. The tables in this report include an annotation for countries in which the overall exclusion of students accounted for more than five percent of the target population. It is possible that in some of these countries, this reduced coverage was a result of the exclusion of Ukrainian refugee students from participation in ICILS. Details of the coverage of the ICILS 2023 target populations, including exclusions of students within ICILS countries on the basis of their years of experience of tuition in the language of testing, are included in Appendix A.

1.7 Structure of this report

This report comprises eight chapters in total. Chapters 1 to 7 provide detailed information about student achievement in CIL and CT, the contexts in which these are developed. These include aspects of students' background, ICT use, and attitudes towards ICT use, both as they are reported by students and as they are associated with CIL and CT achievement. The last chapter (Chapter 8) concludes the report with reflections on the themes that are evident across the student data reported in ICILS 2023 and on future directions in research.

Chapter 2 addresses CIL Research Question 2 and CT Research Question 2, with respect to how CIL and CT education are implemented in countries. It focuses on describing the national contexts for CIL and CT that are reported across the ICILS 2023 countries.

Chapter 3 describes in detail how the CIL test was used to measure CIL achievement and how CIL achievement is conceptualized and described on the ICILS CIL achievement scale. The chapter further describes the substance of the levels of the described CIL achievement scale, and discusses the nature of learning and achievement growth that demonstrate progress across the scale levels. The CIL test instrument and the achievement scale levels are further explicated using example tasks from the CIL test.

Chapter 4 describes in detail how the CT test was used to measure CT achievement and how CT achievement is conceptualized and described on the ICILS CT achievement scale. The chapter further describes the substance of the levels of the described CT achievement scale, and discusses the nature of learning and achievement growth that demonstrate progress across the scale levels. The CT test instrument and the achievement scale levels are further explicated using example tasks from the CT test.

Chapter 5 addresses CIL and CT Research Questions 1 and 3, with respect to the variations in student CIL and CT that exist within and across countries, and changes in CIL achievement across the 10 years since ICILS 2013, and student CT achievement since ICILS 2018. The chapter also addresses CT Research Question 6 by reporting on the associations between CIL and CT, and changes in CT achievement (and in the associations between CIL and CT) between ICILS 2018 and 2023. The chapter includes comparisons within and across countries of CIL and CT scale scores, and of the distributions of student achievement across the levels of the CIL and CT scales. Comparisons are made between CIL and CT achievement in ICILS 2023 and in previous cycles of ICILS.

Chapter 6 addresses CIL and CT Research Questions 4 and 5 with respect to variations in CIL and CT achievement that are associated with students' personal and social backgrounds, including their access to ICT resources. The chapter documents the achievement gaps associated with these key student background characteristics. Additionally, the chapter highlights that the size of performance gaps vary across countries, suggesting statistically significant disparities in the relationship between educational outcomes and social factors.

Chapter 7 addresses CIL and CT Research Question 5 with respect to students' engagement with ICT and associated variations in students' CIL and CT achievement. The chapter investigates and reports on students' use of digital devices, their perceptions about the use of computing technologies, and the circumstances of their learning about ICT. These contribute to an understanding of the broader context in which students develop CIL and CT. In addition, the chapter reports on the associations between these aspects of student engagement with ICT, and achievement in each of CIL and CT.

Chapter 8 discusses the themes emerging from the results of ICILS 2023. We reflect on the key findings relating to student achievement in CIL and CT, and with respect to student characteristics and engagement with ICT. The chapter includes reflections on the implications for policy and practice and suggests some future directions for research on CIL and CT education.

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Chapter 2:

National and school contexts for computer and information literacy and computational thinking education

Julian Fraillon

Chapter Highlights

Data collected from International Computer and Information Literacy Study (ICILS) national study centers, school principals, and information and communication technology (ICT) coordinators suggest that the characteristics of education systems varied considerably across the ICILS 2023 participating countries.

As reported by ICILS national study centers:

- In teaching programs across countries, computer and information literacy (CIL) was included slightly more than computational thinking (CT) at all levels of schooling (Table 2.2).
- CIL and CT education were more prevalent in secondary schooling than in primary schooling (Table 2.2).
- CIL was more frequently compulsory than CT in countries where both were included in the curriculum at a given education level (Table 2.2).
- The elements with the greatest representation in national plans and policies across countries include:
  - Aspects of ICT learning:
    - *The development of information literacy*
    - *ICT-based skills in critical thinking, collaboration, and communication* (Appendix B, Table B.1)
  - Resources:
    - *Internet connectivity*
    - *The provision of computer equipment and other ICT resources*
    - *Support for teachers in using computer equipment and other ICT resources in their work* (Appendix B, Table B.2)
  - Approaches to support student learning:
    - *Pre-service and in-service teacher education* (Appendix B, Table B.3)
  - Plans and programs:
    - *Professional development for teachers' pedagogical use of ICT*
    - *Reduction of the digital divide between groups of students*
    - *Provision of ICT resources and digital learning materials*
    - *The development of ICT competencies in students* (Appendix B, Table B.4)
- A broad range of aspects of CIL were strongly represented in curricula across countries, although there was some variation in the degree to which these aspects were associated with learning goals (Table 2.3).
- Aspects of CT were well represented in curricula across countries, although less so than the representation of CIL. The degree of explicit representation of CT and the association of CT with learning goals was lower than for CIL (Table 2.4).
- There was considerably less emphasis on expectations that CIL and CT skills be assessed when compared to their emphases in curricula across countries (Appendix B, Table B.5).

2.1 Introduction

The contextual framework within the International Computer and Information Literacy Study (ICILS) assessment framework provides a conceptual structure to support the interpretation and analysis of the ICILS data, in particular the data associated with student proficiency in computer and information literacy (CIL) and computational thinking (CT) (Rožman et al., 2024). Similar to the two previous cycles of ICILS, the conceptual structure provided within the framework posits that CIL and CT are developed within four levels of influence: the *wider community*, the *school/classroom*, the *home*, and finally the individual characteristics of *the student*. Furthermore, aspects of each level can be classified either as *antecedents* (external contextual factors that indirectly affect the ways in which learning takes place) and *processes* (contextual factors that directly affect the ways in which learning takes place) (Rožman et al., 2024).

This chapter focuses initially on describing aspects of the highest of these four levels, the contexts associated with the *wider community* within which schools and teachers operate, and students develop CIL and CT. For the most part, the relevant data reported for these contexts relate to antecedent factors, such as the structure of the education system and the availability of information and communication technology (ICT) resources in schools, although some process-related factors, such as policies for ICT in education are also reported. The focus of the chapter then shifts to describing selected school-level contextual factors, as they are represented within ICILS countries. These too, typically are antecedent factors such as the availability of resources within schools. The chapter presents data relevant to Research Question 2 for both CIL and CT: *How is CIL/CT education implemented across countries, and what aspects of schools and countries are related to students' CIL/CT?*

The aspects of the education systems and schools in ICILS countries reported in this chapter include:

- Using data provided by national study centers and external sources:
  - Characteristics of the education systems in ICILS countries
  - The inclusion of CIL and CT education at different levels of schooling
  - Plans, policies, and curricula related to CIL and CT
  - CIL and CT curriculum, learning goals, and assessment
- Using data provided by school principals and ICT coordinators:
  - School-level resource provision and priorities regarding the use of ICT in teaching and learning
  - Principals' reports on the impact of the COVID-19 pandemic on schools

Data sources used in this chapter

The results presented in this chapter were obtained from a variety of data sources, primarily the ICILS 2023 questionnaires.

ICILS national study centers were responsible for completion of the ICILS National Contexts Survey (NCS). The NCS comprised 19 questions containing 122 statements, with most questions also including the option for respondents to elaborate their responses if and as required. The content of the NCS was developed with reference to previous cycles of ICILS and in consultation with ICILS national center experts, to collect information about the structure of the education systems and system-level information about, policies, plans, and resourcing associated with CIL and CT education in ICILS countries. The NCS data were collected in the first half of 2023 in Northern Hemisphere countries and in the second half of 2023 in Southern Hemisphere countries. The NCS data were assumed to be relevant at least within the year of data collection in each country. Supplementary national data were obtained from external databases including selected statistics from the International Telecommunications Union (ITU) and the World Bank. In this chapter, we also report selected information about schools within countries using data collected with the ICILS principal and ICT-coordinator questionnaires, completed by the principal (or designate) and the person with designated responsibility for ICT in each sampled school.

Throughout this chapter we refer to characteristics of the wider community contexts for CIL and CT education as they have been reported by respondents to the NCS. For brevity, we refer to these as characteristics of the ICILS 2023 countries, rather than as characteristics that have been reported to be in the countries. The chapter also includes data collected from school principals and ICT coordinators. These data are reported as the percentages of students in each country in schools where the principal or ICT coordinator has selected a given response, rather than as the percentages of principals or ICT coordinators who have selected a given response. This method of reporting provides a clearer picture for the reported measures of the school contexts for student CIL and CT learning within each country.

2.2 Characteristics of the education systems in ICILS countries

Country profiles describing the responsibility for school education and the design, implementation, and assessment of ICT in education

As part of the ICILS 2023 NCS, each national center was asked to include a brief (not more than 400 words in English) continuous text profile of their country's education system and approach to the delivery of education for ICT. National centers were asked to address the following questions in their country profiles.

- Who has responsibility for establishing the overarching goals and direction for the education system in your country?
- What national/systemwide initiatives, policies or programs are in place to support the use of ICT in education?
- Have there been any major changes introduced relevant to the approach and use of ICT in education in your country in the last 5 years?
- How is curriculum for the use of ICT in education developed and implemented for target grade students?
- How is the use of ICT in education assessed?
- How (to what extent and in what ways) did schooling during the most disruptive periods of the COVID-19 pandemic rely on the use of ICT in teaching and learning?

The country profiles were created by ICILS national study center staff in each country and benchmarking participant. The profiles were copy edited by the ICILS International Study Center (ISC). However, this editing was with respect only to language, expression, and consistency with the style guidelines for this report.

Austria

In Austria, the Federal Ministry of Education, Science, and Research (BMBWF) is responsible for setting overarching goals and directions for the education system. It also oversees the development and implementation of strategies for the digitalization of the school system. Since 2000, strategic initiatives for using digital technologies and media in schools have been in place. In 2018, the comprehensive "Master Plan for the Digitalization of School Education" was developed. Consequently, the Austrian education system was not entirely unprepared when it was necessary to switch to distance learning due to the COVID-19 pandemic. To support schools in this transition, numerous measures were implemented in spring 2020. These included increasing the capacities of learning and communication platforms, bundling digital content and materials, and issuing mobile devices as loan devices to students for distance learning participation.

Based on the master plan from 2018, along with initial international and national findings and practical experiences from the first months of distance learning, a digital school program (8-point plan) was implemented starting in June 2020. This plan comprises eight measures aimed at a rapid, lasting, and nationwide implementation of IT-supported teaching in Austrian schools, focusing on secondary education.

The most comprehensive measure of the 8-point plan is equipping lower secondary students with digital devices. Implementation began gradually in the 5th grade, and by the 2023/24 school year, all four grades of lower secondary schools (a total of 320,000 students) will have their own digital devices.

In the 2018/19 school year, the compulsory exercise "Digital Literacy" ("Digitale Grundbildung") was introduced in lower secondary education (grades 5-8), covering a total of two to four hours per week. Schools autonomously regulated the exact extent and form of this exercise. The next step involved developing this compulsory exercise into a subject that concludes with a mark for students. This new compulsory subject, "Digital Literacy," was introduced and implemented in the 5th-7th grades in 2022/23 and extended to the 8th grade in 2023/24, with at least one hour per week in the timetable, resulting in a total of at least four weekly hours in lower secondary education.

The "Digital Literacy" curriculum also serves as preparation for computer science lessons in the 9th grade and various informatics subjects in upper vocational schools. With the digi.check, based on the digi.komp competency model (aligned to the EC DigComp Framework), students and educators can assess their digital and informatics competencies. The digi.komp model defines target competencies that students and educators should acquire in their educational or professional careers.

Azerbaijan
"Digital Skills," and "STEAM Azerbaijan" projects are the main programs for enhancing the of ICT in education in Azerbaijan.

The "Digital Skills" project was introduced in 2017. As part of this initiative, informatics classes focusing on computer science and programming with special curricula were established in Azerbaijan. Additionally, a pilot project called "Algorithmics: The Methodology of Teaching Programming" has been launched, aiming at teachers' professional development in the field by teaching the use of the Scratch programming language.

Unfortunately, there is no special assessment for the use of ICT in education. ICILS will be the first program in Azerbaijan. Schooling during the COVID-19 pandemic relied on the virtual TV broadcast and Microsoft Teams Platform in Azerbaijan.

Belgium (Flemish)
In Belgium (Flemish), the Flemish Ministry of Education and Training is responsible for establishing the overarching goals of the education system. This ministry sets policies and guidelines, but schools enjoy considerable autonomy in managing their education and making decisions at the school level, such as HR policies, educational projects, and financial management. This autonomy allows schools to adapt their educational policies to the specific needs of their students and communities.

In response to the COVID-19 crisis, Belgium (Flemish) launched the Digisprong programme in 2021, aiming to create a digital transformation of education and improve ICT infrastructure in Flemish schools. This programme contains four key components: a future-oriented and secure ICT infrastructure for all schools, a strong supporting and effective ICT school policy, ICT-competent teachers and teacher trainers with adapted digital learning tools, and a knowledge and advice center named "Digisprong" serving the educational field.

Since September 2019, secondary education in Belgium (Flemish) has been gradually modernized, starting with grades 7 and 8. This modernization introduced a renewed curriculum, which now includes content such as digital literacy and computational thinking, previously limited or absent. These topics are covered under Flemish attainment targets that have a transversal character, making them relevant across different subject areas and encouraging an integrated teaching approach. However, in 2023, the attainment targets for grades 9 to 12 were revised, resulting in clearer and more evaluable formulations with a reduced focus on competencies related to computer and information literacy and computational thinking from grade 9 onwards.

The supervision by the Belgium (Flemish) inspectorate ensures that schools comply with legal requirements and monitors and improves the quality of education. This includes assessing how schools pursue attainment targets, focusing on digital literacy and computational thinking, and monitoring the use of ICT to enhance education quality for all students.

During the most disruptive periods of the COVID-19 pandemic, schools in Belgium (Flemish) relied heavily on ICT for teaching and learning, particularly in secondary education. Remote learning platforms, video conferencing tools, and digital resources were widely used to ensure continuity of education while schools were closed.

Bosnia and Herzegovina

The Bosnia and Herzegovina education system is highly decentralized. Primary education is governed by the Framework Law on Primary Education and the laws and regulations of the entity or canton where a school is located.

The Ministry of Civil Affairs of Bosnia and Herzegovina has a coordinating role at the state level regarding education and educational systems. There are 13 ministries of education in Bosnia and Herzegovina located in the Republika Srpska, the 10 cantons in the Federation of BiH,[5] and the Brčko District of BiH. Ministries at different levels of government share roles and responsibilities. The curricula under the relevant administrative units should be aligned with the Common Core Curriculum (CCC). In practice, this varies. All administrative units have Informatics as a compulsory subject but the subject starts in different grades, from the first to the sixth. At the level of BiH, the Agency for Preschool, Primary, and Secondary Education has been established. It is an independent administrative organization in the field of preschool, primary, and secondary education. The Agency operates at the state level with an advisory role. It is responsible for establishing learning standards, evaluating results, developing the Common Core Curriculum, evaluation of education quality, and for conducting large-scale international education surveys.

In addition to adhering to the laws and regulations of the relevant ministries (entity, cantonal, administrative units), schools also respect the freedom of teachers to conduct their classes as they deem appropriate. However, schools must consider the standards and sustainability of existing and the application of new forms and methods in the teaching process.

UNICEF has launched an initiative to improve education quality in Bosnia and Herzegovina amid the COVID-19 pandemic. A key outcome is the “Basic Technical Standards for ICT Tools in Educational Systems in BiH,” approved by the Ministry of Civil Affairs. This document guides the standardization and categorization of ICT equipment for schools across the country. It sets minimum standards for acceptable ICT equipment, aiding educational authorities in standardizing technology used in educational institutions throughout all administrative units in BiH.

Chile

The Ministry of Education has the responsibility to delimit and establish the goals of the education system in Chile. In the Educational Strategy of Public Education, there is a strategic objective to, “strengthen human and technical capacities of key actors of the system through the improvement of their practices.” This objective has the duty of giving continuous training to teachers and principals in remote software that can support education (Ministerio de Educación de Chile, 2022, p. 6). On the

5 In the Federation of Bosnia and Herzegovina, there is also a Federal Ministry of Education, which has a coordinating role among the 10 cantonal ministries of education in the Federation of Bosnia and Herzegovina.

other hand, the Ministry of Education in 2023 announced a revision of the educational curriculum to incorporate content about digital technologies such as coding and artificial intelligence (Ministerio de Educación de Chile, 2023). In this line, the Ministry of Education launched in May 2023 a guide for teachers about the use of ChatGPT.

The Law of Digital Transformation of the State (Law 21.180, (Gobierno de Chile, 2019)) was published in November 2019 and ratified in June 2022. In this context, the Ministry of Education has a plan for Digital Transformation that seeks to close gaps in the access to technology resources, connectivity, and digital skills development of educational communities. To reach this objective the ministry has four lines of action: a) Connectivity: to provide high speed internet to schools, b) Skills development: to support the development of skills in the educational communities and to seize opportunities related to digital infrastructure and equipment, c)Infrastructure: to facilitate access to technology resources, connectivity, and skills development, d)Technology innovation: to meet and follow advances in and innovations associated with digital technologies, and to promote in the education system those that can contribute to educational improvement.

In practice, one of the most recognized programs in Chile for 2023 was the mentoring program that can operate remotely with volunteers that can teach basic content to students who need it in anywhere Chile. With respect to assessment, a technical-professional online assessment was initiated, and Chile also completed the OECD online Survey on Social and Emotional Skills in 2023. The pandemic provided great impetus for the use of digital strategies of assessment in Chile.

Chinese Taipei

In Chinese Taipei, the Ministry of Education in Taiwan is primarily responsible for establishing the overarching goals and direction of the education system.

In 2019, the implementation of the 12-Year Basic Education Curriculum Guidelines began. A revised national curriculum aligning with the evolving trends in ICT and CT education was initiated. The use of ICT is considered one of the six themes of the learning content in the curriculum. For all levels of K-12 education, 19 defined issues are integrated into various disciplines, with Information Technology being one of these issues. Subsequently, a 4-year nationwide project titled “Every Classroom Has Internet Access, Every Student Has a Tablet” commenced in 2022. This initiative primarily aims to enhance students’ abilities in utilizing digital technology for self-directed learning, supply learning devices to all elementary and junior high schools, improve bandwidth for supporting wireless internet access in classrooms, and reduce the urban-rural digital divide in ICT education. During the COVID-19 pandemic, digital learning devices were provided to economically disadvantaged students. Furthermore, the government has been implementing initiatives to assist in providing digital teaching resources for teachers and establishing professional communities for them to enhance their innovative teaching skills and motivation.

Students learn both ICT and CT through various courses that integrate information technology at the elementary level and through a dedicated Information Technology course at the high school level. Information Technology is now a compulsory subject starting in the 7th grade. This curriculum was initially drafted by computer science experts and computer science teachers from elementary and secondary schools, taking into consideration the developments in information technology and trends in computer science education. It was then subjected to multiple revisions through various public hearings and review meetings before the final version was determined. Through teacher professional development workshops and the systematic provision of instructional resources, teachers are progressively equipped with the ability to teach the content of the new curriculum.

Finally, multiple research-driven initiatives, supported by various governmental units, research centers, and funding agencies, have been undertaken to develop metrics for assessing the effectiveness of ICT in learning and teaching environments. These metrics focus on several aspects, including the use of digital devices, teachers’ professional development in ICT, the extent of teacher involvement in digital teaching, their attitudes towards ICT use, and the enhancement of students’ academic performance through ICT. These metrics are not limited to the aforementioned areas. Nonetheless, as of the latest update, an official policy to systematically evaluate these factors has not yet been fully established.

Croatia

In Croatia, the Ministry of Education is responsible for defining the structure and direction of the education system, as well as national curriculums with educational outcomes. When it comes to ICT in education, there was a Ministry initiative in 2017 when 200 primary schools were each equipped with one computational classroom with 20 computers. The initiative continued in 2018 and another 430 primary schools were equipped in the same way. A new national curriculum for Informatics (i.e., Computer Science) was developed in the school year 2020/2021.

Computer Science was introduced as an elective subject for students in grades 1 to 4 (ISCED 1), compulsory for students in grades 5 and 6 (it was previously an elective) and remained as an elective for students in grades 7 and 8. From 2018 to 2023 there was an important national project called "e-schools" run by the government agency CARnet and supported by the Ministry. The main goal of the project was to raise the digital infrastructure of all schools in Croatia as well as the digital competencies of the teachers and other school staff through various online educations and online digital resources. Within the project, important research on the use of ICT in education was conducted, some of which included external assessment and self-assessment of school ICT infrastructure as well as digital competencies of teachers, principals, and school staff.

During the COVID-19 pandemic, the whole education system went online. In a short period of time, with the support of the Ministry, a substantial number of digital resources were developed, and many teachers were involved in developing digital materials. Educational TV shows were organized for the youngest students (ISCED 1) and teachers started using learning management systems and video conference software more than before.

Cyprus

In Cyprus, educational policy is centrally administered by the Ministry of Education, Sport, and Youth. Public schools must adhere to national curricula, regulations, and guidelines issued by the Ministry. Private schools, however, have more autonomy. Many choose to follow the Ministry's curricula and regulations, or they may opt for a different curriculum of equal standing, approved by the Ministry according to national legislation.

The delivery of ICT education depends on the school type, curriculum followed, and ISCED level. National curricula, followed by all public schools and some private schools, dictate ICT learning outcomes at each educational level. At ISCED1, some ICT concepts, such as internet safety, are integrated into other subjects. At ISCED2 (and year 1 of ISCED3), ICT skills are taught primarily as a separate subject (ICT/Computer Science), which is compulsory for all students and taught for two periods per week. At ISCED3 (years 2 and 3), ICT becomes an optional four-period subject for students following specific pathways.

At ISCED2, assessment is carried out by teachers at the school level, following guidelines and recommendations issued by the Ministry. Schools may select from various recommended assessment approaches, including tests, quizzes, projects, in-class activities, and homework. Typically, students are assessed through one or more written or practical tests per term. Since 2016, the ISCED2 curriculum covers material coinciding with four ECDL modules: Word Processing in year 1, Spreadsheets and Presentations in year 2, and Databases in year 3. Students can certify the corresponding ICT skills at no cost.

A curriculum evaluation and reform are currently underway, expected to enhance the level of ICT-related skills mastered by students.

The COVID-19 pandemic necessitated the implementation of distance learning at all educational levels. This required providing infrastructure, training, and support to all public schools, teachers, and students. Through an existing contractual agreement, all public-school teachers and students were assigned Microsoft 365 accounts, and the Teams online platform was used as the primary tool for administering classes during lockdown periods. Efforts were made to provide students of lower socioeconomic standing with devices (tablets) and internet connectivity. There were also incentives for teachers to purchase laptops for preparing and administering distance learning lessons. School infrastructure was upgraded with new computers, video projectors, cameras, and microphones to support both distance learning and hybrid models for students quarantined at home. Training for teachers in using distance learning tools was conducted, with support provided by the Ministry's ICT unit and local ICT teachers at schools.

Czech Republic

The Ministry of Education, Youth, and Sports (MEYS) is responsible for overseeing and regulating the education system in the country. Among its various responsibilities, it establishes educational policies and shapes curriculum development.

In 2021, the Ministry introduced a new concept of CIL and CT learning, in connection with the Strategy for Education Policy of the Czech Republic until 2030. The MEYS decided to revise curricular documents (Framework Education Programmes). The cross-curricular topic of informatics and information and communication technologies underwent the most significant change targeted at all levels of education (i.e., ISCED 0-3). So far, the reform has made the most progress at primary and lower secondary levels, as basic schools could start teaching according to the new informatics/ computer science curriculum as early as September 2021. However, the obligation to teach according to revised documents for basic schools did not begin until 2023 at the 1st stage (i.e., primary level) and a year later at the 2nd stage (i.e., lower secondary level) of basic schools.

Unlike the previous educational content of ICT in basic schools, which emphasized the ability to use computers and information and digital literacy, this "new informatics" focuses primarily on the development of computational thinking and understanding the principles of how digital technologies work. The new informatics is based on the active approach in which students use informatics procedures and concepts—algorithms, coding, modeling, etc.. The reform also introduces the inclusion of a new key competence—digital—and significantly strengthens the instruction time of informatics at ISCED levels 1 and 2.

The use of ICT in education is built upon the national-level Framework Educational Programme, with each school responsible for concurrently developing its own School Educational Programme. At the national level, The Czech School Inspectorate conducts external evaluations of schools, including ICT use.

During COVID closures, nearly all schools employed a hybrid approach to distance learning, utilizing digital technologies for online instruction alongside offline educational activities. In response to these challenges, various initiatives emerged to support both schools and students in adapting to the new educational challenges. Notably, the Učíme online or #UčímeSeNaDálku projects. In spring 2020[6], the primary focus was on basic digital technology proficiency and technical mastery of video conferencing tools. However, later the emphasis shifted towards a more prominent didactic mastery of online learning.

Denmark

In Denmark, education is compulsory for children from age six. For the target grade of ICILS 2023, 75 percent of students attended public schools (folkeskoler), while the remaining 25 percent attended private schools or independent residential schools. The Danish education system is governed by the Ministry of Education and the Ministry of Higher Education and Science. The 98 municipalities are the school owners. Public schools are regulated by the Folkeskole Act, which provides an overall framework

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for the Danish school system. Within this framework, each municipality in Denmark can make decisions about its public schools, including economic resources and school structure. The national curriculum, described in the Common Objectives (Fælles mål), must be met by each municipality.

Each school has its own school board, comprising mostly parents, but also including students, teachers, school management, and, if desired, a representative from the municipality. The municipality can delegate decisions to the school board but must ensure that each school meets relevant legal requirements.

The national curriculum contains no compulsory ICT subjects. Instead, ICT is integrated into all subjects according to the standards. National exams, tests, and evaluations of students' learning outcomes only indirectly assess students' ICT competencies. Since the 1990s, the government and municipalities have continuously funded the integration of ICT into teaching and learning. Between 2011 and 2017, they provided one billion DKK to support digital learning materials. In line with the global interest in CT, and acknowledging students as producers, not just consumers, of ICT, the Danish Ministry of Education initiated an experiment in 2018 by introducing Technology Comprehension as both a subject and integrated into existing subjects. Forty-six schools participated. The curriculum includes four competence areas: Digital Empowerment, Digital Design and Design Processes, Computational Thinking, and Technological Knowledge and Skills.

There is no compulsory test for students' CIL. Schools can choose to test their students if they wish, and municipalities can decide that their schools should test students in CIL. However, no municipality has mandated this. During the COVID-19 pandemic, Danish schools relied heavily on ICT. For long periods, schools were closed for physical attendance, and classes were conducted via digital video systems like Teams. There was an increased use of digital learning platforms, communication software, and drawing and graphics software to ensure continuity of education.

Finland

The Finnish National Agency for Education, operating under the Ministry of Education and Culture, is responsible for developing and steering education policies and guidelines in Finland. This includes setting curriculum frameworks, learning objectives, and guidelines for different education levels. The use of ICT in education is a key component of the national core curricula, recognized as a transversal competence across all subjects.

Several programs have been funded to support the implementation of ICT in education, aligning with both local and European frameworks. Key plans and policies set during or after ICILS 2018 include:

- The National Core Curriculum for Basic Education (Finnish National Agency for Education, 2014)
- Government Report: Digital Compass (Finnish Government, 2022)
- The Finnish Framework for Digital Competence (Finnish National Agency for Education, 2022)
- Advocacy Programme: "Digitalisation as an Enabler for Learning Reform, Equality, and Accessibility" (Finnish National Agency for Education, 2019)
- Policies for the Digitalisation of Education and Training until 2027 (Finnish National Agency for Education, 2023)
- Target State of Digitalization of Early Childhood Education, Preschool, and Basic Education (Berisha et al., 2023)

The national core curriculum for basic education was updated in 2014 and implemented gradually between 2016 and 2019, placing a stronger emphasis on ICT competence, including CT and CIL. This change required municipalities and schools to update their ICT strategies. Subsequent updates were made also to the curricula for general upper secondary education in 2019 and early education in 2022. In 2020, the "New Literacies" development program was launched to further define digital competence and support curriculum implementation.

All schools in Finland adhere to the national core curriculum, which includes ICT-related objectives and core content. Education providers, typically municipalities, and schools develop their own curricula and ICT strategies within this national framework, allowing schools to tailor their implementation of ICT.

Schools and education providers conduct self-evaluations, and national and international assessments measure learning outcomes in various subjects. Since ICT is not an independent compulsory subject, students' ICT skills are primarily assessed through research-based assessments like ICILS or optional courses. Teachers' use of ICT in teaching is also monitored only through research-based surveys and assessments.

During the COVID-19 pandemic, Finnish schools were closed for 2 months starting in March 2020, except for students needing special support, children of essential workers, and students in grades 1–3 had a possibility to study at school. Schools and teachers determined how to utilize existing digital infrastructure, such as online learning environments, instant messaging, and social media, or opted for independent study using schoolbooks.

France

The Ministry of Education in France is responsible for outlining educational training, setting national curricula, organization and the content of teaching, issuing national diplomas, recruiting and managing staff, allocating educational resources to ensure equal access across the public service, monitoring and evaluating education policies and to ensuring the overall coherence of the education system.

IT teaching is funded by the general budget of the French Ministry of Education. However, depending on the school, other funding is allocated to public schools. For primary schools, the town is the main source of funding. For middle schools, it is the Département; for high schools, the region. Finally, specific funding from the State for teaching IT is regularly injected into school budgets.

The main changes concerning ICT education are following:

- In 2019: creation of the PIX certificate, at the end of middle schools and high schools. This is a certification of computer and digital skills (https://pix.fr/). Pix certifies that pupils have mastered digital skills in grades 9 and 12.
- In 2020: General Assembly on Digital Technology in Education (https://www.education.gouv.fr/les-etats-generaux-du-numerique-pour-l-education-304117). The COVID-19 crisis has highlighted digital inequalities in France: computer access, equipment, connections, and disparities in usage. The Ministry of Education has therefore launched a plan to remedy the situation (https://www.education.gouv.fr/strategie-du-numerique-pour-l-education-2023-2027-344263).

ICT is taught at all school levels. ICT is mentioned in curricula at all levels without differentiating CIL and CT in terms of learning and skills. However, from nursery to elementary school (grade 2), this teaching is an introduction to computing. From grade 3 onwards, ICT becomes an assessed learning subject right up to the end of secondary school. This diploma is compulsory before moving on to the next grade.

During the period of lockdown from 17 March to 11 May 2020 (i.e., 1 month and 25 days); from 30 October to 15 December 2020 (i.e., 1 month and 15 days); from 3 April to 3 May 2021 (i.e., 28 days), the COVID-19 pandemic has had the effect of creating a new form of distance learning: courses, assessments, communication with families, etc. However, teachers were free to choose the form of communication and the media they used: videoconferencing, videos, digital workspace, and lessons sent by e-mail or in mailboxes.

Germany

Germany is a federal republic consisting of 16 states.[7] Each federal state holds supreme legislative authority over all cultural policy issues within its boundaries. This includes administrative power over the state's education system such as regulation of curricula and time schedules, teacher recruitment, professional requirements, and quality professional development in schools.

The national strategy "Education in the Digital World" (KMK, 2016) established the first cross-federal ICT policy regarding digital competencies in Germany. It intended to promote students' individual and self-directed learning, strengthen individual maturity, identity formation, and self-confidence, and enable self-determined participation in the digital society. It brought a nationwide change since the federal states committed themselves to modernizing their curricula and using ICT for teaching and learning as early as elementary school. Since 2016, most of the federal states have made changes to the curricula and supported implementation.

In 2021 the strategy was updated via an additional policy paper which included plans, goals, and policies concerning further aspects of teaching and learning in the digital world (KMK, 2021). The addendum includes re-definitions of the roles of school principals and administration to better support students' development. It also addresses students' competencies, new testing formats, and learning potentials in the digital world, which is perceived as very innovative for Germany. In terms of teaching, the paper refers to pedagogical professionalism, development processes at the school level, the design of learning processes, teacher competencies, and teacher training. ICILS 2023 will be the first study to reveal the potential impacts of this strategy. Additionally, a national extension of TIMSS 2023 will provide information and help monitor digital teaching and learning in primary education.

In the context of the "DigitalPakt Schule" (2019–2024), the German government is also investing in digital education infrastructure by supporting states and municipalities in equipping schools with better ICT equipment as well as technical support. Furthermore, the pandemic was very much associated with a digital shift in schools in terms of a re-organization of teaching and the necessity of distance learning. The additional investment of about 6.5 billion euro into the "DigitalPakt Schule" helped to improve the technical situation in many schools and an increasing number of schools took the opportunity to focus on digital learning options. However, it has not yet been proved whether these efforts achieved sustainable pedagogical changes.

Greece

In Greece, the responsibility for establishing the overarching goals and direction for the education system lies with the Ministry of Education, Religious Affairs and Sports. The Institute of Education Policy (IEP) is a scientific and research organization that supports the Ministry and its supervised bodies in matters related to primary and secondary education curricula, teacher training and other educational policies. The Computer Technology Institute and Press "Diophantus" (CTI Diophantus) is a research and technological organization focusing on research and development in Information and Communication Technologies (ICT) that supports the Ministry. Together, these institutions collaborate to enhance the quality of education by integrating scientific research, curriculum development, teacher training, and advanced ICT solutions.

Several reforms have been advanced during the last 3 years following its strategic goals of upgrading digital and soft skills, promoting inclusive learning and enhancing school autonomy. With regards to ICT in education, the curriculum reform has been accompanied by an emphasis on computational thinking development. Moreover, there is a slight increase in the number of teaching hours for Computer Science, which is provided as a compulsory subject for all students from grade 1 of primary education throughout most of the span of school education. The curriculum approaches to digital competence

7 The country profile for Germany includes information relative to the benchmarking participant North Rhine-Westphalia (Germany), which is one of the 16 German federal states. A separate profile for North Rhine-Westphalia (Germany) has not been included.

include teaching and learning through a separate subject or other subjects (integrated approach). As part of continuing professional development for all teachers, the IEP and CTI Diophantus provide digital skills training on an annual basis.

The Digital Transformation Bible 2020–2025 (Ministry of Digital Governance, 2021) (which is based on on Ministerial Decision 120301 ΕΞ 2021, Government Gazette 2894/B/5-7-2021 https://search.et.gr/el/fek/?fekId=561903) is a record of the necessary interventions in the technological infrastructure of the state, in the education and training of the population for the acquisition of digital skills, and in the way Greece uses digital technology in all sectors of the economy and public administration. It describes more than 400 specific projects designed for the achievement of the relevant goals. Greece plans substantive investments in the digitalization of schools, to be financed from the Recovery and Resilience Facility (RRF) until 2025. Schools are currently in the process of upgrading their technological equipment (desktops, laptops, interactive projectors, network connections—VDSL, and internal cabling for internet connectivity for each classroom). The IEP's projects, including a new digital learning platform and teacher training for new technology equipment and digital content, are funded by the European Regional Development Fund (ERDF) and the European Social Fund (ESF). During the COVID-19 pandemic, in addition to necessary curriculum adjustments and teacher training on distance learning methods and the use of the appropriate software (facilitated by the Ministry and CTI Diophantus), Massive Open Online Courses (MOOCs) were designed by IEP (in collaboration with the Hellenic Open University and the University of the Aegean) for the further training of all schoolteachers. MOOCs were attended by more than 12,000 teachers. Additionally, with the support of the IEP and the Ministry of Education, hundreds of online lessons for students have been developed, which they can access on demand. Finally, a guide for the educational planning of e-lessons was developed for teachers, summarizing the basic principles for the most efficient implementation of distance education.

Hungary

Central management or supervision of public education belongs to the Ministry of the Interior. Within the ministry, the State Secretary for Education is responsible for formulating comprehensive goals related to education. Vocational and higher education is under the supervision of the Ministry of Culture and Innovation.

Vertical management is divided between central (national), regional, and to a certain extent institutional levels in public education. In 2013 the maintenance of state educational (formerly municipal) institutions was taken over by a central state institution: the Klebelsberg Center. This central body performs the central management tasks and supports the coordination of the school districts. Institutional maintenance is the responsibility of the 60 district-level school district centers.

Due to the COVID-19 pandemic, the schools were closed, and digital learning was mandatory twice, first in the spring of 2020[8] and then at the end of 2021. Many schools also ordered temporary teaching breaks for individual classes or the whole institution as needed. A Hungarian Digital Education Strategy was published in 2016, but only a small part of the tasks was completed before 2020. In 2020, schools were given laptops, which made it possible for a significant part of the students to follow school expectations.

The Educational Authority published recommendations to provide comprehensive support to educators teaching in online education. Electronic versions of textbooks and smart textbooks were also available for grades 5 to 12. Microsoft Office 365 ProPlus was also available to all teachers and students for free.

As the pandemic progressed, most schools were increasingly able to create conditions for distance education. Schools teaching disadvantaged students found this to be particularly challenging.

8 20 March to 19 June, 2020.

Italy

The Ministry of Education and Merit (MIM) establishes the broad principles and regulations for the public education system. The key document outlining the goals of digital education is the National Plan for Digital Education (Piano Nazionale Scuola Digitale), which encompasses 35 comprehensive actions for ICT development in public education. The curriculum is guided by different key documents based on the different school grades: the National Guidelines for the Curriculum of Preschool and First Cycle of Education, focusing on preschools, primary schools and lower secondary schools (up to grade 8); the National Guidelines for lyceums; the Guidelines for technical education; and the Guidelines for vocational education. These documents guide actions, tools, and strategies to acquire essential ICT skills to complete each educational phase. The integration of ICT and its educational application is seen as a cross-curricular objective essential for meeting the requirements of every subject. Each school has the autonomy to monitor and evaluate students' progress in ICT, utilizing various tools. The ministry has provided competence certification models that schools can tailor to their needs, featuring a dedicated section for digital competencies.

In Italy, from March 2020 until the end of the 2019/2020 school year, schools were closed due to the COVID-19 pandemic. During the 2020/21 school year, the duration of periods of suspension of in-person teaching varied between different school orders and territories. The Ministerial Decree (DPCM) of 11 March 2020, made activating distance learning mandatory in all schools. Each school could decide how many hours of synchronous teaching to conduct, but the School Plan for Integrated Digital Teaching, issued in the summer of 2020,[9] set a minimum of 15 hours per week of synchronous mode teaching. Classrooms and content for digital learning and digital communication modes were provided to students in most schools (about 90%), in addition to printed materials and non-digital communication.

The Ministry of Education allocated 85 million euros for distance learning activities: 70 million were earmarked to provide digital devices and connectivity to children and youth from socio-economically disadvantaged backgrounds, 10 million to schools to acquire educational platforms, and 5 million to teacher training.

Kazakhstan

The Ministry of Education of the Republic of Kazakhstan is the state central authority responsible for managing education and protecting children's rights. Education curricula and assessments are standardized across the country and implemented in each region and district. The educational process in secondary schools in Kazakhstan follows the Model Curricula approved by the Minister of Education.

Since 2022, ICT has been taught from grade 1 as a subject called "Digital Literacy." Previously, students were introduced to Informatics only in grade 5. The instructive letter "On the Features of the Teaching and Educational Process in Secondary Education Organizations of the Republic of Kazakhstan in the 2023-2024 Academic Year" emphasizes the development of interdisciplinary training in cross-cutting digital skills. These skills, unrelated to a specific subject area, aim to provide a high level (3 and 4) of CIL on the ICILS CIL scale.

In schools, students' ICT competences are assessed through criteria-based assessment, including both formative and summative assessments. In higher educational institutions in Kazakhstan, the discipline "Information and Communication Technologies" is a mandatory component of the program, regardless of the student's specialty. For teachers, the TALIS 2018 results showed that a high proportion (90%) of Kazakhstani teachers participated in advanced training courses on developing ICT skills for teaching. Additionally, as part of the mandatory attestation, teachers are expected to use ICT resources (either ready-made or their own) during their lessons.

During the global pandemic, Kazakhstan, with 5,197 schools located in rural areas (75% of all schools in

9 20 June to 21 September, 2020.

the country), purchased digital devices for low-income families and more than 400,000 students. The country utilized free online platforms and websites offered by private companies. Almost 75 percent of the student population (2.5 out of 3.4 million) continued learning remotely through various formats. Over 320,000 teachers and 2,000 education method specialists were trained to conduct distance lessons (UNESCO Almaty Office, 2021). The need to adapt the learning process to smartphones, coupled with low internet speeds, led to WhatsApp and Telegram becoming the most popular methods of communication and learning. Students from large cities noted that their teachers used a combination of online platforms to organize the learning process, including Zoom, Google Classroom, Microsoft Teams, and instant messengers (Aliyeva & Kovyazina, 2020).

Korea, Republic of

The Ministry of Education (MOE) has traditionally set the goals and direction of the education system in Korea. However, with the establishment of the National Education Commission (NEC) as an administrative committee under the President of Korea in 2022, the NEC now plans the nation's education system, including the educational vision, mid- to long-term policy directions, school systems, and teacher policies. The current curriculum, revised in 2022, defines digital literacy as one of the three fundamental literacies, alongside traditional literacy and numeracy. To support this, the MOE developed and distributed casebooks to cultivate digital literacy and incorporate ICT into all subjects. The research team responsible for the informatics education curriculum has created digital literacy-related content elements, which have been distributed to be included in each subject's curriculum. Specifically, for middle school students, it is mandatory to take the informatics subject, which is closely related to computational thinking (CT).

Following the COVID-19 pandemic, in 2020, the MOE announced the establishment of a digital transformation education foundation as one of the ten policy tasks for future education transition. In 2021, as part of measures to recover learning loss due to COVID-19, the Ministry has been establishing digital infrastructure in classrooms to facilitate new teaching and learning methods such as online and offline blended learning. The policy aims to gradually provide one smart device per student for classroom use and one informatics teacher per school. In 2022, the government prepared a 'Comprehensive Plan for Nurturing Digital Talent' to support the expansion of digital education opportunities and strengthen competencies, with the goal of training one million digital talents by 2026. For example, to enhance digital competencies among elementary and secondary students, the number of instructional hours for informatics education has been increased, and new elective courses have been introduced. An ICT-based teaching and learning support system has been established to enable teachers to utilize various ICT tools and resources. Additionally, AI-based digital textbooks, providing customized education based on student diagnostics and analysis, are being developed and will be gradually distributed starting in 2025.

During the COVID-19 pandemic, the MOE supported online education using a public learning management system called 'E-Hacksouptuh.' Developed to strengthen public education and reduce educational disparities, 'E-Hacksouptuh' allows each provincial and metropolitan office of education to modify and supplement it to suit their characteristics, offering real-time online classes, various content, and assessment items.

Kosovo

Responsibility for establishing the overarching goals and direction for the education system in Kosovo is with the Ministry of Education, Science, Technology, and Innovation.

There is a new curriculum, and the government now is working on school digitalization to use ICT in schools.

Some schools have already been digitalized, and some are in the way of getting digitalized. During the COVID-19 pandemic, e-learning was applied in all schools.

Latvia

The education system in Latvia is managed at the national, municipal, and institutional levels. At the national level, the Parliament (Saeima), the Cabinet of Ministers, and the Ministry of Education and Science are the main decision-making bodies.

The major levels of education are preprimary education, including compulsory education for children aged 5 and 6; compulsory general basic education (grades 1 to 9); general secondary education (grades 10 to 12); and higher education. Basic education consists of two stages: the first stage comprises grades 1 to 6, and the second stage comprises grades 7 to 9.

From October 2016 to October 2021, the National Centre for Education (NCE) developed a new, competency-based curriculum. The aim of the new curriculum is to develop value-based knowledge, skills, and attitudes necessary for the 21st century. The curriculum is being implemented gradually over 5 years, starting in 2019, at all education levels (from the age of 18 months, when children begin to attend preprimary education, up to grade 12, when they graduate from secondary education). The curriculum states that students will acquire ICT knowledge throughout all levels.

With the new competency-based curriculum, teachers are free to choose the most suitable assessment type and decide how frequently to assess students. The main types of assessment are diagnostic, formative, and summative.

When schools were closed during the COVID-19 pandemic, they pivoted to distance learning. Schools could freely choose the platform (e.g., Zoom, Teams) and methodology (e.g., sending instructions/tasks, video instructions/tasks, contacting students and/or their parents by phone, etc.). At the beginning of the pandemic, teachers had few tools specifically created for distance learning, so they had to adapt existing ones. Later, many online learning platforms became available for everyday learning. Teachers were provided with emotional and technical support and received financial assistance to manage the increased workload. During the pandemic, the Latvian government provided students with necessary devices (such as smartphones and tablets) and improved internet quality by signing the memorandum Powerful Internet for Every School in Latvia in cooperation with partners. With the help of teachers and the government, a variety of online learning platforms were created. Additionally, the Latvian government signed the memorandum Computer for Every Child, in which participants aim to provide each student and teacher with a computer necessary for the learning process by 2025.

Luxembourg

In line with the rapid development of ICT in society, Luxembourg has been developing and implementing new strategies for digital education in schools over the last 5 years. These strategies have been initiated and coordinated by the Ministry of National Education, Children, and Youth, as both formal and non-formal education fall under its authority. The digital strategy, which sets out the guiding principles for what digital education in schools should focus on, was launched in 2020 and is called 'Einfach Digital.'

These guiding principles are known as the five Cs: Critical thinking, Creativity, Communication, Collaboration, and Coding (MENJE, 2020). The strategy proposes a transversal, competence-based approach. The objective is to develop students' digital competencies and skills to solve environmental, social, and technological problems (MENJE, 2021). Students will need to learn how to use the principles of technology and automation to produce information that is relevant to developing science and society. The general framework for teaching and evaluation is provided by the 'Guide de référence pour l'éducation aux et par les medias' or 'Medienkompass' (SCRIPT, 2020), written and published under the coordination of the Service de Coordination de la Recherche et de l'Innovation pédagogiques et technologiques or SCRIPT.

SCRIPT is the driving force behind educational development in Luxembourg, charged with promoting, implementing, and coordinating pedagogical and technological innovation throughout the Luxembourg education system. This document was the starting point for defining the digital literacy to be acquired in everyday school life. It also has provided pedagogical support for teachers to actively participate in the implementation and integration of this framework into classroom practice. The next concrete step was to introduce a new subject called 'Digital Sciences' in secondary education starting in 2021. The new subject was first introduced in a pilot phase with the participation of eighteen schools to enrich the framework and gain practical experience. By 2025, 'Digital Sciences' will be introduced in all secondary schools in three grades.

During the COVID-19 health crisis, schools were closed for only 2 months at the primary and secondary levels. During this period of distance learning, teaching and learning relied on the use of ICT, guidance, materials, and digital learning tools provided in a coordinated manner at the national level through the Schouldoheem | Schouldoheem. lu (school from home) website, with a live helpdesk provided by SCRIPT.

Malta

The Directorate for Digital Literacy and Transversal Skills within the Ministry for Education, Youth, Sport, Research, and Innovation (MEYR) in Malta has been at the forefront of fostering digital competencies among educators and students. For over a decade, it has provided resources and pedagogical expertise to integrate CT and coding across the curriculum, aligning with both local and European frameworks such as the National Curriculum Framework and the Digital Education Action Plan 2021–2027.

Annually, the Directorate participates in events such as EU Code Week, Hour of Code, and EU Robotics Week, organizing school activities to promote computational thinking and coding. It also encourages other educators to lead similar activities in their schools. The CT Programme, launched in collaboration with the eSkills Malta Foundation is a pilot project, involving primary schools that aims to introduce innovative teaching approaches and foster CT and coding competences. The Cloud-based Ecosystem for developing 21st-century skills for students in years 1–6 (typically ages 5 to 11 years), is a program which empowers learners to take ownership of their education and become digital publishers. Additionally, the Directorate organizes Family Coding sessions and the EMBED event to celebrate technology use across the curriculum. The Directorate hosts the National eTwinning office, connecting educators across Europe to collaborate on projects that introduce students to programming and CT, fostering technical skills, creativity, problem-solving, and logical thinking.

The ICT C3 programme, introduced in year 7 (typically ages 11 to 12 years) in 2018/19, focuses on digital fundamentals necessary for 21st-century skills, including digital ethics, safety, coding, robotics, and more. This programme complements other digital subjects offered as electives in secondary schools and leads to a qualification certified on the Malta Qualifications Framework.

The One Tablet Per Child project, initiated in 2016, aims to enhance learning, develop digital skills, promote digital inclusivity, and reduce early school leaving. Over 15,000 devices were distributed between 2016 and 2018 to students from year 4 to year 6 (typically ages 8 to 11 years) . This initiative, partly financed by the EU, continues with 5,000 tablets procured annually for year 4 students. MEYR plans to expand this project to middle and secondary schools to support personalized and independent learning.

To support these digital education initiatives, Malta offers extensive teacher training programs. Digital Literacy Support Teachers and Heads of Department provide pedagogical support across primary and secondary schools, guiding the effective integration of technology into the curriculum. The Information Management Unit within the Ministry offers IT support to ensure smooth technology operation in educational settings. Additionally, teachers can enhance their digital skills through professional development courses at the Institute for Education and training by the eSkills Malta Foundation through its Annual Digital Skills Bootcamp.

Netherlands

In the Netherlands, the Ministry of Education has tasked the Curriculum Development Foundation (SLO) with the responsibility of defining the overarching goals and direction for the education system. As of 2024, the goals are still being updated.

The Ministry of Education funds public organizations that provide guidelines and tools to support schools in the professional use of ICT and ensure that technology is used to improve the quality and accessibility of education and to further manage safety and ICT risks. These organizations contribute to the safe use of ICT in education through three complementary roles: (1) guide for schools and boards that must make choices about the use of ICT, (2) developer and service provider of public IT facilities chain, and (3) architecture of the sectoral and supra-sectoral ICT infrastructure in education.

In 2022, the Ministry of Education has classified digital literacy as a fundamental 'basic skill' (next to language, mathematics, and citizenship). The Curriculum Development Foundation is currently (at the time of writing this profile) working on defining the end goals for digital literacy, the end goals are still in progress and therefore not have not yet been implemented.

Schools have a high degree of autonomy to shape the use of ICT in education themselves. There are large differences between schools in the way they teach digital literacy and consecutively difference in levels between students.

Schools are free if and how they assess ICT education. Since digital literacy is not yet part of the end goals of the curriculum, it is not compulsory to test these skills. When the new end goals for digital literacy have been defined and presented, assessing digital literacy will likely be compulsory.

During the most disruptive period of the COVID-19 pandemic, schools were closed and basically, every school in the Netherlands completely relied on ICT for teaching and learning, providing distance education.

North Rhine-Westphalia (Germany)—ICILS 2023 Benchmarking Participant

North Rhine-Westphalia (NRW), Germany's largest federal state with 18 million inhabitants, holds supreme legislative and administrative power over cultural policy, including the education system. This encompasses regulation of curricula, teacher recruitment, professional requirements, and quality development in schools. The nationwide strategy "Education in the Digital World" by the German Standing Conference of Ministers of Education and Cultural Affairs (KMK) in 2016 established the first cross-federal ICT policy in Germany, which is also relevant for NRW. This strategy aims to promote individual and self-directed learning, strengthen individual maturity, identity formation, self-confidence, and enable self-determined participation in the digital society. It led to a nationwide shift as all federal states were supposed to modernize their curricula and integrating ICT in education from elementary school onwards. In 2021, the strategy was updated with an additional policy paper, which redefined the roles of school principals and administration to better support students' development, addressed student competencies, new testing formats, and the innovative potentials of digital learning. It also emphasized pedagogical professionalism, school-level development processes, learning design, teacher competencies, and teacher training. Another significant initiative, "DigitalPakt Schule" (2019–2024), is also relevant for NRW. This initiative involves substantial investment by the German government to improve the digital education infrastructure, equipping schools with better ICT tools and technical support. The COVID-19 pandemic accelerated the digital shift in schools, necessitating distance learning and reorganization of teaching methods. The "DigitalPakt Schule" allocated about 6.5 billion euro to enhance the technical situation in many schools, promoting digital learning options, although it is yet to determine if these efforts resulted in sustainable pedagogical changes.

Specific to NRW is the "Media Competence Framework NRW" (Medienkompetenzrahmen NRW) established in 2017. Based on the above mentioned "Education in the Digital World" strategy, it identifies six competence areas. The first five areas pertain to CIL, while the sixth area shows high affinity to CT. This framework served as the basis for revising all curricula at the primary and lower secondary levels, aiming to integrate digital media use across all subjects and foster the development of digital competences. Since 2018 additional support programs, such as the "Good School 2020" (Gute Schule 2020) funding program, were initiated to improve educational infrastructure and comprises aspects of supporting digital learning.

Moreover, from March 2022 to June 2023, an extensive digital in-service training initiative was conducted for school principals, teachers, and state teacher training moderators, focusing on practical applications of digital media.

Norway

The Norwegian Ministry of Education and Research oversees national educational policy, implementing a centralized curriculum for grades 1 to 13, approved by Parliament through a Ministry-initiated process involving expert groups. The Norwegian Directorate of Education and Training acts as the Ministry's executive agency, granting local schools and teachers, significant autonomy within the curriculum framework to choose textbooks, instruction methods, and organizational strategies.

Since 2006, CIL has been a fundamental interdisciplinary skill alongside reading, writing, numeracy, and oral skills, integrated into other subjects rather than assessed separately. In 2020, a revised national curriculum enhanced digital competence, particularly in CT and programming, and placed greater emphasis on critical thinking and digital judgment. Programming was introduced as an elective subject, assessed locally but not included in national exams.

In 2023, Norway introduced a national strategy for digital competence and infrastructure in kindergarten and education for 2023–2030, following a previous strategy for primary and secondary education (2017–2021), and an action plan for digitalization in schools. This new strategy expanded to include kindergarten (pre-primary school). Based on this strategy, many local and regional authorities developed their own strategies and action plans. In 2017, the Norwegian Directorate for Education and Training launched the Professional Digital Competence Framework for Teachers. This framework serves as a guidance document for policy developers, heads of departments, teacher educators, teachers, student teachers, and others to enhance the quality of teacher education and systematic continuing professional development (CPD). The framework has been widely used to develop national guidelines for teacher education, plan and implement both initial and continuing teacher education, and evaluate and follow up on teachers' professional digital competence. Professional digital competence is now an obligatory part of all CPD course studies for teachers. The Directorate also introduced CPD courses in digitalization for school leaders and studies in professional digital competence for teacher specialists.

Over the past 5–7 years, most students have been provided with a digital unit (1:1 computing) in school, a decision made by local/regional authorities and school owners rather than a national strategy. This widespread availability of digital units facilitated the transition to online teaching and learning during the COVID-19 pandemic, especially for target grade students. Younger students (grades 1–4, and partially grades 5–7) were prioritized for physical attendance at school. In spring 2020,[10] the Directorate introduced a competence package for teachers to support distance learning during the pandemic.

Oman

The Ministry of Education in Oman manages grades 1 to 12, overseeing educational policies, national standards, curricula, textbooks, student assessments, school operations, and providing a range of support. The Ministry collaborates with educational directorates across governorates and is gradually increasing administrative autonomy with budgetary authority.

Oman has pursued a knowledge-based economy and digital society through Oman Vision 2040, focusing on human capacity building, infrastructure development, and e-governance. The education

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system has seen significant developments aligned with global standards, with ongoing improvements outlined in the tenth 5-year plan. To meet Vision 2040 and technological advancements, the Ministry introduced the implementation of an international IT series courses and professional development for educators. This project began with grades 1–2 in 2022/2023 and grades 3–4 in 2023/2024, with plans for further expansion.

The Curriculum Development Directorate develops the in-house IT curriculum, used by grade 8 students in ICILS 2023. ICT skills are integrated into all subjects to enhance both student learning and teaching methods. The Directorate of Educational Supervision monitors the implementation of the IT curriculum and integrated ICT skills in other subjects, overseeing teaching and learning processes and producing annual reports. The Center for Educational Assessment and Measurements (CEAM) prepares assessment documents for IT subjects for all grades, detailing assessment criteria. CEAM uses performance data from all subjects for moderation reports. To evaluate ICT programs, Oman participated in ICILS 2023 for further ICT teaching and learning development.

The Specialized Institute for Professional Teacher Training conducts a variety of programs using different platforms, training over 56,000 teachers. The Ministry ensures that teachers are equipped with the necessary skills to use modern technology in teaching and learning. Various digital resources are provided, including audio materials, educational films, guides for teachers, and YouTube and TV channels, offering educational lessons for students.

During the COVID-19 pandemic, the Ministry adapted teaching, learning, and evaluation methods for 2020/2021. Schools employed a blended learning approach, combining online platforms (Google Classroom/Google Meet) with traditional methods. Continuous Assessment (CA) was applied for the entire year, curriculum content was reduced, and learning time was increased by re-purposing examination days for study. Teachers received support in lesson planning and assessment preparation aligned with the blended learning model. The Ministry of Education continues to facilitate blended learning approach insuring continuing in education during different challenges.

Portugal

The Portuguese education system includes three levels of education: preprimary education (ages 3 to 5, non-compulsory), compulsory education (ages 6 to 17), and higher education (ages 18+). Compulsory education is divided into basic education organized three sequential cycles: grades 1 to 4, grades 5 to 6 and grades 7 to 9, and secondary education. Compulsory education for 12 years of schooling was first applied through the grade 7 or below population of students in 2009–2010. The Ministry of Education defines and enforces core curricula and learning goals for each level of education and subject. The education network comprises state-funded public schools as well as private schools.

ICT is an area of transversal curricular integration in grades 1–4. It aims for students to develop critical, reflective, and responsible attitudes when using digital technologies. It further aims for students to develop skills in: researching and analyzing online information; communicating appropriately using digital resources; thinking creatively, through the exploration of ideas and the development of computational thinking with a view to producing digital artifacts. In grades 5–9, ICT goes beyond the development of basic generalized digital literacy. It moves into the field of developing students' analytical skills by exploring age-appropriate computing environments and emerging technologies. ICT Essential Learning is organized into four areas of work: safety, responsibility, and respect in digital environments; research, and investigation; collaboration and communication; and creativity and innovation.

Assessment is an integral part of educational practice, enabling the systematic collection of formative and summative information by school essential for making appropriate decisions to improve the quality of student learning. Schools have pedagogical autonomy to define the assessment and monitoring criteria for each grade and study cycle by the orientation and goals of the national curricula. At a national level, students' learning is monitored through low-stakes testing provided by the National Education Assessment Institute (IAVE) in grade 2, 5, and 8.

In 2023, ICT was part of the low-stakes assessments administrated to students in grade 8. This was a digital test with no impact on students' progression administrated through a digital platform. All students and schools received individualized reports of their performance. The Portuguese Ministry of Education launched the Action Plan for the Digital Transition in the last 5 years based on three dimensions. Firstly, digital training for teachers to enable and motivate them to use digital technologies with confidence. Secondly, digital school development to develop and implement an Action Plan for the Digital Development of Schools (PADDE) as an instrument for reflection and change of practices in education. Lastly, digital resources and contents to develop and provide digital resources and contents, ensuring their quality, relevance, and accessibility for all students and teachers.

Romania

Romania has been progressively integrating information and communication technologies (ICT) into its education system. This began with revisions to policy documents and the implementation of national programs. In 2001, the Romanian government launched an 8-year program that established, among other things, 5,000 computer labs with internet access. In 2003, Computer-Assisted Instruction became a mandatory course for prospective teachers in the initial teacher training curriculum.

In 2015, Romania adopted a national strategy on the Digital Agenda, outlining actions in key areas that included the use of digital technologies in education. In 2022, the DigCompEdu framework was integrated into Romanian legislation through a decree by the Minister of Education.

The national curriculum includes "Informatics and ICT" as a compulsory core subject with one hour of instruction per week throughout the lower secondary grades. The recommended approach focuses on generalized information processing processes rather than learning specific applications. It aims to develop digital skills for efficient use of computing and communication techniques, critical and creative spirit through the creation of IT products, and construction of information processing algorithms.

The intended curriculum of Informatics and ICT covers about three-quarters of the DigCompEdu framework at the intermediate level, with a slight asymmetry in favor of programming and algorithmic thinking. The general competencies set as learning outcomes are: (i) responsible and effective use of computing and communication technology; (ii) solving elementary problems by building algorithms for information processing; and (iii), and creative development of IT products.

These learning outcomes unfold in specific competencies targeting knowledge, skills, and attitudes in a spiral curriculum progressing from the basics of ICT to more advanced ones. For example, at grade 5 themes include: (i) the effective and safe use of the internet as a source of information; (ii) building algorithms using sequential structure to solve simple problems and (iii); and creative expression using simple digital game-building applications. At grade 8 themes include: (i) using spreadsheets to help solve simple real-world problems; (ii) identifying strings of values in different processing contexts in order to build algorithms; and (iii) implementation of algorithms in a programming environment.

Serbia

The Ministry of Education in Serbia is responsible for setting the overarching goals and direction for the country's education system, as articulated in the Serbian Education Development Strategy 2030. This strategy encompasses several specific objectives aimed at advancing digital education at the pre-university level, including:

- Increasing the number of schools meeting the requirements for blended and online teaching and learning;
- Enhancing the digital capacities of schools through self-evaluation;
- Improving the functionality of the Education Information System;
- Establishing a public online elementary and grammar school; and
- Continuously monitoring the development of digital education.

In a broader educational context, the desired outcome of the learning process goes beyond knowledge acquisition. It also focuses on transforming knowledge into practical skills and fostering attitudes that enable students to navigate complex social situations effectively.

Within primary education, the development of ICT skills, CT, and information literacy is facilitated through two mandatory school subjects: “Digital World” (introduced in 2020/21) and “Computer Science” (implemented in 2017/18). In the early grades (ages 7 to 10), the “Digital World” curriculum covers topics related to the digital society, safe digital device usage, and CT. For older students (ages 11 to 14), “Computer Science” delves into ICT, digital literacy, and CT. Both subjects are taught for one hour per week. Additionally, project-based learning, which incorporates basic ICT skills, CT, and information literacy, is promoted through methodological instructions for teachers and integrated into each school subject’s curriculum.

To support these initiatives, a public Learning Management System (LMS) platform called “My School” is available for schools to create and manage their online classrooms. Additionally, there is a repository of Digital Open Educational Resources dedicated to educational purposes. Recent enhancements include the release of revised version of the Digital Competence Framework for Teachers. Furthermore, a draft versions of the Digital Competence Framework for Principals and Indicators for assessing the development of digital education have been developed, demonstrating a commitment to ongoing improvement in digital education in Serbia.

Slovak Republic

Education is mandatory in the Slovak Republic from ages 6 to 15. Education in all types of schools (ISCED 0–3) is delivered in compliance with the state education program, which prescribes the content of the school subjects. The state educational program is published by the Ministry of Education, Science, Research and Sport of the Slovak Republic (Ministerstvo školstva, vedy, výskumu a športu Slovenskej republiky); it was last revised in 2023.

In the Slovak Republic, ICT/computer science is taught as a separate subject called “Informatics”. Informatics is compulsory for pupils from grade 3 to grade 8, with a time allocation of one class per week. Schools have the option to incorporate Informatics into their curriculum in grades 1, 2, and 9 as well. The prescribed content of the subject at elementary schools is comprehensive, covering both effective and safe use of computer software and hardware, as well as aspects of CT like algorithmic problem solving and programming, which are introduced in later grades.

Reflecting the rapid growth of ICT use in recent years, digital competencies have been added to the state education program’s key competencies. Recent updates of the state educational program have shown an effort to balance aspects of computer literacy and CT, with the latter gaining increasing importance. The revision also increases the weekly time allocation for Informatics to one class per week in grades 1–3, two classes per week in grades 4–5, and three classes per week in grades 6–9. This change is expected to increase the demand for qualified teachers, which is already very high.

During the COVID-19 pandemic, the Slovak government introduced strict lockdown measures, including long-term school closures. Teaching and learning transitioned to online classes. Around 10 percent of pupils, mainly those with low socioeconomic status and low access to technology missed out on online education completely. The use of online learning using the pandemic has not resulted in great changes in online learning thereafter. Schools in the Slovak Republic take part in a voluntary, non-representative internet-based IT Fitness Test administered annually by the Ministry of Education. The testing is designed to assess the ICT knowledge and skills of Slovak students with the aim of improving ICT education in the country.

Slovenia

The Ministry of Education holds the prime responsibility for education in Slovenia. However, it receives operational support from the public National Education Institute Slovenia (ZRSŠ).

In 2016, the Ministry established The Expert Working Group of the Ministry of Education for the Inclusion of the Fundamental Contents of Computing in Slovenian Education (RINOS). In its first report, RINOS made recommendations covering issues of Informatics education, digital literacy, teacher education, and the educational ecosystem. In the second report, RINOS prepared an action plan for introducing Informatics as a compulsory subject, and in the third report, it developed the curricular framework for Informatics in pre-college education.

In 2022, the Ministry of Education published the document "Action Plan of Digital Education 2021–2027." This document addressed six areas: National Coordination, Didactics, Changes in Programs and Work Requirements, Education and Training, Ecosystem, and Education Under Special Circumstances. Around the same time, ZRSŠ started the ongoing curricular reform, which also included a reflection on ICT use and digital literacy in education. Digital literacy is meant to be part of all subjects through the EC DigComp framework.

In 2023, the Ministry launched the project "Digitainable Teacher" (i.e., digital and sustainable), targeting teachers in primary and secondary education to equip them with digital competencies. Also in 2023, the Government of Slovenia published "Digital Slovenia 2030—The Umbrella Strategy for the Digital Transformation of Slovenia until 2030." This strategy emphasizes the development of digital literacy through the DigComp competence set for compulsory education. The Ministry launched a project of experimental classes in 2023, introducing Informatics as a special subject with a limited scope.

Most of these changes resulted from the COVID-19 pandemic, which caused schools to lock down and required the introduction of remote (distance) education. Consequently, Learning Management Systems (LMS) such as Moodle, offered through ARNES (The Academic and Research Network of Slovenia), and videoconferencing systems like Zoom and Teams were introduced. The Ministry also tried to highlight a set of prepared e-textbooks (pubishers opned them for free for that time), though their use varies.

The use of ICT in different subjects is an ad-hoc process. There is no overall assessment activity specifically targeting the use of ICT in education. The COVID-19 pandemic had a decisive impact on the use of ICT in teaching. Besides the already introduced e-Asistent tool, many materials were offered through LMS or via email, while teaching was conducted using videoconferencing systems. Some schools provided computers to students who did not have access to a computer.

Spain

Spain is organized in several regions (Autonomous Communities) where the responsibility for school education rests primarily within State/Provincial authorities. The Ministry of Education establishes overarching goals, national core curriculum, and general guidelines for assessment, promotion across grades, and qualifications. The current education regulations are based on the 2006 Organic Law of Education (LOE), which has been sequentially modified by the 2013 Organic Law for the Improvement of Educational Quality (LOMCE) and the current 2020 Organic Law for the Modification of the Organic Law of Education (LOMLOE). Autonomous Communities also have some freedom in terms of school organization, curriculum development, assessments, or financial and personnel management. With the current LOMLOE law, their curriculum autonomy has been increased up to 40–50 percent, depending on regional languages.

Regarding the curriculum, it is important to mention that the LOMCE curriculum was in place by the time grade 8 Spanish students participated in ICILS 2023. Traditionally, the use of ICT in education has been implemented across different subjects. The current LOMLOE educational law has more specific content and has introduced "Technology and Digitalization" as a compulsory subject. Autonomous Communities have also developed their subjects related to robotics, programming, computing, etc. The new competency-based curriculum establishes an exit profile containing five operational indicators for internal/external assessments of the digital key competence. Current educational law includes ICT use assessment integrated into other competence assessments, but Autonomous Communities and schools can also develop and implement their assessment criteria.

In the last 5 years, the country has experienced several CIL changes through Spain's Digitalization and Digital Competences of the Educational System Plan. Digital competence has been deeply developed in the curriculum. A Reference Framework for Teachers' Digital Competence has been published to accredit their CIL level. The Connected Schools program provides good broadband connectivity to schools. The Educate in Digital initiative offers 500,000 devices to reduce the digital divide. EU-Next Generation funds are making it possible to digitize 240,000 classrooms and provide 300,000 computers/tablets. The plan also creates/disseminates open digitalized educational resources, programs, and materials.

During the COVID-19 pandemic, distance and blended learning were established. ICT was widely used in teaching and learning, ranging from online lessons to the development of learning platforms, but the effectiveness was limited by the number of digital devices available in some cases. Later, top-level authorities upgraded digital resources with major investments (e.g., computers, internet connection) and drafted some guidelines for schools and teachers to support training deficits.

Sweden

The Swedish education system is highly decentralized. The Parliament and government define a national curricula while central authorities, municipalities, and various institutions, such as independent school organizers, ensure that educational activities align with the legislative framework. The Swedish National Agency for Education is responsible for evaluating and supporting the development of school activities. Since 2020, it has a responsibility for supporting digitalization in the school sector, ensuring that the school system can fully utilize opportunities that digitalization can offer to enhance student goal achievement and education equality.

The first national digitalization strategy for the school system was established by the government in 2017 and remained valid until 2022. This strategy emphasized equal access and use of ICT, as well as adequate digital competence for students and teachers. It aimed to ensure that all students possess the digital competencies needed as citizens, and in their working lives. In line with the strategy, four key aspects of digital competence were included across subjects in a revision of the curricula and syllabi available from 2017, which become mandatory from 2018:

1. The ability to use and understand digital systems
2. The ability to relate to digital information critically and responsibly
3. The ability to solve problems and turn ideas into action creatively using digital technology
4. Understanding how digitalization affects individuals and society

Another point of particular interest involves programming, which constitutes a major change in the Swedish curricula. The strategy, the inclusion of digital competence in curricula and the increased emphasis on programming all affect the target grade for ICILS and the cohort for ICILS 2023. To enhance teachers' computer programming skills, several university courses, conferences, and workshops for teachers in mathematics and technology were set up in 2017, peaking in participation in 2018 and 2019. The use of ICT in education is evaluated through national surveys and reports conducted by central educational authorities and at the local school level.

Regarding COVID-19, Sweden did not implement a general closure of primary schools. Most early childhood education and primary schools remained open, even during the most disruptive periods. The same was true for lower secondary schooling, although distance education increased during the pandemic, peaking in the first half of 2021. Distance education was more common in upper secondary schooling. ICT was essential for teaching, examining, and interacting with students during these periods, often taking hybrid forms.

United States

In the United States, most education policy is decided at the state, district, and school levels. State and local governments are primarily responsible for setting overarching goals for their education systems. Each state has a Department of Education that determines education policies and standards. Typically, states establish a statewide curricular framework and allow local districts to customize their approach. As a result, ICT curriculum development and implementation vary across states and districts. Most states have educational standards that include technology integration and outline the technology knowledge and skills students should acquire. Many states also create computer science standards for K-12. Data on the use of ICT in education may be tracked by schools, districts, and states and can also be collected via federal surveys with nationally representative samples and by national non-profits.

Several U.S. initiatives and programs support ICT. In 2022, the United States Department of Education (USED) Office of Educational Technology (OET) launched the Digital Equity Education Roundtables Initiative to foster equity in technology access due to continued disparities in home internet access for some populations. Through the E-Rate program, the Federal Communications Commission (FCC) continues to provide discounts for telecommunications and internet access to eligible schools and libraries to ensure schools have the infrastructure to support the use of ICT. In 2024, OET released its most recent National Educational Technology Plan that outlines a national vision for technology in education. The plan focuses on three key areas: how students use technology; how educators design learning experiences enabled by technology; and equitable access to educational technology for both students and educators. Additionally, OET is developing policies on AI-enabled educational technology to support students with disabilities and language learners, and it also offers professional development in ICT for educators.

The United States Department of Education (USED) periodically releases National Educational Technology Plans that outline a national vision for technology in education. In 2022, USED's Office of Educational Technology (OET) launched the Digital Equity Education Roundtables Initiative to foster equity in technology access due to continued disparities in home internet access for some populations. Additionally, OET is developing policies on AI-enabled educational technology to support students with disabilities and language learners, and it also offers professional development in ICT. Furthermore, the Federal Communications Commission (FCC) administers the E-Rate program, which provides discounts for telecommunications and internet access to eligible schools and libraries to ensure schools have the infrastructure to support the use of ICT.

Over the past 5 years in the United States, there have been significant changes in ICT in education. The COVID-19 pandemic caused most U.S. schools to close by March 2020, accelerating the adoption of remote and blended learning models. During the pandemic, schooling relied heavily on ICT, with most teaching and learning activities transitioning to a virtual setting. The FCC's Emergency Connectivity Fund supported schools and libraries by providing tools and services such as laptops, Wi-Fi hotspots, and off-campus broadband connectivity. Since schools reopened in the 2020–21 school year, blended and fully online learning have continued. Schools in some states have since emphasized teaching digital literacy skills, integrating technology into subjects to enhance learning, providing teachers with professional development opportunities to improve technology integration, and including coding and computational thinking in the K-12 curriculum. The policy priorities of states since the COVID-19 pandemic remained varied, with many states emphasizing workforce development and K-12 funding issues, for example. Everything considered, there remains significant variability in the amount of emphasis placed on digital literacy across the U.S.

Uruguay

Uruguay's education system has a unique structure where the main goals and direction of education are not managed by the Ministry of Education. Instead, the National Administration of Public Education (ANEP), an autonomous entity, is the state agency responsible for planning, managing, and administering the public education system including primary, secondary, vocational, and teacher education. ANEP oversees both public and private education.

ANEP is governed by the Central Directive Council (CODICEN), which consists of five members: its president and representatives from each of the four General Directions (General Direction of Initial and Primary Education, General Direction of Secondary Education, General Direction of Vocational Education (UTU), and Council for Teacher Education). The Ministry of Education provides guidelines and general strategic advice regarding education and cultural matters.

The goals of ANEP are to:

- prepare, implement, and develop educational policies that correspond to the levels of education imparted by the entity.
- guarantee education at different levels and educational modalities, ensuring access, retention, and graduation for all inhabitants.
- ensure compliance with national education principles and guidelines in areas of its competence.
- promote the participation of the whole society in the formulation, implementation, and development of education within its scope.

The government institutions; The National Institute for Educational Evaluation (INEEd) and Ceibal aim to ensure the quality of education and equitable access.

INEEd, established by the General Law of Education, evaluates the quality of national education through specific studies and the development of educational research lines. It aims to:

- Evaluate the quality of education in Uruguay at initial, primary, and middle levels.
- Provide information that ensures students' right to quality education.
- Publicize the degree of compliance with educational objectives and goals.
- Produce knowledge about evaluation processes and provide information about learning.
- Propose criteria and modalities for evaluation processes within the National Education System.
- Advise the Ministry of Education and Culture and ANEP on participation in international evaluation instances.

INEEd is a public institution governed by non-state law, meaning it operates autonomously and is linked to the Ministry of Education and Culture.

Created in 2007, Ceibal is Uruguay's digital technology center for education innovation at the service of public education policies. Every child entering the public education system receives a personal computer with free Internet access at school. Ceibal also provides programs, educational resources, and teacher training courses, transforming teaching and learning methods.

ICT infrastructure and selected economic characteristics of countries

ICILS is a study which, by definition is regarded as most immediately relevant to countries and education systems where the two achievement constructs, CIL and CT, are recognized, valued and deemed to be necessary foundations for successful participation in the contemporary digital world. This comes with the implicit assumption that participating countries have at least a basic level of digital infrastructure to support the use of ICT in education such that CIL and CT education can take place. With this in mind, we present selected indicators of the economic and ICT infrastructure characteristics of the ICILS 2023 countries. This information was collected from official data sources external to ICILS. These data, shown in Table 2.1 comprise:

- The percentage of individuals using the internet in the past 3 months (2021)

These data provide a general indication of the prevalence of internet within and among ICILS countries. The data were sourced from the International Telecommunications Union (ITU) (ITU, 2024b).

- The ICT Development Index (IDI) score and country rank (2023)

  The data provide a general indication of the development of the information and communication technology sector within and among ICILS countries. The IDI is a composite index that incorporates 14 different indicators relating to ICT access (household access and national infrastructure), use (individual use and internet traffic) and skills (education levels and individuals with specified ICT skills). Based on data collected for the 14 indicators, each country is given a score out of 100 that can be used to provide a benchmarking measure to compare ICT development levels with other countries, and within countries over time. Countries are ranked according to their IDI scores. The IDI is generated by the ITU (ITU, 2024a).

- Gross Domestic Product (GDP) per capita ($) (2022)

  These data provide an indirect measure of the per capita income within and among ICILS countries. While GDP per capita is often used to measure economic growth, in this case it is provided as a general indicator of the relative economic prosperity of ICILS countries. These data were sourced from the World Bank (World Bank, 2022).

- Gini coefficient (2021)

  These data provide an indication of the level of income inequality within and among ICILS countries. The Gini coefficient compares cumulative proportions of the population to cumulative proportions of income they receive. The Gini coefficient varies between 0 (income is equally distributed across the population) to 1 (one person has all the income). These date were sourced from the World Bank (World Bank, 2024a).

- Public expenditure on education (% of GDP) (2022)

  These data provide an indication of the priority given by governments, within and among ICILS countries, to education relative to other areas of investment. These data were sourced from the World Bank (World Bank, 2024b).

The data in Table 2.1 show some variation among the ICILS countries with respect to selected antecedent national economic and technological development characteristics. Internet use was generally high across ICILS countries, with at least 85 percent of people being estimated to have used the internet in the previous 3 months in 26 of 34 countries. This was particularly high in Denmark, Korea (Rep. of), Luxembourg, Norway, and the United States where these proportions were greater than 95 percent. In contrast, the lowest percentages of people reported to have used the internet in the past 3 months were in Greece (79%) and Bosnia and Herzegovina (76%). Internet use has become more prevalent since the previous cycle of ICILS. In ICILS 2018 we reported that more than 85 percent of people were estimated to have used the internet in the previous 3 months in four of the 12 listed countries (Fraillon et al., 2020). In ICILS 2023 this has increased to 10 of the 12 same countries that participated in ICILS 2018.

The IDI ranks of 23 of the ICILS countries places were in the top 50 countries in the world with respect to this indicator. The IDI ranks of two countries, Bosnia and Herzegovina (94) and Azerbaijan (84) were below 80.

There was also variation in the economic indicators across the ICILS countries. The GDP per capita ranged from a maximum of US$125,006 in Luxembourg to US$5,340 in Latvia. The middle 50 percent of ICILS countries had GDP per capita in the range between US$19,126 and US$48,718. The balance of income inequity reported by the Gini coefficient varied from 0.45 (Uruguay), 0.41 (Chile) and 0.40 (United States) to 0.26 (Netherlands, Czech Republic, Belgium (Flemish)), 0.24 (Slovenia), and 0.23 (Slovak Republic). The Gini index scores of 12 of the 32 countries for which the Gini has been reported

Table 2.1: ICT infrastructure and selected economic characteristics of the ICILS countries

Country	Percentage of individuals using the internet in the past three months (2021)	ICT Development index score (and country rank) (2023)	Gross Domestic Product (GDP) per capita ($) (2023)	Income Gini coefficient (2022)	Public expenditure on education (% of GDP) (2022)
Austria	93	93 (23)	56,506	[A]0.31	4.8
Azerbaijan	86	79 (84)	7,155	[F]0.27	2.9
[1] Belgium (Flemish)	93	88 (42)	53,475	[A]0.27	[A]6.2
Bosnia and Herzegovina	76	77 (94)	8,426	[E]0.33	
Chile	89	91 (32)	17,093	0.43	[A]4.0
Chinese Taipei	86	[3]95	[4]32,444	[5]0.34	[6]4.9
Croatia	81	87 (47)	21,460	[A]0.29	[A]5.2
Cyprus	91	87 (43)	34,701	[A]0.31	[A]5.5
Czech Republic	83	86 (55)	30,427	[A]0.26	[A]5.1
Denmark	99	97 (4)	67,967	[A]0.28	[A]5.9
Finland	93	97 (6)	53,756	[A]0.28	[A]5.7
France	86	89 (35)	44,461	[A]0.32	[A]5.2
Germany	91	87 (44)	52,746	[B]0.32	4.5
Greece	79	84 (68)	22,990	[A]0.33	[A]4.1
Hungary	89	87 (53)	22,147	[A]0.29	[A]5.0
Italy	82	86 (54)	38,373	[A]0.35	[A]4.0
Kazakhstan	91	89 (37)	13,137	[A]0.29	4.2
Korea, Republic of	98	94 (18)	33,121	[A]0.33	[A]5.4
Kosovo	89		5,943	[D]0.29	
Latvia	91	94 (19)	23,184	[A]0.34	[A]5.6
Luxembourg	99	92 (25)	128,259	[A]0.33	4.7
Malta	88	87 (50)	37,882	[B]0.31	[A]5.4
Netherlands	92	94 (20)	62,537	[A]0.26	[A]5.1
Norway	99	91 (31)	87,962	[C]0.28	4.0
Oman	[B]95	91 (33)	23,295		4.2
Portugal	82	86 (59)	27,275	[A]0.35	[A]4.6
Romania	84	87 (51)	18,419	[A]0.34	[A]3.3
Serbia	81	85 (63)	11,361	[A]0.33	[A]3.3
Slovak Republic	89	87 (48)	24,470	[A]0.24	[A]4.3
Slovenia	89	88 (41)	32,164	[A]0.24	[A]5.7
Spain	94	91 (29)	32,677	[A]0.34	[A]4.6
Sweden	95	94 (17)	56,305	[A]0.30	[A]6.7
United States	97	97 (7)	81,695	0.41	5.4
Uruguay	88	87 (49)	22,565	0.41	4.4
Benchmarking participant					
[2] North Rhine-W. (Germany)	91	87 (44)	52,746	[B]0.32	4.5

Notes: Percentage of individuals using the internet, ICT Development index score, and country rank data were collected from the International Telecommunications Union. Source: http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx [07/03/2024]. Data on GDP per capita, Gini coefficient, and public expenditure on education were collected from the World Bank database (Indicators NY.GDP.PCAP.CD, SI.POV.GINI, SE.XPD.TOTL.GD.ZS, respectively). Source: https://data.worldbank.org/ [26/09/2024].

[1] Data relates to Belgium.

[2] Data relates to Germany.

[3] IDI estimate provided by the National Research Center in Chinese Taipei. Estimate based on data provided by the government of Chinese Taipei for the IDI indicators.

[4] GDP per capita was collected from International Monetary Fund database. Source: https://www.imf.org/external/datamapper/NGDPDPC@WEO/TWN [07/10/2024]

[5] Gini was collected from Statista database. Source: https://www.statista.com/statistics/922574/taiwan-gini-index/ [06/09/2024]

[6] Public expenditure on education provided by Department of Statistics of Ministry of Education in Chinese Taipei.

[ABCDEF] Data relates to the following years: (A) = 2021; (B) = 2020; (C) = 2019; (D) = 2017; (E) = 2011, (F) = 2005 are between 0.23 and 0.39 (moderate inequality) and between 0.3 and 0.42 (high inequality) for a further 19 countries.[11]

Public expenditure on education was between 4 and 6 percent (inclusive) of GDP in 26 of the 31 countries for which data were available. The highest reported expenditure was in Sweden (6.7%) and Belgium (6.2%) and the lowest was in Romania (3.3%), Serbia (3.3%), and Azerbaijan (2.9%).

2.3 Inclusion of CIL and CT education at different levels of schooling

National centers were asked to report how each of CIL and CT education were intended to be included at each of three levels of schooling in their country: ISCED 1 (primary education); ISCED 2 (lower secondary education) and ISCED 3 (upper secondary education). For each of these three levels, and each of CIL and CT, respondents were asked to indicate the requirement for the learning area to be taught (compulsory, can be taught but not compulsory, not taught). Where CIL and/or CT were taught, respondents indicated whether they were taught: as separate subjects; together in a single subject; integrated into science/technology/mathematics subjects; or integrated into many subjects.

Across countries while there was considerable variation in the approaches taken with respect to the integration of CIL and CT in learning, there were also some patterns of similarity (Table 2.2). In general across countries, and across the three levels of schooling, there was slightly more inclusion of CIL than CT in teaching programs. In addition, the inclusion of CIL and CT in teaching was more prevalent in secondary schooling (lower and upper) than in primary schooling. In countries where both CIL and CT were included at an education level, CIL was relatively more likely than CT to be compulsory rather than non-compulsory.

Across countries where CIL was included at the primary schooling level, there were similar proportions of it being taught in a separate subject (with or without CT) or integrated with other subjects, and of this inclusion being compulsory or non-compulsory. In contrast, at secondary schooling levels there were higher proportions of countries where CIL was expected to be taught as part of a separate subject than integrated with other subjects. It should be noted that in many countries, CIL was taught both as a separate subject and integrated within other subjects. When CIL was expected to be taught as a separate subject, this was more commonly compulsory than non-compulsory in lower secondary schooling, and more commonly non-compulsory than compulsory in upper secondary schooling.

There was, however, considerable variation among countries in the number of subject areas in which CIL was expected to be integrated in teaching, and whether the integration was to be compulsory or non-compulsory. National centers from 22 countries reported that CIL was to be taught in at least 8 of the 12 listed subject categories across the three education levels. In Belgium (Flemish), Chile, Chinese Taipei, Denmark, France, Greece, Latvia, the Slovak Republic, and Spain, the inclusion of CIL in learning was compulsory in more than half the subject categories in which it was to be taught. In contrast, the inclusion of CIL learning was non-compulsory in more than half the listed subject categories in Austria, Cyprus, the Czech Republic, Germany (including the benchmarking participant North Rhine-Westphalia), Luxembourg, the Netherlands, Oman, Serbia, the United States, and Uruguay. In each of Finland and Kosovo, there were equal numbers of expectations across subjects that the implementation of CIL was compulsory and non-compulsory (Table 2.2).

There was similar variation in the requirement for CIL to be a compulsory or non-compulsory inclusion in countries where national centers reported that CIL was to be taught across fewer than eight of the 12 listed subject categories across the three education levels. In Norway and Sweden, at all three education levels, the integration of CIL was compulsory in many or all subjects (including science and/or technology subjects) without CIL being included as a separate subject. At all three education levels in in Hungary and Kazakhstan CIL was taught as a compulsory separate subject only, and in Bosnia and

11 The inequality labels and classification based on the Gini coefficient values are based on those suggested by Luebker (2010).

Herzegovina as a non-compulsory separate subject only.

Computational Thinking in primary schooling was more frequently integrated into other subjects (mathematics, science/technology, or many other subjects) than taught as a standalone subject in primary schooling when compared to secondary schooling (Table 2.2).

National centers from 19 countries reported that CT was to be taught in at least eight of the 12 listed subject categories across the three education levels. In Belgium (Flemish), Finland, France, Latvia, Norway, and Sweden the inclusion of CT in learning was compulsory in more than half the subject categories in which it was to be taught. In contrast, the inclusion of CT learning in subjects across the year levels was almost exclusively or largely non-compulsory in Austria, Chile, Chinese Taipei, Cyprus, the Czech Republic, Denmark, Italy, Luxembourg, the Netherlands, Oman, Serbia, Spain, and the United States.

In countries where national centers reported that CT was to be taught across fewer than eight of the 12 listed subject categories across the three education levels there was also some variation of approaches. In Bosnia and Herzegovina, Germany (including the benchmarking participant North Rhine-Westphalia), Kosovo, Slovenia, and Uruguay, any inclusion of CT was almost exclusively non-compulsory. In contrast, in Greece, Hungary, Kazakhstan, Portugal, Romania, and the Slovak Republic, the inclusion of CT in teaching was compulsory in any subjects for which it was included. In Croatia, Malta, and Korea (Rep. of), where CT was included in one subject at each level of schooling, it was compulsory at the lower secondary level, and non-compulsory in at least one other level (Table 2.2).

Table 2.2: National study center reports on the availability of CIL- and CT-related subjects at different levels of schooling

Country	ISCED 1 (primary)							
	CIL education				CT education			
	Taught as a separate subject	Taught with CT as part of a separate subject	Integrated within science and/or technology subjects	Integrated within many or all subjects	Taught as a separate subject	Integrated within mathematics	Integrated within science and/or technology subjects	Integrated within many or all subjects
Austria	–	–	◇	◇	–	◇	◇	◇
Azerbaijan	–	–	–	–	–	–	–	–
Belgium (Flemish)	◆	◆	◆	◆	◇	◇	◇	◇
Bosnia and Herzegovina	–	◇	–	–	◇	◇	–	–
Chile	◆	◆	◆	◇	◆	◇	◇	◇
Chinese Taipei	◇	◇	◆	◆	◇	◇	◆	◆
Croatia	◇	◇	–	–	◇	–	–	–
Cyprus	–	–	◇	◇	–	–	◇	–
Czech Republic	◆	◇	–	–	◇	–	–	–
Denmark	–	–	◆	◆	◇	◇	◇	◇
Finland	◇	◇	◆	◆	◇	◆	◆	◆
France	–	◆	◆	◆	–	◆	◆	◆
Germany	◇	–	◇	◆	–	–	–	◇
Greece	◆	◆	◆	◆	◆	–	–	◆
Hungary	–	◆	–	–	–	–	◆	–
Italy	–	–	–	–	–	◇	◇	◇
Kazakhstan	◆	–	–	–	–	–	◆	–
Korea, Republic of	–	–	◆	–	–	–	◆	–
Kosovo	–	–	–	–	–	◇	–	–
Latvia	◇	◆	–	–	◇	◆	◆	◆
Luxembourg	–	–	◆	◆	–	–	◆	◆
Malta	–	–	–	◇	–	–	–	◇
Netherlands	◇	◇	◇	◇	◇	◇	◇	◇
Norway	–	–	◆	◆	–	◆	◆	◆
Oman	◆	◇	◇	◇	◇	◇	◇	◇
Portugal	◆	–	–	◆	–	–	◆	–
Romania	–	–	◇	–	–	–	–	–
Serbia	–	◆	◇	◇	◆	◇	◇	◇
Slovak Republic	◆	◆	–	◇	◆	–	–	–
Slovenia	–	–	–	–	–	–	–	–
Spain	◇	◇	◆	◆	◇	◇	◇	◇
Sweden	–	–	◆	◆	–	◆	◆	◇
United States	◇	◇	◇	◇	◇	◇	◇	◇
Uruguay	◇	◇	◇	◇	◇	–	–	–
Benchmarking participant								
North Rhine-W. (Germany)	◇	–	◇	◆	–	–	–	◇

Notes: Data collected from ICILS 2023 national contexts survey.
◆ Compulsory to teach
◇ Available but not compulsory to teach
– Not taught

Table 2.2: National study center reports on the availability of CIL- and CT-related subjects at different levels of schooling (cont'd)

Country	ISCED 2 (lower secondary)							
	CIL education				CT education			
	Taught as a separate subject	Taught with CT as part of a separate subject	Integrated within science and/or technology subjects	Integrated within many or all subjects	Taught as a separate subject	Integrated within mathematics	Integrated within science and/or technology subjects	Integrated within many or all subjects
Austria	◆	◆	◇	◇	◆	◇	◇	◇
Azerbaijan	–	–	–	–	–	–	–	–
Belgium (Flemish)	◆	◆	◆	◆	◆	◆	◆	◆
Bosnia and Herzegovina	–	◇	–	–	◇	–	–	–
Chile	◆	◆	◇	◇	◆	◇	◇	◇
Chinese Taipei	◆	◆	◆	◆	◆	◇	◇	◇
Croatia	◆	◆	–	–	◆	–	–	–
Cyprus	◆	◆	◇	◇	◆	◇	◇	◇
Czech Republic	◆	◇	◇	◇	◇	◇	◇	◇
Denmark	–	◇	◆	◆	◇	◇	◆	◇
Finland	◇	◇	◆	◆	◇	◆	◆	◆
France	–	◆	◆	◆	–	◆	◆	◆
Germany	◇	◇	◇	◆	–	–	–	◇
Greece	◆	◆	◆	◆	◆	–	–	◆
Hungary	–	◆	–	–	–	–	◆	–
Italy	◇	–	◇	◇	◇	◇	◇	◇
Kazakhstan	◆	–	–	–	–	–	◆	–
Korea, Republic of	◆	◆	◇	–	◆	–	–	–
Kosovo	◆	◆	◇	◇	◇	◇	◇	–
Latvia	◆	◆	◆	◆	◆	◆	◆	◆
Luxembourg	◆	◆	◇	◇	◆	◆	◇	◇
Malta	–	◆	–	–	–	–	◆	–
Netherlands	◇	◇	◇	◇	◇	◇	◇	◇
Norway	–	–	◆	◆	◇	◆	◆	◆
Oman	◆	◇	◇	◇	◇	◇	◇	◇
Portugal	◆	–	–	–	–	–	◆	–
Romania	◆	◆	–	–	◆	–	–	–
Serbia	–	◆	◇	◇	◆	◇	◇	◇
Slovak Republic	◆	◆	–	◇	◆	–	–	–
Slovenia	◇	◇	–	–	◇	–	–	–
Spain	◆	◆	◆	◆	◇	◇	◇	◇
Sweden	–	–	◆	◆	–	◆	◆	◇
United States	◇	◇	◇	◇	◇	◇	◇	◇
Uruguay	–	◆	–	–	–	–	◆	–
Benchmarking participant								
North Rhine-W. (Germany)	◇	◇	–	◆	–	–	–	◇

Notes: Data collected from ICILS 2023 national contexts survey.
◆ Compulsory to teach
◇ Available but not compulsory to teach
– Not taught

Table 2.2: National study center reports on the availability of CIL- and CT-related subjects at different levels of schooling (cont'd)

Country	ISCED 3 (upper secondary)							
	CIL education				CT education			
	Taught as a separate subject	Taught with CT as part of a separate subject	Integrated within science and/or technology subjects	Integrated within many or all subjects	Taught as a separate subject	Integrated within mathematics	Integrated within science and/or technology subjects	Integrated within many or all subjects
Austria	◇	◆	◇	◇	◆	◇	◇	◇
Azerbaijan	–	–	–	–	–	–	–	–
Belgium (Flemish)	◆	◆	◆	◆	◆	◆	◆	◆
Bosnia and Herzegovina	–	◇	–	–	◇	◇	–	–
Chile	◆	◆	◇	◇	◆	◇	◇	◇
Chinese Taipei	◆	◆	◆	◆	◆	◇	◇	◇
Croatia	◇	◇	–	–	◇	–	–	–
Cyprus	◆	◆	◇	◇	◇	◇	◇	◇
Czech Republic	◆	◇	◇	◇	◇	◇	◇	◇
Denmark	◇	◇	◆	◆	◇	◇	◇	–
Finland	◇	◇	◆	◆	◇	◇	◇	◇
France	◇	◆	◆	◆	◇	◆	◆	◆
Germany	◇	◇	◇	◇	◇	◇	◇	◇
Greece	◆	◆	◆	◆	◆	◆	–	–
Hungary	–	◆	–	–	–	–	◆	–
Italy	◆	◆	◇	◇	◆	◇	◇	◇
Kazakhstan	◆	–	–	–	–	–	◆	–
Korea, Republic of	◇	◇	–	–	◇	–	–	–
Kosovo	◆	◆	◇	◇	◇	◇	◇	–
Latvia	◆	◆	◆	◆	◇	◆	◆	◆
Luxembourg	◇	◇	◇	◇	◇	◇	◇	◇
Malta	–	◆	–	–	–	–	◆	–
Netherlands	◇	◇	◇	◇	◇	◇	◇	◇
Norway	–	–	◆	◆	◇	◆	◆	◆
Oman	◇	◇	◇	◇	◇	◇	◇	◇
Portugal	◇	–	–	–	–	◆	–	–
Romania	◆	◇	–	–	◆	–	–	–
Serbia	–	◆	◇	◇	◆	◇	◇	◇
Slovak Republic	◆	◆	–	◇	◆	–	–	–
Slovenia	◆	◇	–	–	◇	–	–	–
Spain	◇	◇	◆	◆	◇	◇	◇	◇
Sweden	–	–	◆	◆	–	◆	◆	◇
United States	◇	◇	◇	◇	◇	◇	◇	◇
Uruguay	◇	◇	◇	–	◇	◇	◇	–
Benchmarking participant								
North Rhine-W. (Germany)	◇	◇	◇	◇	◇	◇	◇	◇

Notes: Data collected from ICILS 2023 national contexts survey.
◆ Compulsory to teach
◇ Available but not compulsory to teach
– Not taught

2.4 Details of system-level plans and policies for the use of ICT in education

The NCS included a series of five questions about the plans and policies that support the use of ICT in education. The first of these asked national centers to indicate the emphasis placed on improving student learning with respect to:

- Subject matter content (language arts, mathematics, science, etc.)
- Preparing students for using ICT in their future work
- Developing information literacy
- ICT-based skills in critical thinking, collaboration, and communication
- Increasing access to online courses of study (e.g., for rural students)
- Computer programming or developing applications for digital devices
- Responsible and ethical use of digital devices including cyber-safety

The second asked national centers to indicate the emphasis placed on the importance of each of the following infrastructure and learning resources:

- Provision of computer equipment and other ICT resources
- Maintenance of computer equipment and other ICT resources
- Renewal, updating, and replacement of computer equipment and other ICT resources
- Support for teachers for using computer equipment and other ICT resources in their work
- Access to digital educational resources
- Internet connectivity
- Within-school networking
- Home access to school-based digital education resources such as through school-hosted online portals
- Local (within your country) development of digital learning materials

The third asked about the degree of emphasis placed on each of following methods to support student learning:

- Pre-service teacher education in the use of ICT
- In-service teacher education in the use of ICT
- The use of learning management systems
- Reporting to parents
- Providing feedback to students

For each aspect within each of these three questions, national centers could indicate whether the aspect was explicitly stated, implied without being explicitly stated, or that there was no emphasis of the aspect in plans and policies for using ICT in education.

The use of ICT to improve learning

Across countries there was strong emphasis given to the seven listed aspects of ICT learning, with each aspect emphasized (implicitly or explicitly) in plans and policies by at least 26 countries (Appendix B, Table B.1). The aspects with the most frequently explicit representation in plans and policies addressed the *development of information literacy* (27 countries) and *ICT-based skills in critical thinking, collaboration, and communication* (27 countries). The aims of *preparing students for using ICT in their work*, and the *responsible and ethical use of digital devices including cyber-safety* were also frequently explicitly included in plans and policies (25 countries each). Azerbaijan, the Netherlands, Bosnia and Herzegovina, the Slovak Republic, and Slovenia were the only countries in which not one of these four aspects was explicitly stated in plans and policies.

The two aspects of improving student learning with the least explicit representation in the plans and polices for using ICT in education were, *subject matter content* (18 countries, although this was reported to be implicitly stated in a further 12 countries), and *increasing access to online courses* (12 countries, with reported implicit inclusion in 14 countries and no emphasis in eight countries).

The majority of countries reported that all, or almost all mentioned aspects of learning improvement were explicitly or implicitly included in their plans and policies. In six countries there was no emphasis for two or more aspects, these were: Slovenia and Romania (two aspects); Bosnia and Herzegovina and the Slovak Republic (three aspects); the Netherlands (six aspects), and Azerbaijan, where all seven aspects of the use of ICT to improve learning were not mentioned in the plans and policies.

Provision of ICT resources

Countries also reported high levels of explicit and implicit inclusion of ICT resources in their plans and polices for using ICT in education (see Appendix B, Table B.2). Eight of the nine listed resources were stated (implicitly or explicitly) in the plans and policies of at least 29 countries. *Internet connectivity*, the *provision of computer equipment and other ICT resources*, and *support for teachers for using computer equipment and other ICT resources in their work*, were all reported to be explicitly stated in the plans an policies for at least 27 countries and implicitly included in the remaining countries, except for two—Azerbaijan and the Netherlands. The ICT resources that were least included in countries' plans and polices were, *within-school networking*, *home access to school-based digital education resources such as through school-hosted online portals*, and *local (within your country) development of digital learning materials*. These had no emphasis in plans and polices in five, seven, and five countries respectively.

In general across countries, the majority of the resources were explicitly included in plans and policies. Exceptions to this are Hungary, Kazakhstan, Kosovo, and Serbia where there was a tendency for the ICT resources to be implicitly rather than explicitly included in the plans and policies for using ICT in education. Azerbaijan, Croatia, and the Netherlands reported a relatively lower emphasis on ICT resources. In Croatia, five of the nine listed ICT resources were implicitly included with the remaining four not included, in Azerbaijan one ICT resource was implicitly included with eight not included, and in the Netherlands, none of the nine listed ICT resources were included in plans and polices for using ICT in education.

Methods to support student learning

The five listed methods to support student learning were also generally strongly represented in the plans and policies of ICILS countries (see Appendix B, Table B.3), with each method included (implicitly or explicitly) in the plans and policies of at least 28 countries. The two methods associated with teacher education (pre-service and in-service education in the use of ICT) were the most frequently explicitly included in plans and policies for using ICT to support student learning across countries. These were included explicitly in 22 and 24 countries respectively, and not included at all in plans and policies of three and two countries respectively. In contrast, each of, the use of learning management systems and reporting to parents and providing feedback to students, were explicitly included in plans and policies in not more than 15 countries.

In comparison with improving student learning within subject areas and the provision of ICT infrastructure, there was a tendency for the listed methods to support student learning to have higher proportions of implicit inclusion in plans and policies across countries. All five methods to support student learning were included in plans and polices in 23 countries, although in eight of these countries the majority of methods were implicitly rather than explicitly included. In Croatia one method to support student learning was implicitly included with four not included at all, and in the Netherlands none of the five listed methods were included in plans and polices for using ICT in education.

Programs, resources, and goals

National centers were further asked to report on whether or not their plans and policies for using ICT in education referred to providing 1:1 computing in schools, and to report the degree of priority that was evident in the plans and policies for the following range of programs, resources, and goals:

- Professional development for teachers' pedagogical use of ICT
- Sufficient ICT infrastructure and resources in schools
- Development of ICT-related competencies in students
- Development and provision of digital learning materials
- Reduction of the digital divide between groups of students
- Improvement of administrative and management systems in schools
- Use of ICT to improve communication with parents
- Research within schools of the use of ICT in education
- Protection of students against emotional/social harm associated with ICT use (e.g., cyberbullying)
- Protection of students against physical harm associated with ICT use (e.g., neck pain, eye soreness, fatigue)

The plans and policies for using ICT in education referred to providing 1:1 computing in schools in 15 countries. The remaining 19 countries and the benchmarking participant North Rhine-Westphalia (Germany) reported that they did not.

The first five programs, resources, and goals listed above were those with the highest emphasis, with explicit inclusion in plans and policies of at least 22 countries. Additionally, each of these five were indicated to be *not a priority* in no more than three countries (see Appendix B, Table B.4). In contrast, the remaining five programs, resources, and goals were explicitly included in plans and policies by between 10 and 17 countries (see Appendix B, Table B.4). These final five programs, plans, and goals tended to have relatively more implicit inclusion in plans, polices, and programs when compared to the initial five in the set listed above. Two of the items with relatively less explicit representation in plans and policies, *Protection of students against physical harm associated with ICT use*, and *research within schools of the use of ICT in education*, were listed as not being a priority in nine and 14 countries respectively. In contrast, all but one of the remaining items *use of ICT to improve communication with parents* was listed as not being in a priority in at most three countries.

Similar to the previously reported attributes of plans and policies for using ICT in education, most programs, resources, and goals were also strongly represented were strongly represented in national plans and polices. At least seven of the 10 programs, resources, and goals were explicitly or implicitly included in the plans and policies of 32 countries. There was, however, variation in the proportions of explicit and implicit representation across countries (see Appendix B, Table B.4). In 23 of these 32 countries, the majority of attributes were explicitly stated in plans and policies (with all 10 explicitly included in Chinese Taipei, Greece, and Oman). In Cyprus, the Netherlands, and Uruguay, equal numbers of attributes were explicitly and implicitly stated (with two attributes reported as not indicated as a priority in the Netherlands). In Kosovo, all 10 attributes were implicitly included, in Kosovo and Croatia seven were implicitly included, and in each of Serbia, Slovenia and Sweden there were three attributes were explicitly stated with five or six as implicitly stated, and the remaining reported to be not indicated as a priority. The lowest emphasis on the attributes was in Azerbaijan and Latvia where three items were implicitly included and the remaining seven not indicated as a priority in the plans and policies for the use of ICT in education.

2.5 Curriculum and learning goals related to CIL and CT

In addition to collecting information the broader plans and policies that shape CIL and CT education across countries, the NCS asked national centers to provide information about the extent to which the national curriculum emphasized specific learning content associated with each of CIL and CT, with or without learning goals, and whether there was mandated assessments of CIL and CT related skills at the target grade for ICILS (grade 8 or equivalent). The learning content selected for inclusion represents key themes derived from CIL and CT, as they are defined and described in the ICILS 2023 assessment framework (Fraillon & Rožman, 2024).

With respect to CIL, national centers were asked about the degree of emphasis placed on each of:

- Searching for information using ICT
- Evaluating the reliability of information sources accessed using the internet
- Presenting information for a given audience or purpose using ICT
- Organizing information obtained from internet sources
- Issues relating to intellectual property such as copyright and attribution sources
- Responsible and respectful publication of information
- Use of productivity tools (such as word processing, spreadsheet, and presentation software)
- IT security issues (e.g., passwords, malware, phishing)
- Data security (such as the collection of Internet use data by search engines and social media sites)
- Protection of students against emotional/social harm associated with ICT use (e.g., cyberbullying)
- Protection of students against physical harm associated with ICT use (e.g., neck pain, eye soreness, fatigue)

With respect to CT, national centers were asked about the degree of emphasis placed on each of:

- Planning technology-based products or solutions
- Developing technology-based products or solutions to meet user requirements
- Evaluating and refining technology-based products or solutions
- Creating visual representations (e.g., flow charts and decision trees) of processes
- Creating visual representations (e.g., tables, graphs, or charts) of information/data
- Designing user interfaces for technology-based products or solutions
- Revising technology-based products or solutions on the basis of user feedback or other data
- Creating algorithms
- Writing code, programs, or macros
- Evaluating code, programs, or macros
- Developing digital applications (e.g., programs/apps.)
- Identifying and describing the properties of digital systems

National centers could select one of four options to indicate the level of emphasis in the curriculum placed on each aspect of CIL and CT listed above.

- This aspect is explicitly stated in the curriculum including associated learning goals
- This aspect is explicitly stated in the curriculum without associated learning goals
- The value of this aspect is implied without being explicitly stated
- The curriculum places no emphasis on this aspect

CIL in the curriculum

Across all countries, there was strong emphasis on the listed aspects of CIL learning (Table 2.3). Ten of the 11 aspects were explicitly stated in the curriculum (with or without associated learning goals) in at least 25 countries. These aspects were typically associated with learning goals rather than not. The aspect with the lowest reported emphasis in the curriculum was the *protection of students against physical harm associated with ICT use*. This was reported as being explicitly stated in the curriculum (with or without associated learning goals) by 19 countries in total and as having no emphasis in the curriculum by 12 countries.

Despite the strong overall emphasis across countries on the listed aspects of CIL in the curriculum, there were variations in the nature and degree of emphasis among countries (Table 2.3). The majority of aspects were reported to be explicitly included in the curriculum (with or without associated learning goals) in 32 countries. In most of these countries, the majority of the aspects were included with associated learning goals. Exceptions to this are: Germany (including the benchmarking participant North Rhine-Westphalia) and Finland, where 10 of the 11 goals were reported to be explicitly included without associated learning goals; and Korea (Rep. of) and Kosovo where some aspects were explicitly included with associated learning goals but the majority were included without. In two countries, the Netherlands and Slovenia, the majority of aspects were reported either to be implicitly included (four aspects in each country) or as having no emphasis in the curriculum (four aspects in the Netherlands and five aspects in Slovenia).

Table 2.3: National study center reports on emphases in national curricula of teaching aspects related to CIL and ICT use

Country	Extent that the curriculum emphasizes aspects of CIL and ICT use					
	Searching for information using ICT	Evaluating the reliability of information sources accessed using the internet	Presenting information for a given audience or purpose using ICT	Organizing information obtained from internet sources	Issues relating to intellectual property such as copyright and attribution sources	Responsible and respectful publication of information
Austria	●	●	◒	●	●	●
Azerbaijan						
Belgium (Flemish)	●	●	●	●	●	●
Bosnia and Herzegovina	◈	◈	◈	◒	●	●
Chile	●	●	●	●	◒	●
Chinese Taipei	●	●	●	●	●	●
Croatia	●	●	●	●	●	●
Cyprus	●	◈	◒	●	●	●
Czech Republic	●	●	●	●	●	●
Denmark	●	●	●	●	◈	◈
Finland	◒	◒	◒	◒	◒	◒
France	●	●	●	●	●	●
Germany	◒	◒	◒	◒	◒	◒
Greece	●	●	●	●	●	●
Hungary	●	●	●	●	◒	●
Italy	●	●	●	●	●	●
Kazakhstan	●	●	●	●	●	●
Korea, Republic of	◒	◒	◈	●	●	◒
Kosovo	●	◒	◒	◒	◒	◒
Latvia	●	●	●	●	●	◒
Luxembourg	●	●	●	●	●	●
Malta	●	●	●	●	●	●
Netherlands	●	◈	◇	◈	◇	◈
Norway	●	●	●	●	●	●
Oman	●	●	●	●	●	●
Portugal	●	●	●	●	●	◒
Romania	●	●	●	●	◇	◈
Serbia	●	●	●	●	●	●
Slovak Republic	●	●	●	◈	●	◈
Slovenia	◒	◈	◈	◈	◈	◇
Spain	●	●	●	●	●	●
Sweden	●	●	●	◈	◒	◒
United States	●	●	◈	●	●	●
Uruguay	●	●	●	●	●	●
Benchmarking participant						
North Rhine-W. (Germany)	◒	◒	◒	◒	◒	◒

Notes: Data collected from ICILS 2023 national contexts survey.
● Explicitly stated in curriculum associated to learning goals
◒ Explicitly stated in curriculum not associated to learning goals
◈ Implicitly stated in curriculum
◇ No emphasis on this aspect in curriculum

Table 2.3: National study center reports on emphases in national curricula of teaching aspects related to CIL and ICT use (cont'd)

Country	**Extent that the curriculum emphasizes aspects of CIL and ICT use**				
	Use of productivity tools (such as word processing, spreadsheet, and presentation software)	**IT security issues (e.g., passwords, malware, phishing)**	**Data security (such as the collection of internet use data by search engines and social media sites)**	**Protection of students against emotional/social harm associated with ICT use (e.g., cyberbullying)**	**Protection of students against physical harm associated with ICT use (e.g., neck pain, eye soreness, fatigue)**
Austria	◓	●	●	●	◇
Azerbaijan					
Belgium (Flemish)	●	●	●	●	◓
Bosnia and Herzegovina	●	●	●	●	●
Chile	●	◈	◓	●	●
Chinese Taipei	●	●	●	●	●
Croatia	●	●	●	●	◓
Cyprus	●	●	◓	◓	◓
Czech Republic	●	◈	◇	◇	●
Denmark	●	◈	◈	◓	◇
Finland	◓	◓	◓	◓	◈
France	●	●	●	●	◈
Germany	◓	◓	◓	◓	◇
Greece	●	●	●	●	●
Hungary	●	●	◓	◓	●
Italy	●	●	●	●	●
Kazakhstan	●	●	●	●	●
Korea, Republic of	◓	◓	◓	●	◓
Kosovo	●	◈	◈	◈	◈
Latvia	●	●	●	●	●
Luxembourg	◓	●	●	◓	◓
Malta	●	●	●	●	●
Netherlands	◈	◇	◇	◇	◇
Norway	●	◈	◓	◓	◇
Oman	●	●	●	●	●
Portugal	●	●	●	◇	◇
Romania	●	●	◈	◇	◇
Serbia	●	●	●	●	●
Slovak Republic	●	●	●	◇	◇
Slovenia	◓	◇	◇	◇	◇
Spain	●	●	●	●	●
Sweden	●	◓	◓	◈	◇
United States	◓	●	●	●	◇
Uruguay	●	●	●	●	●
Benchmarking participant					
North Rhine-W. (Germany)	◓	◓	◓	◓	◈

Notes: Data collected from ICILS 2023 national contexts survey.
● Explicitly stated in curriculum associated to learning goals
◓ Explicitly stated in curriculum not associated to learning goals
◈ Implicitly stated in curriculum
◇ No emphasis on this aspect in curriculum

CT in the curriculum

Across countries, while still high, the emphasis in the curriculum on the listed aspects of CT learning was generally slightly lower than that of CIL learning (Table 2.4). This can be seen in the number of countries where aspects were explicitly stated in the curriculum, and further when where there was no emphasis in the curriculum. Five of the 12 aspects of CT learning were reported to be explicitly stated in the curriculum (with or without associated learning goals) in at least 25 countries. These aspects were typically associated with learning goals rather than not. Two of the 12 aspects had no emphasis in the curriculum in fewer than four countries, with nine aspects having no emphasis in between four and nine countries (inclusive). The aspect with the highest in the curriculum was *creating visual representations (e.g., tables, graphs, or charts) of information/data*. This was explicitly stated in the curriculum (with or without associated learning goals) in 29 countries and implicitly included by all remaining countries. It is also the aspect with the most obvious cross-curricular applicability of the 12 listed. In contrast, the aspect with the lowest emphasis in the curriculum was *revising technology-based products or solutions on the basis of user feedback or other data*. This was explicitly stated in the curriculum (with or without associated learning goals) in 10 countries in total and had no emphasis in the curriculum in 11 countries.

In comparison to CIL, the relatively lower curriculum emphasis for aspects of CT can also be considered from the perspective of country-level reported approaches (Table 2.4). In 19 countries it was reported that at least half the 12 aspects of CT were explicitly included in the curriculum and associated with learning goals. In four countries, Bosnia and Herzegovina, Finland, Hungary, and Sweden it more than half of the 12 CT learning goals were explicitly stated in the curriculum, but with a majority of these without associated learning goals. In Italy, Kosovo, and Oman at least half the aspects were implicitly stated in the curriculum. In the Czech Republic, the Netherlands, the Slovak Republic, and Slovenia at least half of the 12 listed aspects of CT were had no emphasis in the curriculum.

Table 2.4: National study center reports on emphases in national curricula of teaching aspects related to CT

Country	Extent that the curriculum emphasizes aspects of CT					
	Planning technology-based products or solutions	Developing technology-based products or solutions to meet user requirements	Evaluating and refining technology-based products or solutions	Creating visual representations (e.g., flow charts and decision trees) of processes	Creating visual representations (e.g., tables, graphs, or charts) of information/data	Designing user interfaces for technology-based products or solutions
Austria	●	◇	◓	◇	●	◇
Azerbaijan						
Belgium (Flemish)	◓	◓	◓	●	●	◓
Bosnia and Herzegovina	◈	◈	◈	●	●	◇
Chile	◈	◈	◈	◓	◓	◈
Chinese Taipei	●	●	●	●	●	◓
Croatia	◈	◈	◈	●	●	◈
Cyprus	◓	◓	◓	●	●	◈
Czech Republic	◇	◇	◇	◈	●	◇
Denmark	●	◈	●	◈	◈	◈
Finland	◓	◇	◓	●	●	◇
France	●	●	●	●	●	●
Germany[1]						
Greece	●	●	●	●	●	●
Hungary	◈	◈	◈	◓	◓	◓
Italy	◈	◈	◈	●	●	◈
Kazakhstan	●	●	●	●	●	●
Korea, Republic of	●	●	●	●	●	●
Kosovo	◈	◈	◈	◈	◈	◈
Latvia	●	●	●	●	●	●
Luxembourg	●	●	●	◓	●	●
Malta	●	●	●	●	●	●
Netherlands	◇	◇	◇	●	●	◇
Norway	●	●	●	◓	●	◈
Oman	◈	◈	◈	◈	◈	◈
Portugal	●	●	●	●	●	●
Romania	●	●	●	●	●	●
Serbia	●	●	●	◈	●	●
Slovak Republic	◇	◇	◇	●	●	◇
Slovenia	◈	◈	◇	◈	◈	◇
Spain	●	●	◓	●	●	●
Sweden	●	◓	◓	◓	◓	◈
United States	●	●	●	●	●	●
Uruguay	●	●	●	●	●	●
Benchmarking participant						
North Rhine-W. (Germany)	◓	◓	◓	◓	◓	◓

Notes: Data collected from ICILS 2023 national contexts survey.
[1] The approaches in the individual federal states are different and depend also on whether computer science is implemented as a compulsory subject or not.
● Explicitly stated in curriculum associated to learning goals
◓ Explicitly stated in curriculum not associated to learning goals
◈ Implicitly stated in curriculum
◇ No emphasis on this aspect in curriculum

Table 2.4: National study center reports on emphases in national curricula of teaching aspects related to CT (cont'd)

Country	Extent that the curriculum emphasizes aspects of CT					
	Revising technology-based products or solutions on the basis of user feedback or other data	**Creating algorithms**	**Writing code, programs, or macros**	**Evaluating code, programs, or macros**	**Developing digital applications (e.g., programs/apps)**	**Identifying and describing the properties of digital systems**
Austria	◇	●	●	●	●	◓
Azerbaijan						
Belgium (Flemish)	●	●	●	●	◈	●
Bosnia and Herzegovina	◇	●	◓	◓	◓	◓
Chile	◈	◇	◇	◇	◇	◇
Chinese Taipei	◓	●	●	●	●	●
Croatia	◇	●	●	●	●	◓
Cyprus	◈	●	●	●	●	●
Czech Republic	◇	◇	◇	◇	◇	◇
Denmark	◈	●	●	●	●	●
Finland	◇	◓	◇	◓	●	◇
France	●	●	●	●	◓	●
Germany[1]						
Greece	●	●	●	●	●	●
Hungary	◈	◓	◓	◈	◓	◓
Italy	◇	◈	◈	◈	◈	◈
Kazakhstan	●	●	●	●	●	●
Korea, Republic of	◓	●	●	●	●	●
Kosovo	◈	◓	◈	◈	◈	◈
Latvia	●	◇	●	●	●	◇
Luxembourg	◓	●	●	◓	●	●
Malta	●	●	●	●	●	●
Netherlands	◇	◇	◇	◇	◇	◇
Norway	●	●	●	●	●	●
Oman	◈	◈	◈	◈	◈	◈
Portugal	●	●	●	●	●	●
Romania	●	●	●	●	●	●
Serbia	◈	●	●	●	●	◈
Slovak Republic	◇	●	●	●	◇	◈
Slovenia	◇	◇	◇	◇	◇	◇
Spain	◓	●	●	◓	●	●
Sweden	◈	◓	◓	◓	◈	◓
United States	●	●	◓	◓	◓	●
Uruguay	●	●	●	●	●	●
Benchmarking participant						
North Rhine-W. (Germany)	◓	◓	◓	◓	◓	◓

Notes: Data collected from ICILS 2023 national contexts survey.
[1] The approaches in the individual federal states are different and depend also on whether computer science is implemented as a compulsory subject or not.
● Explicitly stated in curriculum associated to learning goals
◓ Explicitly stated in curriculum not associated to learning goals
◈ Implicitly stated in curriculum
◇ No emphasis on this aspect in curriculum

Assessment of CIL and CT related skills

As a further reflection of the degree of emphasis placed on the inclusion of CIL and CT related skills in the curriculum, national centers were asked to indicate the nature of any mandated national assessment of students in the target grade (grade 8 or equivalent). National centers could select one of the following response options for each of CIL and CT:

- Yes, using a compulsory assessment for all students at the national and/or state/provincial level
- Yes, using a sample-based assessment at the national and/or state/provincial level
- Yes, using a non-compulsory common assessment
- Yes, but assessment is controlled at the school level
- There is no mandated requirement for assessing students in this area

In contrast to the generally high levels of emphasis placed on the inclusion of CIL and CT skills in the curricula across countries, there was considerably less emphasis reflected in the expectations that these skills be assessed (see Appendix B, Table B.5). The assessment of CIL skills at the target grade (grade 8 or equivalent) was mandatory for all students in four countries only, Kosovo, Malta, Oman, and Portugal. In 14 countries the assessment of CIL skills was non-compulsory to be administered either as a common assessment or controlled at the school level, and in 16 countries there was no mandated requirement for assessing the CIL skills of students in the target grade.

The profile of mandated assessment of CT skills was very similar to that of CIL. The assessment of CT skills at the target grade (grade 8 or equivalent) was mandatory for all students in Oman and Portugal only. In 14 countries the assessment of CT skills was non-compulsory to be administered either as a common assessment or controlled at the school level, and in 18 countries there was no mandated requirement for assessing the CT skills of students in the target grade (Appendix B, Table B.5).

2.6 School-level resource provision and priorities regarding the use of ICT in teaching and learning

In this section we present data at the country level relating to schools' reports (from ICT coordinators and principals) of access to software resources, technology facilities, and ICT devices in their schools, with priority given to the various ways of facilitating the use of ICT in teaching and learning in schools.

Access to software resources in schools

In ICILS 2018 it was reported that "while the provision of ICT infrastructure in schools can impact on the likelihood of teachers using ICT, they should be accompanied with the provision of time for teachers to plan for ICT use and develop ICT skills" (Fraillon et al., 2020, p. 247). As such, the reported access to ICT resources in schools is included to provide an overview of the technological context of countries participating in ICILS as a foundation to support the use of ICT in teaching and learning, and not as a proxy for the necessary training and pedagogical support required to facilitate the effective use of ICT in teaching and learning.

ICT-coordinators in schools were asked to indicate whether the following range of software resources were made available by their school to teachers and students:[12]

- Practice programs or apps where teachers decide which questions are asked of students
- Single-user digital learning games
- Multi-user digital learning games with graphics and inquiry tasks
- Word-processor software
- Presentation software

12 The software resources were presented in the questionnaire with examples of product names to support respondents. These names have not been included in the list provided in the report.

- Video and photo software for capture and editing
- Concept mapping software
- Data logging and monitoring tools that capture real-world data digitally for analysis
- Simulations and modeling software
- Graphing or drawing software
- e-portfolios
- Digital contents linked with paper-based textbooks
- Digital textbooks
- Educational virtual reality and/or augmented reality apps
- Adaptive learning systems (software that gathers and uses student data to deliver personalized resources and learning activities to address the individual needs of students)
- Interactive whiteboard software

ICT-coordinators could indicate whether the software resource was made available to teachers, students, both, or not made available at all. The national percentages of students in schools where the ICT-coordinator reported that the software resources were made available to students and teachers Table 2.5 show considerable variation across countries and software resources.

Word-processor and presentation software were the two resources that were reported to be in schools accounting for the greatest number of students across countries. On average across countries these were reported to be available in schools accounting for 94 percent and 95 percent of students respectively. These software resources also showed the smallest range in availability across countries. With it being reported in many countries that all students were in schools where these resources were available and with the lowest availability for word-processor software in schools accounting for 66 percent of students in Kosovo, and for presentation software in schools accounting for 70 percent of students in Azerbaijan.

In contrast, the availability of some software resources varied considerably more among countries (Table 2.5). There were eight resources for which the difference in availability among countries between the highest and lowest was greater than 70 percentage points of students in schools. These resources were: single-user digital learning games, concept mapping software, simulations and modeling software, graphing or drawing software, e-portfolios, digital contents linked with paper-based textbooks, digital textbooks, and interactive whiteboard software. The overall availability of these resources also varied. On average, across all countries, the average percentages of students in schools where these resources were available was above 50 percent for four of the resources (with a maximum of 71% for each of digital contents linked with paper-based textbooks and digital textbooks) and below 50 percent for the remaining four resources (with a minimum of 32% for e-portfolios).

On average across countries, the two software resources that were available in schools accounting for the smallest proportions of students were data logging and monitoring tools (20%) and adaptive learning systems (23%). These were the only two resources that, on average across countries, were available in schools accounting for less than 25 percent of students.

There was also considerable variation in the availability of the listed software resources among ICILS countries (Table 2.5).

Table 2.5: ICT coordinator reports on the availability of software resources for teaching and learning in schools

Country	Percentages of students in schools whose ICT coordinator indicated availability of the following (made available to teachers and students)				
	Practice programs or apps where teachers decide which questions are asked of students	Single-user digital learning games	Multi-user digital learning games with graphics and inquiry tasks	Word-processor software	Presentation software
[1] Austria	90 (2.7) ▲	46 (4.4)	21 (3.5) ▽	100 (0.0) ▲	100 (0.0) ▲
Azerbaijan	33 (4.5) ▽	9 (3.0) ▽	13 (3.4) ▽	68 (4.4) ▽	70 (4.4) ▽
† Belgium (Flemish)	92 (2.2) ▲	71 (4.0) ▲	56 (4.5) ▲	98 (1.1) ▲	98 (1.1) ▲
[3] Bosnia and Herzegovina	27 (6.3) ▽	26 (5.2) ▽	16 (4.5) ▽	87 (4.7)	92 (3.7)
Chinese Taipei	59 (3.8) ▽	30 (3.2) ▽	28 (3.6)	96 (1.6)	97 (1.3)
[1] Croatia	87 (3.8) ▲	51 (4.8)	46 (4.8) ▲	98 (1.2) ▲	98 (1.2) ▲
Cyprus	44 (2.6) ▽	50 (2.7)	16 (1.3) ▽	92 (0.8)	94 (0.8)
[1] Czech Republic	79 (2.6) ▲	45 (4.2)	28 (3.6)	99 (0.5) ▲	99 (0.6) ▲
†[1] Denmark	93 (2.3) ▲	92 (2.6) ▲	36 (5.1)	99 (1.1) ▲	100 (0.0) ▲
Finland	84 (2.6) ▲	69 (3.6) ▲	62 (4.5) ▲	99 (0.8) ▲	99 (1.0) ▲
France	63 (4.6)	46 (4.8)	17 (3.5) ▽	97 (1.6) ▲	96 (1.8)
Germany	67 (3.9)	50 (3.7)	17 (3.4) ▽	90 (2.9)	90 (2.9)
Greece	40 (4.4) ▽	20 (3.5) ▽	10 (2.4) ▽	96 (1.8)	96 (1.8)
Hungary	60 (4.9) ▽	26 (4.2) ▽	17 (3.7) ▽	92 (2.5)	91 (2.8)
Italy	63 (4.3)	53 (4.7)	23 (3.5) ▽	94 (2.2)	93 (2.3)
[1] Kazakhstan	80 (3.5) ▲	68 (4.4) ▲	49 (3.8) ▲	98 (1.3) ▲	96 (1.6)
† Korea, Republic of	72 (4.0)	53 (4.1)	39 (4.1)	90 (2.9)	90 (2.8)
[1] Kosovo	42 (4.7) ▽	17 (3.2) ▽	20 (3.7) ▽	66 (4.0) ▽	71 (3.9) ▽
[1] Latvia	62 (4.2)	28 (4.0) ▽	23 (4.0) ▽	97 (1.6)	97 (1.6)
Luxembourg	92 (1.5) ▲	92 (2.0) ▲	33 (2.0)	100 (0.0) ▲	100 (0.0) ▲
Malta	78 (0.5) ▲	62 (0.6) ▲	45 (0.6) ▲	100 (0.0) ▲	99 (0.0) ▲
[1] Norway (Grade 9)	91 (2.8) ▲	92 (2.0) ▲	49 (4.9) ▲	100 (0.0) ▲	100 (0.0) ▲
Oman	53 (4.2) ▽	49 (4.6)	49 (4.2) ▲	83 (2.7) ▽	89 (1.9) ▽
[1] Portugal	81 (3.3) ▲	43 (4.0)	37 (4.0)	100 (0.5) ▲	100 (0.5) ▲
†[1,2] Romania	47 (5.3) ▽	20 (3.8) ▽	21 (4.3) ▽	90 (2.9)	92 (2.4)
[1] Serbia	54 (4.2) ▽	53 (4.1)	43 (4.4) ▲	97 (1.4) ▲	98 (1.1) ▲
Slovak Republic	90 (2.4) ▲	40 (3.7) ▽	17 (3.2) ▽	93 (2.2)	95 (1.7)
[1] Slovenia	81 (3.1) ▲	26 (3.5) ▽	21 (3.2) ▽	99 (0.9) ▲	99 (0.9) ▲
[1] Spain	76 (3.2)	39 (2.9) ▽	43 (2.7) ▲	97 (1.3) ▲	97 (1.3)
[1] Sweden	92 (2.3) ▲	81 (3.2) ▲	56 (4.3) ▲	99 (1.1) ▲	99 (1.0) ▲
† Uruguay	78 (3.5) ▲	55 (4.9)	34 (4.9)	100 (0.2) ▲	99 (0.9) ▲
ICILS 2023 average	70 (0.7)	49 (0.7)	32 (0.7)	94 (0.4)	95 (0.3)
Benchmarking participant					
[1] North Rhine-W. (Germany)	63 (4.0)	42 (4.6)	12 (3.4) ▽	93 (2.1)	94 (2.1)
Country not meeting sample participation requirements					
‡ United States	95 (2.1) ▲	82 (4.3) ▲	70 (5.2) ▲	99 (0.7) ▲	100 (0.0) ▲

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.

† Met guidelines for sampling participation rates only after replacement schools were included.

‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

[2] Country surveyed target grade in the first half of the school year.

[3] National defined population covers 61% of the national target population.

Table 2.5: ICT coordinator reports on the availability of software resources for teaching and learning in schools (cont'd)

Country	**Percentages of students in schools whose ICT coordinator indicated availability of the following (made available to teachers and students)**				
	Video and photo software for capture and editing	**Concept mapping software**	**Data logging and monitoring tools**	**Simulations and modelling software**	**Graphing or drawing software**
[1] Austria	87 (3.1) ▲	36 (4.1)	15 (2.9)	96 (1.4) ▲	92 (2.2) ▲
Azerbaijan	53 (4.8) ▽	19 (3.7) ▽	22 (4.4)	17 (3.5) ▽	41 (4.8) ▽
[†] Belgium (Flemish)	87 (3.1) ▲	72 (4.5) ▲	41 (4.8) ▲	76 (4.2) ▲	80 (3.9) ▲
[3] Bosnia and Herzegovina	79 (5.5)	16 (4.7) ▽	15 (4.7)	17 (4.3) ▽	57 (7.4)
Chinese Taipei	76 (3.4)	65 (4.1) ▲	11 (2.6) ▽	27 (3.7) ▽	69 (3.7)
[1] Croatia	81 (4.1)	44 (4.8)	9 (2.4) ▽	16 (3.2) ▽	68 (3.9)
Cyprus	79 (0.7)	22 (2.6) ▽	5 (2.4) ▽	78 (1.9) ▲	60 (1.8) ▽
[1] Czech Republic	86 (2.7) ▲	41 (3.3)	26 (3.3) ▲	9 (1.4) ▽	87 (2.4) ▲
[†1] Denmark	89 (2.4) ▲	65 (4.9) ▲	45 (4.8) ▲	67 (3.8) ▲	75 (4.3)
Finland	90 (2.5) ▲	54 (4.1) ▲	27 (3.4) ▲	87 (2.5) ▲	79 (3.6) ▲
France	85 (3.1) ▲	71 (3.8) ▲	13 (3.5)	38 (4.5)	83 (3.3) ▲
Germany	66 (4.2) ▽	35 (3.4) ▽	32 (3.7) ▲	27 (3.9) ▽	75 (3.4)
Greece	71 (3.7)	38 (4.4)	5 (1.7) ▽	16 (3.2) ▽	21 (3.2) ▽
Hungary	54 (4.8) ▽	10 (2.9) ▽	2 (1.5) ▽	15 (3.3) ▽	76 (3.9)
Italy	52 (4.3) ▽	51 (4.4)	8 (2.4) ▽	12 (2.9) ▽	46 (4.1) ▽
[1] Kazakhstan	85 (2.6) ▲	47 (3.8)	37 (3.9) ▲	47 (3.8) ▲	76 (3.0) ▲
[†] Korea, Republic of	56 (4.7) ▽	37 (4.3)	20 (3.5)	27 (4.1) ▽	58 (4.7) ▽
[1] Kosovo	42 (4.5) ▽	9 (2.8) ▽	10 (3.0) ▽	15 (2.8) ▽	31 (4.3) ▽
[1] Latvia	66 (3.8) ▽	12 (2.6) ▽	23 (4.0)	16 (3.3) ▽	75 (3.6)
Luxembourg	96 (1.0) ▲	52 (1.9) ▲	28 (2.4) ▲	29 (2.2) ▽	89 (1.8) ▲
Malta	98 (0.0) ▲	37 (0.6) ▽	39 (0.6) ▲	57 (0.6) ▲	76 (0.6) ▲
[1] Norway (Grade 9)	98 (0.6) ▲	83 (3.2) ▲	19 (4.1)	38 (4.5)	82 (3.9) ▲
Oman	84 (2.7) ▲	52 (3.8) ▲	18 (3.4)	26 (3.6) ▽	66 (3.5)
[1] Portugal	84 (2.9) ▲	37 (4.3)	17 (3.4)	32 (3.9)	56 (4.2) ▽
[†12] Romania	71 (4.9)	7 (2.1) ▽	10 (3.8) ▽	12 (4.2) ▽	48 (5.1) ▽
[1] Serbia	85 (3.2) ▲	25 (3.8) ▽	23 (3.8)	45 (4.1) ▲	78 (3.2) ▲
Slovak Republic	69 (3.6) ▽	21 (3.1) ▽	7 (2.0) ▽	8 (2.1) ▽	72 (3.4)
[1] Slovenia	88 (2.6) ▲	63 (3.6) ▲	8 (2.2) ▽	66 (4.0) ▲	80 (3.3) ▲
[1] Spain	84 (2.1) ▲	69 (3.1) ▲	20 (2.6)	28 (2.9) ▽	81 (2.4) ▲
[1] Sweden	72 (4.1)	46 (4.6)	8 (2.5) ▽	25 (4.4) ▽	81 (3.5) ▲
[†] Uruguay	88 (3.4) ▲	69 (4.4) ▲	32 (4.8) ▲	38 (5.0)	72 (4.4)
ICILS 2023 average	78 (0.6)	43 (0.7)	20 (0.6)	36 (0.6)	69 (0.7)
Benchmarking participant					
[1] North Rhine-W. (Germany)	73 (4.6)	39 (4.3)	30 (4.2) ▲	23 (4.1) ▽	79 (3.8) ▲
Country not meeting sample participation requirements					
[‡] United States	73 (5.1)	44 (5.4)	33 (4.9) ▲	38 (5.3)	57 (4.9) ▽

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
[†] Met guidelines for sampling participation rates only after replacement schools were included.
[‡] Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.

Table 2.5: ICT coordinator reports on the availability of software resources for teaching and learning in schools (cont'd)

Country	Percentages of students in schools whose ICT coordinator indicated availability of the following (made available to teachers and students)					
	e-portfolios	Digital contents linked with paper-based textbooks	Digital textbooks	Educational virtual reality and/or augmented reality apps	Adaptive learning systems	Interactive whiteboard software
[1] Austria	42 (4.3) ▲	95 (1.7) ▲	94 (2.1) ▲	28 (4.1)	20 (3.4)	60 (4.1)
Azerbaijan	20 (4.0) ▽	47 (4.9) ▽	48 (5.3) ▽	16 (4.3) ▽	17 (4.0)	34 (5.1) ▽
[†] Belgium (Flemish)	97 (1.8) ▲	95 (1.7) ▲	88 (3.1) ▲	23 (4.2)	56 (4.6) ▲	69 (4.7) ▲
[3] Bosnia and Herzegovina	10 (4.0) ▽	34 (6.7) ▽	24 (5.7) ▽	17 (4.1) ▽	15 (3.8) ▽	38 (6.9) ▽
Chinese Taipei	48 (4.0) ▲	66 (3.7)	52 (4.1) ▽	35 (4.0)	37 (3.9) ▲	62 (4.1)
[1] Croatia	70 (4.6) ▲	96 (1.6) ▲	97 (1.5) ▲	40 (4.6) ▲	22 (3.4)	42 (4.2) ▽
Cyprus	7 (2.3) ▽	57 (1.9) ▽	62 (2.1) ▽	23 (2.2) ▽	10 (2.3) ▽	32 (2.4) ▽
[1] Czech Republic	7 (1.7) ▽	71 (3.2)	69 (3.5)	56 (3.3) ▲	16 (2.6) ▽	74 (3.6) ▲
[†1] Denmark	30 (4.8)	74 (4.3)	96 (1.8) ▲	41 (4.8) ▲	37 (5.0) ▲	57 (4.9)
Finland	50 (3.7) ▲	78 (3.9) ▲	65 (4.3)	21 (3.6) ▽	26 (3.7)	49 (4.3)
France	78 (3.7) ▲	58 (4.2) ▽	58 (4.6) ▽	24 (4.0)	20 (3.6)	40 (4.6) ▽
Germany	23 (3.5) ▽	54 (4.5) ▽	35 (4.4) ▽	14 (2.9) ▽	10 (2.6) ▽	47 (4.4)
Greece	4 (1.7) ▽	66 (4.4)	82 (3.7) ▲	27 (4.3)	7 (2.3) ▽	35 (4.1) ▽
Hungary	2 (1.3) ▽	59 (4.4) ▽	57 (4.1) ▽	9 (2.4) ▽	4 (1.8) ▽	60 (4.2)
Italy	4 (1.8) ▽	96 (1.7) ▲	95 (1.9) ▲	34 (4.1)	18 (3.4)	88 (2.6) ▲
[1] Kazakhstan	44 (4.1) ▲	82 (3.2) ▲	86 (2.8) ▲	42 (3.9) ▲	58 (4.3) ▲	69 (3.3) ▲
[†] Korea, Republic of	42 (4.4) ▲	71 (4.0)	72 (4.1)	34 (4.3)	26 (3.9)	51 (4.3)
[1] Kosovo	14 (3.6) ▽	34 (4.7) ▽	36 (4.6) ▽	16 (3.6) ▽	19 (3.9)	15 (3.6) ▽
[1] Latvia	9 (2.6) ▽	74 (3.7)	88 (2.7) ▲	22 (3.9) ▽	16 (3.3) ▽	74 (3.9) ▲
Luxembourg	19 (1.7) ▽	75 (2.3) ▲	83 (2.2) ▲	32 (1.9)	16 (1.8) ▽	80 (2.3) ▲
Malta	23 (0.5) ▽	61 (0.6) ▽	64 (0.6) ▽	61 (0.7) ▲	45 (0.7) ▲	65 (0.7) ▲
[1] Norway (Grade 9)	15 (3.6) ▽	83 (3.8) ▲	92 (2.6) ▲	24 (3.7)	46 (4.5) ▲	41 (4.6) ▽
Oman	66 (3.2) ▲	65 (4.2)	63 (4.4)	37 (3.8)	36 (4.0) ▲	70 (3.9) ▲
[1] Portugal	34 (4.3)	82 (2.8) ▲	64 (3.9)	41 (4.4) ▲	22 (3.7)	54 (3.9)
[†12] Romania	9 (3.0) ▽	70 (4.1)	93 (2.5) ▲	23 (4.6)	18 (3.9)	71 (4.3) ▲
[1] Serbia	33 (4.0)	87 (2.9) ▲	95 (1.9) ▲	14 (3.1) ▽	8 (2.4) ▽	33 (4.0) ▽
Slovak Republic	4 (1.6) ▽	24 (3.3) ▽	34 (3.9) ▽	18 (3.0) ▽	21 (3.1)	62 (3.5) ▲
[1] Slovenia	20 (3.4) ▽	79 (3.5) ▲	81 (3.3) ▲	34 (3.6)	11 (2.7) ▽	53 (4.1)
[1] Spain	29 (2.9)	83 (2.5) ▲	80 (2.2) ▲	41 (3.2) ▲	22 (2.6)	72 (2.9) ▲
[1] Sweden	19 (3.6) ▽	89 (3.0) ▲	93 (2.2) ▲	35 (4.7)	15 (3.4) ▽	54 (4.7)
[†] Uruguay	96 (1.8) ▲	80 (4.1) ▲	76 (4.3)	42 (4.6) ▲	28 (4.6)	47 (5.0)
ICILS 2023 average	32 (0.6)	71 (0.7)	71 (0.6)	30 (0.7)	23 (0.6)	54 (0.8)
Benchmarking participant						
[1] North Rhine-W. (Germany)	20 (3.3) ▽	53 (4.0) ▽	38 (4.1) ▽	18 (3.6) ▽	8 (3.0) ▽	57 (4.5)
Country not meeting sample participation requirements						
[‡] United States	32 (5.2)	82 (3.9) ▲	86 (3.2) ▲	52 (5.3) ▲	68 (5.5) ▲	77 (4.6) ▲

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
[†] Met guidelines for sampling participation rates only after replacement schools were included.
[‡] Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.

In Belgium (Flemish), Denmark, Finland, Kazakhstan, Luxembourg, Malta, and Norway, significantly higher percentages of students than the ICILS 2023 average were reported to have at least 10 of the 19 software resources available to them in schools. Relatively lower availability of the listed software resources was evident in Azerbaijan, Bosnia and Herzegovina, Cyprus, Hungary, Kosovo, and the Slovak Republic, where statistically significantly lower percentages of students than the ICILS 2023 average were reported to have at least 10 of the 19 software resources available in schools.

Access to technology facilities in schools

ICT-coordinators in schools were also asked to provide information about the availability of technology infrastructure and hardware resources in their schools. They were asked to indicate whether each technology resource was made available to teachers, students, both, or not made available at all. In total, ICT-coordinators reported on the availability of 20 resources. In this report, we are presenting data relating to six of these resources. These six were selected to represent the nature and breadth of resources included in the full set of 20. They combine network access resources and hardware devices that can be used in teaching and learning.

The data in Table 2.6 show the percentage of students in schools where the ICT-coordinator reported that each technology resource was made available to students and teachers in schools. The resources included:

- Access to Wi-Fi
- Space on a school network to store files
- Remote access to the school network from home
- A learning management system
- 3D printers
- Programmable robots or robotic devices

The two resources reported to be in schools accounting for the greatest number of students across countries were, *a learning management system* and *access to Wi-Fi*. On average across countries these were available in schools accounting for 71 percent and 67 percent of students respectively (Table 2.6). These two resources, together with *space on a school network to store files* were the three that showed the largest range in availability across countries. *Access to Wi-Fi* was reported to be in schools accounting for 99 percent of students in each of Denmark and Luxembourg, and for more than 90 percent of students in 10 countries in total. In contrast, it was reported to be available in schools accounting for 13 percent of students in Greece, and 21 percent of students in Cyprus. *Space on a school network to store files* was reported to be available in schools accounting for all students in Luxembourg, although for more than 90 percent of students in four countries only. In Bosnia and Herzegovina, *space on a network to store files* was reported to be available in schools accounting for 13 percent of students. *A learning management system* was reported to be available in schools accounting for 99 percent of students in Austria, and for more than 90 percent of students in 12 countries in total. In contrast, this was reported to be available in schools accounting for 16 percent of students in Kosovo and for 25 percent of students in Cyprus.

Remote access to the school network from home is the resource with both the lowest reported and smallest range of access available to teachers and students. On average across countries, this was available in schools accounting for 18 percent of students and this ranged from a minimum of three percent of students in the Slovak Republic to a maximum of 39 percent of students in Germany.

There was also considerable variation among countries in the overall availability of the technology resources across countries (Table 2.6).

Table 2.6: ICT coordinator reports on available technology facilities for teaching and learning of target grade students

Country	Percentages of students in schools whose ICT coordinator indicated availability of the following (made available to teachers and students)					
	Access to Wi-Fi	**Space on a school network to store files**	**Remote access to the school network from home**	**A learning management system**	**3D printers**	**Programmable robots or robotic devices**
[1] Austria	97 (1.4) ▲	94 (2.2) ▲	12 (3.0)	99 (1.0) ▲	28 (4.1)	47 (4.7)
Azerbaijan	47 (4.6) ▽	48 (5.8)	23 (3.8)	27 (4.6) ▽	29 (4.4)	13 (2.8) ▽
[†] Belgium (Flemish)	98 (1.3) ▲	75 (3.9) ▲	16 (3.9)	98 (1.8) ▲	48 (4.7) ▲	78 (4.0) ▲
[3] Bosnia and Herzegovina	33 (6.7) ▽	13 (4.5) ▽	9 (3.6) ▽	39 (5.6) ▽	19 (5.2) ▽	32 (5.2) ▽
Chinese Taipei	70 (4.0)	82 (3.1) ▲	38 (4.0) ▲	75 (3.0)	52 (3.6) ▲	45 (3.5) ▽
[1] Croatia	86 (3.3) ▲	42 (4.9) ▽	6 (1.9) ▽	70 (4.2)	14 (3.0) ▽	45 (4.7) ▽
Cyprus	21 (2.4) ▽	40 (1.6) ▽	13 (2.6)	25 (2.0) ▽	15 (2.7) ▽	56 (2.0)
[1] Czech Republic	57 (3.4) ▽	78 (2.9) ▲	12 (2.5) ▽	93 (1.8) ▲	65 (3.4) ▲	87 (2.3) ▲
[†1] Denmark	99 (0.6) ▲	82 (3.9) ▲	25 (4.4)	89 (3.5) ▲	50 (4.9) ▲	62 (4.2)
Finland	98 (1.2) ▲	89 (2.6) ▲	24 (3.9)	94 (1.8) ▲	55 (4.6) ▲	75 (3.9) ▲
France	36 (4.8) ▽	91 (2.9) ▲	20 (3.9)	40 (4.4) ▽	54 (4.3) ▲	62 (4.6)
Germany	65 (4.2)	90 (2.3) ▲	39 (4.0) ▲	78 (2.9) ▲	30 (4.1)	64 (4.3)
Greece	13 (2.9) ▽	28 (3.8) ▽	4 (1.8) ▽	35 (4.3) ▽	12 (2.3) ▽	44 (4.7) ▽
Hungary	60 (4.8)	40 (4.0) ▽	6 (2.1) ▽	80 (3.0) ▲	23 (3.9) ▽	52 (4.5)
Italy	48 (4.3) ▽	54 (4.4)	10 (2.5) ▽	92 (2.4) ▲	52 (3.8) ▲	78 (3.7) ▲
[1] Kazakhstan	61 (4.3)	44 (3.9) ▽	31 (3.7) ▲	90 (2.5) ▲	38 (4.3)	63 (3.4) ▲
[†] Korea, Republic of	93 (2.4) ▲	23 (4.2) ▽	21 (3.4)	90 (2.5) ▲	34 (3.9)	50 (4.0)
[1] Kosovo	31 (3.9) ▽	17 (3.7) ▽	19 (3.3)	16 (3.3) ▽	9 (2.4) ▽	26 (4.2) ▽
[1] Latvia	79 (3.6) ▲	50 (4.4)	16 (2.9)	48 (4.1) ▽	70 (3.8) ▲	44 (4.3) ▽
Luxembourg	99 (0.1) ▲	100 (0.0) ▲	11 (1.3) ▽	46 (2.2) ▽	62 (2.1) ▲	67 (2.3) ▲
Malta	62 (0.6) ▽	44 (0.7) ▽	38 (0.7) ▲	91 (0.3) ▲	47 (0.7) ▲	86 (0.5) ▲
[1] Norway (Grade 9)	96 (1.7) ▲	84 (3.4) ▲	29 (4.3) ▲	68 (4.2)	37 (5.0)	73 (4.2) ▲
Oman	43 (3.4) ▽	40 (3.4) ▽	12 (2.4) ▽	60 (3.7) ▽	6 (1.9) ▽	55 (3.5)
[1] Portugal	90 (2.4) ▲	48 (4.3)	18 (3.2)	92 (2.4) ▲	34 (3.7)	58 (4.2)
[†12] Romania	64 (4.6)	33 (4.8) ▽	19 (4.2)	73 (4.3)	9 (3.1) ▽	12 (3.3) ▽
[1] Serbia	51 (4.6) ▽	30 (4.3) ▽	10 (2.6) ▽	33 (3.7) ▽	2 (1.1) ▽	22 (3.6) ▽
Slovak Republic	49 (4.0) ▽	34 (3.4) ▽	3 (1.2) ▽	93 (1.9) ▲	22 (3.0) ▽	42 (3.4) ▽
[1] Slovenia	63 (4.1)	42 (3.6) ▽	9 (2.3) ▽	92 (2.1) ▲	28 (3.5) ▽	56 (3.4)
[1] Spain	83 (2.3) ▲	58 (3.3)	17 (2.3)	93 (1.8) ▲	52 (2.6) ▲	62 (2.9) ▲
[1] Sweden	97 (1.4) ▲	69 (4.2) ▲	28 (4.2) ▲	90 (2.8) ▲	26 (4.0) ▽	56 (4.3)
[†] Uruguay	94 (2.9) ▲	40 (4.3) ▽	14 (3.5)	96 (1.7) ▲	29 (4.9)	80 (3.9) ▲
ICILS 2023 average	67 (0.6)	56 (0.7)	18 (0.6)	71 (0.6)	35 (0.7)	56 (0.7)
Benchmarking participant						
[1] North Rhine-W. (Germany)	70 (4.1)	86 (3.4) ▲	39 (4.3) ▲	78 (4.0)	29 (4.0)	73 (4.4) ▲
Country not meeting sample participation requirements						
[‡] United States	95 (2.5) ▲	72 (4.3) ▲	36 (5.3) ▲	98 (1.3) ▲	51 (3.5) ▲	53 (5.1)

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
[†] Met guidelines for sampling participation rates only after replacement schools were included.
[‡] Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.

In Belgium (Flemish), the Czech Republic, Denmark, Finland, Luxembourg, Malta, Norway, Spain, and Sweden at least four of the six listed technology resources were available in schools accounting for statistically significantly higher percentages of students than the ICILS 2023 average. Six of these countries—Belgium (Flemish), Denmark, Finland, Luxembourg, Malta, and Norway—were previously noted (see Table 2.5) as providing relatively higher access to more than half the reported software resources, in comparison to the ICILS 2023 average. In contrast, in Bosnia and Herzegovina, Croatia, Cyprus, Greece, Kosovo, Oman, Serbia, and the Slovak Republic at least four of the six software resources were available in schools accounting for statistically significantly lower percentages of students than the ICILS 2023 average. Four of these countries—Bosnia and Herzegovina, Cyprus, Kosovo, and the Slovak Republic—were also listed previously (see Table 2.5) as providing relatively lower access to more than half the reported software resources, in comparison to the ICILS 2023 average.

School priorities for facilitating the use of ICT in teaching and learning

The level of available access to the ICT software and fundamental IT infrastructure components reported in the previous section, can be interpreted to represent varying combinations across countries of the resources available to schools and the priority given to making these resources available. To further elaborate on the nature of school-level priorities for facilitating the use of ICT in teaching and learning, school principals were asked to rate the degree of priority given to the following set of measures that could influence the use of ICT in teaching and learning in their schools.

- Increasing the numbers of computers per student in the school
- Improving the speed and reliability of internet connectivity
- Increasing the variety of digital learning resources available for teaching and learning
- Establishing or enhancing an online learning support platform
- Supporting participation in professional development on the use of ICT in teaching and learning
- Increasing the availability of qualified technical personnel to support the use of ICT
- Providing teachers with incentives to integrate ICT use in their teaching
- Providing more time for teachers to prepare lessons in which ICT is used
- Increasing the professional learning resources for teachers in the use of ICT
- Fostering collaboration between teachers within the school to support the integration of ICT use in their teaching
- Fostering collaboration between teachers in this school and with teachers in other schools (e.g., teacher networks) to support the integration of ICT use in their teaching
- Developing a shared vision for using ICT to support teaching and learning

Principals could select one of five response options for each measure listed above: *High priority*; *Medium priority*; *Low priority*; *Not a priority*; and *The school has no influence over this way of facilitating the use of ICT in teaching and learning*.

The final response option was included to account for principals in schools where the provision of a given measure to influence the use of ICT in teaching and learning was not under control of the school, and consequently it was not possible to attribute a degree of priority to that measure. We report the degree of priority attributed to the measures in two stages. In the first stage (see Appendix B, Table B.6) we report the percentages of students in each country (and benchmarking participant) accounted for by schools where the principals had reported that the school had any influence over each listed measure. This is estimated using data from the principals who selected one of the four priority categories rather than indicating that their school had no influence over the measure. In the second stage, using only data from the subset of schools where the principals selected one of the four priority categories, we report the percentages of students in schools where the principal indicated that the school gives high priority to each listed measure. It is therefore possible, for example, for a given measure to be reported to be under control of the school in schools accounting for 80 percent of students, but then to be a high priority in schools accounting for 90 percent of students. In this example, the 90 percent of students is estimated only from data relating to students within the schools in which the principal had already reported that the school had control over the given measure.

On average across countries, principals in schools accounting for more than 75 percent of students reported that their school had influence over the 12 listed measures for facilitating the use of ICT in teaching and learning (Appendix B, Table B.6). Principals in schools accounting for more than 90 percent of students on average across countries indicated that their school had influence over six of the listed measures:

- Fostering collaboration between teachers within the school to support the integration of ICT use in their teaching (97% on average across countries ranging from 100% in Belgium (Flemish), Denmark, Luxembourg, and Sweden to 86% in Malta)
- Developing a shared vision for using ICT to support teaching and learning (96% on average across countries ranging from 100% in Luxembourg and the Slovak Republic to 87% in Cyprus)
- Supporting participation in professional development on the use of ICT in teaching and learning (96% on average across countries ranging from 100% in Belgium (Flemish), Latvia, Luxembourg, Romania, and the Slovak Republic to 88% in Uruguay)
- Fostering collaboration between teachers in this school and with teachers in other schools (e.g., teacher networks) to support the integration of ICT use in their teaching (94% on average across countries ranging from 100% in Belgium (Flemish) and the Slovenia to 86% in Malta)
- Increasing the variety of digital learning resources available for teaching and learning (92% on average across countries ranging from 100% in Azerbaijan and Italy to 72% in Cyprus)
- Providing teachers with incentives to integrate ICT use in their teaching (91% on average across countries ranging from 100% in Azerbaijan, Belgium (Flemish), and the Slovak Republic to 61% in Uruguay)

The remaining six measures were reported to be under any influence of the school by principals in schools accounting for less than 90 percent of students on average across countries:

- Increasing the professional learning resources for teachers in the use of ICT (88% on average across countries ranging from 100% in Denmark to 53% in in Cyprus)
- Establishing or enhancing an online learning support platform (86% on average across countries ranging from 99% in Azerbaijan to 61% in Uruguay)
- Increasing the numbers of computers per student in the school (83% on average across countries ranging from 100% in Italy to 60% in Uruguay, and 57% in the benchmarking participant North Rhine-Westphalia (Germany))
- Providing more time for teachers to prepare lessons in which ICT is used (82% on average across countries ranging from 100% in Norway to 57% in Germany)
- Improving the speed and reliability of internet connectivity (82% on average across countries ranging from 99% in Azerbaijan and Romania, to 50% in Denmanrk, and 47% in the benchmarking participant North Rhine-Westphalia (Germany))
- Increasing the availability of qualified technical personnel to support the use of ICT (78% on average across countries ranging from 99% in Azerbaijan to 44% in Germany)

Across countries there was also variation in the degree to which principals reported school-level influence over measures to facilitate the use of ICT in teaching and learning. Principals in schools accounting for at least 95 percent of students reported school-level influence on average across the 12 measures, in nine countries: Azerbaijan, Belgium (Flemish), Chinese Taipei, the Czech Republic, France, Kazakhstan, Latvia, the Slovak Republic, and Slovenia. In contrast, principals in schools accounting for less than 80 percent of students reported having school-level influence on average across the 12 measures in Cyprus, Germany, Malta and Uruguay (see Appendix B, Table B.6).

Where principals reported having influence over the listed measures, an average of 34 to 79 percent of students across countries were in schools where principals considered these measures to be of *high priority* (Table 2.7). It is likely that the level of priority given to the different measures is influenced by principals' perceptions of the degree to which the measure is valued and believed to be potentially effective in the school and their perceptions about the degree to which the measure is believed to be lacking in the school. For example, principals indicating that their schools give high priority to increasing the number of computers per student, may be influenced by both their beliefs in the need for students to have access to computers as well as the existing student to computer ratio in their schools. Principals in schools accounting for 60 percent or more students on average across countries indicated that in their school *high priority* was given to five listed measures:

- Improving the speed and reliability of internet connectivity (79% on average across countries ranging from 95% in Oman to 40% in Sweden)
- Increasing the numbers of computers per student in the school (62% on average across countries ranging from 88% in Azerbaijan to 38% in the Czech Republic)
- Increasing the variety of digital learning resources available for teaching and learning (62% on average across countries ranging from 90% in Oman to 25% in Sweden)
- Supporting participation in professional development on the use of ICT in teaching and learning (62% on average across countries ranging from 91% in Romania to 20% in Denmark)
- Fostering collaboration between teachers within the school to support the integration of ICT use in their teaching (60% on average across countries ranging from 90% in Oman to 21% in Denmark)

Table 2.7: School principal reports on the priority given to ways of facilitating ICT use in teaching and learning

Country	Percentages of students in schools that prioritize the following ways of facilitating ICT use in teaching and learning (high priority)					
	Increasing the numbers of computers per student in the school	Improving the speed and reliability of Internet connectivity	Increasing the variety of digital learning resources available for teaching and learning	Establishing or enhancing an online learning support platform	Supporting participation in professional development on the use of ICT in teaching and learning	Increasing the availability of qualified technical personnel to support the use of ICT
[1] Austria	47 (5.0) ▽	73 (4.7)	42 (4.5) ▽	41 (4.7)	59 (4.7)	55 (4.8)
Azerbaijan	88 (2.8) ▲	93 (2.4) ▲	78 (3.8) ▲	54 (4.5)	75 (4.1) ▲	74 (4.6) ▲
[†] Belgium (Flemish)	71 (4.4) ▲	80 (3.6)	42 (4.4) ▽	35 (5.2) ▽	50 (4.9) ▽	60 (5.0)
[3] Bosnia and Herzegovina	84 (4.9) ▲	89 (4.1) ▲	67 (6.4)	56 (7.8)	73 (5.7) ▲	70 (6.5)
Chinese Taipei	50 (4.2) ▽	86 (2.8) ▲	73 (3.8) ▲	67 (3.7) ▲	70 (3.8)	50 (4.5)
[1] Croatia	65 (5.1)	88 (3.4) ▲	60 (5.0)	54 (5.2)	55 (4.7)	63 (5.3)
Cyprus	72 (2.9) ▲	92 (1.4) ▲	78 (4.0) ▲	73 (3.6) ▲	73 (2.3) ▲	80 (4.8) ▲
[1] Czech Republic	38 (3.6) ▽	76 (3.5)	55 (3.7)	41 (3.7)	61 (3.4)	70 (3.5) ▲
[†1] Denmark	[s]42 (6.7) ▽	[s]64 (8.1)	[s]51 (6.1)	[s]42 (6.7)	[s]20 (4.8) ▽	[s]45 (5.8) ▽
Finland	68 (4.4)	71 (5.0)	49 (5.0) ▽	24 (4.1) ▽	48 (4.4) ▽	48 (5.2) ▽
France	39 (4.7) ▽	64 (4.6) ▽	32 (4.1) ▽	10 (2.9) ▽	31 (4.1) ▽	33 (4.6) ▽
Germany	54 (5.7)	75 (5.3)	44 (4.3) ▽	35 (4.6) ▽	44 (4.6) ▽	59 (6.2)
Greece	80 (2.7) ▲	86 (3.1) ▲	69 (3.9)	53 (4.9)	76 (3.4) ▲	57 (5.8)
Hungary	61 (5.5)	76 (5.5)	51 (4.5) ▽	27 (4.3) ▽	58 (5.1)	44 (5.4) ▽
Italy	58 (4.1)	76 (3.8)	70 (4.2) ▲	41 (4.1)	77 (3.9) ▲	57 (5.2)
[1] Kazakhstan	58 (3.9)	63 (3.8) ▽	69 (4.1)	52 (4.3)	74 (3.6) ▲	68 (4.2) ▲
[†] Korea, Republic of	52 (5.5)	75 (4.7)	77 (4.3) ▲	66 (4.7) ▲	64 (4.7)	52 (5.6)
[1] Kosovo	86 (4.0) ▲	88 (3.5) ▲	78 (5.0) ▲	75 (4.7) ▲	81 (3.9) ▲	60 (5.6)
[1] Latvia	62 (4.5)	79 (3.7)	75 (4.1) ▲	43 (4.4)	61 (4.6)	69 (4.6) ▲
Luxembourg	50 (2.1) ▽	78 (2.2)	48 (2.1) ▽	5 (1.7) ▽	50 (1.9) ▽	[r]56 (3.1)
Malta	56 (0.7) ▽	86 (0.4) ▲	66 (0.6) ▲	54 (0.7) ▲	76 (0.4) ▲	70 (0.6) ▲
[1] Norway (Grade 9)	56 (4.7)	64 (5.4) ▽	61 (4.5)	46 (5.7)	43 (4.6) ▽	32 (5.4) ▽
Oman	83 (3.5) ▲	95 (1.8) ▲	90 (2.2) ▲	76 (3.3) ▲	84 (3.0) ▲	84 (3.3) ▲
[1] Portugal	76 (3.8) ▲	92 (3.1) ▲	67 (3.7)	63 (4.3) ▲	80 (3.3) ▲	69 (4.2) ▲
[†12] Romania	87 (3.4) ▲	88 (3.1) ▲	84 (3.5) ▲	75 (4.7) ▲	91 (2.8) ▲	78 (4.5) ▲
[1] Serbia	79 (3.6) ▲	84 (3.3)	81 (3.5) ▲	68 (4.4) ▲	76 (3.4) ▲	77 (3.8) ▲
Slovak Republic	57 (3.7)	88 (2.6) ▲	74 (3.7) ▲	42 (3.9)	68 (3.4)	64 (4.2)
[1] Slovenia	49 (4.0) ▽	74 (3.3)	59 (4.1)	41 (3.9)	72 (3.7) ▲	64 (3.8)
[1] Spain	70 (3.4) ▲	92 (1.8) ▲	57 (3.1)	56 (3.6) ▲	75 (2.9) ▲	40 (2.9) ▽
[1] Sweden	49 (5.4) ▽	40 (5.8) ▽	25 (4.3) ▽	[r]29 (5.3) ▽	32 (4.7) ▽	24 (4.8) ▽
[†] Uruguay	[r]70 (7.1)	[r]80 (6.5)	[r]65 (7.1)	[r]52 (8.0)	[r]58 (6.7)	[r]47 (7.5)
ICILS 2023 average	62 (0.8)	79 (0.7)	62 (0.8)	47 (0.8)	62 (0.8)	58 (0.9)
Benchmarking participant						
[1] North Rhine-W. (Germany)	52 (6.0)	71 (6.3)	57 (5.4)	47 (5.5)	48 (5.0) ▽	45 (6.0) ▽
Country not meeting sample participation requirements						
[‡] United States	67 (3.6)	80 (4.5)	60 (5.4)	52 (6.1)	35 (4.4) ▽	34 (5.0) ▽

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. School principals stating that the school has no influence over this way of facilitating the use of ICT in teaching and learning were removed from the estimations.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.
[r] indicates data are available for at least 70% but less than 85% of the students.
[s] indicates data are available for at least 50% but less than 70% of the students.

Table 2.7: School principal reports on the priority given to ways of facilitating ICT use in teaching and learning (cont'd)

Country	Percentages of students in schools that prioritize the following ways of facilitating ICT use in teaching and learning (high priority)					
	Providing teachers with incentives to integrate ICT use in their teaching	**Providing more time for teachers to prepare lessons in which ICT is used**	**Increasing the professional learning resources for teachers in the use of ICT**	**Fostering collaboration between teachers within the school to support the integration of ICT use in their teaching**	**Fostering collaboration between teachers in this school and with teachers in other schools to support the integration of ICT use in their teaching**	**Developing a shared vision for using ICT to support teaching and learning**
[1] Austria	44 (5.0) ▽	31 (4.7)	39 (4.9) ▽	57 (4.6)	17 (3.7) ▽	48 (4.5)
Azerbaijan	80 (3.7) ▲	66 (4.5) ▲	76 (4.2) ▲	70 (4.4) ▲	63 (4.6) ▲	63 (4.9) ▲
[†] Belgium (Flemish)	57 (4.7)	6 (2.9) ▽	36 (4.6) ▽	53 (4.7)	15 (3.2) ▽	52 (4.8)
[3] Bosnia and Herzegovina	72 (4.5) ▲	51 (8.0) ▲	61 (7.1)	70 (5.3)	53 (7.3) ▲	63 (5.2)
Chinese Taipei	56 (3.8)	45 (4.5) ▲	64 (4.1) ▲	64 (4.0)	56 (4.2) ▲	48 (4.3)
[1] Croatia	61 (5.0)	42 (5.7)	61 (5.8)	61 (5.1)	30 (4.8)	55 (4.8)
Cyprus	63 (3.3) ▲	54 (4.5) ▲	59 (5.9)	77 (3.1) ▲	43 (3.4) ▲	75 (3.2) ▲
[1] Czech Republic	57 (3.3)	18 (2.7) ▽	59 (3.8) ▲	58 (3.6)	11 (2.1) ▽	34 (3.9) ▽
[†1] Denmark	[s]25 (4.8) ▽	[s]5 (2.7) ▽	[s]15 (4.2) ▽	[s]21 (4.7) ▽	[s]9 (3.1) ▽	[s]16 (4.2) ▽
Finland	20 (3.8) ▽	15 (3.3) ▽	24 (3.9) ▽	40 (4.1) ▽	20 (3.6) ▽	35 (4.1) ▽
France	42 (5.0) ▽	5 (2.2) ▽	16 (3.7) ▽	37 (4.1) ▽	12 (3.1) ▽	35 (4.6) ▽
Germany	33 (4.0) ▽	17 (4.4) ▽	34 (4.4) ▽	54 (4.6)	7 (1.6) ▽	55 (4.4)
Greece	70 (4.7) ▲	58 (5.1) ▲	62 (5.7) ▲	70 (3.9) ▲	42 (4.7)	55 (4.8)
Hungary	74 (4.2) ▲	16 (3.7) ▽	40 (4.7) ▽	54 (4.9)	20 (4.1) ▽	35 (4.5) ▽
Italy	42 (4.6) ▽	24 (3.8) ▽	68 (4.3) ▲	74 (4.0) ▲	37 (4.7)	56 (4.7)
[1] Kazakhstan	81 (2.9) ▲	57 (3.7) ▲	63 (4.2) ▲	76 (3.6) ▲	58 (3.6) ▲	76 (3.4) ▲
[†] Korea, Republic of	53 (4.8)	38 (5.0)	55 (4.7)	60 (4.7)	55 (5.2) ▲	48 (5.2)
[1] Kosovo	68 (5.0) ▲	72 (4.9) ▲	75 (4.7) ▲	81 (4.2) ▲	67 (5.2) ▲	87 (3.6) ▲
[1] Latvia	70 (4.4) ▲	26 (4.0)	50 (4.8)	60 (4.6)	22 (3.9) ▽	53 (4.2)
Luxembourg	28 (2.3) ▽	[r]12 (1.6) ▽	31 (2.0) ▽	40 (2.2) ▽	8 (1.1) ▽	33 (2.6) ▽
Malta	69 (0.5) ▲	43 (0.8) ▲	70 (0.4) ▲	62 (0.6)	41 (0.8) ▲	53 (0.6)
[1] Norway (Grade 9)	28 (5.1) ▽	19 (3.7) ▽	27 (4.3) ▽	42 (5.1) ▽	16 (3.6) ▽	28 (4.8) ▽
Oman	77 (3.2) ▲	72 (3.6) ▲	84 (2.7) ▲	90 (2.3) ▲	81 (3.0) ▲	84 (2.7) ▲
[1] Portugal	53 (4.2)	35 (4.5)	50 (4.4)	71 (3.4) ▲	39 (4.4)	70 (3.9) ▲
[†12] Romania	57 (6.3)	63 (6.0) ▲	79 (4.5) ▲	82 (4.0) ▲	69 (5.5) ▲	81 (3.8) ▲
[1] Serbia	83 (3.0) ▲	61 (4.6) ▲	72 (3.9) ▲	77 (3.9) ▲	51 (4.3) ▲	72 (3.5) ▲
Slovak Republic	72 (3.5) ▲	36 (4.0)	55 (3.8)	65 (3.9)	24 (3.1) ▽	53 (3.9)
[1] Slovenia	68 (3.7) ▲	35 (4.4)	47 (4.2)	72 (3.6) ▲	43 (4.1) ▲	64 (4.1) ▲
[1] Spain	59 (3.2)	18 (3.2) ▽	61 (3.5) ▲	54 (3.2)	24 (3.2) ▽	52 (3.1)
[1] Sweden	28 (4.4) ▽	5 (2.0) ▽	20 (4.2) ▽	31 (4.1) ▽	16 (3.2) ▽	18 (4.0) ▽
[†] Uruguay	[r]32 (7.6) ▽	[r]29 (6.9)	[r]47 (8.6)	[r]72 (5.7) ▲	[r]38 (6.2)	[r]65 (6.1) ▲
ICILS 2023 average	56 (0.8)	34 (0.8)	51 (0.8)	60 (0.8)	34 (0.7)	53 (0.8)
Benchmarking participant						
[1] North Rhine-W. (Germany)	37 (4.5) ▽	19 (4.0) ▽	46 (5.3)	63 (4.8)	21 (4.1) ▽	67 (4.6) ▲
Country not meeting sample participation requirements						
[‡] United States	16 (4.6) ▽	28 (5.3)	29 (4.7) ▽	38 (4.9) ▽	28 (4.3)	31 (4.9) ▽

▲ Percentage significantly higher than ICILS 2023 average.

▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. School principals stating that the school has no influence over this way of facilitating the use of ICT in teaching and learning were removed from the estimations.

† Met guidelines for sampling participation rates only after replacement schools were included.

‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

2 Country surveyed target grade in the first half of the school year.

3 National defined population covers 61% of the national target population.

r indicates data are available for at least 70% but less than 85% of the students.

s indicates data are available for at least 50% but less than 70% of the students.

Principals in schools accounting for between 50 and 60 percent of students on average across countries indicated that in their school *high priority* was given to four listed measures:

- Increasing the availability of qualified technical personnel to support the use of ICT (58% on average across countries ranging from 84% in Oman to 24% in Sweden)
- Providing teachers with incentives to integrate ICT use in their teaching (56% on average across countries ranging from 83% in Romania to 24% in Sweden)
- Developing a shared vision for using ICT to support teaching and learning (53% on average across countries ranging from 87% in Kosovo to 16% in Denmark)
- Increasing the professional learning resources for teachers in the use of ICT (51% on average across countries ranging from 84% in Oman to 15% in Denmark)

Principals in schools accounting for 50 percent or fewer students on average across countries indicated that in their school *high priority* was given to three listed measures:

- Establishing or enhancing an online learning support platform (47% on average across countries ranging from 76% in Oman to 5% in Luxembourg)
- Providing more time for teachers to prepare lessons in which ICT is used (34% on average across countries ranging from 72% in Oman to 5% in Sweden)
- Fostering collaboration between teachers in this school and with teachers in other schools (e.g., teacher networks) to support the integration of ICT use in their teaching (31% on average across countries ranging from 81% in Oman to 7% in Germany)

Across countries there was also variation in the degree to which principals reported that their school gave high priority to the measures to facilitate the use of ICT in teaching and learning. In six countries, principals in schools accounting for at least 70 percent of students reported high priority on average across the 12 measures: Azerbaijan, Cyprus, Kosovo, Oman, Romania, and Serbia. In contrast, principals in schools accounting for 40 percent or fewer students reported high priority on average across the 12 measures in Denmark, Finland, France, Luxembourg, Norway, and Sweden.

2.7 The impact of the COVID-19 pandemic on schools

The most extreme impacts of the COVID-19 pandemic on schooling (such as widespread school closures and the use of online rather than in-person teaching in many countries) took place in the period between data collection in the previous cycle of ICILS in 2018 and in ICILS 2023. The ICILS data are cross-sectional and were not collected with the intention of estimating the impact of the COVID-19 on schooling and student outcomes with respect to CIL and CT. However, it is important to keep in mind the occurrence of the COVID-19 pandemic and its potential to have impacted schooling when considering the broader national contexts of schooling across countries.

For this reason, we included two sets of questions for school principals relating to the impact of the COVID-19 pandemic on their schools. The first of these questions asked principals to indicate, separately for each Northern Hemisphere school year from 2019/20 to 2022/23, the number of weeks that in-person teaching to students in the target grade (grade 8 or equivalent) did not take place in their school because of the COVID-19 pandemic. ICILS countries with Southern Hemisphere school calendars adapted the questions to refer to Southern Hemisphere school years between 2019 and 2023. Adaptations to the school years are indicated with annotations for the relevant countries (Korea (Rep. of) and Uruguay) and listed in the notes section of the tables. The second question asked principals to indicate, for the same school years, the number of weeks that digitally supported remote learning was partially or fully implemented for target grade students. In each of Slovenia and the Czech Republic, these data were provided by the relevant central authority rather than based on the responses of principals.

Principals were then asked to indicate how they believed the experience of the COVID-19 pandemic had affected the following aspects of teaching and learning at their schools:

- Teachers' willingness to use ICT in their teaching
- The effectiveness of teachers' use of ICT in their teaching
- Students' learning progress in language arts: test language
- Students' learning progress in mathematics
- Students' learning progress across all subjects
- Students' digital literacy skills

in-person teaching and remote learning

The impact of the COVID-19 pandemic on in-person teaching, and the use of digitally supported remote learning at the target grade was largest in the 2019/2020 and 2020/2021 school years (Table 2.8). In 2019/2020, on average across countries 68 percent of students were in schools where in-person teaching did not take place for eight weeks or more. These percentages ranged from a minimum of five percent in Sweden to a maximum of 100 percent of students in the Czech Republic and Slovenia. Similar proportions of students were in schools that made use of prolonged periods of digitally supported remote learning. This took place on average across countries, for at least eight weeks in schools accounting for 65 percent of students, with minimum of five percent in Sweden and a maximum of 100 percent in the Czech Republic and Slovenia.

The 2020/21 school year was also largely affected by the COVID-19 pandemic. In 2020/21, on average across countries, 49 percent of students were in schools where in-person teaching did not take place for eight weeks or more. These percentages ranged from zero percent in Serbia to 100 percent in the Czech Republic and Slovenia. Digitally supported remote learning took place for at least eight weeks in schools accounting for 53 percent of students on average across countries, with a minimum of zero percent in Serbia and a maximum of 100 percent in the Czech Republic and Slovenia.

Table 2.8: School principal reports on the number of weeks closed due to the COVID-19 pandemic

Country	Percentages of students in schools where 8 weeks or longer			
	In-person instruction for target grade students did not take place in school because of the COVID-19 pandemic (school year 2019–2020)	Digitally supported remote learning partially or fully implemented for target grade students (school year 2019–2020)	In-person instruction for target grade students did not take place in school because of the COVID-19 pandemic (school year 2020–2021)	Digitally supported remote learning partially or fully implemented for target grade students (school year 2020–2021)
[1] Austria	[r]67 (5.0)	[r]48 (5.2) ▽	[r]53 (5.1)	[r]57 (5.2)
Azerbaijan	80 (4.4) ▲	[r]71 (5.2)	[r]67 (5.1) ▲	[r]65 (5.1) ▲
[†] Belgium (Flemish)	77 (5.0)	[r]65 (4.9)	[r]14 (3.7) ▽	[r]18 (4.2) ▽
[3] Bosnia and Herzegovina	84 (4.9) ▲	92 (3.7) ▲	[r]30 (5.7) ▽	40 (6.3) ▽
Chinese Taipei	8 (2.1) ▽	12 (2.7) ▽	18 (3.2) ▽	20 (3.4) ▽
[1] Croatia	49 (5.0) ▽	81 (3.5) ▲	23 (3.8) ▽	37 (4.7) ▽
Cyprus	73 (2.7)	76 (2.7) ▲	76 (2.6) ▲	76 (2.8) ▲
[1] Czech Republic	100 *	100 *	100 *	100 *
[†1] Denmark	[s]58 (6.3)	[s]51 (6.0) ▽	[s]62 (6.6)	[s]62 (6.7)
Finland	58 (4.6) ▽	55 (4.5) ▽	20 (4.0) ▽	18 (3.7) ▽
France	65 (5.0)	63 (4.5)	12 (3.1) ▽	18 (3.9) ▽
Germany	[r]65 (4.0)	[r]48 (4.5) ▽	[r]60 (5.0) ▲	[r]65 (4.6) ▲
Greece	55 (4.9) ▽	31 (4.5) ▽	93 (2.2) ▲	94 (2.2) ▲
Hungary	89 (2.8) ▲	90 (2.7) ▲	67 (4.8) ▲	67 (4.6) ▲
Italy	95 (1.7) ▲	91 (2.4) ▲	39 (4.2) ▽	48 (3.4)
[1] Kazakhstan	74 (3.6)	68 (3.8)	77 (3.5) ▲	85 (3.0) ▲
[†] Korea, Republic of	[r]13 (3.3) ▽	[r]10 (3.1) ▽	[r]82 (3.7) ▲	[r]79 (3.8) ▲
[1] Kosovo	50 (5.6) ▽	72 (4.8)	16 (4.2) ▽	31 (5.1) ▽
[1] Latvia	86 (3.1) ▲	79 (3.6) ▲	89 (2.9) ▲	92 (2.6) ▲
Luxembourg	47 (2.5) ▽	55 (2.6) ▽	7 (1.8) ▽	14 (2.0) ▽
Malta	90 (0.5) ▲	82 (0.6) ▲	21 (0.4) ▽	17 (0.3) ▽
[1] Norway (Grade 9)	[r]39 (5.2) ▽	[r]52 (5.3) ▽	[r]14 (3.3) ▽	[r]22 (3.7) ▽
Oman	76 (3.0) ▲	34 (3.3) ▽	72 (3.6) ▲	88 (2.3) ▲
[1] Portugal	86 (3.0) ▲	91 (2.4) ▲	57 (4.3)	59 (4.2)
[†12] Romania	78 (4.7) ▲	72 (4.5)	75 (4.7) ▲	77 (4.0) ▲
[1] Serbia	84 (3.1) ▲	88 (3.0) ▲	0 (0.0) ▽	0 (0.0) ▽
Slovak Republic	91 (2.2) ▲	72 (3.5) ▲	92 (2.2) ▲	93 (2.0) ▲
[1] Slovenia	100 *	100 *	100 *	100 *
[1] Spain	92 (2.0) ▲	88 (2.5) ▲	17 (3.1) ▽	23 (3.0) ▽
[1] Sweden	[r]5 (2.1) ▽	[r]5 (2.2) ▽	[r]24 (4.3) ▽	[r]26 (4.4) ▽
[†] Uruguay	[r]88 (3.8) ▲	[r]84 (4.7) ▲	[r]72 (6.1) ▲	[r]75 (5.9) ▲
ICILS 2023 average	68 (0.7)	65 (0.7)	49 (0.7)	53 (0.7)
Benchmarking participant				
[1] North Rhine-W. (Germany)	51 (5.3) ▽	36 (5.0) ▽	65 (4.7) ▲	68 (4.6) ▲
Country not meeting sample participation requirements				
[‡] United States	83 (3.8) ▲	86 (3.5) ▲	45 (4.9)	72 (3.3) ▲

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.

[†] Met guidelines for sampling participation rates only after replacement schools were included.

[‡] Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

[2] Country surveyed target grade in the first half of the school year.

[3] National defined population covers 61% of the national target population.

[r] indicates data are available for at least 70% but less than 85% of the students.

[s] indicates data are available for at least 50% but less than 70% of the students.

* This information was provided for Slovenia by the Slovenian Ministry of Education and for Czech Republic by the Czech School Inspectorate.

Table 2.8: School principal reports on the number of weeks closed due COVID-19 pandemic (cont'd)

Country	Percentages of students in schools where 8 weeks or longer			
	In-person instruction for target grade students did not take place in school because of the COVID-19 pandemic (school year 2021–2022)	**Digitally supported remote learning partially or fully implemented for target grade students (school year 2021–2022)**	**In-person instruction for target grade students did not take place in school because of the COVID-19 pandemic (school year 2022–2023)**	**Digitally supported remote learning partially or fully implemented for target grade students (school year 2022–2023)**
[1] Austria	[r] 6 (2.2)	[r] 6 (2.5)	2 (1.6)	[r] 1 (0.8)
Azerbaijan	[r] 22 (4.2) ▲	[r] 9 (3.1)	[r] 18 (3.8) ▲	[r] 1 (0.8)
[†] Belgium (Flemish)	1 (0.9) ▽	2 (1.3) ▽	0 (0.0) ▽	1 (0.8)
[3] Bosnia and Herzegovina	[r] 4 (2.8) ▽	[r] 0 (0.0) ▽	4 (2.8)	[r] 0 (0.0) ▽
Chinese Taipei	30 (3.8) ▲	32 (3.8) ▲	6 (1.9)	10 (2.5) ▲
[1] Croatia	3 (1.7) ▽	3 (1.5) ▽	0 (0.0) ▽	0 (0.0) ▽
Cyprus	13 (2.2)	12 (0.7) ▲	6 (2.1)	3 (0.1) ▲
[1] Czech Republic	0 *	0 *	0 *	0 *
[†1] Denmark	[s] 20 (5.1)	[s] 16 (4.7)	[s] 5 (2.5)	[s] 1 (1.3)
Finland	7 (2.4)	7 (1.9)	4 (1.8)	[r] 0 (0.0) ▽
France	3 (1.5) ▽	4 (1.8) ▽	2 (1.1) ▽	3 (1.5)
Germany	[r] 4 (1.4) ▽	[r] 8 (2.2)	0 (0.0) ▽	1 (0.8)
Greece	6 (2.1) ▽	3 (1.5) ▽	4 (1.8)	0 (0.0) ▽
Hungary	5 (2.1) ▽	4 (1.9) ▽	1 (0.8) ▽	0 (0.0) ▽
Italy	3 (1.6) ▽	12 (2.9)	1 (0.8) ▽	3 (1.0)
[1] Kazakhstan	25 (3.8) ▲	[r] 9 (2.5)	[r] 20 (3.2) ▲	[r] 3 (1.3)
[†] Korea, Republic of	[r] 53 (4.5) ▲	[r] 53 (4.8) ▲	[r] 8 (2.5)	[r] 7 (2.5) ▲
[1] Kosovo	[r] 5 (2.5) ▽	[r] 6 (2.5)	[r] 5 (2.7)	[r] 2 (1.6)
[1] Latvia	20 (3.8) ▲	19 (3.6) ▲	2 (1.2)	2 (1.2)
Luxembourg	0 (0.0) ▽	[r] 0 (0.0) ▽	0 (0.0) ▽	[r] 0 (0.0) ▽
Malta	8 (0.2) ▽	6 (0.2) ▽	7 (0.1) ▲	0 (0.0) ▽
[1] Norway (Grade 9)	7 (2.6)	[r] 5 (2.3)	4 (2.3)	[r] 3 (1.9)
Oman	29 (4.0) ▲	34 (4.1) ▲	3 (1.4)	4 (1.4)
[1] Portugal	4 (1.8) ▽	3 (1.7) ▽	1 (0.6) ▽	0 (0.0) ▽
[†12] Romania	27 (4.7) ▲	27 (4.9) ▲	3 (2.0)	8 (3.7)
[1] Serbia	0 (0.0) ▽	0 (0.0) ▽	0 (0.0) ▽	0 (0.0) ▽
Slovak Republic	17 (3.1) ▲	17 (3.0) ▲	2 (1.3)	0 (0.0) ▽
[1] Slovenia	0 *	0 *	0 *	0 *
[1] Spain	5 (1.5) ▽	4 (1.3) ▽	5 (1.5)	3 (1.1)
[1] Sweden	[r] 6 (2.3) ▽	[r] 6 (2.4)	0 (0.0) ▽	[r] 0 (0.0) ▽
[†] Uruguay	[r] 3 (2.2) ▽	[r] 4 (2.7) ▽	[r] 3 (2.2)	[r] 4 (2.6)
ICILS 2023 average	10 (0.5)	9 (0.4)	4 (0.3)	2 (0.2)
Benchmarking participant				
[1] North Rhine-W. (Germany)	8 (3.1)	[r] 12 (3.4)	0 (0.0) ▽	1 (1.1)
Country not meeting sample participation requirements				
[‡] United States	2 (1.4) ▽	9 (2.8)	2 (1.2)	4 (2.1)

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
[†] Met guidelines for sampling participation rates only after replacement schools were included.
[‡] Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.
[r] indicates data are available for at least 70% but less than 85% of the students.
[s] indicates data are available for at least 50% but less than 70% of the students.
* This information was provided for Slovenia by the Slovenian Ministry of Education and for Czech Republic by the Czech School Inspectorate.

In general after the first two school years beginning in 2019, the time that in-person teaching did not take place, and digitally supported remote learning was used decreased. In the 2021/22 school year, on average across countries 10 percent of students were in schools where in-person teaching did not take place for eight weeks or more. These percentages varied from zero percent in the Czech Republic, Luxembourg, Serbia, and Slovenia to 53 percent in Korea (Rep. of). Digitally supported remote learning took place for at least eight weeks in schools accounting for nine percent of students on average across countries, with minimum of zero percent in Bosnia and Herzegovina, the Czech Republic, Luxembourg, Serbia, and Slovenia, and a maximum of 53 percent in Korea (Rep. of). In the 2022/23 school year on average across countries, four percent of students were in schools where in-person teaching did not take place for at least eight weeks or more. In two countries only, Azerbaijan (18%) and Korea (Rep. of) (20%) did this exceed ten percent of students. Digitally supported remote learning took place for at least eight weeks in schools accounting for 10 percent of students in Chinese Taipei and for less than 10 percent of students in all other countries.

Aspects of teaching and learning

There is a clear distinction between three aspects of teaching and learning that school principals generally did not report to have been adversely affected by the COVID-19 pandemic and the three aspects that principals reported to have been adversely affected to a greater extent (Table 2.9).

Three aspects of teaching and learning were reported by principals to have either remained the same or increased in response to the COVID-19 pandemic—*teachers' willingness to use ICT in their teaching*, *the effectiveness of teachers' use of ICT in their teaching* and *students' digital literacy skills*. Theses were reported by principals in schools accounting for 99 percent, 99 percent, and 98 percent of students respectively, on average across countries. In 20 countries at least one of these aspects was reported by principals in schools accounting for 100 percent of students to have not changed or increased.

In contrast, the percentages of principals reporting no change or an improvement were far lower when reporting on students' learning progress in the language of testing, in mathematics and in general across all subjects. On average across countries, principals in schools accounting for 59 percent of students reported that they believed students' learning progress in the language of testing had either stayed the same or improved during the experience of the COVID-19 pandemic. This means that, on average across countries, principals in schools accounting for 41 percent of students reported the belief that student learning progress had decreased (to some degree or substantially). There was, however, considerable variation across countries. In Malta, principals in schools accounting for 100 percent of students reported that student learning in the language of testing did not change or increased, in contrast with principals in schools accounting for 31 percent of students in Germany.

Table 2.9: School principal reports on the impact of COVID-19 in their schools

Country	Percentage of students in schools where specific aspects did not change, increased, or substantially increased because of COVID-19 pandemic					
	Teachers' willingness to use ICT in their teaching	**The effectiveness of teachers' use of ICT in their teaching**	**Students' learning progress in language arts (test language)**	**Students' learning progress in mathematics**	**Students' learning progress across all subjects**	**Students' digital literacy skills**
[1] Austria	100 (0.0) ▲	99 (1.0)	45 (4.8) ▽	49 (4.6)	44 (4.4)	100 (0.0) ▲
Azerbaijan	96 (2.3)	93 (2.7) ▽	72 (4.3) ▲	55 (4.6)	53 (4.7)	89 (3.0) ▽
[†] Belgium (Flemish)	100 (0.0) ▲	100 (0.0) ▲	44 (4.0) ▽	49 (4.4)	51 (4.7)	96 (2.3)
[3] Bosnia and Herzegovina	95 (2.9)	97 (2.4)	58 (7.1)	53 (7.1)	44 (6.7)	98 (1.6)
Chinese Taipei	100 (0.0) ▲	98 (1.0)	74 (3.8) ▲	70 (3.8) ▲	66 (4.0) ▲	99 (0.7) ▲
[1] Croatia	100 (0.0) ▲	100 (0.0) ▲	56 (4.5)	52 (4.3)	53 (4.2)	100 (0.0) ▲
Cyprus	99 (0.0) ▽	96 (0.1) ▽	53 (2.8) ▽	52 (3.1)	45 (2.7) ▽	97 (0.1)
[1] Czech Republic	100 (0.0) ▲	100 (0.0) ▲	68 (3.7) ▲	69 (3.4) ▲	66 (3.7) ▲	100 (0.0) ▲
[†1] Denmark	r100 (0.0) ▲	r100 (0.0) ▲	r69 (4.8) ▲	r68 (4.5) ▲	r58 (5.0)	r99 (1.0)
Finland	99 (0.9)	99 (0.8)	50 (4.6)	47 (4.4)	39 (4.3) ▽	96 (1.9)
France	100 (0.0) ▲	100 (0.0) ▲	58 (4.5)	68 (4.6) ▲	62 (4.3) ▲	95 (2.1)
Germany	100 (0.0) ▲	99 (1.0)	31 (4.2) ▽	32 (3.9) ▽	34 (3.9) ▽	100 (0.2) ▲
Greece	99 (1.0)	98 (1.1)	33 (3.7) ▽	33 (4.0) ▽	30 (3.9) ▽	96 (1.8)
Hungary	100 (0.0) ▲	100 (0.0) ▲	45 (4.7) ▽	38 (4.5) ▽	33 (4.3) ▽	99 (0.7) ▲
Italy	100 (0.0) ▲	100 (0.0) ▲	56 (4.3)	53 (4.4)	53 (4.2)	99 (0.9)
[1] Kazakhstan	99 (0.9)	98 (1.1)	77 (3.5) ▲	63 (4.1) ▲	63 (3.7) ▲	95 (1.7)
[†] Korea, Republic of	100 (0.0) ▲	99 (0.9)	45 (4.7) ▽	42 (4.5) ▽	40 (4.5) ▽	96 (1.8)
[1] Kosovo	98 (1.2)	98 (1.4)	81 (4.1) ▲	73 (4.1) ▲	69 (5.0) ▲	94 (2.5)
[1] Latvia	99 (0.9)	100 (0.0) ▲	37 (4.4) ▽	26 (3.7) ▽	26 (3.9) ▽	99 (0.9)
Luxembourg	100 (0.0) ▲	100 (0.0) ▲	58 (2.2)	46 (2.1) ▽	45 (2.1) ▽	96 (0.8) ▽
Malta	100 (0.0) ▲	100 (0.0) ▲	100 (0.0) ▲	76 (0.7) ▲	66 (0.7) ▲	100 (0.0) ▲
[1] Norway (Grade 9)	100 (0.0) ▲	99 (1.3)	76 (4.2) ▲	67 (4.8) ▲	76 (4.3) ▲	99 (0.6) ▲
Oman	99 (0.7)	98 (0.9)	65 (3.5)	67 (3.2) ▲	59 (3.1) ▲	97 (1.4)
[1] Portugal	100 (0.0) ▲	100 (0.3) ▲	42 (4.4) ▽	41 (4.3) ▽	37 (4.2) ▽	99 (0.8)
[†12] Romania	93 (2.5) ▽	95 (2.3)	53 (5.0)	51 (5.0)	48 (5.1)	90 (3.4) ▽
[1] Serbia	99 (0.8)	100 (0.0) ▲	69 (3.8) ▲	61 (4.1)	63 (4.3) ▲	99 (0.8)
Slovak Republic	100 (0.4)	99 (0.6)	59 (3.9)	52 (3.6)	53 (3.8)	99 (0.5) ▲
[1] Slovenia	100 (0.5)	100 (0.0) ▲	33 (4.0) ▽	39 (4.0) ▽	33 (4.1) ▽	98 (0.7)
[1] Spain	100 (0.0) ▲	100 (0.0) ▲	68 (3.1) ▲	66 (3.1) ▲	68 (3.1) ▲	99 (0.5) ▲
[1] Sweden	100 (0.0) ▲	100 (0.0) ▲	79 (3.8) ▲	67 (4.3) ▲	74 (4.2) ▲	100 (0.0) ▲
[†] Uruguay	99 (1.1)	97 (2.4)	61 (6.5)	64 (6.8)	58 (6.3)	99 (1.4)
ICILS 2023 average	99 (0.2)	99 (0.2)	59 (0.8)	55 (0.8)	52 (0.8)	98 (0.2)
Benchmarking participant						
[1] North Rhine-W. (Germany)	100 (0.0) ▲	100 (0.0) ▲	33 (4.3) ▽	33 (5.0) ▽	38 (4.4) ▽	99 (0.8)
Country not meeting sample participation requirements						
[‡] United States	95 (1.3) ▽	96 (1.2) ▽	40 (5.1) ▽	35 (4.8) ▽	41 (4.8) ▽	94 (2.7)

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
[†] Met guidelines for sampling participation rates only after replacement schools were included.
[‡] Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.
[r] indicates data are available for at least 70% but less than 85% of the students.

Slightly lower percentages of principals reported that student learning progress did not change or improved with respect to mathematics and in general across all subjects in comparison to learning progress in the language of testing. On average across countries, principals in schools accounting for 55 percent and 52 percent of students reported that learning progress had either not changed or improved in mathematics and across all subjects respectively. Overall, within countries, principals' views of learning progress were largely consistent across the three listed areas. The range of percentages of students in schools where the principal indicated that learning progress had not changed or increased across the three areas (language of testing, mathematics and all subjects) varied relatively little within each country. In 20 countries this variation was less than ten percentage points. The largest difference across the three areas was seen in Malta where principals in schools accounting for 100 percent of students reported that student learning progress in the language of testing had not changed or improved in comparison with principals in schools accounting for 66 percent of students when considering learning progress across all subjects.

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Chapter 3:

Measuring students' computer and information literacy

Daniel Duckworth and Julian Fraillon

Chapter highlights

The ICILS 2023 computer and information literacy (CIL) test instrument comprised seven 30 minute computer-based test modules. Each student completed two modules. The modules were designed to assess the broad range of knowledge, skills, and understandings that comprise the CIL achievement construct by:

- reflecting real-world scenarios with a cross-curricular focus;
- integrating a range of ICT-based technical, receptive, productive, and evaluative skills; and
- requiring students also to demonstrate understanding of safe, responsible, and ethical use of ICT.

The ICILS CIL achievement scale was established in ICILS 2013 and reviewed and revised as part of each subsequent assessment cycle. CIL achievement is described across four levels of increasing proficiency.

- Students working at CIL Level 1 demonstrate an understanding of computers as tools for completing simple tasks and basic operational skills with computers (Table 3.3).
- Students working at CIL Level 2 use computers to complete basic and explicit information gathering and management tasks and to create simple information products that reflect standard design and layout conventions (Table 3.3).
- Students working at CIL Level 3 demonstrate the capacity to work independently with computers for information gathering and management tasks, and they show an understanding of basic information design conventions by formatting and arranging content in order to support comprehension of their information products (Table 3.3).
- Students working at CIL Level 4 select the most relevant information to use for communicative purposes, evaluate its usefulness, credibility, and reliability, and create information products adapted from digital resources in ways that make the information more accessible to the target audience (Table 3.3).

3.1 Introduction

Computer and information literacy (CIL) is defined in the International Computer and Information Literacy Study (ICILS) as 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 & Duckworth, 2024, p. 26). In the ICILS, there is an operational emphasis on students' abilities to use computers to collect and manage information, produce information products, and exchange information. Computer and information literacy comprises four strands, each of which is specified in terms of a number of aspects. The strands describe CIL in terms of the following: understanding computer use, gathering information, producing information, and digital communication[13] (Fraillon & Duckworth, 2024).

In this chapter, we elaborate on the measurement of CIL within the context of ICILS and the development of the CIL achievement scale. We begin with a brief explanation of the foundational principles underpinning the CIL test instrument. This is followed by a description of the test environment and design, which has been consistently implemented since the inception of ICILS. Subsequently, we provide an overview of the test content by describing the assessment tasks from two CIL modules, illustrating how the test operationalizes the CIL construct (Fraillon & Duckworth, 2024). Furthermore, we present the CIL achievement scale and explain the methodology used to establish this scale, highlighting its significance in interpreting student test scores. The chapter concludes with illustrative examples of items from the release modules, demonstrating the characteristics of student achievement at each level of the scale. This final section has been included as resource for educators aiming to target specific areas of teaching to support students' learning progress in CIL.

3.2 The CIL test instrument

Background

The approach to CIL assessment in ICILS, established for the first cycle of ICILS in 2013 and maintained in subsequent cycles, including ICILS 2023, incorporates several essential features of assessment in this domain:

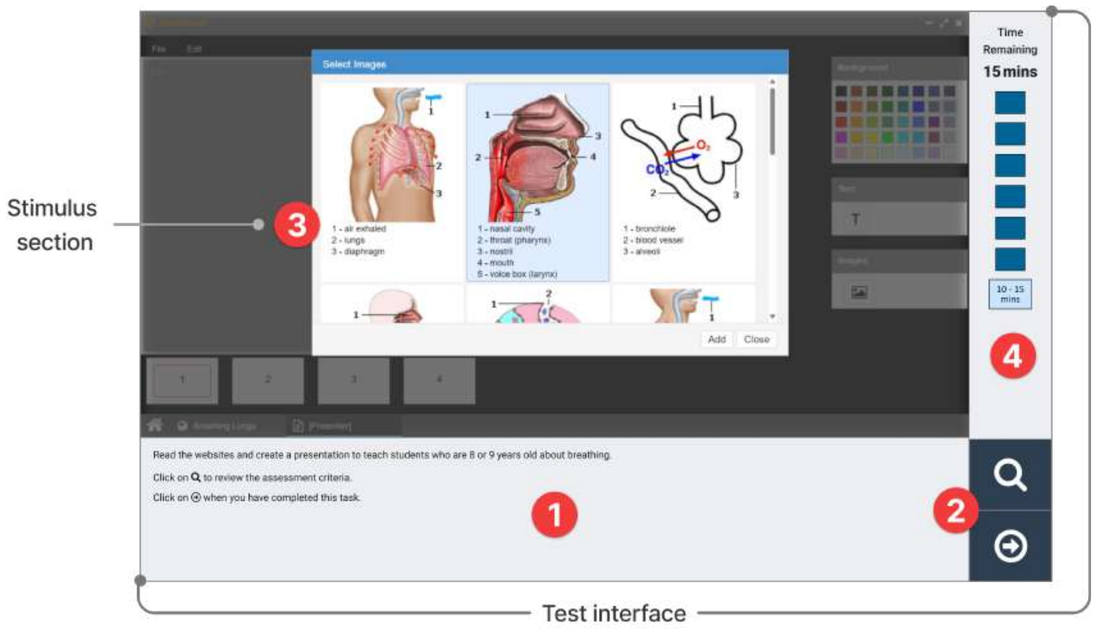
- Computer-based tasks: Students engage exclusively with tasks on a computer, ensuring a direct assessment of their skills and knowledge.
- Real-world, cross-curricular focus: The test is designed to reflect real-world scenarios, necessitating the application of skills and knowledge in various contexts.
- Integration of diverse skills: Tasks within the test require combinations of technical, receptive, productive, and evaluative skills. This reflects the multimodal and multifaceted nature of digital technologies and computer-based tasks.
- Inclusion of tasks that reflect safe and ethical use of computer-based information: In addition to integrating technical, receptive, productive, and evaluative skills, the test requires students to demonstrate understanding of responsible and ethical use of computer-based information and communication technologies.

In addition to these features, the ICILS CIL test environment and instrument are designed to ensure uniformity of the test-taking experience and standardization of test content for all participants. The ICILS tests were required to be delivered on computers with a minimum screen size of 11 inches, and with an external keyboard and mouse. The ICILS test instrument software uses a fixed display resolution and employs a quarantined software environment, or a "walled garden." Within this environment, real-world applications (such as web browsers and desktop productivity applications) can be used to access digital resources and to create authentic computer-based information products. However, access to digital resources from outside the test is prevented, so that all students share an equivalent experience of the test content. Within the test, all content is designed to provide students with the necessary contextual information for completing the assessment, thereby reducing dependency on prior external knowledge that could unfairly benefit certain student groups. Additionally, "specialized information, such as scientific terminology, is presented at a complexity level commensurate with upper-primary or elementary school understanding" (Duckworth & Fraillon, 2024, p. 61).

13 See also Chapter 1 for more detail of the CIL construct.

The ICILS test environment is realized by a graphical user interface (GUI), which is divided into two main functional areas: the test interface and the stimulus section (see Figure 3.1[14]).

Figure 3.1: ICILS 2023 test environment



1. Instructions section: Presents contextual information, questions about, or instructions in relation to the computer-based tasks presented in the stimulus section.
2. Navigation and test information: Buttons that facilitate moving between tasks and access to information about the test or current task.
3. Stimulus section: Interactive and non-interactive content depicting computer-based tasks and scenarios.
4. Test progress: Indicates the total number of tasks to be completed, the number of tasks that have been completed, the position of the current task, the number of tasks yet to be completed, the suggested time needed to complete large authoring tasks (where relevant), and the remaining time allocated to complete the tasks.

While standardizing the test experience and content is a key consideration in ICILS, when planning the evolution of the ICILS test environment across cycles "we leave open the possibility to adapt, as appropriate, the presentation of the assessment content to align with contemporary user interface conventions" (Duckworth & Fraillon, 2024, p. 57). This flexibility applies to both the design of the test interface and the simulated applications shown in the stimulus section. For example, in ICILS 2013, the test interface was set to display at 1024 px by 768 px, whereas in ICILS 2023, the specification was updated to 1280 px by 800 px to "reflect the trend toward wider display screens..." (Duckworth & Fraillon, 2024, p. 57) and to offer "a more versatile canvas for the development of test content that accurately reflects the evolving design norms of real-world software applications" (Duckworth & Fraillon, 2024, p. 57). When adapting trend material to a wider display format, adjustments typically focus on the layout and size of elements with minor changes to visual style. However interaction design, such as adding animated transitions for menu interactions, are typically unchanged.

14 The example shown in Figure 3.1 is of the GUI used for languages with left-to-right text. An equivalent GUI was used for languages with right-to-left text.

Test design and content

In each cycle of ICILS, the CIL test instruments were developed to be consistent with the overarching design principles established for ICILS 2013 and designed to reflect contexts that complemented the existing content of the ICILS test and respect the evolving nature of the real-world digital experiences of students, including developments in digital tools and user interface (UI) conventions.

The CIL test instrument for ICILS 2023 consisted of seven modules (see Table 3.1) of questions and tasks that took 30 minutes to complete each. This composition comprised three new modules specifically developed for the 2023 study cycle, alongside four secure trend modules: two from ICILS 2013 and two from ICILS 2018. The inclusion of secure trend modules facilitates the reporting of student achievement data collected in the current study cycle on the ICILS CIL proficiency scale established from the ICILS 2013 data. It also facilitates the analysis of trends in student achievement over time for countries that participate in multiple study cycles.

Table 3.1: ICILS 2023 CIL module summaries

Module title	Description
Board games club	Students use a school-based social network for direct messaging and group posts to encourage peers to join a board games interest group.
Breathing	Students manage files and collect and evaluate information to create a presentation explaining the process of breathing to eight-or-nine-year-old students.
Computer use and health	Students collaborate with a partner using a chat app to communicate, manage files, and access and evaluate information sources for a research report on computer use and health issues.
Internet safety	Students research information on identifying fake information and scams, personal information security, and reporting suspicious content to authorities. They work on a project to create a digital poster for younger students at their school, providing guidelines and tips for avoiding scams.
Paper books vs ebooks	Students use the internet to find people's opinions about their preferences for paper books and ebooks. They then write a set of notes comparing the positives and negatives of each, which someone else can use to prepare a presentation.
Recycling	Students access and evaluate information from a video-sharing website to identify a suitable source related to waste reduction, reuse, and recycling. They take research notes from the video and use these notes as the basis for designing an infographic to raise awareness about waste reduction, reuse, and recycling.
School trip	Students help plan a walking tour excursion using online database tools, selecting and adapting information to produce an information sheet for their peers. The information sheet includes a map with tour directions created using a map annotation tool.

Each module's content emphasizes the core elements of CIL, adapting to ensure that the conventions assessed are both current and relevant to students' digital experiences at the time of data collection. By tailoring module content to prevailing digital norms, ICILS aims to provide an authentic test-taking experience that mirrors real-world digital tasks. This approach ensures the instrument captures an accurate assessment of students' capacity to express CIL skills in settings consistent with their everyday digital environments. In ICILS 2013, students completed CIL tests in a software environment consistent with the prevalent UI conventions at the time. The students who completed ICILS in 2023 were typically three to four years-old in 2013, and eight to nine years-old in 2018, and would likely have little or no memory of their computer use from these times. Were the ICILS 2023 UI to have been identical to that of ICILS 2013, or ICILS 2018, the students in 2023 would have been relatively disadvantaged by working in an outdated and unfamiliar environment. The approach in ICILS is to make use of UI conventions that are relevant at the time of administration, so that the students' likely familiarity with and readiness to interact with the test UI is consistent across ICILS cycles. Moreover, through the on-going refinement of assessment items, the CIL test remains responsive to new technologies and digital communication trends, ensuring that students' digital competencies are evaluated against standards pertinent to their immediate context.

In the test, each student completed a randomly assigned pair of CIL test modules out of the seven available modules in a fully balanced rotational design.[15] For a comprehensive explanation of the ICILS test design, including detailed insights into the evolution of the computer-based test interface design and the variety of task types, see Chapter 5 of the ICILS 2023 assessment framework (Duckworth & Fraillon, 2024).

Each CIL test module comprises a set of questions and tasks based on a real-world theme and follows a linear narrative structure. Each module has a series of smaller discrete tasks,[16] each of which is designed to be able to be completed quickly (usually in less than one minute), and a large authoring task. The narrative of each module frames the smaller discrete tasks as a mix of information management and skill execution tasks that students need to complete in preparation for the large task in which students create information products using productivity applications (such as text editing, website editing, or presentation software). These applications, bespoke developed for ICILS, are designed to reflect contemporary software application conventions, such as the use of recognizable icons associated with typical functions, or common UI feedback responses to given commands.

When starting each module, students were presented with an overview of the theme and purpose of the tasks in the module, as well as a basic description of what the large task would entail. As explained in the ICILS 2023 assessment framework "[W]hile the themes of the CIL modules are situated within a school environment, they are not confined to traditional academic subjects. Modules may encompass themes related to school subject-based social or environmental issues, but can also extend to scenarios such as planning a class excursion or establishing an online interest club with a community and social emphasis rather than academic one" (Duckworth & Fraillon, 2024, p. 61). Illustrations of this contextualization are included in the module summary descriptions in Table 3.1.

The students were required to complete the tasks in the allocated sequence within in each module, and could not return to review or revise completed tasks "to prevent the utilization of information from subsequent tasks for answering earlier ones" (Duckworth & Fraillon, 2024, p. 61) . Students were free to decide how much time to spend on each individual task. However, in each module, they were given an indication of how much time it was recommended for them to leave available to complete the large task, typically between 10 and 15 minutes (see section 4 in Figure 3.1).

CIL construct coverage

Data collected from the seven test modules were used to measure and describe CIL achievement. In total, the data comprised 156 score points derived from 52 tasks. Approximately 60 percent of the score points were derived from criteria associated with the seven large tasks. Students' responses to these tasks were scored in each country by trained expert scorers. Data were only included where they met or exceeded the IEA technical requirements. The ICILS 2023 technical report (Fraillon et al., forthcoming) provides additional information on scoring, adjudication scaling, and analyses of the CIL test item data.

The ICILS 2023 CIL framework describes the CIL construct using a structure comprising four strands,

15 In a fully balanced rotational test design, every combination of two modules is equally likely to be assigned to a student, and every module is equally likely to be paired with any other module.
16 We describe these tasks as discrete because, although connected by a narrative, students could complete subsequent tasks irrespective of the correctness of their responses to previous tasks.

each of which is specified by several aspects. The strands reflect the overarching conceptual categories for articulating the skills and knowledge assessed by the CIL instrument, while the aspects further articulate CIL in terms of the main (but not exclusive) constituent processes that underpin the skills and knowledge (Fraillon & Duckworth, 2024). We use this structure primarily as an organizational tool when describing the breadth of content of the CIL construct and is not intended to form the basis of analysis and reporting of achievement by sub-dimensions (such as by strand or aspect).

Table 3.2 outlines the four strands and the corresponding aspects of the CIL framework, together with the score points and respective percentages[17] (of the 156 total score points) attributed to each strand and each aspect within the strands.

Table 3.2: Distribution of score points and percentages across CIL strands and aspects

Strand / Aspect	Score points	Percentage of total
1: Understanding computer use	18	12%
1.1: Foundations of computer use	3	2%
1.2: Computer use conventions	15	10%
2: Gathering information	33	21%
2.1: Accessing and evaluating information	22	14%
2.2: Managing information	11	7%
3: Producing information	76	49%
3.1: Transforming information	22	14%
3.2: Creating information	54	35%
4: Digital communication	29	19%
4.1: Sharing information	12	8%
4.2: Using information responsibly and safely	17	11%

Approximately two thirds of the score points are associated with the 'Gathering information' and 'Producing information' strands and one third with the 'Understanding computer use' and 'Digital communication' strands. These proportions correspond to the amount of time students were expected to spend on the tasks assessing each strand. The aspects of 'Producing information' were assessed primarily through large tasks at the end of each module, with students expected to spend approximately two thirds of their working time on these tasks. As stated in the ICILS 2023 assessment framework, "[t]he ICILS tasks are designed to collect information about specific aspects of the relevant construct (CIL or CT), and each module typically includes content that addresses most, if not all, aspects of the construct. However, the test design of ICILS does not require that equal proportions of all aspects of the CIL and CT constructs are assessed" (Duckworth & Fraillon, 2024, p. 76).

3.3 CIL release modules

At the end of each ICILS study cycle, we release a subset of secure items to increase the transparency of the assessment content and to enable researchers, educators, and policy makers to contextualize primary and secondary analyses of ICILS data. The release modules are replaced by newly developed modules for each cycle. This is essential to ensuring that the ICILS CIL instrument remains up to date with new developments in digital technology over time. We selected the Breathing and School trip modules (see Table 3.1) for public release. Both modules were developed for ICILS 2013 and kept secure for use in ICILS 2018 and ICILS 2023. We chose to release these modules because their tasks and items collectively reflect all aspects of the CIL construct.

In Appendix E we provide detailed descriptions of the assessment tasks for the two CIL release mod-

17 Because results are rounded to the nearest whole number, some aggregate statistics may appear inconsistent.

ules. An online web player for these modules is also available on the IEA website at https://www.iea.nl/icils2023-assessment.

3.4 The CIL achievement scale

The CIL achievement scale offers a standardized approach for interpreting student test scores. This allows educators, researchers, and policymakers to analyze students' CIL both within and across countries and to empirically monitor trends in achievement over multiple study cycles. The scale was first established in 2013 with a mean scale score of 500 and a standard deviation of 100 based on equally weighted national samples from participating countries (Fraillon et al., 2014). ICILS 2013 data were used to equate ICILS 2018 data with the existing CIL scale (Fraillon et al., 2020; Ockwell et al., 2020). Similarly, in ICILS 2023, the ICILS 2018 data were used for equating. Detailed scaling procedures are provided in the ICILS 2023 technical report (Fraillon et al., forthcoming).

In 2013, when we established the CIL achievement scale, we also described the achievement represented by the scale by considering both the content and the scaled difficulties of test items.[18] We described the knowledge, skills, and understanding demonstrated by students for each non-zero score for each item, ordering these descriptions from least to most difficult. By examining the content and relative difficulty of the scaled descriptors, we identified themes and cognitive processes involved, which enabled us to define different levels of the scale. We iteratively adjusted the level boundaries, reviewing the content until each level showed distinct characteristics and a clear progression from lower to higher achievement.

The final level boundaries established by this process were at 407, 492, 576, and 661 CIL scale score points, with a corresponding level width of 85 scale score points for each level with an upper and lower boundary. The levels were then labeled as: *Below level 1* (407 scale score points and below);[19] *Level 1* (above 407 scale score points to 492 scale score points); *Level 2* (above 492 scale score points to 576 scale score points); *Level 3* (above 576 scale score points to 661 scale score points); and *Level 4* (above 661 scale score points).

Student CIL achievement and the difficulty of each CIL item are reported as CIL scale scores on the same scale. The described CIL scale was established so that the relative positions of the students' CIL scale scores and the item difficulties represent a response probability of 0.62. Thus, a student with a CIL scale score equal to the difficulty of a given item, would have a 62 percent chance of answering that item correctly. Using this response probability and a scale level width of 85 scale points, a student who achieves a score corresponding to the lower boundary of a given bounded level, could be expected to correctly answer approximately 50 percent of a set of items in a test comprising items distributed equally across the difficulty range of that level. Consequently, we could expect that any students with scores located above the lower boundary within a given bounded level, could correctly answer more than 50 percent of items on a similarly configured test. This means that, in general when a student's score is located within a bounded level, we can be confident that the student is able to manage at least half of the described content within that level. The scale is hierarchical in the sense that CIL proficiency becomes more sophisticated as student achievement progresses up the scale. We assume that a student with an achievement score at a given point on the scale would be able to successfully accomplish tasks with difficulties at and below that point.

While the described CIL scale was established in ICILS 2013, the level descriptors and examples of achievement are reviewed and revised with each successive cycle. This was done as part of ICILS 2018

18 Test item scaled difficulties refers to the locations of non-zero scores (one or more depending on the item) for each item, on a continuous scale of difficulty determined by the item calibration and equating processes (see Fraillon et al., forthcoming for details of the scaling and equating processes).

19 A small number of test items had scaled difficulties below CIL Level 1. These items represented execution of the most basic single action skills, such as clicking on hyperlinks and interacting with application UIs (e.g., adjusting sliders and selectively clicking functional buttons) and therefore did not provide sufficient information to warrant description on the scale.

(Fraillon et al., 2020) and again as part of ICILS 2023 using the content and scaled difficulty of the test items. Based on this review in 2023, we revised the scale level and item descriptors for each of the four described levels. The revisions were intended to improve the readability of the descriptions and to ensure that the CIL scale content reflected the contemporary content included in the ICILS 2023 test instrument.

The description of the scale comprises syntheses of the common elements of the knowledge, skills and understanding of CIL at each proficiency level (Table 3.3). It also describes the typical ways in which students working at a level demonstrate their proficiency. Each level of the scale articulates the characteristics of students' engagement with computers for the purposes of accessing, using, and creating information, as well as for communicating with others. The scale thus reflects a broad spectrum of development. A key characteristic underpinning this development is the degree of autonomy exhibited by students in their use of computers. At the lower end, students rely on explicit instructions to execute software commands. This progresses to a phase of increasing independence in their selection and utilization of information for communication with others. At the upper end of the scale, students can use a broad range of software tools to select and adapt information that improves the quality and clarity of their communication with others. Also included in this development are students' knowledge and understanding of issues related to internet safety and ethical use of digital information. This understanding encompasses knowledge of information types and security procedures through demonstrable awareness of the social, ethical, and legal consequences of known and unknown users accessing digital information.

In summary, the developmental sequence articulated by the CIL achievement scale has the following underpinnings: knowledge and understanding of the conventions of digital information sources and software applications; ability to critically reason about and determine the relevance and veracity of information from a variety of sources; and the planning, evaluation, and technical skills needed to create and refine information products for specified communicative purposes.

Table 3.3: Described CIL achievement scale

Description of the proficiency level	Examples of achievements by students at this proficiency level
CIL Level 1 (from above 407 to 492 scale score points)	
Students working at CIL Level 1 demonstrate basic operational skills with computers and an understanding of computers as tools for completing simple tasks. They use computers to perform routine research and communication tasks under explicit instruction. These students manage simple content creation, such as entering text or images into pre-existing templates, and are familiar with basic document layout and formatting conventions. They recognize the security risks associated with shared computer use.	Students working at CIL Level 1, for example: • Open a link in a browser. • Use an appropriate communication tool for a particular communicative context. • Identify who receives an email by carbon copy (CC). • Identify problems that can result from mass messaging. • Record key points from a video into a text-based note taking application. • Use software to crop an image. • Place a title in a prominent position on a webpage. • Create a suitable title for a slide show. • Demonstrate basic control of color when adding content to a simple document. • Insert an image into a document. • Suggest one or more risks of failing to log out from a user account when using a publicly accessible computer.

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Table 3.3: Described CIL achievement scale (cont'd)

Description of the proficiency level	**Examples of achievements by students at this proficiency level**
CIL Level 2 (from above 492 to 576 scale score points)	
Students working at CIL Level 2 use computers to complete basic and explicit information gathering and management tasks. They locate explicit information from within given digital sources. They make basic edits and add content to existing information products in response to specific instructions. They create simple information products that reflect standard design and layout conventions. Additionally, they show an understanding of personal data protection strategies and recognize the implications of their personal information being publicly accessible.	Students working at CIL Level 2, for example: • Explain the advantages of using a communication tool for a particular communicative context. • Explain a potential problem if a personal email address is publicly available. • Associate the breadth of a character set with the strength of a password. • Navigate to a URL presented as plain text. • Insert information into a specified cell in a spreadsheet. • Locate explicitly stated simple information within a website with multiple webpages. • Know that search engines can prioritize sponsored content over non-sponsored content. • Differentiate between paid and non-paid search results returned by a search engine. • Explain a benefit of citing sources of information obtained from the internet. • Format and position text to denote its role as a tile in an information sheet. • Use the full canvas when laying out a poster. • Control the size of elements relative to one another when laying out a poster. • Demonstrate basic control of text layout and color use when creating a slide show. • Use a simple webpage editor to add specified text to a webpage.

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Table 3.3: Described CIL achievement scale (cont'd)

Description of the proficiency level	**Examples of achievements by students at this proficiency level**
CIL Level 3 (from above 576 to 661 scale score points)	
Students working at CIL Level 3 demonstrate the capacity to work independently when using computers as information gathering and management tools. These students select the most appropriate information source to meet a specified purpose and retrieve information from given digital sources to answer concrete questions. They can follow instructions to edit and add content to information products using standard productivity software applications. They demonstrate understanding of basic information design conventions by formatting and arranging content in order to support comprehension of their information products. They demonstrate an awareness of the target audience by making some adaptations to content sourced from digital resources. They recognize that the credibility of web-based information can be influenced by the identity, expertise, and motives of the people who create, publish, and share it.	Students working at CIL Level 3, for example: • Explain the disadvantages of using a communication tool for a particular communicative context. • Identify characteristics of scams in digital communication. • Evaluate the reliability of information presented on a crowdsourced website. • Identify when content published on the internet may be biased as a result of a publisher's content guidelines or advertising revenue directing content. • Explain the purpose of explicitly labeling sponsored content published on the internet websites. • Explain the benefit of a common information organization and retrieval system. • Know what information is useful to include when recording a source of information from the internet. • Use generic online mapping software to represent text information as a map route. • Select an appropriate website navigation structure for given content. • Select and adapt some relevant information from given sources when creating a poster. • Adapt language and content of web-based resources to suit a younger audience when creating a poster. • Demonstrate control of image layout and color when creating a poster. • Demonstrate control of text layout when creating a presentation. • Create posters and presentations with well-planned layouts that enhance readability and viewer comprehension.

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Table 3.3: Described CIL achievement scale (cont'd)

Description of the proficiency level	**Examples of achievements by students at this proficiency level**
CIL Level 4 (above 661 scale score points)	
Students working at CIL Level 4 select the most relevant information to use for communicative purposes to meet their needs as information consumers and producers. They evaluate the usefulness of information and evaluate the credibility and reliability of information based on its content and probable origin. These students create information products with consideration of audience and communicative purpose. They apply formatting and structure information in ways that support and enhance the communicative effect of their information products. They adapt information sourced from digital resources in ways that make the information more accessible to the target audience. These students also demonstrate awareness of problems that can arise regarding the use of proprietary information on the internet.	Students working at CIL Level 4, for example: • Use search operators and filters to refine information retrieval. • Evaluate the reliability of information intended to promote a product on a commercial website. • Differentiate between sponsored and non-sponsored content in a web-based article. • Select and use relevant images to represent a three-stage process in a presentation. • Select and use relevant images to support information presented in a digital poster. • Select from sources and adapt text for a presentation so that it suits a specified audience and purpose. • Demonstrate control of color to support the communicative purpose of a presentation. • Use text layout and formatting features to denote the role of elements in an information poster. • Create a balanced layout of text and images for an information sheet. • Recognize the difference between legal, technical, and social requirements when using images on a website. • Explain that passwords can be encrypted and decrypted. • Source relevant facts from digital sources for use in a social media post to engender support. • Identify multiple ways of verifying the veracity of information from a web-based article. • Explain how communication tools can be used to demonstrate inclusive behavior. • Cite the relevant source of information from the internet when creating an information product.

3.5 CIL achievement scale level illustrations

In this section, we briefly describe the key characteristics of each level on the CIL achievement scale and illustrate each level with examples of items from the CIL release modules. The descriptions here focus on the differences between achievements at each level with a view to providing ideas for educators about target areas for teaching to support students' learning progress through the levels.

CIL Level 1

Students working at CIL Level 1 demonstrate familiarity with the range of software commands that enable them to access files and perform routine tasks, such as text editing and document layout under explicit instruction. Their CIL extends to recognizing key conventions of digital communication across different social contexts and the basic security measures necessary to safeguard private accounts on shared devices.

The distinction between CIL Level 1 and below CIL Level 1 achievements lies in the ability to execute a sequence of software commands to accomplish tasks. While students working at below CIL Level 1 need explicit step-by-step instructions to perform simple actions, such as clicking a link, students working at CIL Level 1 can undertake more complex sequences, including switching between applications when provided with directive cues. The distinctions between CIL Level 1 and higher levels relate to the breadth of students' familiarity with conventional software commands, the degree to which they can search for and locate information, and their capacity to plan how they will use information when creating information products.

Example Item A (Figure 3.2), a skill execution task, is the third task in the Breathing module (see Figure E.1 in Appendix E) and illustrates achievement at Level 1 on the CIL scale. The item assesses students' knowledge and use of the application taskbar to switch from a presentation editor to a web browser labeled as [WebSearch]. Students who clicked on the web browser button received credit for this item. On average across all countries, 71 percent of students achieved full credit for Example Item A. This varied from 29 percent to 85 percent across countries and benchmarking participants, indicating a general competency among students to complete this highly scaffolded task within a familiar technological framework.

Figure 3.2: CIL Level 1, Example Item A with framework references and overall percent correct

Country	Percentage scoring one point
[1] Austria	83 (1.3)
Azerbaijan	34 (2.5)
† Belgium (Flemish)	80 (2.1)
[3] Bosnia and Herzegovina	63 (2.5)
Chinese Taipei	78 (1.3)
[1] Croatia	70 (1.9)
Cyprus	67 (1.7)
[1] Czech Republic	80 (1.1)
†[1] Denmark	81 (1.4)
Finland	85 (1.3)
France	81 (1.4)
Germany	79 (1.6)
Greece	57 (1.8)
Hungary	68 (2.0)
Italy	67 (1.9)
[1] Kazakhstan	64 (1.4)
† Korea, Republic of	83 (1.3)
[1] Kosovo	29 (1.7)
[1] Latvia	80 (1.9)
Luxembourg	69 (1.3)
Malta	73 (1.8)
[1] Norway (Grade 9)	80 (1.2)
Oman	50 (1.6)
[1] Portugal	80 (1.4)
†[1,2] Romania	56 (2.8)
[1] Serbia	66 (2.1)
Slovak Republic	81 (1.4)
[1] Slovenia	80 (1.3)
[1] Spain	77 (1.2)
[1] Sweden	79 (1.7)
† Uruguay	69 (2.0)
ICILS 2023 average	71 (0.3)
Benchmarking participant	
North Rhine-W. (Germany)	77 (2.3)
Country not meeting sample participation requirements	
‡ United States	75 (2.3)

You want to use the internet to find some websites to help you with your presentation.
Open the internet browser application from the taskbar.

Score	CIL scale difficulty	CIL scale level	Range (%)
One point	431	1	29 to 85

Item descriptor

Switches applications to an internet browser from the taskbar.

ICILS assessment framework reference: 1.2

Strand: Understanding computer use

Aspect: Computer use conventions

Notes: ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Does not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.

CIL Level 2

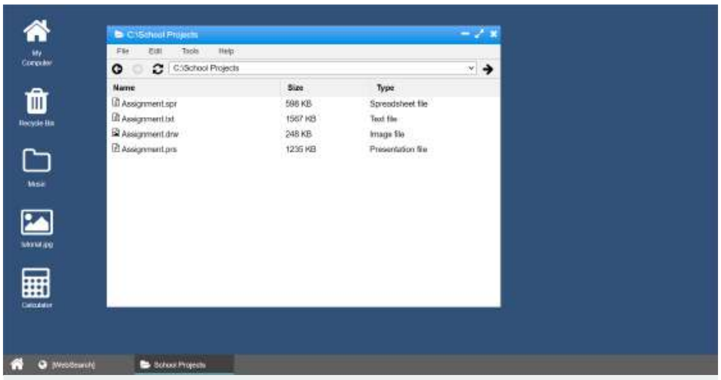
Students working at Level 2 demonstrate the basic use of computers as resources for finding information. They can recognize common file types, locate explicit information in digital resources, and incorporate selected content into information products. Additionally, these students exercise some control over the placement of elements and formatting of text and images in information products. They understand the purpose of a variety of communication tools across different contexts and demonstrate awareness about the security of electronic information and the potential repercussions of unauthorized access.

A key distinction between Level 2 achievement from achievement at higher levels is the extent to which students critically assess information and work independently to produce information products.

Example Item B (Figure 3.3) illustrates student achievement at Level 2 on the CIL scale. It was the first task in the Breathing module (see Figure E.1 in Appendix E) and required students to identify and open a presentation file among a collection of various file types within a folder labeled 'C:\School Projects.' Students who recognized the presentation file by its extension or description and could open the file using standard methods (such as double-clicking or accessing the context menu) received credit on this item. On average across all ICILS countries, 54 percent of students achieved credit for this item. This varied from 24 to 73 percent across countries and benchmarking participants.

Figure 3.3: CIL Level 2, Example Item B with framework references and overall percent correct

Country	Percentage scoring one point
[1] Austria	70 (1.8)
Azerbaijan	29 (1.7)
† Belgium (Flemish)	66 (1.7)
[3] Bosnia and Herzegovina	35 (2.1)
Chinese Taipei	58 (1.5)
[1] Croatia	54 (1.9)
Cyprus	73 (1.6)
[1] Czech Republic	64 (1.4)
†[1] Denmark	64 (1.8)
Finland	47 (1.6)
France	58 (1.7)
Germany	53 (1.8)
Greece	47 (2.0)
Hungary	65 (1.8)
Italy	51 (2.0)
[1] Kazakhstan	46 (1.7)
† Korea, Republic of	67 (1.3)
[1] Kosovo	24 (1.5)
[1] Latvia	59 (2.2)
Luxembourg	57 (1.4)
Malta	62 (1.9)
[1] Norway (Grade 9)	62 (1.5)
Oman	41 (1.4)
[1] Portugal	64 (2.0)
†[12] Romania	30 (2.6)
[1] Serbia	49 (1.7)
Slovak Republic	61 (1.8)
[1] Slovenia	46 (1.6)
[1] Spain	57 (1.5)
[1] Sweden	58 (1.8)
† Uruguay	38 (1.8)
ICILS 2023 average	54 (0.3)
Benchmarking participant	
North Rhine-W. (Germany)	48 (1.8)
Country not meeting sample participation requirements	
‡ United States	49 (2.4)



Open the presentation file in the folder 'C:\School Projects'.

Score	CIL scale difficulty	CIL scale level	Range (%)
One point	512	2	24 to 73

Item descriptor

Opens a file of a specified file type.

ICILS assessment framework reference: 1.1

Strand: Understanding computer use

Aspect: Foundations of computer use

Notes: ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Does not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.

CIL Level 3

CIL Level 3 marks an important shift from the levels below. At CIL Level 3, students exhibit emerging autonomy in their use of computers, changing from dependence on explicit instruction at the lower levels to a more self-directed engagement with digital technologies. In addition to exhibiting knowledge of various software applications, they further demonstrate the ability to harness this knowledge to independently search, locate, and critically evaluate information. The information products they create demonstrate their capacity to control information layout and design. Furthermore, students working at CIL Level 3 demonstrate awareness that the information they access can be biased, inaccurate, or unreliable.

The key differences between CIL Level 3 achievement, in contrast to CIL Level 4, lie in the precision of students' information searches and the degree to which they apply critical reasoning and planning skills in the creation and refinement of information products.

Example Item C (Figure 3.4), an open text response item, was task six in the Breathing module (see Figure E.2 in Appendix E) and illustrates achievement at CIL Level 3. Students were presented with an article from a crowd-sourced encyclopedia website. The item required students to respond by expressing a written opinion on the reliability of the information.[20] Students who engaged critically, drawing on their understanding of author credibility and public editing dynamics, received credit on this item. On average across countries, 32 percent of students received full credit for this item. This varied from six percent to 72 percent of students across countries and benchmarking participants.

Example Item D (Figure 3.5) represents an assessment criterion in the large task for School trip (see Figure E.8 in Appendix E). It illustrates proficiency in information layout and design at CIL Level 3. Students used an itinerary design application to create an information sheet for their classmates about a walking tour. The information related to the title, start and end times of the walking tour, details of exhibitions, a map showing the route of the walking tour, and the cost of the trip.

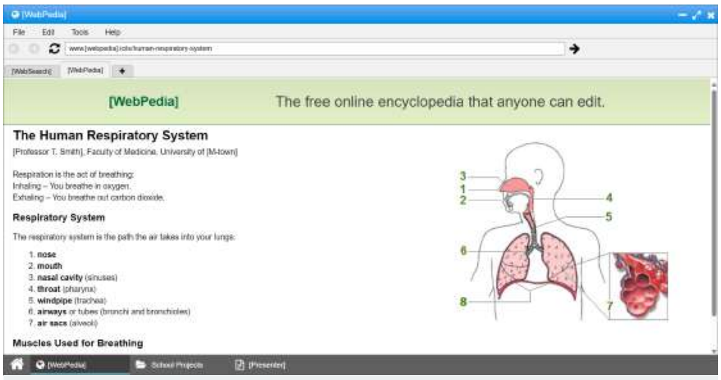
Students received one score point (out of a possible two) if they demonstrated basic control of the layout elements. Students needed to be capable of applying formatting consistently enough not to impede understanding of the information. For example, headings and subheadings had to be generally distinguishable from the main body of text using formatting techniques such as color, emphasis, underlining, italicizing, or an increase in font size. Students also needed to demonstrate thoughtful control over the alignment of text box elements such that they did not overlap with each other or the map to the extent that they hindered the flow of reading.

On average across countries 30 percent of students received at least at least one score point for Example Item D. This varied from four percent to 57 percent across countries and benchmarking participants. This variation suggests that, while some students are competent in basic information layout and design, there remains a significant proportion for whom this is a developing competency.

20 The students' written responses to this item were scored by scorers in each country using an online scoring platform. As an international standard for scorer training, the same set of example responses were provided to all scorers across all countries. Only data that met the requisite ICILS scoring standards were included in the analysis of this item. Approximately 200 student responses to each constructed response item and large task criterion were independently scored by two scorers in each country. Data from each human scored item from any given country were used only where the resultant measurement properties for that item were consistent with those for the item across countries, and where at least 60 percent of double-scored responses received the same score from both scorers.

Figure 3.4: CIL Level 3, Example Item C with framework references and overall percent correct

Country	Percentage scoring one point	
[1] Austria	28	(1.6)
Azerbaijan	6	(0.9)
† Belgium (Flemish)	52	(2.4)
[3] Bosnia and Herzegovina	13	(1.4)
Chinese Taipei	49	(1.8)
[1] Croatia	33	(1.8)
Cyprus	29	(1.4)
[1] Czech Republic	26	(1.1)
†[1] Denmark	47	(1.8)
Finland	49	(1.8)
France	33	(1.6)
Germany	26	(1.6)
Greece	20	(1.3)
Hungary	35	(1.7)
Italy	25	(1.7)
[1] Kazakhstan	11	(1.1)
† Korea, Republic of	72	(1.4)
[1] Kosovo	9	(1.1)
[1] Latvia	29	(1.9)
Luxembourg	30	(1.3)
Malta	33	(1.6)
[1] Norway (Grade 9)	56	(1.9)
Oman	18	(1.1)
[1] Portugal	45	(1.8)
†[12] Romania	16	(1.6)
[1] Serbia	13	(1.3)
Slovak Republic	25	(1.6)
[1] Slovenia	37	(1.3)
[1] Spain	33	(1.2)
[1] Sweden	46	(1.9)
† Uruguay	29	(1.7)
ICILS 2023 average	32	(0.3)
Benchmarking participant		
North Rhine-W. (Germany)	24	(1.7)
Country not meeting sample participation requirements		
‡ United States	40	(2.6)



The [WebPedia] website is another new search result.
Is the information presented on the [WebPedia] website reliable (trustworthy)?
Explain your answer.

Score	CIL scale difficulty	CIL scale level	Range (%)
One point	610	3	6 to 72

Item descriptor

Evaluates the reliability of a crowd sourced information website.

ICILS assessment framework reference: 2.1

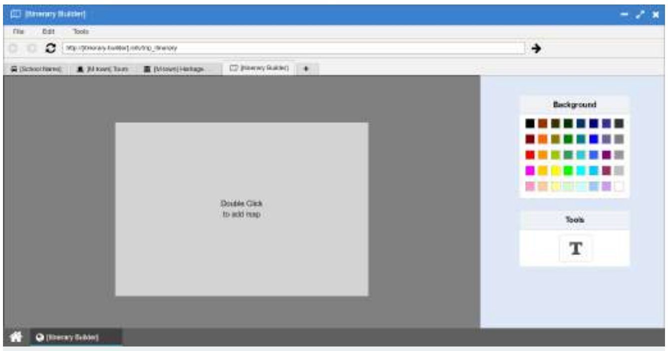
Strand: Gathering information

Aspect: Accessing and evaluating information

Notes: ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Does not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.

Figure 3.5: CIL Level 3, Example Item D with framework references and overall percent correct

Country	Percentage scoring at least one out of two points	Percentage scoring two points
[1] Austria	37 (1.9)	7 (0.9)
Azerbaijan	4 (0.8)	1 (0.3)
† Belgium (Flemish)	25 (1.5)	6 (0.8)
[3] Bosnia and Herzegovina	16 (1.7)	6 (1.0)
Chinese Taipei	46 (1.9)	18 (1.2)
[1] Croatia	43 (2.1)	10 (1.2)
Cyprus	21 (1.4)	3 (0.8)
[1] Czech Republic	55 (1.2)	9 (0.7)
†[1] Denmark	45 (1.9)	4 (0.6)
Finland	35 (2.0)	3 (0.6)
France	19 (1.4)	6 (0.7)
Germany	41 (1.9)	13 (1.1)
Greece	33 (2.1)	10 (1.0)
Hungary	13 (1.3)	9 (1.0)
Italy	36 (1.7)	11 (1.0)
[1] Kazakhstan	12 (1.1)	5 (0.8)
† Korea, Republic of	42 (1.8)	12 (1.1)
[1] Kosovo	9 (1.0)	4 (0.6)
[1] Latvia	25 (1.9)	9 (1.2)
Luxembourg	48 (1.7)	12 (1.0)
Malta	28 (1.3)	7 (0.9)
[1] Norway (Grade 9)	43 (1.7)	8 (1.0)
Oman	14 (0.8)	4 (0.5)
[1] Portugal	26 (1.6)	11 (1.1)
†[1,2] Romania	11 (1.4)	1 (0.4)
[1] Serbia	16 (1.7)	3 (0.7)
Slovak Republic	57 (1.9)	13 (1.1)
[1] Slovenia	35 (1.5)	9 (1.0)
[1] Spain	37 (1.4)	10 (0.6)
[1] Sweden	20 (1.6)	3 (0.8)
† Uruguay	25 (1.7)	6 (0.8)
ICILS 2023 average	30 (0.3)	8 (0.2)
Benchmarking participant		
North Rhine-W. (Germany)	34 (1.7)	9 (1.2)
Country not meeting sample participation requirements		
‡ United States	29 (2.6)	10 (1.3)



You will now create an information sheet for your classmates about the walking tour.
It must include: an appropriate title, the start and finish times of Walking Tour 3, the exhibitions you can see at the [M-town Heritage Museum], a map showing the route for Walking Tour 3, and the total cost of the trip.
Click on 🔍 to review the assessment criteria.
Click on ➜ when you have completed this task.

Score	CIL scale difficulty	CIL scale level	Range (%)
At least one of two points	595	3	4 to 57
Two points	718	4	1 to 18

Item descriptor (one out of two points)

Creates an information sheet with some control of the layout of text and images.

Item descriptor (two points)

Creates an information sheet with balanced and controlled layout of text and images.

ICILS assessment framework reference: 3.2

Strand: Producing information

Aspect: Creating information

Notes: ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Does not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.

CIL Level 4

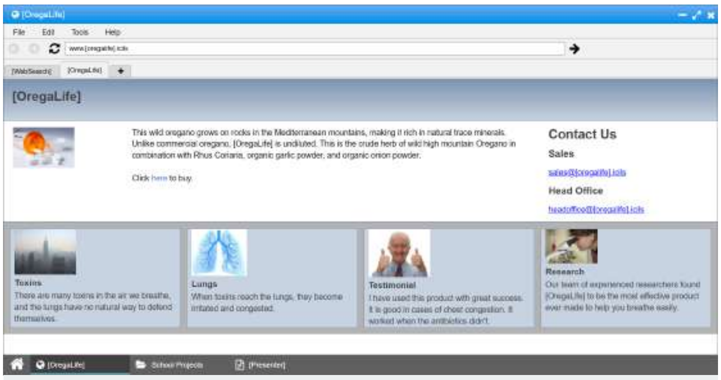
Students working at CIL Level 4 exhibit evaluative judgment and control when searching for information and creating information products. They also demonstrate awareness of audience and purpose when searching for information, selecting information to include in information products, and formatting and laying out the information products they create. Students working at Level 4 also demonstrate awareness of the potential for information to be a commercial and malleable commodity and understand how the conventions of a group communication application can be used to promote inclusiveness.

Example Item E (Figure 3.6) was task five in the Breathing module (see Figure E.2 in Appendix E) and was an open text response item that tasked students with evaluating the reliability of the information presented by a commercial website that sells health supplements. Students received credit for this item if their opinion referred to characteristics of the website such as: (1) the lack of independent research on the efficacy of the product; (2) the lack of cited sources or supporting evidence; (3) the presence of only a single anonymous testimonial; or (4) the potential for exaggerated claims resulting from commercial bias. On average across countries, 16 percent of students received credit for this item. This varied from one percent to 50 percent across countries and benchmarking participants.

Example Item F (Figure 3.7) corresponds to a full credit score of two on the large task assessment criterion described in Example Item D and reflects achievement at CIL Level 4. Students who used formatting tools effectively to create a clear and organized layout in the information sheet were awarded full credit. This involved applying consistent formatting styles such as emphasis, underlining, or changing font styles to differentiate between headings, subheadings, and main body text. Furthermore, careful management in the positioning and alignment of text boxes was necessary to avoid any overlaps and ensure clear visual flow, thus enhancing readability and aiding in the effective interpretation of the information provided. On average across countries, eight percent of students achieved full credit on this item and this varied from one percent to 18 percent across countries and benchmarking participants.

Figure 3.6: CIL Level 4, Example Item E with framework references and overall percent correct

Country	Percentage scoring one point
[1] Austria	17 (1.4)
Azerbaijan	1 (0.3)
† Belgium (Flemish)	17 (1.3)
[3] Bosnia and Herzegovina	9 (1.3)
Chinese Taipei	34 (1.6)
[1] Croatia	20 (1.7)
Cyprus	7 (1.0)
[1] Czech Republic	17 (0.8)
†1 Denmark	18 (1.4)
Finland	21 (1.4)
France	14 (1.3)
Germany	20 (1.2)
Greece	11 (1.1)
Hungary	11 (1.2)
Italy	12 (1.2)
[1] Kazakhstan	6 (0.8)
† Korea, Republic of	50 (1.6)
[1] Kosovo	13 (1.2)
[1] Latvia	13 (1.4)
Luxembourg	20 (1.0)
Malta	12 (1.0)
[1] Norway (Grade 9)	29 (1.7)
Oman	6 (0.6)
[1] Portugal	16 (1.2)
†12 Romania	7 (1.0)
[1] Serbia	9 (1.1)
Slovak Republic	12 (1.4)
[1] Slovenia	16 (1.4)
[1] Spain	13 (0.8)
[1] Sweden	27 (1.3)
† Uruguay	17 (1.4)
ICILS 2023 average	16 (0.2)
Benchmarking participant	
North Rhine-W. (Germany)	17 (1.2)
Country not meeting sample participation requirements	
‡ United States	30 (2.5)



The [OregaLife] website is a new search result. Think about the website.
Is the information presented on the [OregaLife] website reliable (trustworthy)?
Explain your answer.

Score	CIL scale difficulty	CIL scale level	Range (%)
One point	694	4	1 to 50

Item descriptor

Evaluates the reliability of a commercial website.

ICILS assessment framework reference: 2.1

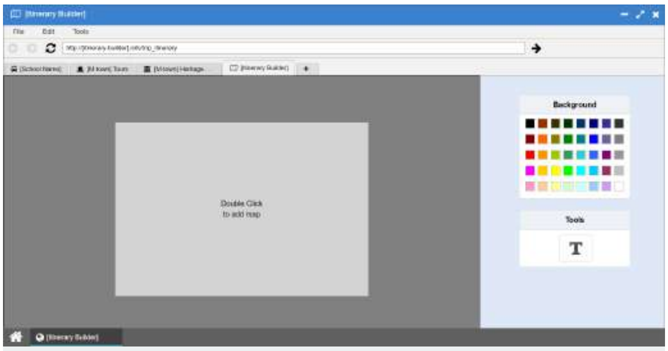
Strand: Gathering information

Aspect: Accessing and evaluating information

Notes: ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Does not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.

Figure 3.7: CIL Level 4, Example Item F with framework references and overall percent correct

Country	Percentage scoring at least one out of two points	Percentage scoring two points
[1] Austria	37 (1.9)	7 (0.9)
Azerbaijan	4 (0.8)	1 (0.3)
† Belgium (Flemish)	25 (1.5)	6 (0.8)
[3] Bosnia and Herzegovina	16 (1.7)	6 (1.0)
Chinese Taipei	46 (1.9)	18 (1.2)
[1] Croatia	43 (2.1)	10 (1.2)
Cyprus	21 (1.4)	3 (0.8)
[1] Czech Republic	55 (1.2)	9 (0.7)
†[1] Denmark	45 (1.9)	4 (0.6)
Finland	35 (2.0)	3 (0.6)
France	19 (1.4)	6 (0.7)
Germany	41 (1.9)	13 (1.1)
Greece	33 (2.1)	10 (1.0)
Hungary	13 (1.3)	9 (1.0)
Italy	36 (1.7)	11 (1.0)
[1] Kazakhstan	12 (1.1)	5 (0.8)
† Korea, Republic of	42 (1.8)	12 (1.1)
[1] Kosovo	9 (1.0)	4 (0.6)
[1] Latvia	25 (1.9)	9 (1.2)
Luxembourg	48 (1.7)	12 (1.0)
Malta	28 (1.3)	7 (0.9)
[1] Norway (Grade 9)	43 (1.7)	8 (1.0)
Oman	14 (0.8)	4 (0.5)
[1] Portugal	26 (1.6)	11 (1.1)
†[1,2] Romania	11 (1.4)	1 (0.4)
[1] Serbia	16 (1.7)	3 (0.7)
Slovak Republic	57 (1.9)	13 (1.1)
[1] Slovenia	35 (1.5)	9 (1.0)
[1] Spain	37 (1.4)	10 (0.6)
[1] Sweden	20 (1.6)	3 (0.8)
† Uruguay	25 (1.7)	6 (0.8)
ICILS 2023 average	30 (0.3)	8 (0.2)
Benchmarking participant		
North Rhine-W. (Germany)	34 (1.7)	9 (1.2)
Country not meeting sample participation requirements		
‡ United States	29 (2.6)	10 (1.3)



You will now create an information sheet for your classmates about the walking tour.
It must include: an appropriate title, the start and finish times of Walking Tour 3, the exhibitions you can see at the [M-town Heritage Museum], a map showing the route for Walking Tour 3, and the total cost of the trip.
Click on 🔍 to review the assessment criteria.
Click on ➔ when you have completed this task.

Score	CIL scale difficulty	CIL scale level	Range (%)
At least one of two points	595	3	4 to 57
Two points	718	4	1 to 18

Item descriptor (one out of two points)

Creates an information sheet with some control of the layout of text and images.

Item descriptor (two points)

Creates an information sheet with balanced and controlled layout of text and images.

ICILS assessment framework reference: 3.2

Strand: Producing information

Aspect: Creating information

Notes: ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Does not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.

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Chapter 4:

Measuring students' computational thinking

Daniel Duckworth and Julian Fraillon

Chapter highlights

The International Computer and Information Literacy Study (ICILS) 2023 computational thinking (CT) test instrument comprised four 25 minute computer-based test modules. Each student completed two modules. The modules were designed to assess the planning, operationalizing, and evaluation competences comprising the CT achievement construct using real-word problem solving scenarios.

Descriptions of the CT tasks, together with assessment data were used to establish the ICILS CT described achievement scale.

CT achievement can be described across four levels of increasing proficiency:

- Students working at CT Level 1 can recognize the logic associated with fundamental computational concepts as they may apply to problems with constrained, explicit parameters (Table 4.3).
- Students working at CT Level 2 demonstrate the ability to engage with a range of structured computational problems (Table 4.3).
- Students working at CT Level 3 engage with problems that include a variety of computational concepts such as simulation, conditional logic, and data interpretation. They can interpret problem scenarios and explain the application of fundamental elements of problem-solving (Table 4.3).
- Students working at CT Level 4 recognize and analyze problems involving a broad variety of computational concepts and operations. They can decompose complex problems into smaller, manageable components and apply relevant algorithms to solve these sub-problems to contribute to the overarching problem solution (Table 4.3).

4.1 Introduction

Computational thinking (CT) is defined in the International Computer and Information Literacy Study (ICILS) as 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" (Duckworth & Fraillon, 2024a, p. 38). In ICILS, CT emphasizes "framing solutions to real-world problems in a way that these solutions could be executed by computers…and…implementing and testing solutions using the procedural algorithmic reasoning that underpins programming" (Duckworth & Fraillon, 2024a, p. 37). CT comprises two strands, each of which is specified in terms of a number of aspects. The strands are: conceptualizing problems and operationalizing solutions. The aspects further articulate CT in terms of the main processes applied within each strand. The three aspects that make up the conceptualizing problems strand are: knowing about and understanding digital systems, formulating and analyzing problems, and collecting and representing relevant data. The two aspects that make up the operationalizing solutions strand are: planning and evaluating solutions, and developing algorithms, programs, and interfaces. See also Chapter 1 for more detail of the CT construct.

In this chapter, we elaborate on the measurement of CT within the context of ICILS, and the development of the CT achievement scale. We begin with a brief explanation of the foundational principles underpinning the CT test instrument. Subsequently, we provide an overview of the test content, illustrating how the test operationalizes the CT construct (Duckworth & Fraillon, 2024a). Furthermore, we present the CT achievement scale and explain the methodology used to establish this scale. The chapter concludes with illustrative examples of items from the CT release modules, illustrating the characteristics of student achievement at different levels of the scale. This final section has been included as resource for educators aiming to target specific areas of teaching to support students' learning progress in CT.

4.2 The CT test instrument

Background

The approach to CT assessment in ICILS, established in 2018 and maintained ICILS 2023, incorporates several essential features:

- Computer-based tasks: Students engage exclusively with tasks on a computer, ensuring a direct assessment of their skills and knowledge.
- Integration of diverse skills: The assessment tasks are designed to require a blend of technical competencies, critical thinking, problem-solving abilities, and evaluative skills.
- Real-world problems: The assessment tasks are designed to reflect real-world problems, providing students with relevant contexts that enhance the authenticity and applicability of the assessment.
- Solutions that can be operationalized with a computer: An important aspect of the CT test is the facility for students to create and execute algorithms without the need to learn the syntax or features of a specific programming language.

In addition to these features, the ICILS CT test instrument is underpinned by the fundamental tenets of standardized testing, ensuring uniformity of the test experience for all participants and comparability of collected data. To accomplish both the set of essential features of CT assessment and the standardization of testing, ICILS employs a quarantined software environment, or a "walled garden." Within this environment, computational tools can be used to explore and solve problems. However, access to resources from outside the test is prevented so that all students share an equivalent experience of the test content.

Test design and content

In ICILS 2023, the CT test instruments were developed to be consistent with the overarching design principles established for ICILS 2018 and designed to reflect contexts that complemented the existing content of the CT test and respect the evolving nature of the real-world digital experiences of students, including developments in digital tools and user interface (UI) conventions. In ICILS 2018, the CT instrument comprised two test modules, each focused primarily on assessing the competencies associated with one of the two strands of the ICILS CT framework (Duckworth & Fraillon, 2024a). Data collected from the CT instrument supported the reporting of CT as a single measurement dimension (Fraillon et al., 2020; Ockwell et al., 2020). Two tasks from each of these CT modules were released with the ICILS 2018 international report, and the remaining tasks in each module were retained as secure test materials to facilitate the comparison of CT achievement in ICILS 2018 with that of ICILS 2023. In preparation for ICILS 2023, four new tasks were created to replace the four that had been released as part of ICILS 2018. These four replacement tasks were slight adaptations of the original tasks designed to maintain conceptual flow through each module and be similar to the original tasks. In addition, two new CT test modules were created. The new modules were designed to include tasks that assessed competencies associated with both CT strands. Hence, the content of these tasks reflected the processes of understanding and conceptualizing problems and executing and evaluating computer-based solutions to those problems. In total, the ICILS 2023 CT instrument consequently comprised four 25-minute test modules: two secure trend modules from ICILS 2018 (with secure replacement tasks) and two new modules developed for ICILS 2023.

Table 4.1: ICILS 2023 CT module summaries

Module title	Description
Activity tracker	Students use decision trees, simulations, and block-based coding to plan, develop, evaluate, and debug components of a smartphone app that tracks a user's physical activity using data from the device's sensors.
Automated bus	Students plan various aspects of a program and configure the navigation and brake systems to operate a driverless bus using interactive directed graphs, decision trees, and simulations.
Farm drone	Students work in a block-based coding environment to create, test, and debug the conditional logic, loops, and commands that control a farming drone's actions.
Suns and moons	Students use decision trees and a block-based coding environment to create, evaluate, and debug the rules and logic of a tic-tac-toe game.

In countries that participated in the CT option, students completed two randomly assigned CT test modules in a fully balanced rotational design. As was the case in ICILS 2018, students completed the two CT modules only after having completed the CIL test and the student questionnaire. For a comprehensive explanation of the ICILS assessment design, see the ICILS 2023 assessment framework, Chapter 5 (Duckworth & Fraillon, 2024b).

CT construct coverage

Data collected from the ICILS 2023 CT instrument were used to measure and describe CT achievement. In total, the data comprised 65 score points derived from 31 discrete tasks and questions. Student responses were captured and, in most cases coded with initial scores automatically by the computer-based delivery system.[21] The CT test also included three questions to which students responded by entering free text, which typically comprises one or two sentences. These responses were scored by trained expert scorers in each country. Data were included only where they met or exceeded the IEA technical requirements. The ICILS 2023 technical report (Fraillon et al., forthcoming) provides additional information on scoring, adjudication scaling, and analyses of the CT test item data.

The two strands of the ICILS CT framework describe the CT construct in terms of: conceptualizing problems and operationalizing solutions. Each of these strands is further described in several aspects. The strands refer to the overarching conceptual categories for framing the skills and knowledge assessed by the CT instrument, while the aspects further articulate CT in terms of the main constituent processes that underpin the skills and knowledge (Duckworth & Fraillon, 2024a). The structure described for the CT construct (two strands comprising two and three respective aspects) was established to "organize the CT content in a way that allows readers to clearly see the different related aspects of CT and to support the auditing of the CT instruments against the full breadth of content in the CT construct" (Duckworth & Fraillon, 2024a, p. 39). This described structure was not intended to presuppose a sub-dimensional structure for the analysis and reporting of the CT construct.

The respective number of score points and percentages (of the 65 total score points) in the ICILS 2023 CT assessment attributed to each strand and each aspect within the strands are outlined in Table 4.2.

21 For some items, these initially allocated scores were used in the CT scaling and analyses, for other items, these initial scores were combined and/or re-coded in order to establish the final scores. Full details of the CT scoring and scaling analyses are provided in the ICILS 2023 technical report (Fraillon et al., forthcoming)

Table 4.2: Distribution of score points and percentages across CT strands and aspects

Strand / Aspect	Score points	Percentage of total
1: Conceptualizing problems	20	31
1.1: Knowing about and understanding digital systems	9	14
1.2: Formulating and analyzing problems	4	6
1.3: Collecting and representing relevant data	7	11
2: Operationalizing solutions	45	69
2.1: Planning and evaluating solutions	19	29
2.2: Developing algorithms, programs, and interfaces	26	40

Approximately one third of the score points are associated with 'Conceptualizing problems' (Strand 1) and two thirds with 'Operationalizing solutions' (Strand 2), reflecting the expected time planned for students to complete the tasks associated with each strand. The aspects of Strand 2 were primarily assessed through block-based coding environments. As explained in the ICILS 2023 assessment framework, "[t]he ICILS tasks are designed to collect information about specific aspects of the relevant construct (CIL or CT), and each module typically includes content that addresses most, if not all, aspects of the construct. However, the test design of ICILS does not require that equal proportions of all aspects of the CIL and CT constructs are assessed" (Duckworth & Fraillon, 2024b, p. 76).

4.3 CT release modules

At the end of each ICILS study cycle, we release a subset of secure items to increase the transparency of the assessment content and to enable researchers, educators, and policymakers to contextualize primary and secondary analyses of ICILS data. Of the four CT modules (see Table 4.1) comprising the ICILS 2023 CT instrument, we selected the Automated bus and Farm drone modules for public release. Both modules were developed for ICILS 2018 and kept secure for use in ICILS 2023.[22]

In Appendix F we provide detailed descriptions of the assessment tasks for both CT release modules. An online web player for these modules is also available on the IEA website at https://www.iea.nl/icils2023-assessment.

Automated bus

The Automated bus module was designed primarily to assess competencies associated with CT strand 1: Conceptualizing problems. Assessment tasks related to planning various aspects of a program and configuring the navigation and brake systems to operate a driverless bus. They involved using interactive directed graphs, decision trees, and a simulation. The simulation task facilitated the collection of data to support evidence-based analysis and conclusions.

Farm drone

The Farm drone module was designed to assess aspects of CT strand 2: Operationalizing solutions, where students worked in a block-based coding environment to create, test, and debug the conditional logic, loops, and commands that control a farming drone's actions.

The Farm drone block-based coding environment included the following key elements:

- A work space in which code blocks could be placed, ordered and re-ordered, and removed from the work space.
- A space containing the code blocks that could be selected and used in the work space. These included code blocks that control the movement of the drone, some simple configurable com-

22 These two modules have been released in the form they were used in ICILS 2023, that is, including the tasks developed to replace the four tasks that were released as part of ICILS 2018.

mands for the drone to execute, simple loops, and conditional statements.

- The facility for students to execute the code any number of times and at any time, and to see the consequent behavior of the drone as the code was being executed.
- The facility to reset the code in the work space (to the default state of each task) and to reset the starting position of the drone before executing code.

The Farm drone module was designed to comprise tasks of incrementally increasing complexity. Across the tasks, complexity was influenced by the range of functions available (with conditional functions and loops progressively introduced), the number of actions the drone was required to perform, and the intricacies of the sequences of those actions. Students were permitted to return to previous tasks within this module. This decision was made because, unlike other ICILS test modules, the tasks did not follow a sequence in which information from subsequent tasks could explicitly include the correct response to earlier tasks. Consequently, the test interface for this module included features allowing students to "flag" tasks they might wish to revisit and a navigation function enabling them to freely move between previously viewed tasks. Students' responses were captured by the assessment system and later scored based on two characteristics:

- Correctness: The degree to which the drone performs the required actions specified in the task, including the presence or absence of any unnecessary actions.
- Efficiency: Measured by comparing the number of code blocks used in the solution with the minimum number required for a fully correct solution. Longer code sequences typically corresponded to lower scores. Each task included an instruction for students to use as few code blocks as possible.

Each coding task received a single score derived from combining the correctness and efficiency scores. For most tasks, the efficiency score moderated the score attributed to completely correct responses. An illustrative example of the scoring of *correctness*, *efficiency*, and the combination of the two, for a Farm drone test item released in 2018 is included in the ICILS 2018 technical report (Fraillon, 2020). Full details of the scoring for each Farm drone task used in ICILS 2023 are provided in the ICILS 2023 technical report (Fraillon et al., forthcoming).

The interface design for the Farm drone tasks (presented across Figures F.5 to F.8) was divided into two functional spaces. The test interface was the same as that used for the CIL test modules. However, unlike in other CIL and CT test modules, in the Farm drone module, students could return to previously completed tasks by clicking on a green task box corresponding to the ordinal position of the task. Students could also use a toggle to mark tasks they wanted to revisit if they had enough time to review and improve their solutions.

The stimulus area comprised three separate parts: the code blocks space (bottom left of the screen), the farm drone display space (the 9 × 9 grid at the top left), and the work space (central space where code blocks could be arranged to form an algorithm). All tasks in the Farm drone module presented students with the same interface design, with variations in the configuration of the farm, the task objectives, the available code block functions, and the initial state of the work space. The work space was presented as empty (with only the fixed "when run" command present) for tasks that required students to create code sequences. The work space was pre-populated with algorithms for tasks that required students to debug code.

Students could drag code blocks into the work space, connecting them to the "when run" code block to send instructions to the drone when the green "run program" button was clicked. They could reset the state of the drone and the farm by clicking the blue reset button and reset the work space state by clicking the orange reset button.

The complexity of the tasks increased progressively through the module. They are influenced by the following key characteristics:

- Task type (code creation or debugging)
- Variety of available code operations (movement, action, repeat, conditional)
- Number of targets (tiles requiring specific actions, such as dropping water, seeds, or fertilizer)
- Number of different target types (dirt, low, or high crops)
- Whether any given target required multiple actions
- Layout configuration of the targets (single or multiple rows)
- Number of different materials to be dropped on targets (water, seeds, fertilizer)

4.4 The CT achievement scale

In 2018, the ICILS CT reporting scale was established with a mean of 500 (the ICILS average score) and a standard deviation of 100 for equally weighted national samples from countries that had met the IEA sample participation requirements (Fraillon et al., 2020). Data collected in ICILS 2018 were used to equate ICILS 2023 data with the ICILS CT reporting scale established in 2018 (Fraillon et al., 2020; Ockwell et al., 2020). The ICILS 2023 technical report provides details on the procedures used to scale and equate the test items (Fraillon et al., forthcoming).

In order to provide substantive meaning to the ICILS CT reporting scale in 2018, we used both the content and the scaled difficulties of the test items[23] to establish preliminary described regions on the CT scale. We divided the scaled assessment items ordered by difficulty into thirds, with approximately equal numbers of items in each third, and used the content and relative difficulty of the items to characterize ranges of item difficulties as preliminary "lower, middle, and upper regions of the scale" (Fraillon et al., 2020, p. 92). These preliminary descriptions were developed in order to provide a generalized profile of CT learning progress, with with the intention of reviewing and revising the scale descriptors, including the level boundaries as part of ICILS 2023 on the basis of data collected in 2023 from a larger number of items.

The described CT scale established for ICILS 2023 is based on the content and scaled difficulties of the assessment items used in the ICILS 2023 CT instrument. This 2023 CT scale was established to supersede and replace the preliminary regions described in ICILS 2018.

We reviewed the content and relative difficulty of the ICILS 2023 items to identify themes in the subject matter, item characteristics that contributed to difficulty, and the computational concepts involved. This enabled us to characterize different ranges of item difficulties as levels of the scale. We iteratively adjusted the positions of the level boundaries, the upper and lower ends of a range, reviewing and summarizing the themes, characteristics, and concepts of each level. This process was repeated until the content of each level showed distinct characteristics and the differences between levels demonstrated clear progression from lower to higher achievement.

The final level boundaries established by this process were at 330, 440, 550, and 660 CT scale score points, with a corresponding level width of 110 scale score points for each level with an upper and lower boundary. The levels were then labeled as: *Below Level 1* (330 scale score points and below)[24]; *Level 1* (above 330 scale score points to 440 scale score points); *Level 2* (above 440 scale score points

23 Test item scaled difficulties refers to the locations of non-zero scores (one or more depending on the item) for each item, on a continuous scale of difficulty determined by the item calibration and equating processes (see Fraillon et al., forthcoming for details of the scaling and equating processes).

24 A small number of test items had scaled difficulties below Level 1 of the scale. These items represented execution of the most basic skills such as interacting with application controls (e.g., drag-and-drop and selectively clicking functional buttons and did not provide sufficient information to warrant description on the scale).

to 550 scale score points); *Level 3* (above 550 scale score points to 660 scale score points); and *Level 4* (above 660 scale score points).

The ICILS 2023 described CT scale was based on a transformation of the original item calibration so that the relative positions of students' scaled scores and the item difficulties within each level would represent a response probability of 0.62. Thus, a student with a CT scale score equal to the difficulty of a given item, would have a 62 percent chance of answering that item correctly. Using this response probability and a scale level width of 110 scale points, a student who achieves a score corresponding to the lower boundary of a given bounded level, could be expected to correctly answer approximately 50 percent of a set of items in a test comprising items distributed equally across the difficulty range of that level. Consequently, we could expect that any students with scores located above the lower boundary within a given bounded level, could correctly answer more than 50 percent of items on a similarly configured test. This means that, in general when a student's score is located within a bounded level, we can be confident that the student is able to manage at least half of the described content within that level. The scale is hierarchical in the sense that CT proficiency becomes more sophisticated as student achievement progresses up the scale. We assume that a student with an achievement score at a given point on the scale would be able to undertake and successfully accomplish tasks with difficulties at and below that point.

The levels of the described CT scale established as part of ICILS 2023 were developed using a different method from that used to describe the preliminary regions in ICILS 2018, and were developed expressly to supersede the described regions of 2018. The levels of the 2023 CT described scale (which will be the basis for future cycles of ICILS) are therefore not comparable with the preliminary regions described in ICILS 2018. However, students' CT scale scores, as measured in ICILS 2023, are directly comparable to those of ICILS 2018.

The descriptions of each level are syntheses of the common elements of CT knowledge, skills, and understanding described by the items within each level. They also describes the typical ways in which students working at a level demonstrate their proficiency. Each level of the scale articulates the characteristics of students' engagement with computers to conceptualize problems and operationalize solutions. The scale thus reflects a broad spectrum of development, underpinned by the progressive complexity and integration of computational problem-solving strategies.

At the lower end of the scale, students demonstrate understanding of patterns and simple sequences, they follow explicit instructions to modify code segments and gradually progress to conditional decision-making in algorithm design. As they advance, they utilize simulations to grasp the interdependencies among problem components. At higher end of the scale, students demonstrate understanding of a wide range of computational concepts and types of commands, effectively applying abstractions to address real-world problems, and creating precise solutions that meet specified requirements.

In summary, the developmental sequence articulated by the CT achievement scale has the following underpinnings: recognizing patterns and simple sequences, conditional decision-making, conceptualizing problems involving abstraction, application of computational concepts and commands, and implementing code-based solutions to solve problems framed in real-world contexts.

Table 4.3: Described CT achievement scale

Description of the proficiency level	**Examples of achievements by students at this proficiency level**
CT Level 1 (from above 330 to 440 scale score points)	
Students working at CT Level 1 can recognize the logic associated with fundamental computational concepts (such as sequencing, loops, and conditional logic) as they may apply to problems with constrained, explicit parameters. These students recognize patterns and can create straightforward algorithms to address a small number of explicit objectives. Students can logically sequence a small variety of commands, understand and apply loops for repetitive actions, and ensure conditions are met to direct program flow. These students may rely on a clear visual correspondence between executed code and outcomes to evaluate the accuracy and efficiency of their coding solutions.	Students working at CT Level 1, for example: • Complete a decision tree to establish the sequential logic of decisions leading to the display of user messages based on the outcome of comparing the magnitude of two stored values. • Identify incomplete sets of winning combinations in a game by recognizing simple patterns. • Use an interactive node graph to establish a route meeting given criteria for a bus to pick up passengers and drive them to an event. • Generate block-based code that repeats an action. • Generate block-based code that meets a small set of specified objectives with errors or meets all specified objectives inefficiently.

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Table 4.3: Described CT achievement scale (cont'd)

Description of the proficiency level	**Examples of achievements by students at this proficiency level**
CT Level 2 (from above 440 to 550 scale score points)	
Students working at CT Level 2 demonstrate the ability to engage with a range of structured computational problems. They can recognize and apply various combinations within limited groups of commands and concepts, including sequencing, conditional logic, and loops, to formulate and solve problems. They demonstrate algorithmic thinking by recognizing the necessary conditions and identifying the data required for performing computational tasks. When planning and creating algorithmic solutions, students working at CT Level 2 can use block-based coding environments to establish control flow and implement repetition. Their coding solutions involve several steps using a variety of commands, meeting multiple objectives with moderate precision and efficiency. They can use the correspondence between executed code and visual displays of outcomes to refine their code to improve the precision of their solutions.	Students working at CT Level 2, for example: • Use a route simulation tool to store data, compare the time taken across alternative routes, and determine the fastest route available from the set of alternative routes. • Use an interactive node graph to establish the most effective route to meet a set of given criteria. • Modify code to display accurate user messages based on conditional logic to one of three users or incorrect messages to all three users. • Modify code to convert minutes to hours. • Complete a decision tree describing the logic in a simple game to determine a player's turn. • Modify block-based code to make a simulated farming drone perform actions (e.g., drop water or fertilizer) based on the type of tile it encounters, using a small range of navigation commands (such as move and turn), along with loops and conditional logic for a limited numbers of targets.

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Table 4.3: Described CT achievement scale (cont'd)

Description of the proficiency level	**Examples of achievements by students at this proficiency level**
CT Level 3 (from above 550 to 660 scale score points)	
Students working at CT Level 3 engage with problems that include a variety of computational concepts such as simulation, conditional logic, and data interpretation. These students use patterns, loops, and conditional logic to define system behaviors under varying conditions through simulations and data modeling. They can interpret problem scenarios and explain the application of fundamental elements of problem-solving. For example, they understand the benefits of using computer simulations to generate data about real-world systems and can map animated simulations of movements to data plots. Students at this level make independent efforts to develop solutions with efficient code. They use loops for repetitive actions and conditional statements for decision-making, ensuring the proper sequence of operations. Their block-based coding solutions typically meet desired outcomes with a moderate degree of efficiency, while also minimizing errors for problems involving several objectives. They can solve moderately complex problems that require nested combinations of commands, such as inner loops within outer loops, and conditionals within loops. They demonstrate the capacity to plan a series of interrelated operations, where dependencies and relationships between different steps may influence each other, but may not be explicitly represented in a corresponding visual display of outcomes.	Students working at CT Level 3, for example: • Configure and use a braking simulator to establish a minimum viable braking distance under given conditions. • Provide one benefit of using computer simulations of real-world systems to collect data. • Determine which node graph correctly represents all possible routes a bus can take given a set of known parameters. • Modify code to ensure that a simulated farming drone performs precise and accurate watering and fertilizing actions to meet a small set of given criteria. • Interpret visual displays of three-dimensional movement to match simulated movement patterns with graphical representations of the movement. • Modify code to draw lines between given sets of coordinates. • Place all the described actions and rules of a simple game in the logical sequence in which they should be conducted. • Partially complete a decision tree to represent the logic of a simplified automated braking system.

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Table 4.3: Described CT achievement scale (cont'd)

Description of the proficiency level	Examples of achievements by students at this proficiency level
CT Level 4 (above 660 scale score points)	
Students working at CT Level 4 recognize and analyze problems that involve a broad variety of computational concepts and commands. They can decompose complex problems into smaller, manageable components and apply relevant algorithms to solve these sub-problems to contribute to the overarching problem solution. These students demonstrate understanding of the relationships between complex problems and their component sub-problems. Their understanding of digital systems enables them to formulate and represent problems in a structured manner, logically analyzing and organizing data for computational solutions. Students at Level 4 iteratively test and refine block-based coding solutions, resulting in solutions with moderate-to-high levels of both precision and efficiency. They manage to identify solutions to problems involving multiple objectives and for which there is little or no direct and explicit correspondence between the visual display of outcomes and the logic flow, and the execution of nested combinations of commands within code.	Students working at CT Level 4, for example: • Modify code to sum values in a data table based on true/false conditions, incorporating conditional logic. • Sequence function definitions to process sensor data accurately. • Manage game states accurately by modifying code to ensure correct player actions with event handling and conditional logic. • Configure a simulated farming drone's position and orientation in multi-step parallel procedures such that it accurately and precisely performs a specified complex set of actions. • Test the functionality of an interactive game board to evaluate and describe how identified problems in the control flow result in functional errors in the execution of the game play. • Provide two benefits of using of computer simulations of real-world systems to collect data.

4.5 CT achievement scale level illustrations

In this section, we briefly describe the key characteristics of each level on the CT achievement scale and illustrate each level with examples of items from the CT release modules. The descriptions here focus on the differences between achievements across the levels with a view to providing ideas for educators about target areas for teaching to support students' learning progress through the levels.

CT Level 1

Students working at CT Level 1 focus on fundamental concepts of CT, including the sequencing of ideas and actions. They can arrange code block commands in a logical order to solve simple problems when commands are clearly defined and discrete. Students at this level solve problems with small and functionally independent set of steps. They may use simple loops to perform repetitive actions. Significant visual support is necessary for these students to interpret abstractions, apply computational concepts, and assess the correctness of solutions.

Key differences between Level 1 achievement and achievement at higher levels are students' comprehension of decision-making processes, capacity to plan and optimize sequences, and in the formulation of steps for repetition with loops, while maintaining precision.

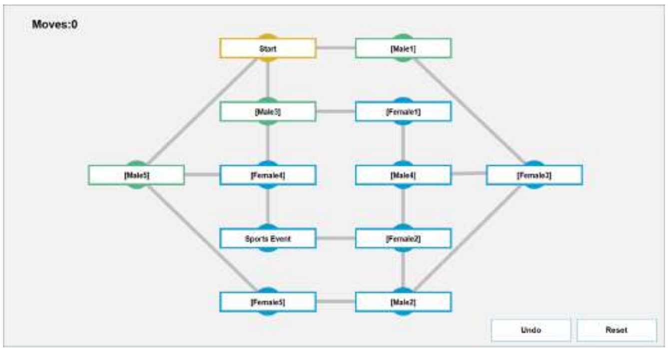
Example Item A (Figure 4.1) illustrates student achievement at CT Level 1. This item is from the second task of the Automated bus module (see Figure F.1 in Appendix F). The task required students to use an interactive node graph to establish the most direct route for a bus to pick up all passengers and drive them to a sports event. The key CT concepts and cognitive processes involved in the task were: (a) pathfinding, identifying a route with an interactive node graph that visits all required nodes (people) and reaches the final destination (sports event); (b) sequencing, ensuring that the sequence of locations visited is correct and follows a logical order; (c) optimization, finding the most efficient path that includes all people with the least amount of travel or moves.

Students who created a route that visited all passenger locations and ended at the sports event location but was sub-optimal (i.e., made redundant moves by revisiting locations unnecessarily) were awarded one point.

On average across countries, 76 percent of students scored at least one point on this task. This varied from 53 to 89 percent across countries and benchmarking participants.

Figure 4.1: CT Level 1, Example Item A with framework references and overall percent correct

Country	Percentage scoring at least one out of two points	Percentage scoring two points
[1] Austria	80 (1.2)	60 (1.4)
† Belgium (Flemish)	81 (1.8)	63 (2.1)
Chinese Taipei	76 (1.2)	62 (1.3)
[1] Croatia	67 (1.8)	43 (1.9)
[1] Czech Republic	89 (0.6)	70 (0.9)
†[1] Denmark	83 (1.1)	66 (1.4)
Finland	84 (1.4)	67 (1.7)
France	75 (1.1)	57 (1.4)
Germany	79 (1.4)	62 (1.4)
Italy	80 (1.1)	62 (1.4)
† Korea, Republic of	53 (1.4)	42 (1.5)
[1] Latvia	77 (1.6)	58 (1.8)
Luxembourg	76 (0.9)	56 (1.2)
Malta	66 (1.5)	40 (1.4)
[1] Norway (Grade 9)	74 (1.2)	57 (1.7)
[1] Portugal	78 (1.2)	56 (1.4)
[1] Serbia	64 (1.8)	43 (1.8)
Slovak Republic	82 (1.1)	63 (1.6)
[1] Slovenia	76 (1.0)	54 (1.2)
[1] Sweden	83 (1.2)	66 (1.6)
† Uruguay	64 (1.8)	41 (1.7)
ICILS 2023 average	76 (0.3)	57 (0.3)
Benchmarking participant		
North Rhine-W. (Germany)	76 (1.5)	58 (1.6)
Country not meeting sample participation requirements		
‡ United States	70 (2.2)	48 (2.3)



The bus needs to drive all people to the sports event.
Click on the names to create the most direct route that includes all people.
Start at 'Start' and finish at 'Sports Event'.
Click ➔ when you are ready to continue.

Score	CT scale difficulty	CT scale level	Range (%)
At least one of two points	426	1	53 to 89
Two points	500	2	40 to 70

Item descriptor (one out of two points)

Uses an interactive graph to establish a route to meet a set of given criteria.

Item descriptor (two points)

Uses an interactive node graph to establish the most direct route to meet a set of given criteria.

ICILS assessment framework reference: 1.1

Strand: Conceptualizing problems

Aspect: Knowing about and understanding digital systems

Notes: ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Does not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

CT Level 2

Students working at CT Level 2 apply diverse computational concepts such as aggregation, arithmetic conversion, graphs, loops, and optimization. They optimize or correct their solutions to meet required criteria with moderate precision and efficiency, addressing multiple objectives for problems that involve several types of commands. These students depend on visual aids such as diagrams, decision trees, and interactive graphs, to understand abstractions and evaluate solutions.

The defining characteristic of Level 2 achievement, in contrast to Level 3, is awareness of the interdependencies between different components of a problem. Between Levels 2 and 3, student achievement transitions from a narrow focus on executing individual instructions sequentially to a more holistic integration of algorithmic and procedural thinking. This development entails the application of the same range of command types to meet a greater number of objectives with greater precision. Although explicit visual correspondence between code and the outcomes of code execution remains important at CT Level 2, this importance decreases with respect to Level 1 and below, as students begin to rely more on their internalized computational understanding of control flows and relationships among elements in their coding solutions.

Example Item B (Figure 4.2) illustrates student achievement at Level 2 on the CT scale. It is from the same task as Example Item A. Students who created a route that visited all passenger locations and ended at the sports event location optimally (i.e., visited each location only once) were awarded two points.

On average across countries, 57 percent of students achieved a score of two on this task. This varied from 40 to 70 percent across countries and benchmarking participants.

Example Item C (Figure 4.3) illustrates student achievement at Level 2 on the CT scale. The item is from Farm drone task six (see Figure F.7 in Appendix F). The task was a high-complexity debugging task that required students to use a loop to efficiently perform the move action multiple times to navigate the tiles and, using a conditional, determine whether the drone should drop water and/or fertilizer based on the size of the crop tile. Students were instructed to optimize their solution using the fewest number of code blocks to complete the task correctly, without affecting any grass tiles. The task involved two types of materials (water and fertilizer) and two types of targets (big and small crops), of which two needed both materials.

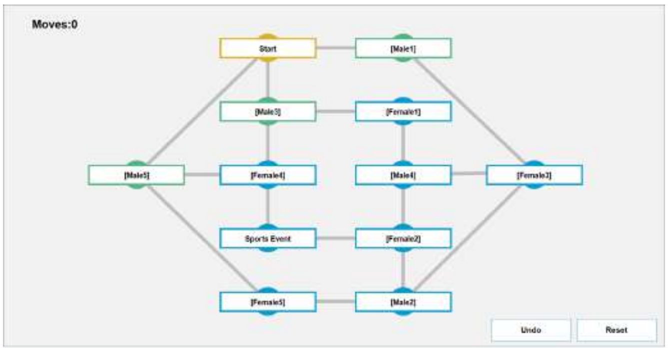
The key CT concepts and cognitive processes involved in the task were: (a) sequencing, arranging commands in the correct order to achieve the desired outcome of moving, watering, and fertilizing the crops; (b) loops, utilizing repetition to efficiently perform the same action multiple times, specifically using the 'repeat do' block to navigate the tiles; (c) conditional logic, using conditional statements to determine whether the drone should drop water or fertilizer based on the size of the crop tile; (d) optimization, optimizing a solution to use the fewest number of code blocks to complete the task correctly.

Students could receive a score of zero, one, two, or three points on this task. Students whose solutions met the specified objectives with errors or met all the specified objectives inefficiently (using more than 13 commands) were awarded one point.

On average across countries 56 percent of students achieved at least one point on this task. This varied from 36 to 71 percent across countries and benchmarking participants.

Figure 4.2: CT Level 2, Example Item B with framework references and overall percent correct

Country	Percentage scoring at least one out of two points		Percentage scoring two points	
[1] Austria	80	(1.2)	60	(1.4)
† Belgium (Flemish)	81	(1.8)	63	(2.1)
Chinese Taipei	76	(1.2)	62	(1.3)
[1] Croatia	67	(1.8)	43	(1.9)
[1] Czech Republic	89	(0.6)	70	(0.9)
†[1] Denmark	83	(1.1)	66	(1.4)
Finland	84	(1.4)	67	(1.7)
France	75	(1.1)	57	(1.4)
Germany	79	(1.4)	62	(1.4)
Italy	80	(1.1)	62	(1.4)
† Korea, Republic of	53	(1.4)	42	(1.5)
[1] Latvia	77	(1.6)	58	(1.8)
Luxembourg	76	(0.9)	56	(1.2)
Malta	66	(1.5)	40	(1.4)
[1] Norway (Grade 9)	74	(1.2)	57	(1.7)
[1] Portugal	78	(1.2)	56	(1.4)
[1] Serbia	64	(1.8)	43	(1.8)
Slovak Republic	82	(1.1)	63	(1.6)
[1] Slovenia	76	(1.0)	54	(1.2)
[1] Sweden	83	(1.2)	66	(1.6)
† Uruguay	64	(1.8)	41	(1.7)
ICILS 2023 average	76	(0.3)	57	(0.3)
Benchmarking participant				
North Rhine-W. (Germany)	76	(1.5)	58	(1.6)
Country not meeting sample participation requirements				
‡ United States	70	(2.2)	48	(2.3)



The bus needs to drive all people to the sports event.
Click on the names to create the most direct route that includes all people.
Start at 'Start' and finish at 'Sports Event'.
Click ➔ when you are ready to continue.

Score	CT scale difficulty	CT scale level	Range (%)
At least one of two points	426	1	53 to 89
Two points	500	2	40 to 70

Item descriptor (one out of two points)

Uses an interactive graph to establish a route to meet a set of given criteria.

Item descriptor (two points)

Uses an interactive node graph to establish the most direct route to meet a set of given criteria.

ICILS assessment framework reference: 1.1

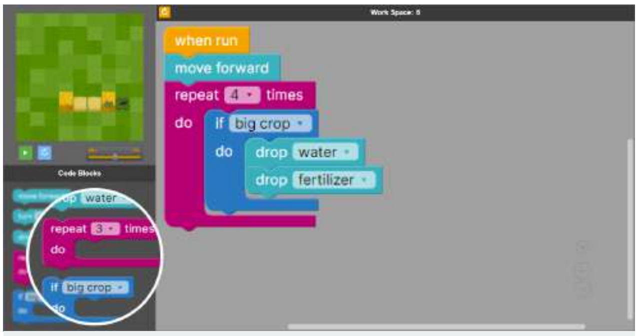
Strand: Conceptualizing problems

Aspect: Knowing about and understanding digital systems

Notes: ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Does not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

Figure 4.3: CT Level 2, Example Item C with framework references and overall percent correct

Country	Percentage scoring at least one out of three points	Percentage scoring at least two out of three points	Percentage scoring three points
[1] Austria	55 (1.8)	25 (1.4)	3 (0.4)
† Belgium (Flemish)	63 (1.9)	32 (1.8)	4 (0.5)
Chinese Taipei	70 (1.5)	43 (1.5)	5 (0.5)
[1] Croatia	36 (1.6)	15 (1.1)	2 (0.4)
[1] Czech Republic	71 (1.0)	37 (1.2)	5 (0.4)
†[1] Denmark	65 (1.5)	29 (1.3)	4 (0.6)
Finland	64 (1.7)	35 (1.5)	6 (0.7)
France	61 (1.5)	34 (1.3)	5 (0.7)
Germany	59 (1.6)	27 (1.4)	4 (0.5)
Italy	60 (1.3)	22 (1.0)	3 (0.5)
† Korea, Republic of	71 (1.3)	46 (1.5)	8 (0.7)
[1] Latvia	59 (2.1)	27 (1.9)	4 (0.6)
Luxembourg	53 (1.3)	26 (1.0)	4 (0.5)
Malta	46 (1.5)	22 (1.2)	3 (0.4)
[1] Norway (Grade 9)	53 (1.9)	32 (1.4)	5 (0.6)
[1] Portugal	59 (1.8)	22 (1.1)	2 (0.4)
[1] Serbia	38 (2.0)	15 (1.1)	2 (0.4)
Slovak Republic	63 (1.4)	30 (1.2)	4 (0.5)
[1] Slovenia	47 (1.9)	20 (1.4)	2 (0.3)
[1] Sweden	56 (1.8)	31 (1.4)	4 (0.5)
† Uruguay	37 (1.7)	17 (1.2)	2 (0.4)
ICILS 2023 average	56 (0.4)	28 (0.3)	4 (0.1)
Benchmarking participant			
North Rhine-W. (Germany)	76 (1.5)	23 (1.7)	4 (0.4)
Country not meeting sample participation requirements			
‡ United States	46 (2.6)	22 (2.0)	3 (0.7)



Code blocks have been placed in the work space.
The drone needs to:

- drop water on all of the crop tiles (big and small)
- drop fertilizer on only the small crop tiles.

The code blocks in the work space do not do this correctly.
Click on ➔ to see the problem.
Change the code blocks in the work space to fix the problem.

Score	CT scale difficulty	CT scale level	Range (%)
At least one of three points	513	2	36 to 71
At least two of three points	634	3	15 to 46
Three points	860	4	2 to 8

Item descriptor (one out of three points)

Generates code modifications that meet the specified objectives with errors or meet all specified objectives inefficiently.

Item descriptor (two out of three points)

Generates code modifications that meet all specified objectives with moderate efficiency.

Item descriptor (three points)

Generates code modifications that meet all specified objectives with optimal efficiency.

ICILS assessment framework reference: 2.2

Strand: Operationalizing solutions

Aspect: Developing algorithms, programs and interfaces

Notes: ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Does not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

CT Level 3

Students at CT Level 3 understand and integrate a broad variety of computational concepts and commands such as simulation, data processing, loops, and conditional logic. Their solutions balance the need for precision and efficiency with moderate visual support. Students optimize or correct their solutions to meet the required criteria with high precision and moderate efficiency to solve problems with several objectives. These students demonstrate evidence of multistep procedural thinking through their capacity to interpret code where the visual output does not explicitly correspond to the operations executed in the code.

Key distinctions between Level 3 achievement from achievement at Level 4 and above are the variety of computational concepts and commands involved in students' solutions and the degree of precision exhibited by those solutions.

Example Item D (Figure 4.4) illustrates student achievement at Level 3 on the CT scale. The item is from the same task as Example Item C. Students whose solutions met all specified objectives, with moderate efficiency (between six and seven commands) were awarded two points.

This task saw an average of 28 percent of students achieving a score of at least two out of three points. This varied from 15 to 46 percent across countries and benchmarking participants.

Example Item E (Figure 4.5) also illustrates student achievement at Level 3 on the CT scale. The item is from Automated bus task eight (see Figure F.4 in Appendix F) and is a constructed response item in which students were asked give two two reasons for why computer simulations of real-world systems are useful. The key CT concept assessed was computer simulations, and the cognitive process involved was reasoning, specifically about how simulations can model real-world systems to test and predict outcomes under various conditions.

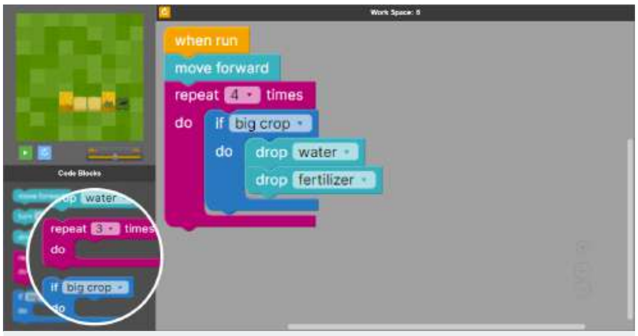
Students could receive a score of zero, one, or two points on this task. Their responses were scored by trained expert scorers in each country.[25] Students received one point if they provided one benefit from any of the following categories enhancing safety; pragmatism (e.g., simulating planetary movements); a controlled environment (e.g., variable manipulation); or resource efficiency (e.g., time, materials, money).

On average across countries, 27 percent of students scored at least one point on this task. This varied from eight percent to 72 percent across countries and benchmarking participants.

25 The students' written responses to this item were scored by scorers in each country using an online scoring platform. As an international standard for scorer training, the same set of example responses were provided to all scorers across all countries. Only data that met the requisite ICILS scoring standards were included in the analysis of this item. Approximately 200 student responses to each constructed response item and large task criterion were independently scored by two scorers in each country. Data from each human scored item from any given country were used only where the resultant measurement properties for that item were consistent with those for the item across countries, and where at least 60 percent of double-scored responses received the same score from both scorers.

Figure 4.4: CT Level 3, Example Item D with framework references and overall percent correct

Country	Percentage scoring at least one out of three points		Percentage scoring at least two out of three points		Percentage scoring three points	
[1] Austria	55	(1.8)	25	(1.4)	3	(0.4)
† Belgium (Flemish)	63	(1.9)	32	(1.8)	4	(0.5)
Chinese Taipei	70	(1.5)	43	(1.5)	5	(0.5)
[1] Croatia	36	(1.6)	15	(1.1)	2	(0.4)
[1] Czech Republic	71	(1.0)	37	(1.2)	5	(0.4)
†[1] Denmark	65	(1.5)	29	(1.3)	4	(0.6)
Finland	64	(1.7)	35	(1.5)	6	(0.7)
France	61	(1.5)	34	(1.3)	5	(0.7)
Germany	59	(1.6)	27	(1.4)	4	(0.5)
Italy	60	(1.3)	22	(1.0)	3	(0.5)
† Korea, Republic of	71	(1.3)	46	(1.5)	8	(0.7)
[1] Latvia	59	(2.1)	27	(1.9)	4	(0.6)
Luxembourg	53	(1.3)	26	(1.0)	4	(0.5)
Malta	46	(1.5)	22	(1.2)	3	(0.4)
[1] Norway (Grade 9)	53	(1.9)	32	(1.4)	5	(0.6)
[1] Portugal	59	(1.8)	22	(1.1)	2	(0.4)
[1] Serbia	38	(2.0)	15	(1.1)	2	(0.4)
Slovak Republic	63	(1.4)	30	(1.2)	4	(0.5)
[1] Slovenia	47	(1.9)	20	(1.4)	2	(0.3)
[1] Sweden	56	(1.8)	31	(1.4)	4	(0.5)
† Uruguay	37	(1.7)	17	(1.2)	2	(0.4)
ICILS 2023 average	56	(0.4)	28	(0.3)	4	(0.1)
Benchmarking participant						
North Rhine-W. (Germany)	76	(1.5)	23	(1.7)	4	(0.4)
Country not meeting sample participation requirements						
‡ United States	46	(2.6)	22	(2.0)	3	(0.7)



Code blocks have been placed in the work space.
The drone needs to:
- drop water on all of the crop tiles (big and small)
- drop fertilizer on only the small crop tiles.

The code blocks in the work space do not do this correctly.
Click on ➔ to see the problem.
Change the code blocks in the work space to fix the problem.

Score	CT scale difficulty	CT scale level	Range (%)
At least one of three points	513	2	36 to 71
At least two of three points	634	3	15 to 46
Three points	860	4	2 to 8

Item descriptor (one out of three points)

Generates code modifications that meet the specified objectives with errors or meet all specified objectives inefficiently.

Item descriptor (two out of three points)

Generates code modifications that meet all specified objectives with moderate efficiency.

Item descriptor (three points)

Generates code modifications that meet all specified objectives with optimal efficiency.

ICILS assessment framework reference: 2.2

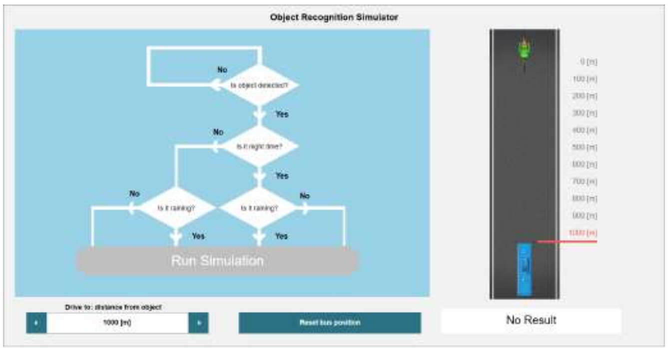
Strand: Operationalizing solutions

Aspect: Developing algorithms, programs and interfaces

Notes: ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Does not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

Figure 4.5: CT Level 3, Example Item E with framework references and overall percent correct

	Country	Percentage scoring at least one out of two points		Percentage scoring two points	
[1]	Austria	39	(1.7)	11	(0.8)
†	Belgium (Flemish)	23	(1.3)	3	(0.5)
	Chinese Taipei	39	(1.6)	8	(0.7)
[1]	Croatia	23	(1.5)	5	(0.7)
[1]	Czech Republic	26	(0.8)	4	(0.3)
†[1]	Denmark	26	(1.4)	4	(0.6)
	Finland	31	(1.6)	3	(0.4)
	France	18	(1.0)	2	(0.4)
	Germany	22	(1.4)	5	(0.7)
	Italy	28	(1.4)	3	(0.4)
†	Korea, Republic of	72	(1.4)	36	(1.5)
[1]	Latvia	26	(1.5)	4	(0.6)
	Luxembourg	25	(1.1)	3	(0.4)
	Malta	17	(1.0)	3	(0.5)
[1]	Norway (Grade 9)	22	(1.2)	3	(0.4)
[1]	Portugal	37	(1.7)	2	(0.3)
[1]	Serbia	8	(0.8)	1	(0.2)
	Slovak Republic	31	(1.5)	3	(0.4)
[1]	Slovenia	19	(1.0)	3	(0.4)
[1]	Sweden	11	(0.8)	3	(0.4)
†	Uruguay	27	(1.3)	4	(0.5)
	ICILS 2023 average	27	(0.3)	5	(0.1)
Benchmarking participant					
	North Rhine-W. (Germany)	19	(1.4)	4	(0.6)
Country not meeting sample participation requirements					
‡	United States	22	(2.1)	4	(0.8)



Why are computer simulations of real-world systems useful?
Give two different reasons.

Score	CT scale difficulty	CT scale level	Range (%)
At least one of two points	650	3	8 to 72
Two points	839	4	1 to 36

Item descriptor (one out of two points)

Provides one benefit of using simulations to collect data on real-world problems.

Item descriptor (two points)

Provides two benefits of using simulations to collect data on real-world problems.

ICILS assessment framework reference: 1.1

Strand: Conceptualizing problems

Aspect: Knowing about and understanding digital systems

Notes: ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Does not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

CT Level 4

Students at CT Level 4 effectively apply abstractions to engage with real-world problems. They can work with problem contexts involving several integrated computational concepts, such as state management, with the greatest variety of commands and highest demands for precision without relying on explicit visual correspondence between outputs and code operations. Their solutions meet specific requirements accurately through iterative testing and debugging.

Example Item F (Figure 4.6) illustrates student achievement at Level 4 on the CT scale. The item is from Farm drone task seven (see Figure F.7 in Appendix F) and is a high-complexity code creation task. Students were instructed to make the drone drop water on the big and small crop tiles and fertilizer on only the small crop tiles, completing a total of 12 actions across the eight tiles. The key CT concepts and cognitive processes involved in the task were: (a) sequencing, arranging commands in the correct order to move the drone and perform actions accurately on different tile types; (b) loops, utilizing repetition to efficiently perform the same action across multiple tiles, minimizing the number of commands needed; (c) conditional logic, using if-else statements to check the type of tile and determine whether to drop water, fertilizer, or nothing; (d) efficiency, optimizing the sequence of commands to use the fewest number of blocks while achieving the correct outcome.

Students could receive a score of zero, one, or two points on this task. Students whose solutions met all specified objectives with optimal efficiency (not more than 19 commands using loops with nested conditionals) were awarded three points.

On average, across all ICILS countries, 12 percent of students achieved the maximum score of three on this task. This varied from five percent to 24 percent across countries and benchmarking participants.

Figure 4.6: CT Level 4, Example Item F with framework references and overall percent correct

Country	Percentage scoring at least one out of three points		Percentage scoring at least two out of three points		Percentage scoring three points	
[1] Austria	45	(1.8)	22	(1.4)	9	(0.9)
† Belgium (Flemish)	56	(2.1)	27	(1.9)	13	(1.1)
Chinese Taipei	69	(1.6)	43	(1.5)	21	(1.0)
[1] Croatia	28	(1.9)	12	(1.3)	6	(0.9)
[1] Czech Republic	64	(1.4)	32	(1.1)	17	(0.9)
†[1] Denmark	56	(1.6)	27	(1.3)	14	(1.3)
Finland	57	(2.0)	30	(1.3)	17	(1.1)
France	52	(1.5)	28	(1.1)	15	(0.9)
Germany	47	(1.5)	21	(1.1)	10	(0.8)
Italy	47	(1.6)	18	(1.0)	9	(0.7)
† Korea, Republic of	67	(1.3)	45	(1.3)	24	(1.1)
[1] Latvia	54	(2.2)	24	(1.9)	13	(1.3)
Luxembourg	45	(1.2)	23	(1.1)	12	(0.8)
Malta	38	(1.1)	17	(0.9)	9	(0.7)
[1] Norway (Grade 9)	49	(1.9)	28	(1.4)	15	(1.1)
[1] Portugal	49	(1.8)	17	(1.0)	7	(0.7)
[1] Serbia	27	(1.9)	11	(0.9)	5	(0.7)
Slovak Republic	56	(1.4)	26	(1.3)	13	(0.9)
[1] Slovenia	36	(1.9)	17	(1.5)	7	(0.8)
[1] Sweden	49	(2.1)	29	(1.5)	14	(0.8)
† Uruguay	28	(1.6)	12	(1.0)	6	(0.6)
ICILS 2023 average	48	(0.4)	24	(0.3)	12	(0.2)
Benchmarking participant						
North Rhine-W. (Germany)	41	(1.6)	19	(1.0)	9	(0.7)
Country not meeting sample participation requirements						
‡ United States	36	(3.0)	17	(1.8)	9	(1.1)

Make the drone:
The drone needs to:

- drop water on all of the crop tiles (big and small)
- drop fertilizer on only the small crop tiles.

The drone should not drop water or fertilizer on the grass tiles.
Click on ▶ to see the results.
Click on ➔ when you are ready to continue.

Score	CT scale difficulty	CT scale level	Range (%)
At least one of three points	546	2	27 to 69
At least two of three points	641	3	11 to 45
Three points	701	4	5 to 24

Item descriptor (one out of three points)

Generates a coding solution that meets the specified objectives with errors, or meets all specified objectives inefficiently.

Item descriptor (two out of three points)

Generates a coding solution that meets the specified objectives with no or minor errors, with moderate efficiency.

Item descriptor (three points)

Generates a coding solution that meets the specified objectives with no or minor errors, with optimal efficiency.

ICILS assessment framework reference: 2.2

Strand: Operationalizing solutions

Aspect: Developing algorithms, programs and interfaces

Notes: ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Does not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

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Chapter 5:

Student achievement in computer and information literacy and computational thinking

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Chapter highlights

Students' computer and information literacy (CIL) varied considerably both within and across countries.

- The difference between the highest and lowest average CIL scale scores across countries was more than 200 scale score points, this corresponds to a difference of more than two international standard deviations (Table 5.1).
- The difference between the lowest performing students within International Computer and Information Literacy Study (ICILS) countries (bottom 10%) and the highest performing students (top 10%) was also more than 200 CIL scale score points in most countries (Table 5.1).

Many students demonstrated only basic CIL competence (below CIL Level 2). Students below CIL Level 2 generally require explicit step-by-step instructions to perform simple CIL actions associated with information location and communication in the digital environment.

- On average across countries, nearly half of students' CIL achievement was below Level 2 (Table 5.2).
- In some countries, more than three quarters of students' CIL achievement was below CIL Level 2 (Table 5.2).
- In the highest performing countries between a quarter to a third of students' CIL achievement was below Level 2 (Table 5.2).

Students' CIL achievement was typically lower in 2023 than in 2018 and 2013, in countries with comparable data across the cycles. There were some individual exceptions to this general pattern.

- Students' average CIL decreased significantly between 2013 and 2023 in six of seven countries. In the remaining country, students' average CIL did not change significantly (Table 5.3).
- Students' average CIL decreased significantly between 2018 and 2023 in four countries. In two countries students' CIL increased significantly[26] (Table 5.3).
- The differences in students' CIL across study cycles were also reflected in the differences in students achieving at CIL Level 2 or above across the cycles (Table 5.4).

Students' computational thinking (CT) varied both within and across countries. In comparison to CIL, students' CT varied considerably more within countries than across countries.

26 In Italy, the testing time in 2023 differed from 2018. ICILS 2018 data were collected in the first half of the school year, so caution is advised when comparing CIL achievement between ICILS 2018 and 2023.

- The difference between the highest and lowest average CT scores across ICILS countries was more than 120 scale score points, this corresponds to a difference of slightly more than one international standard deviation (Table 5.1).
- The difference between the lowest performing students within ICILS countries (bottom 10%) and the highest performing students (top 10%) was more than 270 scale score points in most countries (Table 5.1).

Students' CT achievement typically did not change significantly between 2018 and 2023 in countries with comparable data across the two cycles.

- Students' average CT did not change significantly between 2018 and 2023 in five of seven countries (Table 5.7).
- Students' average CT increased significantly in one country, and decreased significantly in two countries between 2018 and 2023 (Table 5.7).

5.1 Introduction

The International Computer and Information Literacy Study (ICILS) measures computer and information literacy (CIL) and computational thinking (CT) achievement in grade 8 students within and across countries. Computer and information literacy refers to the "ability to use computers to investigate, create, and communicate in order to participate effectively at home, at school, in the workplace, and in the society" (Fraillon & Duckworth, 2024, p. 26). Computational thinking refers to the "ability to recognize aspects of real-world problems which 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" (Duckworth & Fraillon, 2024, p. 38). For more information about the CIL and CT constructs and the assessment instruments see Chapter 1, Chapter 3, and the ICILS assessment framework (Fraillon & Rožman, 2024).

This chapter examines student CIL and CT achievement in ICILS 2023. We begin by reporting the average performance in CIL for each country, followed by an examination of variation in performance within and across countries. This is done to address Research Question CIL 1: *What variations exist in students' CIL within and across countries?* (see Chapter 1, Fraillon and Rožman, 2024). Additionally, we address Research Question CIL 3: *How has CIL changed since ICILS 2013?*. This is done by examining trends in student performance over time. Specifically, we present students' CIL achievement in ICILS 2023 in comparison to CIL achievement in previous cycles of ICILS. We then report student CT achievement within and among countries following the same structure as is used to present CIL achievement to address Research Question CT 1: *What variations exist in students' CT within and across countries?*, and Research Question CT 3: *How has CT changed since ICILS 2018?*. We present students' CT achievement in ICILS 2023 across countries and, and for selected countries, in comparison to CT achievement in 2018. In addition, we address Research Question CT 6: *What is the association between students' CIL and CT, and how has this changed since 2018?* by reporting the association between CT and CIL in 2023 and in 2018.

The ICILS 2023 data reported in this chapter include 32 countries and one benchmarking participant, North Rhine-Westphalia (Germany). Twenty-two of these countries and the benchmarking participant conducted the CT assessment. The averages reported in this chapter are calculated based on the countries that met sampling participation requirements, excluding Romania because of late testing. When statements are made describing the data in this chapter, the term "countries" refers to the countries and benchmarking participant that met the ICILS sampling requirements. See Chapter 1 for further details.

Proficiency estimation of CIL and CT

The ICILS reporting scales for CIL and CT were established in ICILS 2013 and ICILS 2018, respectively, setting the mean of national average scores for equally weighted ICILS countries that met sampling requirements to 500 and the standard deviation to 100. To track trends over time, subsequent ICILS assessments transformed achievement data to this metric so that CIL scale scores across ICILS cycles are directly comparable, as are CT scale scores across cycles. It is important to note that the CIL and CT scales are independent of each other and CIL and CT scale scores are not directly comparable.

In ICILS 2023, as in previous cycles of ICILS and in other international large scale assessments (such as TIMSS, PIRLS, ICCS, and PISA), we used a rotated test booklet design. This allows for the full breadth of the achievement constructs to be measured by the assessment instruments without overburdening individual students with tests comprising content assessing every aspect of each construct. In ICILS 2023, each student was assigned two out of seven CIL modules and two out of four CT modules (see Chapter 3, and Chapter 4 for full details of the CIL and CT assessment).

Due to the test administration and the rotation of modules, each student receives only a subset of the total item pool, posing challenges for generating individual proficiency estimates. Plausible value methods (Mislevy, 1991) were used to generate population-level proficiency estimates. Full details of the procedures used to generate the ICILS CIL and CT scales and population-level proficiency estimates are provided in the ICILS 2023 technical report (Fraillon et al., forthcoming).

Proficiency levels of CIL and CT

In ICILS we describe achievement results by defining specific proficiency levels (see Chapter 3 for CIL and Chapter 4 for CT). The proficiency levels describe the knowledge, skills, and understanding in CIL and CT as they progressively increase in each scale. Students at a particular level typically demonstrate the specific understandings and skills associated with that level, in addition to those from lower levels.

For CIL, the level boundaries are located at 407, 492, 576, and 661 CIL scale score points and were established as part of ICILS 2013. For CT, the level boundaries were established as part of ICILS 2023 at 330, 440, 550, and 660 CT scale score points. Chapter 3 and Chapter 4 provide detailed descriptions of the content of each proficiency level on the CIL and CT achievement scales, supplemented by example items illustrating achievement at each level.

5.2 Comparison of CIL across countries

Distribution of student CIL scores

The average score on the trend scale for ICILS 2023 countries was 476 scale score points, with a standard deviation of 88 scale score points for equally weighted national samples that met sample participation guidelines.

In ICILS 2023 the range average student CIL achievement scores was more than 220 scale score points, from 319 (Azerbaijan) to 540 scale score points (Korea (Rep.of)).[27] This range represents a wide spectrum of achievement, spanning from below Level 1 to within Level 3, equivalent to approximately 2.5 international standard deviations (Table 5.1).

There was also considerable variation of CIL achievement within countries. The variation in achievement between the relatively high and low achieving students within countries can be illustrated, for example, by considering the breadth of CIL scores accounting for the middle 80 percent of students within each country. This range reflects the difference between the 10th percentile of CIL achievement (the CIL score below which 10% of students CIL scores are evident) and the 90th percentile (the CIL score above which 10% of student CIL scores are evident). Across all countries, the average range accounting for the middle 80 percent of students was 226 CIL scale score points, similar to the range of average scale scores across all ICILS 2023 countries and equivalent to slightly less than the span of three levels on the CIL scale. This range was smallest in the Czech Republic (172 CIL scale points, equivalent to slightly less than the width of two levels on the CIL scale) and largest in Malta (273 scale points, more than the width of three levels on the CIL scale).

27 The apparent inconsistency between the reported scores and the difference is due to rounding.

Table 5.1: Country averages and distribution for CIL

Country	Average CIL scale score		
[†] Korea, Republic of	540	(2.5)	▲
[1] Czech Republic	525	(2.1)	▲
[†1] Denmark	518	(2.7)	▲
Chinese Taipei	515	(3.0)	▲
[†] Belgium (Flemish)	511	(4.4)	▲
[1] Portugal	510	(3.0)	▲
[1] Latvia	509	(3.6)	▲
Finland	507	(3.6)	▲
[1] Austria	506	(2.5)	▲
Hungary	505	(3.8)	▲
[1] Sweden	504	(3.0)	▲
[1] Norway (Grade 9)	502	(2.9)	▲
Germany	502	(3.5)	▲
Slovak Republic	499	(2.7)	▲
France	498	(2.7)	▲
[1] Spain	495	(1.9)	▲
Luxembourg	494	(2.0)	▲
Italy	491	(2.6)	▲
[1] Croatia	487	(3.9)	▲
[1] Slovenia	483	(2.3)	▲
ICILS 2023 average	476	(0.6)	
Malta	475	(2.5)	
Cyprus	460	(2.6)	▽
Greece	460	(3.3)	▽
[†] Uruguay	447	(3.6)	▽
[1] Serbia	443	(3.7)	▽
[3] Bosnia and Herzegovina	440	(3.8)	▽
[†12] Romania	418	(5.3)	▽
[1] Kazakhstan	407	(3.1)	▽
Oman	379	(3.0)	▽
[1] Kosovo	356	(4.1)	▽
Azerbaijan	319	(5.1)	▽
Benchmarking participant			
[1] North Rhine-W. (Germany)	485	(4.1)	▲
Country not meeting sample participation requirements			
[‡] United States	482	(6.6)	

CIL distribution

▲ Average significantly higher than ICILS 2023 average.

▽ Average significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Countries are ranked in descending order of the average CIL scale score.

[†] Met guidelines for sampling participation rates only after replacement schools were included.

[‡] Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

[2] Country surveyed target grade in the first half of the school year.

[3] National defined population covers 61% of the national target population.

Achievement across countries with respect to proficiency levels

The variation within countries was generally slightly larger in countries with lower CIL. The median range for the middle 80 percent of students was 263 scale score points in the 10 countries with average CIL scale scores statistically significantly below the ICILS 2023 average, in comparison to 211 scale points in the 21 countries with statistically significant average scale scores above the ICILS 2023 average (Table 5.1).

On average across countries, 49 percent of students achieved scores that placed them at or above Level 2 of the CIL scale (Table 5.2), while 27 percent of students with scores that placed them in Level 1, and 24 percent of students scored below Level 1.

In 22 countries, the highest percentage of students achieved CIL scores in Level 2. In eight of the remaining countries, the highest percentage of students had CIL scores below Level 1, and in two countries (Greece and Serbia), the highest percentage of students achieved CIL scores at Level 1. No country had the highest percentage of students' CIL scores in Level 3 or 4.

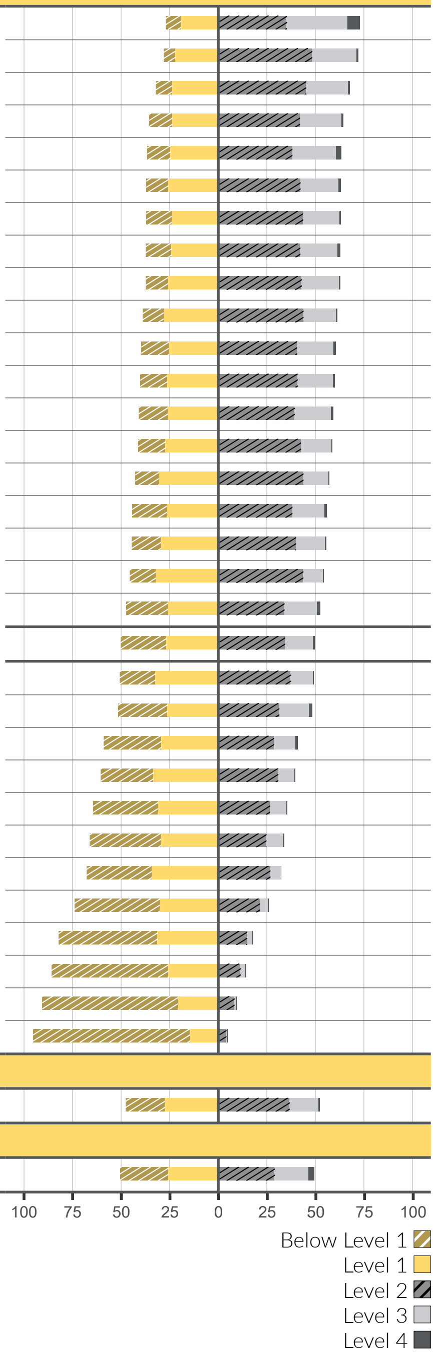
In 21 countries including the benchmarking participant North Rhine-Westphalia (Germany), the percentage of students with CIL scores at Level 2 or above is greater than the percentage below Level 2.

In all countries, except Korea (Rep. of), the proportion of student scores below Level 2 (i.e., at Levels 1 and below) is higher than the proportion of student scores above Level 2 (i.e., Levels 3 and 4).

While, overall across countries majorities of students are demonstrating CIL achievement within Levels 1 and 2, in all countries there remain many students with CIL achievement below Level 1. These students generally require explicit step-by-step instructions to perform simple CIL actions associated with information location and communication in the digital environment.

Table 5.2: Percentage of students at each CIL proficiency level across countries

Country	Percentage of students achieving at each CIL level				
	Below Level 1	Level 1	Level 2	Level 3	Level 4
† Korea, Republic of	8 (0.6)	19 (0.9)	35 (1.2)	31 (1.1)	6 (0.6)
1 Czech Republic	6 (0.7)	22 (0.9)	48 (1.0)	23 (0.8)	1 (0.2)
†1 Denmark	8 (0.9)	24 (1.0)	45 (1.2)	22 (1.1)	1 (0.3)
† Belgium (Flemish)	12 (1.6)	24 (1.4)	42 (1.7)	22 (1.5)	1 (0.3)
Chinese Taipei	12 (1.0)	25 (1.0)	38 (1.2)	23 (1.3)	3 (0.4)
1 Portugal	11 (1.0)	26 (1.1)	42 (1.3)	20 (1.1)	1 (0.2)
Hungary	13 (1.6)	24 (1.3)	44 (1.3)	19 (1.1)	1 (0.2)
Finland	13 (1.2)	24 (1.0)	42 (1.2)	19 (1.1)	1 (0.3)
1 Latvia	11 (1.2)	26 (1.3)	43 (1.5)	19 (1.3)	1 (0.2)
1 Austria	11 (0.9)	28 (1.2)	44 (1.2)	17 (0.8)	1 (0.2)
1 Sweden	14 (1.1)	25 (1.3)	41 (1.3)	19 (1.4)	1 (0.2)
1 Norway (Grade 9)	14 (1.0)	26 (1.0)	41 (1.0)	18 (1.0)	1 (0.2)
Germany	15 (1.4)	26 (1.2)	39 (1.4)	19 (1.2)	1 (0.3)
Slovak Republic	14 (1.0)	27 (1.2)	43 (1.2)	16 (1.1)	1 (0.2)
France	12 (1.3)	30 (1.3)	44 (1.5)	13 (0.8)	0 (0.1)
Luxembourg	18 (0.8)	26 (0.8)	38 (0.9)	17 (0.9)	1 (0.2)
1 Spain	15 (0.8)	30 (0.8)	40 (0.8)	15 (0.7)	1 (0.2)
Italy	14 (1.2)	32 (1.1)	44 (1.5)	10 (0.8)	0 (0.1)
1 Croatia	21 (1.7)	26 (1.2)	34 (1.6)	17 (1.2)	2 (0.3)
ICILS 2023 average	24 (0.2)	27 (0.2)	34 (0.2)	14 (0.2)	1 (0.0)
1 Slovenia	18 (1.0)	32 (1.0)	37 (1.2)	12 (0.7)	0 (0.2)
Malta	25 (1.0)	26 (0.9)	31 (1.1)	15 (1.1)	2 (0.2)
Cyprus	30 (1.2)	29 (1.4)	29 (1.2)	11 (0.8)	1 (0.3)
Greece	27 (1.5)	33 (1.1)	31 (1.2)	8 (0.9)	0 (0.1)
† Uruguay	33 (1.6)	31 (1.1)	27 (1.4)	9 (0.8)	0 (0.2)
3 Bosnia and Herzegovina	37 (1.6)	29 (1.3)	25 (1.4)	9 (0.9)	1 (0.2)
1 Serbia	33 (1.7)	34 (1.2)	27 (1.4)	5 (0.5)	0 (0.1)
†12 Romania	44 (2.3)	30 (1.4)	21 (1.5)	4 (0.5)	0 (0.1)
1 Kazakhstan	51 (1.6)	31 (1.4)	15 (1.0)	3 (0.5)	0 (0.0)
Oman	60 (1.2)	26 (0.8)	11 (0.7)	2 (0.3)	0 (0.1)
1 Kosovo	70 (1.7)	21 (1.3)	8 (0.8)	1 (0.3)	0 (0.1)
Azerbaijan	81 (1.7)	15 (1.2)	4 (0.6)	0 (0.2)	0 (0.0)
Benchmarking participant					
1 North Rhine-W. (Germany)	20 (1.6)	27 (1.1)	37 (1.3)	15 (1.3)	1 (0.2)
Countries not meeting sample participation requirements					
‡ United States	25 (2.2)	26 (1.4)	29 (1.8)	18 (2.0)	3 (0.6)



Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Countries are ranked in descending order of the percentage of students reaching Level 2 or above.

† Met guidelines for sampling participation rates only after replacement schools were included.

‡ Does not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

2 Country surveyed target grade in the first half of the school year.

3 National defined population covers 61% of the national target population.

Changes in CIL since 2013

The ICILS 2023 CIL achievement test included four secure test modules from previous ICILS cycles—two from ICILS 2013 and two from ICILS 2018—comprising 64 items. This inclusion meant that we could report student CIL achievement data collected in the current study cycle on the ICILS CIL proficiency scale established in 2013, and also compare changes in CIL achievement across the three cycles of ICILS. Germany and Korea (Rep. of) participated in all three cycles of ICILS, and met the necessary sample participation requirements within each cycle. In these two countries, valid comparisons of students' CIL achievement can be made across the three ICILS cycles. Denmark,[28] Finland, France, Italy,[26] Kazakhstan, Luxembourg, Uruguay, and the benchmarking participant North Rhine-Westphalia (Germany) participated in ICILS 2018 and 2023 and met the sample participation requirements allowing for comparisons in CIL achievement between these two ICILS cycles. A further five countries, Croatia, the Czech Republic, Norway, the Slovak Republic, and Slovenia participated in ICILS 2013 and 2023 and met the sample participation requirements allowing for comparisons in CIL achievement between the two cycles, across this 10 year period.

Student CIL achievement in Germany was statistically significantly lower in ICILS 2023 than in each of the two previous cycles. In Germany, average CIL scores have decreased across the cycles, although the decrease between ICILS 2013 and 2018 was not statistically significant (Fraillon et al., 2020, p. 77). The changes in average scale scores in Korea (Rep. of) have been small and not statistically significant across the three cycles of ICILS (Table 5.3).

Statistically significant decreases in average CIL took place in all five countries with comparable data between ICILS 2013 and 2023 only. These decreases ranged from 35 scale score points in Norway to 19 scale score points in the Slovak Republic. Since these countries did not participate in ICILS 2018, it is unclear when the decrease occurred.

There was some variation in differences in average CIL achievement in the countries with comparable data between ICILS 2018 and 2023 only. Statistically significant increases were recorded in Italy[26] (30 scale score points), and Luxembourg (12 scale score points). Statistically significant decreases were evident in Denmark (35 scale score points), the benchmarking participant North Rhine-Westphalia (Germany) (30 scale score points), and Finland (24 scale score points). In each of France, Kazakhstan, Portugal, and Uruguay the differences in average CIL achievement between ICILS 2023 and 2018 were not statistically significant.

28 Denmark also participated in ICILS 2013 but did not meet the sampling participation requirements.

Table 5.3: Changes in average CIL achievement across ICILS cycles

Country	Average 2023	Average 2018	Average 2013	Difference 2023-2018	Difference 2023-2013
[1] Croatia	487 (3.9)		512 (2.9)		**-26** (6.8)
[1] Czech Republic	525 (2.1)		553 (2.1)		**-28** (5.6)
[†1] Denmark	518 (2.7)	[b,d] 553 (2.0)		**-35** (4.4)	
Finland	507 (3.6)	531 (3.0)		**-24** (5.4)	
France	498 (2.7)	499 (2.3)		-1 (4.6)	
Germany	502 (3.5)	518 (2.9)	[b] 523 (2.4)	**-16** (5.4)	**-22** (6.4)
Italy	491 (2.6)	[e] 461 (2.8)		**30** (4.7)	
[1] Kazakhstan	407 (3.1)	[d] 395 (5.4)		12 (6.8)	
[†] Korea, Republic of	540 (2.5)	542 (3.1)	536 (2.7)	-2 (4.9)	4 (6.1)
Luxembourg	494 (2.0)	482 (0.8)		**12** (3.6)	
[1] Norway (9)	502 (2.9)		[f] 537 (2.4)		**-35** (6.1)
[1] Portugal	510 (3.0)	[c,d] 516 (2.6)		-7 (4.9)	
Slovak Republic	499 (2.7)		517 (4.6)		**-19** (7.2)
[1] Slovenia	483 (2.3)		511 (2.2)		**-27** (5.8)
[†] Uruguay	447 (3.6)	450 (4.3)		-3 (6.3)	
Benchmarking participant					
[1] North Rhine-W. (Germany)	485 (4.1)	515 (2.6)		**-30** (5.7)	

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant differences between cycles are marked in **Bold**.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Does not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.
[b] Country met guidelines for sampling paticipation rates only after replacement schools were included in the indicated cycle.
[c] Country nearly met guidelines for sampling paticipation rates after replacement schools were included in 2018.
[d] National defined population covered 90% to 95% of national target population in 2018.
[e] Country surveyed target grade in the first half of the school year in 2018.

Changes in percentages of students achieving Level 2 or above since 2013

Level 2 on the CIL described achievement scale describes students demonstrating basic functional and critical digital literacy skills. This may be considered to be a crucial learning threshold in the development of CIL. As part of the European Commission's Digital Education Action Plan (2021–2027), a target has been set to reduce the proportion of grade 8 (or equivalent) students with CIL below Level 2 to less than 15 percent by 2030. The data in Table 5.4 detail the percentages of students achieving at Level 2 or above across the three ICILS cycles.

The general trends described in average student CIL across the cycles is reflected in the changes in percentages of students achieving at CIL Level 2 or above.

In Germany, the percentage of students at CIL Level 2 or above decreased from 71 percent in 2013 to 67 percent in 2018 (this difference was not statistically significant (Fraillon et al., 2020, p. 77)) and to 59 percent in 2023. The percentage of students at CIL Level 2 or above was statistically significantly lower in 2023 than in each of the previous cycles. In contrast, the percentage of students at CIL Level 2 or above in Korea (Rep. of) has remained stable between 72 percent and 73 percent of students across the three cycles with none of the between cycle differences being statistically significant (Table 5.4).

Statistically significant decreases over the 10 year period between ICILS 2013 and 2023, were recorded in the percentages of students achieving at CIL Level 2 or above in each of Croatia, the Czech Republic, Norway, the Slovak Republic, and Slovenia. These decreases ranged from 16 percentage points in Norway to 8 percentage points in Slovenia.

There were statistically significant increases in the percentages of students achieving at CIL Level 2 or above between ICILS 2018 and 2023 in Luxembourg (6 percentage points) and Italy[26] (17 percentage points). Statistically significant decreases were recorded in Denmark (16 percentage points), the benchmarking participant North Rhine-Westphalia (Germany) (12 percentage points), and in Finland (10 percentage points). The differences in the percentages of students achieving at CIL Level 2 or above between ICILS 2018 and ICILS 2023 were not statistically significant in each of France, Kazakhstan, Portugal, and Uruguay.

Table 5.4: Changes in percentages of students at Level 2 or above across ICILS cycles

Country	% Level 2 or higher 2023	% Level 2 or higher 2018	% Level 2 or higher 2013	Difference 2023-2018	Difference 2023-2013
[1] Croatia	53 (1.7)		64 (1.6)		**-11** (2.3)
[1] Czech Republic	72 (1.2)		85 (1.1)		**-13** (1.6)
[†1] Denmark	68 (1.4)	[b,d]84 (1.0)	79 (1.9)	**-16** (1.7)	
Finland	63 (1.7)	73 (1.5)		**-10** (2.3)	
France	57 (1.7)	56 (1.3)		1 (2.1)	
Germany	59 (1.6)	67 (1.5)	[b]71 (1.6)	**-8** (2.2)	**-12** (2.2)
Italy	54 (1.4)	[e]37 (1.4)		**17** (2.5)	
[1] Kazakhstan	18 (1.2)	[d]19 (1.6)		-1 (2.0)	
[†] Korea, Republic of	73 (1.2)	72 (1.5)	72 (1.3)	1 (1.9)	1 (1.8)
Luxembourg	56 (1.0)	49 (0.6)		**6** (1.1)	
[1] Norway (Grade 9)	60 (1.4)		76 (1.3)		**-16** (1.9)
[1] Portugal	63 (1.5)	[c,d]67 (1.4)		-3 (2.1)	
Slovak Republic	59 (1.6)		67 (2.0)		**-8** (2.6)
[1] Slovenia	49 (1.3)		64 (1.6)		**-15** (2.1)
[†] Uruguay	36 (1.6)	37 (2.1)		-2 (2.6)	
Benchmarking participant					
[1] North Rhine-W. (Germany)	52 (1.7)	64 (1.6)		**-12** (2.3)	

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant differences between cycles are marked in **Bold**.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Does not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
2 Country surveyed target grade in the first half of the school year.
3 National defined population covers 61% of the national target population.
b Country met guidelines for sampling paticipation rates only after replacement schools were included in the indicated cycle.
c Country nearly met guidelines for sampling paticipation rates after replacement schools were included in 2018.
d National defined population covered 90% to 95% of national target population in 2018.
e Country surveyed target grade in the first half of the school year in 2018.

5.3 Comparison of CT across countries

Distribution of student CT scores

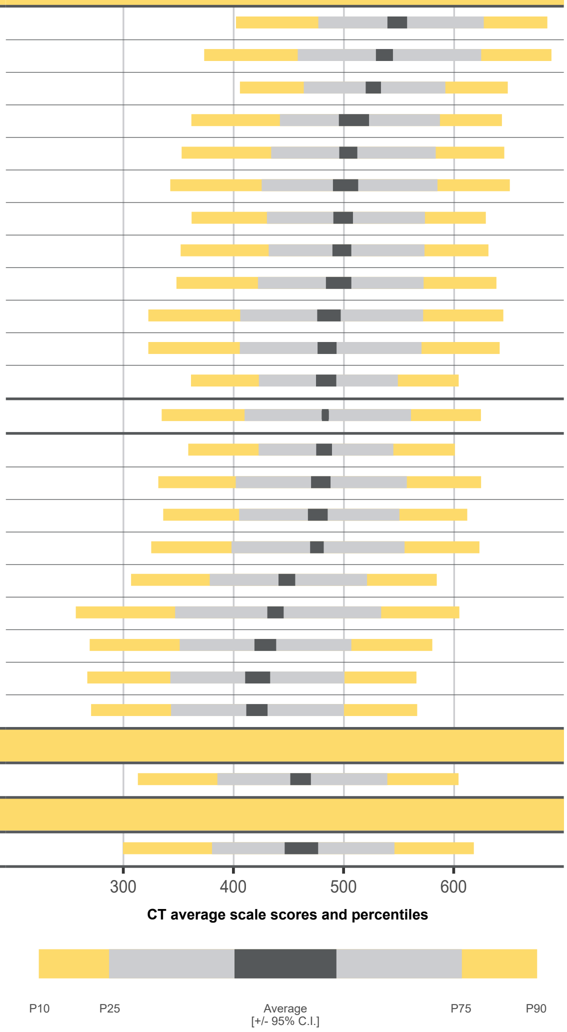
The CT assessment was introduced as an international option as part of ICILS 2018 and was completed by students in eight countries and one benchmarking participant. Seven of the eight countries met the sampling participation requirements for ICILS. The average score on the CT reporting scale was set to reflect an average of 500 and a standard deviation of 100 for those seven participating countries using equally weighted national samples.

The average score on the equated CT scale in ICILS 2023 was 483 scale score points, with a standard deviation of 112 scale score points for those 21 participating countries. In ICILS 2023, the range of average student achievement scores on the CT scale across countries was 127 scale points, extending from 421 scale score points (Uruguay) to 548 scale score points (Chinese Taipei). This spans a range of achievement slightly larger than the width of one level (from close to the top of Level 1 to very close to the top of Level 2) on the CT achievement scale, and equivalent to slightly more than one international standard deviation (Table 5.5).

Table 5.5: Country averages and distribution for CT

Country	Average CT scale score		
Chinese Taipei	548	(3.9)	▲
† Korea, Republic of	537	(3.3)	▲
1 Czech Republic	527	(2.9)	▲
† Belgium (Flemish)	509	(6.3)	▲
†1 Denmark	504	(3.5)	▲
Finland	502	(5.2)	▲
France	499	(3.9)	▲
Slovak Republic	498	(3.7)	▲
1 Latvia	495	(5.2)	▲
1 Sweden	486	(4.8)	
1 Norway (Grade 9)	485	(3.7)	
1 Portugal	484	(4.0)	
ICILS 2023 average	483	(0.9)	
Italy	482	(3.0)	
Germany	479	(3.8)	
1 Austria	476	(3.9)	
Luxembourg	476	(2.5)	▽
1 Slovenia	448	(3.2)	▽
Malta	438	(3.1)	▽
1 Croatia	429	(4.4)	▽
1 Serbia	422	(5.1)	▽
† Uruguay	421	(4.3)	▽
Benchmarking participant			
1 North Rhine-W. (Germany)	461	(4.1)	▽
Country not meeting sample participation requirements			
‡ United States	461	(7.1)	▽

CT distribution



▲ Average significantly higher than ICILS 2023 average.

▽ Average significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements. Countries are ranked in descending order of the average CT scale score.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

The variation of CT achievement within countries exceeded the variation of achievement across countries. The variation in achievement between the relatively high and low achieving students within countries can be illustrated, for example, by considering the breadth of CT scores accounting for the middle 80 percent of students within each country. This reflects the breadth of difference between the 10th percentile of CT achievement (the CT score below which 10% of students CT scores are evident) and the 90th percentile (the CT score above which 10% of student CT scores are evident). Across all countries, the average range accounting for the middle 80 percent of students was 287 scale score points, more than double the range of average CT scale scores across countries, and equivalent to more than two-and-a-half levels on the CT achievement scale. This range was smallest in Italy (239 CT scale points, equivalent to slightly more than the width of two levels on the CT scale), and largest in Malta (345 scale points, more than the width of three levels on the CT scale).

In Chapter 3, we reported that the average range accounting for the middle 80 percent of student CIL scale scores was similar to the range of average CIL scale scores across all ICILS 2023 countries. In contrast, the relative range of students' CT achievement within countries was considerably larger than the range of CT achievement across countries (Table 5.5). This apparent difference in relative ranges between CIL and CT is largely because the subset of countries that completed the CT assessment did not include the countries with relatively lower CIL achievement. Consequently, the range of average CIL scale scores across all countries was considerably larger than the range of average CIL scores across the subset of countries that also completed the CT assessment. For this subset of countries, the difference between the highest and lowest average CIL scale scores was 97 CIL scale score points (slightly more than one international CIL standard deviation), less than half the average range accounting for the middle 80 percent of student CIL scale scores of 217 CIL scale score points (approximately two-and-a-half international CIL standard deviations).[29] In these same countries, the difference between the highest and lowest average country CT scale scores of 127 CT scale score points (slightly more than one international CT standard deviation) was also less than half the average range of CT scale scores accounting for the middle 80 percent of students of 287 CT scale score points (slightly more than two-and-a-half international CT standard deviations).[30]

Achievement across countries with respect to proficiency levels

On average across countries, the distribution of student CT achievement scores was centered around Level 2 on the CT achievement scale. Thirty-seven percent of students achieved scores that placed them within Level 2, with 34 percent of student scores below Level 2 and 29 percent of student scores above Level 2 (Table 5.6).

In 19 countries, the highest percentage of students had CT achievement scores at Level 2. In Uruguay, the highest percentage of students scored at Level 1, while in Chinese Taipei and Korea (Rep. of), the highest percentage of students scored at Level 3. No country had the highest percentage of students scoring below Level 1 or above Level 3.

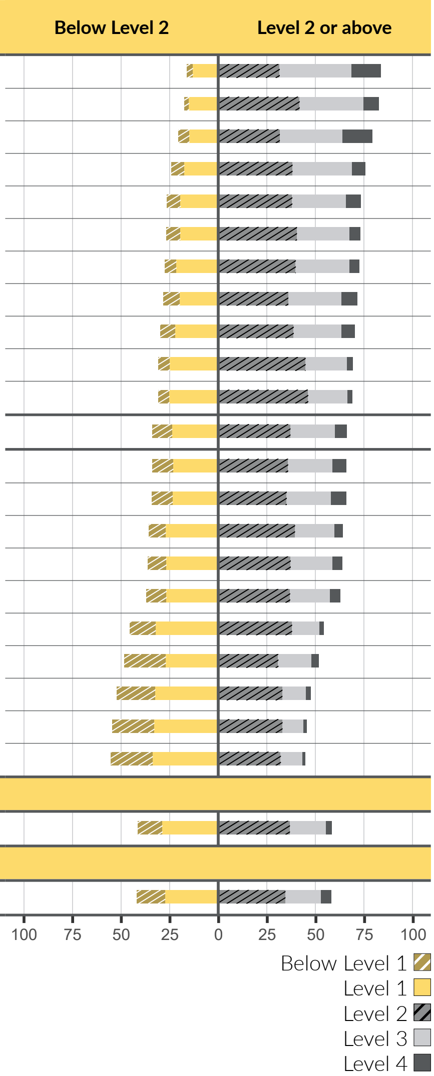
In 12 countries, the proportion of students scoring at CT Level 1 or below was higher than those scoring above Level 2 (i.e., at Levels 3 and 4). In 10 countries, the proportion of student scores above CT Level 2 was higher than the proportion of student scores below Level 2.

While, overall across countries majorities of students demonstrated CT achievement within Levels 1, 2, and 3, in all countries there remain many students with CT achievement below Level 1. On average across countries, this represents 10 percent of students and ranges from two percent in the Czech Republic to 22 percent in Serbia. These students are capable of performing only the most basic tasks, such as interacting with application controls by using drag-and-drop features and selectively clicking on functional buttons. Thus, their CT capability is limited to fundamental interactions, indicating a need for further development in this area (Table 5.6).

29 One international CIL standard deviation in ICILS 2023 equals 88 CIL scale score points.
30 One international CT standard deviation in ICILS 2023 equals 112 CT scale score points.

Table 5.6: Percentage of students at each CT proficiency level across countries

Country	Percentage of students achieving at each CT level: Below Level 1	Level 1	Level 2	Level 3	Level 4
Chinese Taipei	3 (0.5)	13 (0.8)	32 (1.2)	37 (1.3)	15 (1.0)
[1] Czech Republic	2 (0.4)	15 (0.8)	42 (0.8)	33 (1.1)	8 (0.6)
[†] Korea, Republic of	6 (0.6)	15 (0.9)	32 (1.1)	32 (1.0)	15 (0.8)
[†] Belgium (Flemish)	7 (1.1)	17 (1.6)	38 (1.5)	31 (1.8)	7 (1.0)
[†1] Denmark	7 (0.9)	19 (0.9)	38 (1.1)	28 (1.2)	8 (0.6)
Slovak Republic	7 (0.8)	19 (1.2)	40 (1.2)	27 (1.4)	5 (0.7)
France	6 (0.8)	22 (1.3)	40 (1.4)	28 (1.2)	5 (0.6)
Finland	8 (1.1)	20 (1.1)	36 (1.3)	27 (1.3)	8 (0.7)
[1] Latvia	8 (1.0)	22 (1.4)	39 (1.4)	25 (1.4)	7 (0.9)
[1] Portugal	6 (0.8)	25 (1.2)	45 (1.5)	21 (1.4)	3 (0.4)
Italy	6 (0.7)	25 (1.0)	46 (1.2)	20 (1.1)	2 (0.3)
ICILS 2023 average	10 (0.2)	24 (0.3)	37 (0.3)	23 (0.3)	6 (0.1)
[1] Norway (Grade 9)	11 (0.9)	23 (1.1)	36 (1.3)	23 (1.2)	7 (0.6)
[1] Sweden	11 (1.0)	23 (1.1)	35 (1.2)	23 (1.4)	8 (0.7)
[1] Austria	9 (0.9)	27 (1.1)	39 (1.2)	21 (1.1)	4 (0.5)
Germany	10 (1.1)	27 (1.3)	37 (1.4)	21 (1.1)	5 (0.6)
Luxembourg	11 (0.6)	27 (0.8)	37 (1.0)	21 (0.8)	5 (0.5)
[1] Slovenia	13 (1.1)	32 (1.5)	38 (1.3)	14 (1.0)	2 (0.3)
Malta	21 (1.0)	27 (1.0)	31 (0.9)	17 (1.0)	4 (0.4)
[1] Croatia	20 (1.5)	32 (1.7)	33 (1.6)	12 (1.0)	3 (0.4)
[1] Serbia	22 (1.6)	33 (1.2)	33 (1.4)	11 (1.0)	2 (0.4)
[†] Uruguay	21 (1.4)	34 (1.3)	32 (1.4)	11 (1.0)	2 (0.3)
Benchmarking participant					
[1] North Rhine-W. (Germany)	13 (1.4)	29 (1.5)	37 (1.4)	19 (1.0)	3 (0.4)
Countries not meeting sample participation requirements					
[‡] United States	15 (1.5)	27 (1.4)	35 (1.5)	18 (1.6)	5 (0.9)



Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements. Countries are ranked in descending order of the percentage of students reaching Level 2 or above.

† Met guidelines for sampling participation rates only after replacement schools were included.

‡ Does not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

Changes in CT achievement since 2018

The ICILS 2023 test included two secure test modules from ICILS 2018. This inclusion meant that we could report student CT achievement data collected in ICILS 2023 on the CT achievement scale established in 2018, and also compare CT achievement between 2018 and 2023. Seven countries (Denmark, Finland, France, Germany, Korea (Rep. of), Luxembourg, and Portugal), and the benchmarking participant (North Rhine-Westphalia (Germany)) participated in the CT option and met the ICILS sampling participation requirements in ICILS 2018 and 2023.

As was described in Chapter 4, the levels of the described CT scale established as part of ICILS 2023 were developed using a different method from that used to describe the preliminary regions in ICILS 2018, and were developed expressly to supersede the described regions of 2018. It is consequently not possible to use the percentages of students achieving proficiency levels on the CT scale used in this

Table 5.7: Changes in average CT achievement since 2018

Country	Average 2023	Average 2018	Difference 2023–2018
†1 Denmark	504 (3.5)	b,d 527 (2.3)	**-23** (4.9)
Finland	502 (5.2)	508 (3.4)	-7 (6.7)
France	499 (3.9)	501 (2.4)	-2 (5.2)
Germany	479 (3.8)	486 (3.6)	-7 (5.9)
† Korea, Republic of	537 (3.3)	536 (4.4)	0 (6.1)
Luxembourg	476 (2.5)	460 (0.9)	**16** (3.7)
1 Portugal	484 (4.0)	c,d 482 (2.5)	2 (5.4)
Benchmarking participant			
1 North Rhine-W. (Germany)	461 (4.1)	485 (3.0)	**-25** (5.7)

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant differences between cycles are marked in **Bold**.
† Met guidelines for sampling participation rates only after replacement schools were included.
1 National defined population covers 90% to 95% of the national target population.
b Country met guidelines for sampling paticipation rates only after replacement schools were included in the indicated cycle.
c Country nearly met guidelines for sampling paticipation rates after replacement schools were included in 2018.
d National defined population covered 90% to 95% of national target population in 2018.

report with the described regions used in ICILS 2018. However, student CT scale scores as measured in ICILS 2023 are directly comparable to those of ICILS 2018.

Between 2018 and 2023, CT achievement increased in Luxembourg by a statistically significant 16 scale score points and decreased in Denmark by a statistically significant 23 scale score points. The changes in CT achievement between the two cycles in the remaining five participants were seven scale points or less and were not statistically significant.

5.4 The association between CT and CIL

The CIL and CT constructs are distinctly conceptualized within the ICILS framework (Fraillon & Rožman, 2024), each addressing different aspects of students' use of computers. Computer and information literacy emphasizes the practical use of computers to find, evaluate, and manage information, create information products, and facilitate communication. It represents a "convergence between information literacy and computer literacy skills" (Fraillon & Duckworth, 2024, p. 25), focusing on real-world contexts where these skills are essential.

In contrast, CT is focused on the formulation of solutions to real-world problems that can be executed by computers. It represents the "procedural algorithmic reasoning that underpins programming" (Duckworth & Fraillon, 2024, p. 37). Thus, the CT construct extends beyond the functional use of computers as tools to include understanding digital systems, developing algorithms, and evaluating the outcomes of these algorithms in simulated environments.

While there are shared elements between CIL and CT such as "literacy skills (in reading and responding to tasks) and critical thinking (through the evaluation of information, data, and solutions to problems)" (Fraillon et al., 2020, p. 110), the two constructs are distinguished by their focus areas. A comparison of the CIL achievement scale and example tasks shown in Chapter 3 with the CT achievement scale and example tasks shown in Chapter 4 reveals differences in how the constructs are operationalized by the CIL and CT test instruments. Computer and information literacy is more aligned with information management, evaluation, and communication requiring direct interaction with information and digital content creation while CT emphasizes the logic and process underpinning digital problem-solving, requiring algorithmic reasoning and digital systems thinking.

The distinction between CIL and CT is also manifest at different contextual levels, particularly in how these constructs are emphasized in national curricula (wider community contextual level) and how student achievement in these areas varies by student background (home environment contextual level). For example, the variation in curricular focus across countries and within national education systems highlights how these constructs are differently prioritized and taught (see Chapter 2). This is further evidenced by the differing patterns of achievement by gender between CIL and CT (see Chapter 6), which suggests that while related, the two constructs tap into different underlying capabilities and are influenced by different educational and societal factors.

Despite these differences, there is a strong statistical association between CIL and CT achievement. In ICILS 2018, a positive correlation was observed between CIL and CT scale scores across participating countries, with an average correlation coefficient of 0.82 (Fraillon et al., 2020, p. 110). This high correlation reflects the shared foundational skills of digital literacy and critical thinking. However, the distinct nature of the constructs suggests that while these skills are related, they are applied differently depending on the context and the specific demands of CIL and CT tasks. Thus, understanding the nuances of these constructs is critical for interpreting the statistical associations and for developing educational strategies that effectively target the unique aspects of CIL and CT.

The association between CT and CIL in ICILS 2023

In ICILS 2023, on average across all countries, the within-country correlation between students' CIL and CT scale scores was 0.76 (Table 5.8), based on students' plausible values. The observed correlation is slightly lower than that reported in ICILS 2018 with a considerably smaller group of countries. The correlation between CIL and CT scores was consistent across countries and varied from 0.69 in the Slovenia to 0.82 in the Slovak Republic.

In addition to reporting the correlations between CIL and CT scores, we have reported the average CT scale scores for students within each CIL proficiency level across countries (Table 5.8). The average CT scores of students increase as the CIL levels of students increase. On average across all countries, the difference in student CT scale scores between students in adjacent CIL levels of achievement varied from 95 CT scale points (between students with CIL of Level 1 and below Level 1) and 70 CT scale points (between students with CIL of Level 3 and Level 4 or above). Across countries there was a general tendency for the difference in average CT scale scores of students in adjacent CIL proficiency levels to be larger between the lower levels than between the higher levels.

Table 5.8: Correlations between CIL and CT and average CT performance for students at each CIL proficiency level

Country	Correlation CIL-CT	Average CT by CIL level				
		Below Level 1	Level 1	Level 2	Level 3	Level 4
¹ Austria	0.76 (0.01)	331 (7.4)	420 (4.0)	506 (3.2)	580 (5.0)	651 (20.7)
† Belgium (Flemish)	0.81 (0.01)	341 (9.8)	452 (5.5)	536 (3.9)	606 (4.6)	672 (17.9)
Chinese Taipei	0.77 (0.01)	393 (6.5)	490 (3.7)	571 (2.9)	638 (3.7)	695 (8.9)
¹ Croatia	0.70 (0.02)	310 (7.4)	396 (5.0)	467 (4.8)	534 (6.6)	602 (24.4)
¹ Czech Republic	0.75 (0.01)	370 (6.8)	459 (2.8)	536 (2.2)	607 (3.6)	680 (13.8)
†¹ Denmark	0.74 (0.01)	338 (8.4)	436 (4.7)	522 (3.4)	598 (4.2)	675 (19.4)
Finland	0.81 (0.01)	329 (7.6)	442 (4.2)	533 (2.9)	611 (4.0)	695 (18.8)
France	0.78 (0.01)	355 (6.7)	453 (3.5)	538 (2.9)	608 (5.3)	680 (26.7)
Germany	0.78 (0.01)	341 (6.9)	423 (4.2)	510 (3.2)	590 (5.1)	661 (21.6)
Italy	0.78 (0.01)	360 (6.8)	447 (3.2)	518 (2.5)	590 (5.2)	686 (34.7)
† Korea, Republic of	0.73 (0.01)	353 (8.3)	453 (4.8)	533 (3.2)	610 (3.2)	675 (7.7)
¹ Latvia	0.74 (0.01)	351 (9.1)	434 (5.3)	522 (4.1)	596 (6.2)	664 (24.3)
Luxembourg	0.78 (0.01)	342 (3.9)	432 (2.8)	513 (2.4)	591 (4.0)	671 (17.1)
Malta	0.79 (0.01)	300 (5.5)	408 (4.0)	498 (4.4)	571 (4.9)	646 (12.4)
¹ Norway (Grade 9)	0.75 (0.01)	329 (7.0)	429 (3.9)	519 (3.5)	598 (4.8)	664 (22.3)
¹ Portugal	0.72 (0.02)	358 (8.5)	437 (3.5)	505 (3.2)	564 (4.7)	630 (15.0)
¹ Serbia	0.77 (0.01)	324 (5.3)	426 (4.6)	503 (4.6)	587 (8.2)	658 (42.1)
Slovak Republic	0.82 (0.01)	341 (8.1)	452 (4.3)	537 (3.5)	608 (5.3)	683 (22.0)
¹ Slovenia	0.69 (0.01)	340 (5.3)	420 (3.8)	491 (3.5)	556 (6.5)	618 (28.2)
¹ Sweden	0.76 (0.01)	331 (8.2)	428 (4.4)	518 (3.7)	603 (5.9)	682 (20.4)
† Uruguay	0.76 (0.01)	326 (4.5)	419 (3.7)	495 (4.0)	562 (8.1)	602 (33.7)
ICILS 2023 average	0.76 (0.00)	341 (1.6)	436 (0.9)	518 (0.8)	591 (1.2)	661 (5.0)
Benchmarking participant						
¹ North Rhine-W. (Germany)	0.80 (0.01)	334 (6.2)	425 (4.7)	505 (3.5)	580 (6.0)	649 (16.7)
Country not meeting sample participation requirements						
‡ United States	0.74 (0.01)	345 (6.1)	431 (7.1)	502 (6.2)	574 (8.2)	642 (16.0)

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements. All correlations between CIL and CT are statistically significant ($p<0.01$).
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Does not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
¹ National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

Changes in the association between CT and CIL between 2018 and 2023

The associations between CT and CIL changed very little in the seven countries and one benchmarking participant (North Rhine-Westphalia (Germany)) in which CT was assessed in both ICILS 2018 and 2023. The average of the correlation coefficients these participants was 0.81 in 2018 and 0.76 in 2023. This tendency to a slight decrease was reflected in all countries and was statistically significant in Denmark, Finland, France, and Portugal. However, the magnitude of the change in the correlation coefficient between 2018 and 2023 was less than 0.1 for all eight participants.

Table 5.9: Correlations between CIL and CT in ICILS 2023 and ICILS 2018

Country	Correlation CIL-CT 2023	Correlation CIL-CT 2018	Difference correlation CIL-CT 2023–2018
[†1] Denmark	0.74 (0.01)	[b,d]0.81 (0.01)	**-0.08** (0.02)
Finland	0.81 (0.01)	0.89 (0.01)	**-0.09** (0.01)
France	0.78 (0.01)	0.87 (0.01)	**-0.09** (0.01)
Germany	0.78 (0.01)	0.81 (0.01)	-0.03 (0.02)
[†] Korea, Republic of	0.73 (0.01)	0.74 (0.01)	-0.02 (0.01)
Luxembourg	0.78 (0.01)	0.80 (0.01)	-0.02 (0.01)
[1] Portugal	0.72 (0.02)	[c,d]0.78 (0.01)	**-0.06** (0.02)
Benchmarking participant			
[1] North Rhine-W. (Germany)	0.80 (0.01)	0.81 (0.01)	-0.01 (0.02)

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. All correlations between CIL and CT are statistically significant (p<0.01).

[†] Met guidelines for sampling participation rates only after replacement schools were included.

[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

[b] Country met guidelines for sampling paticipation rates only after replacement schools were included in the indicated cycle.

[c] Country nearly met guidelines for sampling paticipation rates after replacement schools were included in 2018.

[d] National defined population covered 90% to 95% of national target population in 2018.

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Chapter 6:

Relationships between computer and information literacy, computational thinking, and student background

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Chapter Highlights

Computer and information literacy (CIL) and computational thinking (CT) achievement differed by student gender.

- Female students demonstrated higher CIL achievement than male students. The average CIL scores for female students were statistically significantly higher than male students in 28 of 32 countries (Table 6.1).
- In contrast, on average across countries, male students demonstrated higher CT achievement than female students. However, this pattern was not consistent, with statistically significant differences evident in only six of 22 countries (Table 6.2).

Immigrant background and language spoken at home were associated with student CIL and CT achievement.

- In most countries, with some exceptions, students with an immigrant background demonstrated statistically significantly lower achievement in both CIL and CT than students without an immigrant background (Table 6.3 and Table 6.5).
- Students who spoke the language of the test the majority of the time at home demonstrated statistically significantly higher achievement in both CIL and CT assessments across the majority of countries. (Table 6.4 and Table 6.6)

Socioeconomic status (SES), as measured by parental education, parental occupation, and number of books in the home, was linked with student CIL and CT achievement.

- In all countries and across all measures of SES, students in the groups related to higher SES backgrounds demonstrated statistically significantly higher CIL and CT achievement than those in the groups associated with lower SES backgrounds (Table 6.7, Table 6.8, and Appendix H, Table H.1, Table H.2, Table H.3, and Table H.4).

Home information and communication technology (ICT) resources were important indicators of student CIL and CT achievement across nearly all countries.

- Average CIL and CT scale scores for students reporting that PC devices in their home were always accessible when needed for their schoolwork were statistically significantly higher than for students who reported that they were not always accessible (Table 6.9 and Table 6.10).
- Students experiencing fewer internet disruptions demonstrated statistically significantly higher CIL and CT achievement than students with less reliable home internet (Appendix H, Table H.5 and Table H.7).
- Students with at least two PC devices in their home demonstrated statistically significantly higher CIL and CT achievement than students with less than two PC devices (Appendix H, Table H.6 and Table H.8).

6.1 Introduction

This chapter examines the achievement gaps in computer and information literacy (CIL) and computational thinking (CT) across students from different social backgrounds, including gender, immigration status, socioeconomic status (SES), and access to home computing resources. International large-scale assessments have consistently shown evidence of inequalities in educational outcomes, highlighting disparities by various characteristics of students and their families across nearly all countries. These differences in achievement by student background suggest persistent inequalities, a topic that has been central in research on educational equality for decades (e.g., Coleman et al., 1966; Jencks et al., 1972). Within the domains of CIL and CT, the exploration of social inequalities takes on new dimensions. In an era where computers and digital technologies increasingly influence every aspect of life, understanding how students from different social backgrounds navigate this digital landscape is crucial.

The goal of this chapter is to examine student background characteristics that are commonly associated with student achievement in CIL and CT. International reports from prior International Computer and Information Literacy Study (ICILS) cycles have shown how average achievement in CIL and CT differed by several student and family background measures: gender, immigrant background, SES, and number of computer devices in the home (Fraillon et al., 2014, 2020). In addition to past ICILS reports, other research has explored the relationship between these background characteristics and the learning of ICT skills (Nasah et al., 2010; National Assessment of Educational Progress, 2016). Gender differences have shown more mixed patterns of association with CIL, CT, and ICT-skills, these are explored in the following section. With respect to the other background measures used in ICILS, patterns reported often indicate that students from typically disadvantaged backgrounds (e.g., lower SES, having fewer computer devices, etc.) tend to lag behind their peers in ICT learning.

The ability of these background characteristics to predict CIL and CT achievement is likely indicative of the presence of social inequalities that are important to be reported and addressed. These differences are often discussed in the context of the *digital divide*. Referencing work of Hohlfeld et al. (2008), ICILS defines the *digital divide* as the varying opportunities and access that people have to digital technologies extending "beyond access to technology to include how technology is used in schools and how students are empowered through technology to participate in their digital world" (Fraillon et al., 2020, p. 244). While ICILS was not designed with a particular model of the digital divide in mind, the results from the study can provide valuable insights into the discussion surrounding the digital divide and its influence on student learning. While often viewed in relation to differences by SES, several other background factors, including those discussed in this chapter, can contribute to the digital divide (Scheerder et al., 2017).

This chapter will address Research Question CIL 4 and Research Question CT 4 (Chapter 1): *What aspects of students' personal and social backgrounds (such as gender, and socioeconomic background) are related to students CIL and CT, respectively?* In each of the sections, differences in achievement between student groups (i.e., gender, immigration/language background, SES, and home resources) will be reported.

The ICILS 2023 data reported in this chapter include 32 countries and one benchmarking participant, North Rhine-Westphalia (Germany). Twenty-two of these countries and the benchmarking participant conducted the CT assessment. The averages reported in this chapter are calculated based on the countries that met sampling participation requirements, excluding Romania because of late testing. When statements are made describing the data in this chapter, the term "countries" refers to the countries and benchmarking participant that met the ICILS sampling requirements. See Chapter 1 for further details.

6.2 Achievement differences by gender

Gender differences in student achievement outcomes have been the subject of extensive research within and across countries. Persistent gender gaps in reading at the end of primary school have been evident for decades (Steinmann et al., 2023). In the mathematics and science domains, the gender gap has been less clear, as there is variation on the size and direction of the gender achievement gap between countries and across grade levels (Leder, 2019; Rosén et al., 2022; Steinmann & Rutkowski, 2023). In mathematics, boys often outperform girls in primary school across several countries, but this gender gap tends to narrow by secondary school. Conversely, in science, girls outperform boys starting in primary school in many countries, and this gap typically widens as they progress to secondary school (Mullis et al., 2020). One meta-analysis finds that gender achievement gaps in ICT literacy tend to be smaller in size relative to those observed in social sciences, science, and mathematics (Siddiq & Scherer, 2019). Yet, differences are still evident and important to consider. This perspective becomes particularly relevant when considered alongside broader societal gender imbalances, such as disparities in income or the underrepresentation of women in pivotal social and/or political roles. Consequently, education emerges as a potential equalizer, aimed at addressing these inequalities. Thus, gender gaps that benefit girls in educational settings may be viewed positively within this broader socio-political framework.

Past ICILS cycles have reported gender differences in CIL and CT achievement. Specifically, females tended to score higher than males in CIL across the majority of countries (Fraillon et al., 2014, 2020). In addition, patterns from national studies in Australia (NAP-ICT) and the United States (NAEP-TEL) have revealed that females in secondary school scored statistically significantly higher than males in assessments of ICT literacy (ACARA, 2018; National Assessment of Educational Progress, 2018). In assessments of CT, ICILS 2018 found that boys tend to score higher than girls, however, this was not a consistent finding across all participating countries and only a limited number of countries administrated the CT test (Fraillon et al., 2020). It was suggested that the diverging patterns of gender differences for CIL and CT could be "consistent with the patterns of gender differences in students' uses of and attitudes towards the use of ICT" (see Fraillon et al., 2020, p. 244, for more detail).

As an indicator of gender, we use the variable as reported by students. While some countries administered a national option allowing students to select one of three gender categories, for the analysis presented here, we focus on two groupings: male and female.

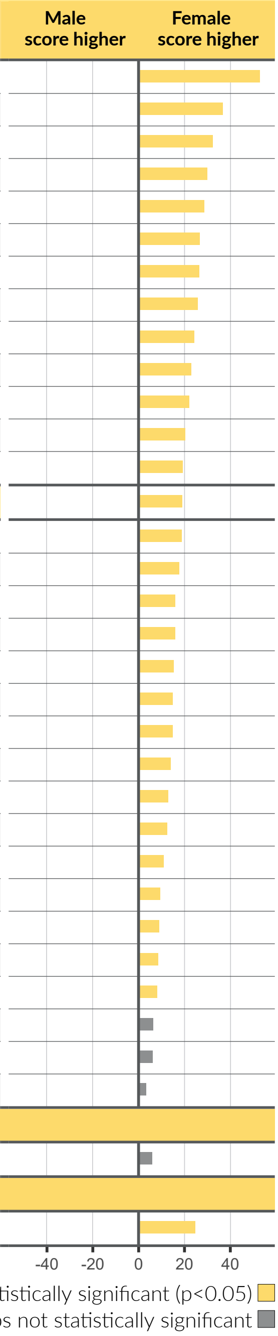
Gender differences in CIL

In ICILS 2018, "the average CIL scale scores of female students were statistically significantly higher than those of male students" in nearly all countries (Fraillon et al., 2020, p. 79). A similar pattern is observed across the broader set of participating countries in ICILS 2023 (Table 6.1). Female students outperformed male students in 28 of 32 countries. This pattern did not hold in Hungary, Uruguay, the Czech Republic, and North Rhine-Westphalia (Germany) where the differences between average female and male student CIL scale score points were not statistically significant. Male students did not statistically significantly outperform female students in CIL in any of the countries.

On average across countries, female students scored 486 CIL scale score points whereas male students scored 467 CIL scale score points, a difference of 19 points. The magnitude of gender differences, that were statistically significant, ranged from eight points in France and the Slovak Republic to 53 points in Oman.

Table 6.1: CIL achievement by gender

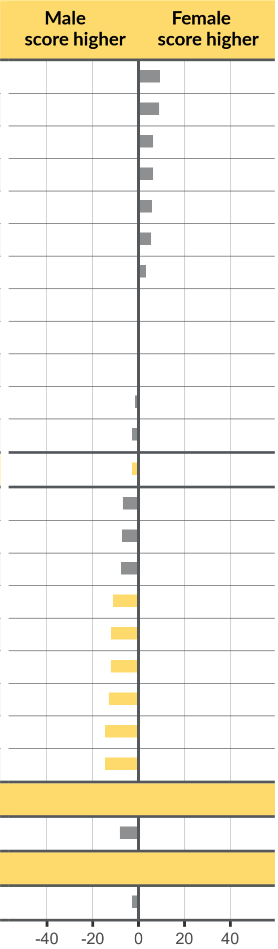
Country	Male		Female		Difference CIL score averages
	Percentage	Average score	Percentage	Average score	Female - Male
Oman	52 (1.5)	354 (4.9)	48 (1.5)	406 (3.2)	**53** (5.9)
[1] Croatia	51 (0.8)	469 (4.7)	49 (0.8)	505 (4.6)	**37** (5.1)
Malta	49 (0.9)	460 (3.6)	51 (0.9)	493 (3.1)	**32** (4.2)
Chinese Taipei	54 (0.8)	501 (3.8)	46 (0.8)	531 (2.9)	**30** (3.3)
[†] Korea, Republic of	51 (1.0)	527 (3.1)	49 (1.0)	556 (3.1)	**29** (3.9)
[1] Slovenia	51 (0.7)	471 (2.7)	49 (0.7)	497 (2.8)	**27** (2.9)
Cyprus	49 (0.7)	447 (3.7)	51 (0.7)	473 (2.9)	**26** (4.3)
[1] Norway (Grade 9)	51 (0.8)	490 (3.7)	49 (0.8)	516 (3.0)	**26** (3.7)
Finland	49 (1.0)	494 (4.5)	51 (1.0)	519 (3.5)	**24** (3.8)
[†1] Denmark	51 (1.0)	508 (3.6)	49 (1.0)	531 (2.6)	**23** (3.6)
[1] Latvia	50 (1.1)	498 (4.4)	50 (1.1)	520 (3.7)	**22** (3.7)
Azerbaijan	53 (0.9)	309 (5.6)	47 (0.9)	329 (5.4)	**20** (4.4)
Luxembourg	51 (0.7)	484 (2.5)	49 (0.7)	504 (2.5)	**19** (3.1)
ICILS 2023 average	51 (0.2)	467 (0.7)	49 (0.2)	486 (0.6)	**19** (0.7)
[1] Spain	52 (0.8)	486 (2.4)	48 (0.8)	505 (2.0)	**19** (2.5)
Italy	51 (0.9)	482 (3.1)	49 (0.9)	500 (2.7)	**18** (2.6)
[†] Belgium (Flemish)	53 (2.0)	504 (5.1)	47 (2.0)	520 (5.2)	**16** (4.9)
[1] Sweden	52 (1.2)	497 (3.7)	48 (1.2)	513 (3.4)	**16** (4.0)
[1] Austria	49 (1.4)	498 (3.2)	51 (1.4)	513 (2.8)	**15** (3.3)
Greece	51 (1.0)	453 (4.2)	49 (1.0)	468 (3.5)	**15** (3.9)
[1] Kazakhstan	51 (0.7)	400 (3.7)	49 (0.7)	415 (3.3)	**15** (3.3)
[1] Kosovo	52 (1.0)	349 (4.3)	48 (1.0)	363 (4.9)	**14** (4.5)
[3] Bosnia and Herzegovina	52 (1.3)	434 (4.8)	48 (1.3)	447 (4.6)	**13** (5.7)
[†12] Romania	50 (1.2)	412 (5.8)	50 (1.2)	424 (6.4)	**12** (5.9)
[1] Serbia	52 (1.0)	438 (4.2)	48 (1.0)	449 (4.1)	**11** (4.0)
Germany	51 (1.1)	497 (4.1)	49 (1.1)	507 (3.7)	**10** (3.7)
[1] Portugal	50 (1.1)	505 (3.5)	50 (1.1)	514 (3.6)	**9** (3.5)
Slovak Republic	50 (1.0)	494 (3.1)	50 (1.0)	503 (3.0)	**8** (2.8)
France	50 (0.7)	494 (3.1)	50 (0.7)	502 (3.0)	**8** (2.9)
Hungary	50 (0.9)	502 (4.3)	50 (0.9)	508 (4.2)	6 (3.7)
[†] Uruguay	51 (0.8)	444 (4.4)	49 (0.8)	450 (4.0)	6 (4.2)
[1] Czech Republic	51 (0.7)	524 (2.1)	49 (0.7)	527 (2.4)	3 (1.8)
Benchmarking participant					
[1] North Rhine-W. (Germany)	53 (1.0)	482 (6.3)	47 (1.0)	488 (3.7)	6 (6.5)
Country not meeting sample participation requirements					
[‡] United States	49 (1.5)	468 (7.5)	51 (1.5)	493 (6.8)	**25** (6.0)



Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant differences (p<0.05) between subgroups are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Countries are ranked in descending order of the CIL score difference between groups.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
2 Country surveyed target grade in the first half of the school year.
3 National defined population covers 61% of the national target population.

Table 6.2: CT achievement by gender

Country	Male		Female		Difference CT score averages
	Percentage	Average score	Percentage	Average score	Female - Male
Finland	49 (1.0)	497 (6.8)	51 (1.0)	506 (5.1)	9 (6.1)
† Korea, Republic of	51 (1.0)	533 (4.4)	49 (1.0)	542 (4.4)	9 (5.9)
Malta	49 (0.9)	437 (4.8)	51 (0.9)	444 (3.5)	6 (5.3)
1 Norway (Grade 9)	51 (0.8)	482 (4.9)	49 (0.8)	488 (4.0)	6 (5.1)
1 Croatia	51 (0.8)	426 (5.5)	49 (0.8)	432 (4.7)	6 (5.4)
Chinese Taipei	54 (0.8)	546 (5.2)	46 (0.8)	551 (3.5)	5 (4.5)
1 Serbia	52 (1.0)	420 (5.7)	48 (1.0)	423 (5.8)	3 (5.3)
†1 Denmark	51 (1.0)	505 (5.2)	49 (1.0)	505 (3.6)	0 (5.5)
1 Latvia	50 (1.1)	495 (6.3)	50 (1.1)	495 (5.2)	0 (5.2)
Luxembourg	51 (0.7)	476 (3.4)	49 (0.7)	475 (2.8)	-1 (3.7)
1 Slovenia	51 (0.7)	449 (4.1)	49 (0.7)	448 (3.2)	-2 (3.7)
Slovak Republic	50 (1.0)	499 (4.2)	50 (1.0)	497 (4.2)	-3 (3.9)
ICILS 2023 average	51 (0.2)	485 (1.1)	49 (0.2)	482 (1.0)	**-3** (1.1)
Germany	51 (1.1)	483 (5.0)	49 (1.1)	476 (4.4)	-7 (5.3)
Italy	51 (0.9)	485 (3.6)	49 (0.9)	478 (3.4)	-7 (3.7)
France	50 (0.7)	503 (4.7)	50 (0.7)	496 (4.1)	-8 (4.2)
1 Portugal	50 (1.1)	489 (4.5)	50 (1.1)	478 (4.7)	**-11** (4.5)
1 Sweden	52 (1.2)	493 (6.2)	48 (1.2)	481 (5.0)	**-12** (5.8)
1 Austria	49 (1.4)	482 (5.0)	51 (1.4)	470 (4.0)	**-12** (4.4)
† Uruguay	51 (0.8)	427 (5.0)	49 (0.8)	414 (4.8)	**-13** (4.9)
1 Czech Republic	51 (0.7)	534 (3.0)	49 (0.7)	519 (3.2)	**-14** (2.4)
† Belgium (Flemish)	53 (2.0)	517 (7.5)	47 (2.0)	502 (6.6)	**-15** (6.6)
Benchmarking participant					
1 North Rhine-W. (Germany)	53 (1.0)	465 (6.3)	47 (1.0)	457 (3.9)	-8 (6.9)
Country not meeting sample participation requirements					
‡ United States	49 (1.5)	462 (8.2)	51 (1.5)	459 (6.9)	-3 (5.7)



Difference between groups statistically significant (p<0.05)
Difference between groups not statistically significant

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant differences (p<0.05) between subgroups are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements. Countries are ranked in descending order of the CT score difference between groups.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

Gender differences in CT

As mentioned above, in ICILS 2018, patterns of gender differences in CT scale score points diverged from those observed in CIL. Specifically, "the average CT scale score of male students was statistically significantly higher than that of female students...[h]owever, this difference was not consistent at the country level" (Fraillon et al., 2020, p. 105). A similar pattern emerges in ICILS 2023 data. On average across countries, female students scored 482 CT scale score points compared to 485 scale score points for male students. The difference of 3 points is small but nonetheless statistically significant.

However, similar to what was observed in ICILS 2018, the pattern did not hold for the majority of countries. Male students scored statistically significantly higher than female students on the CT assessment in only six of 22 countries. In the remaining countries, the gender differences were not statistically significant, although the average CT scale scores were higher for male students in a further six countries, and for female students in nine countries (in each of Denmark and Latvia, the average CT scores of female students was higher, but are displayed as zero in Table 6.2 because of rounding).

6.3 Achievement differences by immigration background and language use

Many studies provide evidence of the influence of students' cultural and language background on their educational performance (see, for example, Elley, 1992; Kao, 2004; Kao & Thompson, 2003; Mullis et al., 2007; OECD, 2006). Students from immigrant families, especially those families recently arrived in a country, often lack proficiency in the language of instruction and may be unfamiliar with the norms of the dominant culture. Ethnic minorities also tend to have a lower SES, which in turn is often negatively associated with learning and engagement. In addition, several studies indicate that when socioeconomic background is controlled for, immigrant status and language still provide unique predictors of students' literacy achievement (Lehmann, 1996). In sum, immigration differences are not only explained by differences in socioeconomic resources, but also by language resources, socio-cultural differences, system-wide factors of the origin and destination countries, and the destination countries' policies (Buchmann & Parrado, 2006; Dronkers & Levels, 2007; Jackson, 2012; Levels et al., 2008; Schmid, 2001; Strand, 2011, 2014). Therefore, while these patterns are evident in the data, the direction of the gap may differ country by country depending on the origin of the immigrating family and reason for immigration. This is important to keep in mind when reviewing the results.

ICILS 2013 and 2018 found that the cultural and language background of students is associated with educational performance in CIL and CT (see, for example, Fraillon et al., 2014, 2020). Specifically, they report that students with an immigrant background (i.e., that they themselves or their parents were born abroad) tended to score lower on CIL and CT compared to those without an immigrant background. In addition, past studies have reported that students who did not speak the language of the test at home most of the time tended to score lower than those who did.

To measure immigration background, we utilize information from the ICILS student questionnaire which asks students to report on their own and their parents' country of birth. Responses were then recoded to classify each student and any reported parents as "born in country of test" or "not born in country of test." These data were further reduced to form a single variable relating to the student. This variable was coded as a family with an "immigrant background" when the student reported all parents as born abroad (regardless of where the student was born) and as coming from a family with a "non-immigrant background" when at least one parent was born in the country where the survey was conducted. To capture language background, the student questionnaire asked students to specify which language was spoken most frequently in their home. To facilitate analysis, student responses to this question were recoded into two categories: "language of test" or "other language." Both are relevant indicators and can speak to different disparities in the education system: one dealing with the integration of immigrants into educational and social contexts and the other policies aimed at supporting language minorities.

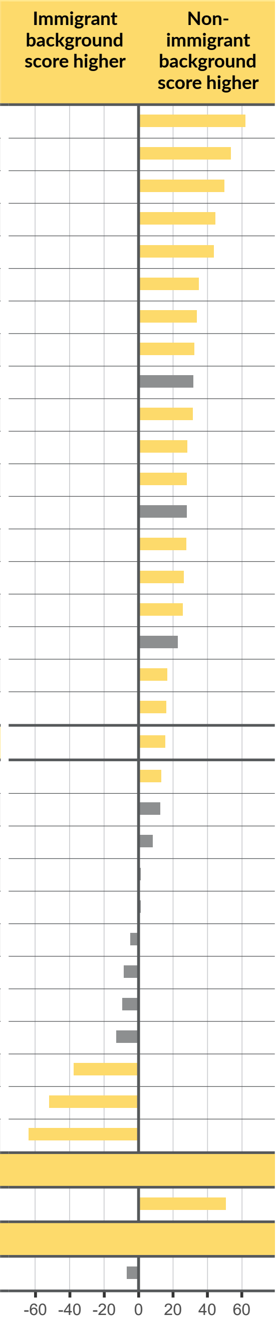
Immigration and language background differences in CIL

In ICILS 2018, "[s]tudents without immigrant backgrounds tended to have higher CIL average scores than those with an immigrant background" (Fraillon et al., 2020, p. 83). This story holds for ICILS 2023 (Table 6.3). Students who reported they were from immigrant families score, on average, 468 CIL scale score points, compared to an average of 483 scale score points for students from non-immigrant families. It should be noted that the percentage of students from immigrant families is substantially smaller than those with non-immigrant backgrounds (13% versus 87%, respectively), with large variation across countries. In some countries, only one percent of the student population report having an immigrant background, while in others it can be as high as 63 percent. Therefore, some care should be taken in the interpretation of these differences, and consideration should be made about the differences in the immigration context between countries.

In 18 of 32 countries, students with a non-immigrant background scored statistically significantly higher than students with an immigrant background. Statistically significant differences in favor of students from non-immigrant families ranged from 13 points in Italy up to 62 points in Finland. In three countries, the reverse pattern was found: students from immigrant families scored statistically significantly higher than students from non-immigrant families. The greatest difference was found in Oman (64 points).

Table 6.3: CIL achievement by immigration background

Country	Immigrant background: Percentage	Immigrant background: Average score	Non-immigrant background: Percentage	Non-immigrant background: Average score	Difference CIL score averages: Non-immigrant background - Immigrant background
Finland	6 (0.8)	452 (10.2)	94 (0.8)	514 (3.1)	**62** (9.8)
Germany	28 (1.3)	470 (7.3)	72 (1.3)	524 (2.9)	**54** (6.7)
†1 Denmark	11 (1.1)	477 (6.4)	89 (1.1)	527 (2.3)	**50** (5.9)
Greece	14 (1.0)	424 (6.4)	86 (1.0)	468 (3.1)	**44** (5.8)
† Belgium (Flemish)	24 (2.2)	482 (6.7)	76 (2.2)	525 (4.2)	**44** (7.3)
1 Sweden	22 (1.8)	481 (4.9)	78 (1.8)	516 (2.9)	**35** (5.1)
France	18 (1.3)	472 (5.7)	82 (1.3)	506 (2.8)	**34** (5.7)
1 Slovenia	15 (0.9)	459 (4.4)	85 (0.9)	492 (2.4)	**32** (4.7)
† Korea, Republic of	1 (0.2)	512 (16.3)	99 (0.2)	543 (2.4)	32 (16.5)
1 Portugal	14 (0.9)	484 (5.3)	86 (0.9)	516 (3.0)	**31** (5.4)
1 Austria	27 (1.1)	488 (3.9)	73 (1.1)	516 (2.7)	**28** (4.4)
1 Spain	20 (1.0)	477 (3.8)	80 (1.0)	504 (1.9)	**28** (3.8)
Slovak Republic	1 (0.2)	476 (15.7)	99 (0.2)	504 (2.8)	28 (15.7)
1 Latvia	3 (0.5)	483 (14.0)	97 (0.5)	511 (4.0)	**28** (13.9)
1 Czech Republic	6 (0.4)	502 (5.0)	94 (0.4)	528 (2.1)	**26** (4.9)
1 Croatia	9 (0.8)	468 (9.4)	91 (0.8)	494 (3.7)	**26** (9.5)
†12 Romania	1 (0.3)	405 (18.0)	99 (0.3)	428 (4.8)	23 (18.1)
1 Norway (Grade 9)	16 (1.0)	493 (4.2)	84 (1.0)	510 (2.7)	**17** (4.4)
Luxembourg	63 (1.0)	490 (2.4)	37 (1.0)	506 (2.6)	**16** (3.2)
ICILS 2023 average	13 (0.2)	468 (2.0)	87 (0.2)	483 (0.6)	**15** (2.0)
Italy	14 (1.0)	481 (4.5)	86 (1.0)	494 (2.7)	**13** (4.9)
Malta	15 (0.7)	471 (6.9)	85 (0.7)	484 (2.5)	13 (6.8)
Chinese Taipei	1 (0.2)	508 (16.6)	99 (0.2)	516 (2.9)	8 (16.5)
† Uruguay	3 (0.4)	450 (14.4)	97 (0.4)	452 (3.6)	1 (14.5)
1 Kazakhstan	7 (0.8)	407 (7.0)	93 (0.8)	408 (3.1)	1 (6.6)
1 Kosovo	1 (0.2)	366 (29.7)	99 (0.2)	361 (4.0)	-5 (28.8)
Cyprus	22 (1.6)	470 (7.3)	78 (1.6)	462 (3.3)	-9 (9.1)
1 Serbia	4 (0.4)	464 (8.4)	96 (0.4)	455 (3.4)	-10 (8.7)
Hungary	3 (0.3)	520 (10.0)	97 (0.3)	507 (3.7)	-13 (11.0)
3 Bosnia and Herzegovina	2 (0.5)	481 (17.2)	98 (0.5)	444 (3.6)	**-38** (17.0)
Azerbaijan	2 (0.3)	377 (12.8)	98 (0.3)	326 (4.9)	**-52** (12.9)
Oman	12 (0.6)	443 (5.8)	88 (0.6)	380 (2.9)	**-64** (6.1)
Benchmarking participant					
1 North Rhine-W. (Germany)	33 (1.7)	458 (5.8)	67 (1.7)	508 (5.7)	**51** (7.4)
Country not meeting sample participation requirements					
‡ United States	26 (1.9)	494 (12.0)	74 (1.9)	487 (5.7)	-7 (10.4)



Difference between groups statistically significant (p<0.05)
Difference between groups not statistically significant

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant differences (p<0.05) between subgroups are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Countries are ranked in descending order of the CIL score difference between groups.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
2 Country surveyed target grade in the first half of the school year.
3 National defined population covers 61% of the national target population.

It is important to point out that the student population with an immigrant background is very small (2%) in the other two countries where the scores of students from immigrant families were higher than those of students from non-immigrant families: Bosnia and Herzegovina and Azerbaijan. In the remaining 11 countries differences between students from immigrant families and those from non-immigrant families were not statistically significant. In interpreting these results, it is important to keep in mind that the social and political circumstances associated with immigration and immigrant people vary across countries and play an important role in the patterns observed in CIL achievement.

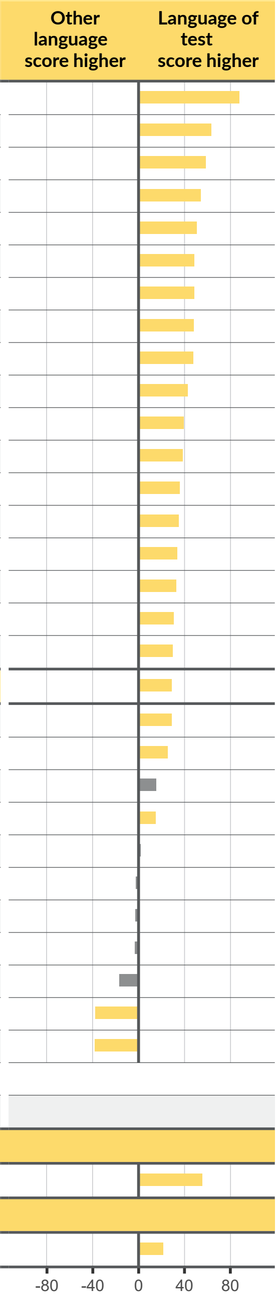
In ICILS 2018, "CIL scores tended to be higher among students speaking the test language at home" (Fraillon et al., 2020, p. 83). A similar pattern can be found in ICILS 2023 (Table 6.4). The average CIL scale scores of students who spoke the language of the test (most often) at home, was 479 CIL scale score points compared to an average of 450 scale score points for students who spoke another language (most often) at home. This results in a statistically significant difference of 29 points. In 22 of 30 countries that had sufficient data for reporting, students speaking the language of the test (most often) at home scored statistically significantly higher than students who did not. The opposite pattern was found in two countries: Azerbaijan and Oman. Differences by language background were not statistically significant in the remaining six countries.

Similar to what was found when comparing CIL achievement with respect to immigration background, the share of students in the "other language" category can be quite small in some countries. On average across countries, 81 percent of students in ICILS 2023 spoke the test language most often at home compared to 19 percent who did not. This pattern was the opposite in some countries, such as in Luxembourg and Malta, where the test language was not the language most often spoken in the home for most students. Therefore, the specific country contexts should be considered in interpreting country-by-country differences in CIL in relation to the language spoken in the home. Chinese Taipei and Korea (Rep. of) did not have sufficient data to report average scale scores for students who did not speak the language of the test most often at home, hence, no scale score differences are reported.

Across the two indicators, immigration and language background, differences in CIL achievement are larger, on average, based on student language spoken at home (29 CIL scale score points in favor of students who speak the language of the test most often at home) compared to student immigration background (15 scale score points, in favor of students from non-immigrant families). While there seems to be some similarities in the size of the differences for the two indicators for individual countries (e.g., Germany), there also appears to be some countries where the gaps are of different magnitudes (e.g., Slovak Republic). This illustrates that the two indicators, although related, could be capturing different populations of students as well as distinct aspects of education systems' success.

Table 6.4: CIL achievement by language at home

Country	Other language: Percentage	Other language: Average score	Language of test: Percentage	Language of test: Average score	Difference CIL score averages: Language of test - Other language
Slovak Republic	11 (1.1)	421 (7.0)	89 (1.1)	508 (2.8)	**88** (7.6)
[1] Serbia	3 (0.6)	382 (13.0)	97 (0.6)	446 (3.7)	**63** (12.9)
Germany	27 (1.4)	463 (7.6)	73 (1.4)	521 (2.7)	**59** (7.2)
Greece	11 (0.9)	412 (8.0)	89 (0.9)	466 (3.2)	**54** (7.7)
† Uruguay	3 (0.4)	399 (15.7)	97 (0.4)	450 (3.5)	**51** (15.4)
[1] Croatia	5 (0.5)	442 (12.4)	95 (0.5)	491 (3.9)	**49** (12.8)
Finland	11 (1.2)	466 (8.4)	89 (1.2)	514 (3.1)	**48** (7.6)
†[1] Denmark	10 (0.9)	476 (7.9)	90 (0.9)	524 (2.3)	**48** (7.2)
† Belgium (Flemish)	30 (2.2)	478 (5.9)	70 (2.2)	525 (4.5)	**48** (6.0)
[1] Slovenia	14 (1.0)	448 (4.7)	86 (1.0)	491 (2.2)	**43** (4.7)
France	17 (1.1)	466 (5.7)	83 (1.1)	505 (2.6)	**39** (5.4)
[1] Austria	27 (1.1)	478 (3.7)	73 (1.1)	516 (2.7)	**38** (4.0)
[1] Sweden	21 (1.6)	477 (5.0)	79 (1.6)	513 (3.0)	**36** (5.1)
[1] Czech Republic	7 (0.5)	493 (5.1)	93 (0.5)	528 (2.0)	**35** (4.3)
Italy	25 (1.1)	465 (4.3)	75 (1.1)	499 (2.4)	**34** (4.2)
Luxembourg	79 (0.9)	488 (2.2)	21 (0.9)	520 (3.3)	**33** (3.5)
[1] Portugal	5 (0.4)	481 (9.7)	95 (0.4)	512 (2.9)	**30** (9.2)
Malta	78 (0.7)	471 (2.8)	22 (0.7)	500 (4.3)	**30** (4.6)
ICILS 2023 average	19 (0.2)	450 (1.6)	81 (0.2)	479 (0.6)	**29** (1.6)
[1] Norway (Grade 9)	16 (0.9)	481 (4.9)	84 (0.9)	509 (2.7)	**29** (4.8)
[1] Latvia	27 (2.9)	491 (6.4)	73 (2.9)	516 (4.1)	**26** (6.2)
Hungary	2 (0.3)	491 (14.6)	98 (0.3)	506 (3.9)	15 (15.0)
[1] Spain	25 (1.2)	485 (5.0)	75 (1.2)	500 (1.9)	**15** (5.4)
[1] Kazakhstan	12 (1.1)	406 (7.5)	88 (1.1)	407 (3.2)	2 (7.7)
[3] Bosnia and Herzegovina	5 (0.9)	443 (12.2)	95 (0.9)	440 (3.8)	-2 (12.0)
[1] Kosovo	4 (0.7)	359 (12.8)	96 (0.7)	356 (4.1)	-3 (12.4)
†[1][2] Romania	4 (0.6)	424 (11.6)	96 (0.6)	421 (5.1)	-3 (11.0)
Cyprus	23 (1.6)	478 (7.5)	77 (1.6)	461 (3.2)	-17 (8.8)
Oman	18 (0.9)	412 (6.2)	82 (0.9)	374 (2.8)	**-38** (5.8)
Azerbaijan	8 (1.3)	355 (12.8)	92 (1.3)	317 (5.1)	**-38** (12.8)
Chinese Taipei	0 (0.1)	~	100 (0.1)	516 (2.9)	
† Korea, Republic of	1 (0.1)	~	99 (0.1)	542 (2.5)	
Benchmarking participant					
[1] North Rhine-W. (Germany)	31 (1.6)	449 (6.2)	69 (1.6)	504 (5.4)	**55** (7.6)
Country not meeting sample participation requirements					
‡ United States	23 (1.7)	470 (11.4)	77 (1.7)	491 (5.9)	**22** (9.6)



Difference between groups statistically significant (p<0.05)
Difference between groups not statistically significant

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant differences (p<0.05) between subgroups are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. In addition, data from Chinese Taipei and Korea (Republic of) were excluded in the calculations of all ICILS 2023 averages. Countries are ranked in descending order of the CIL score difference between groups.

† Met guidelines for sampling participation rates only after replacement schools were included.

‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

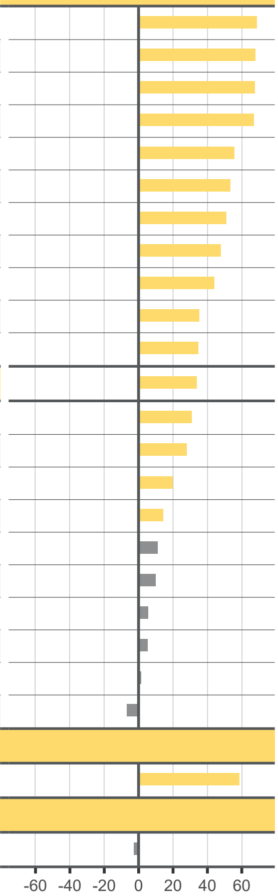
[2] Country surveyed target grade in the first half of the school year.

[3] National defined population covers 61% of the national target population.

~ indicates insufficient number of cases to report result.

Table 6.5: CT achievement by immigration background

Country	Immigrant background		Non-immigrant background		Difference CT score averages
	Percentage	Average score	Percentage	Average score	Non-immigrant background - Immigrant background
Finland	6 (0.8)	441 (12.7)	94 (0.8)	510 (4.8)	**69** (12.2)
Germany	28 (1.3)	438 (7.7)	72 (1.3)	505 (4.2)	**68** (8.1)
† Belgium (Flemish)	24 (2.2)	463 (8.2)	76 (2.2)	531 (5.9)	**68** (9.1)
†1 Denmark	11 (1.1)	447 (9.2)	89 (1.1)	514 (3.2)	**67** (8.9)
† Korea, Republic of	1 (0.2)	485 (23.3)	99 (0.2)	540 (3.2)	**56** (23.4)
1 Sweden	22 (1.8)	449 (7.0)	78 (1.8)	502 (4.8)	**53** (7.3)
France	18 (1.3)	460 (7.7)	82 (1.3)	511 (3.8)	**51** (7.4)
1 Slovenia	15 (0.9)	411 (5.6)	85 (0.9)	459 (3.2)	**48** (5.3)
1 Austria	27 (1.1)	448 (5.7)	73 (1.1)	492 (4.2)	**44** (5.7)
1 Latvia	3 (0.5)	460 (15.1)	97 (0.5)	495 (5.9)	**35** (13.7)
1 Portugal	14 (0.9)	456 (6.3)	86 (0.9)	491 (3.9)	**35** (5.9)
ICILS 2023 average	14 (0.2)	458 (2.5)	86 (0.2)	492 (0.9)	**34** (2.5)
1 Croatia	9 (0.8)	404 (8.2)	91 (0.8)	435 (4.4)	**31** (8.5)
1 Norway (Grade 9)	16 (1.0)	467 (5.8)	84 (1.0)	495 (3.6)	**28** (6.2)
1 Czech Republic	6 (0.4)	509 (5.8)	94 (0.4)	529 (2.9)	**20** (5.6)
Italy	14 (1.0)	471 (5.7)	86 (1.0)	486 (3.1)	**14** (6.2)
Malta	15 (0.7)	436 (10.2)	85 (0.7)	447 (3.1)	11 (10.2)
Slovak Republic	1 (0.2)	494 (15.6)	99 (0.2)	504 (3.6)	10 (15.3)
Luxembourg	63 (1.0)	476 (3.0)	37 (1.0)	481 (3.5)	6 (4.3)
Chinese Taipei	1 (0.2)	544 (23.9)	99 (0.2)	550 (3.8)	5 (23.6)
† Uruguay	3 (0.4)	423 (15.2)	97 (0.4)	424 (4.3)	2 (15.2)
1 Serbia	4 (0.4)	443 (12.5)	96 (0.4)	436 (4.9)	-7 (12.5)
Benchmarking participant					
1 North Rhine-W. (Germany)	33 (1.7)	428 (6.4)	67 (1.7)	486 (5.6)	**58** (7.8)
Country not meeting sample participation requirements					
‡ United States	26 (1.9)	468 (12.5)	74 (1.9)	465 (7.1)	-3 (10.7)



Difference between groups statistically significant (p<0.05)
Difference between groups not statistically significant

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant differences (p<0.05) between subgroups are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements. Countries are ranked in descending order of the CT score difference between groups.

† Met guidelines for sampling participation rates only after replacement schools were included.

‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

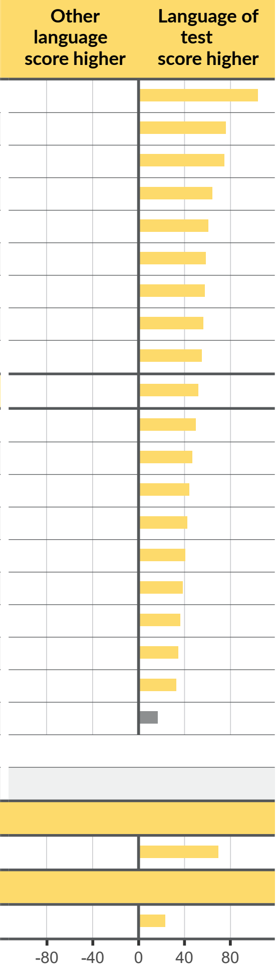
Immigration and language background differences in CT

In ICILS 2018, CT achievement differences by student immigrant background followed a similar pattern to CIL. That is, CT scores tended to be higher for students with a non-immigrant background. The same pattern was observed in ICILS 2023 (Table 6.5). On average across countries, students with a non-immigrant background scored 492 CT scale score points, compared to an average of 458 scale score points for students with an immigrant background—a statistically significant difference of 34 scale score points.

The average CT scale scores of students with a non-immigrant background were statistically significantly higher than students with an immigrant background in 16 of 22 countries. The statistically significant differences ranged from 14 CT scale score points in Italy up to 69 scale score points in Finland. In the remaining six countries, differences by immigration background were not statistically

Table 6.6: CT achievement by language at home

Country	Other language		Language of test		Difference CT score averages
	Percentage	Average score	Percentage	Average score	Language of test - Other language
Slovak Republic	11 (1.1)	406 (8.7)	89 (1.1)	509 (4.0)	**104** (9.3)
Germany	27 (1.4)	427 (7.8)	73 (1.4)	503 (3.9)	**76** (8.2)
† Belgium (Flemish)	30 (2.2)	457 (7.3)	70 (2.2)	532 (6.2)	**75** (7.5)
†1 Denmark	10 (0.9)	446 (10.7)	90 (0.9)	510 (3.3)	**64** (10.4)
1 Slovenia	14 (1.0)	397 (5.8)	86 (1.0)	457 (3.2)	**61** (5.5)
France	17 (1.1)	451 (7.7)	83 (1.1)	509 (3.7)	**58** (7.2)
1 Austria	27 (1.1)	435 (5.4)	73 (1.1)	492 (4.1)	**58** (5.4)
1 Sweden	21 (1.6)	442 (7.5)	79 (1.6)	499 (4.9)	**56** (8.0)
Finland	11 (1.2)	455 (11.8)	89 (1.2)	510 (4.8)	**55** (9.9)
ICILS 2023 average	22 (0.3)	437 (2.2)	78 (0.3)	489 (1.0)	**52** (2.2)
1 Serbia	3 (0.6)	375 (16.5)	97 (0.6)	424 (5.2)	**50** (17.1)
Malta	78 (0.7)	430 (3.5)	22 (0.7)	476 (6.3)	**47** (6.8)
Luxembourg	79 (0.9)	467 (2.7)	21 (0.9)	511 (4.4)	**44** (4.5)
† Uruguay	3 (0.4)	380 (16.2)	97 (0.4)	422 (4.2)	**42** (15.9)
Italy	25 (1.1)	452 (4.5)	75 (1.1)	492 (2.9)	**41** (4.5)
1 Norway (Grade 9)	16 (0.9)	455 (7.5)	84 (0.9)	493 (3.5)	**38** (7.4)
1 Croatia	5 (0.5)	395 (13.9)	95 (0.5)	431 (4.4)	**36** (13.8)
1 Latvia	27 (2.9)	468 (9.9)	73 (2.9)	502 (6.0)	**34** (9.9)
1 Czech Republic	7 (0.5)	496 (6.0)	93 (0.5)	529 (2.8)	**33** (5.1)
1 Portugal	5 (0.4)	469 (12.1)	95 (0.4)	485 (3.9)	16 (11.1)
Chinese Taipei	0 (0.1)	~	100 (0.1)	549 (3.8)	
† Korea, Republic of	1 (0.1)	~	99 (0.1)	538 (3.2)	
Benchmarking participant					
1 North Rhine-W. (Germany)	31 (1.6)	414 (6.2)	69 (1.6)	484 (5.3)	**69** (7.6)
Country not meeting sample participation requirements					
‡ United States	23 (1.7)	444 (11.0)	77 (1.7)	468 (7.3)	**23** (9.2)



Difference between groups statistically significant (p<0.05)
Difference between groups not statistically significant

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant differences (p<0.05) between subgroups are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements. In addition, data from Chinese Taipei and Korea (Republic of) were excluded in the calculations of all ICILS 2023 averages. Countries are ranked in descending order of the CT score difference between groups.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
~ indicates insufficient number of cases to report result.

significant.

ICILS 2018 reported that CT scores were higher for students speaking the test language at home (Fraillon et al., 2020, p. 107). This is also true in ICILS 2023 (Table 6.6). The average CT scale scores of students who spoke the language of the test most often at home was 489 CT scale score points, compared to an average of 437 scale score points for those who did not—a statistically significant difference.

The average CT scale scores of students who spoke the test language most often at home were statistically significantly higher than those who did not in 18 of the 20 countries that had sufficient data for reporting. Statistically significant differences ranged from 33 CT scale score points in the Czech

Republic to 104 scale score points in the Slovak Republic. In Portugal, the difference between groups was not statistically significant.

Differences in CT scale scores across the indicators are, on average, larger when comparing groups on the basis of student language spoken at home (52 scale score points in favor of students speaking the language of the test most often at home) compared to differences based on immigration background (34 scale score points in favor of students from non-immigrant families). Some countries show differences in the magnitude of gaps across the two indicators. For example, in the Slovak Republic, with the largest difference shown by language background (104 scale score points), there is not a statistically significant difference shown for students by immigration background (10 scale score points).

6.4 Achievement differences by socioeconomic status

Socioeconomic status (SES) is a construct regarded as manifest in occupation, education, and wealth (Hauser, 1994). A large body of literature shows the influence of students' SES on achievement in a variety of learning areas (see, for example, National Assessment of Educational Progress, 2016; Saha, 1997; Scheerder et al., 2017; Sirin, 2005; Woessmann, 2004). In addition, these differences were evident in the very first international large-scale assessments decades ago and have persisted until today (Chmielewski, 2019). The differences in achievement observed among children from varying socioeconomic backgrounds can be attributed to the limited educational resources available to students from lower SES families. This difference in the level of resources accumulates alongside the child's developmental trajectory, explaining the disparities in achievement. Following Bourdieu's theory, these resources are manifested as economic resources (e.g., families with higher incomes can send their children to private schools or afford private tutoring) and in the families' cultural and social capital (Bourdieu, 1986; Broer et al., 2019; Coleman, 1988, 1990).

While it is widely regarded internationally as an important correlate of a range of learning outcomes (Sirin, 2005; Woessmann, 2004), there is no scholarly consensus on which measures should be used for capturing family SES (Entwislea & Astone, 1994; Hauser, 1994) and no agreed standards for creating composite measures of SES (Gottfried, 1985; Mueller & Parcel, 1981). Furthermore, in the context of international studies, there are caveats relating to the validity and cross-national comparability of socioeconomic background measures (Buchmann, 2002). In this chapter, our considerations of the influence of socioeconomic background on CIL and CT focuses on within-country differences in achievement between several dichotomized indicators of SES.

Past cycles of ICILS revealed that, in participating countries, socioeconomic background consistently explained considerable variation in students' CIL and/or CT (Fraillon et al., 2014, 2020). Specifically, across several measures capturing different aspects of family SES, students from lower SES backgrounds scored statistically significantly lower on both CIL and CT assessments compared to their more advantaged peers.

Here, to capture student socioeconomic background we use student reports of the highest educational levels achieved by their mother and father are used and defined in accordance with the International Standard Classification of Education (ISCED) (UNESCO Institute for Statistics, 2012). Based on these classifications, this information is recoded to separate students into two groups: those whose parents highest education level is at least a Bachelor's degree (i.e., ISCED 6) and those whose parents highest education level is less than the Bachelor-level (i.e., lower than ISCED 6).

However, we acknowledge that there are multiple dimensions of SES and we present results for two other measures of student socioeconomic background taken from responses to the student questionnaire. First, we examine a measure of parental occupation. The reported occupation of each parent is recorded through open-ended questions, with occupations classified according to the International Standard Classification of Occupations (ISCO) framework (ILO, 2012) and then scored using the International Socioeconomic Index (ISEI) of occupational status (Ganzeboom et al., 1992). Students are again placed into two distinct groupings: students whose parents' highest occupation has an ISEI 50 or above (e.g., medical professionals, lawyers, engineers) versus those whose parents' highest occupation has an ISEI below 50 (e.g., farm workers, cashiers, machine operators). Finally, home literacy resources are measured through a question asking students to report the approximate numbers of books at home. Students are placed into two categories: those with 26 or more books in the home in comparison to those with fewer than 26 books in the home. Average achievement in CIL and CT is compared across these groupings for the three distinct indicators of SES. Results from such analyses are described in this chapter with the tables included in Appendix H.

SES differences in CIL

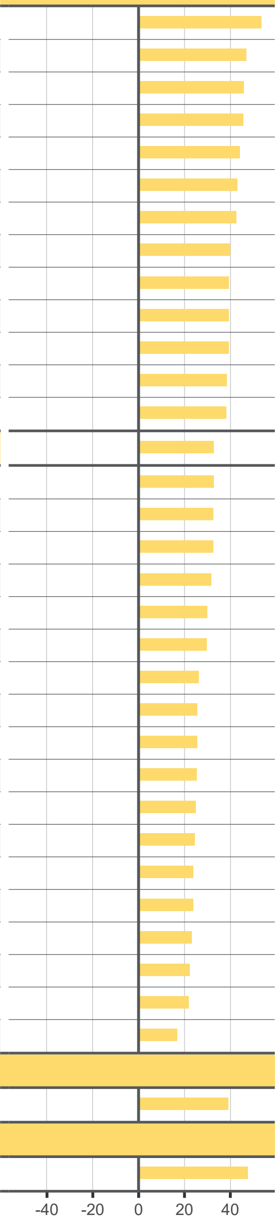
In ICILS 2018, "statistically significant associations between each of the three socioeconomic background variables and CIL across all countries" were found (Fraillon et al., 2020, p. 81). Similar to ICILS 2018, the data from ICILS 2023 indicates that students who have at least one parent with a university degree (Bachelor's degree or higher) tend to, on average, outperform students whose parents' highest level of education is short-cycle tertiary or below (Table 6.7). The average difference between these two groups was a statistically significant 33 CIL scale score points. This pattern is consistent across all countries with statistically significant differences ranging from 17 scale score points in Croatia to 53 scale score points in Hungary. It should be noted that some countries (e.g., Norway, 73%, and Cyprus, 70%) have a larger percentage of students with parents' reported to be in the higher education category compared to others (e.g., Uruguay and Azerbaijan, 28%).

In Appendix H, similar gaps can be observed when looking at differences by parental occupation (Table H.1). On average across countries, the CIL scale scores of students whose parents have an occupation scored at or above 50 on the ISEI scale (highest among the parents) was 505 scale score points compared to 464 scale score points for students whose parents' highest occupation is scored below 50. This corresponds to a statistically significant difference of 41 scale score points. As was the case for parental education, this pattern is consistent with statistically significant differences observed in all countries ranging from a difference of 22 scale score points in Korea (Rep. of) to 61 scale score points in Bosnia and Herzegovina. The percentage of students in the higher parental occupation category was lowest in Bosnia and Herzegovina and Uruguay (33%) and highest in Denmark (65%).

Patterns remain the same when examining the third indicator of SES included in ICILS 2023: books in the home (Table H.2). On average across countries, the CIL scale scores of students who report having fewer than 26 books was 448 scale score points compared to 496 scale score points for students reporting having 26 or more books in the home. This corresponds to a difference of 48 scale score points. The differences in CIL scale scores between the groups are statistically significant in all countries and range from 23 scale score points in Oman to 73 scale score points in Hungary. Across all countries, the percentage of students reporting 26 books or more in the home ranged from 31 percent in Uruguay to 80 percent in Korea (Rep. of).

Table 6.7: CIL achievement by parental education

Country	Below Bachelor-level		Bachelor-level or above		Difference CIL score averages
	Percentage	Average score	Percentage	Average score	Bachelor-level or above - Below Bachelor-level
Hungary	58 (1.6)	483 (5.1)	42 (1.6)	537 (2.6)	**53** (5.0)
Luxembourg	48 (1.0)	476 (2.3)	52 (1.0)	523 (2.6)	**47** (3.2)
Slovak Republic	62 (1.4)	482 (3.1)	38 (1.4)	528 (3.3)	**46** (3.9)
[3] Bosnia and Herzegovina	68 (1.7)	426 (4.1)	32 (1.7)	472 (6.0)	**46** (6.8)
†[12] Romania	62 (2.0)	404 (5.0)	38 (2.0)	449 (6.6)	**44** (6.4)
Cyprus	30 (1.0)	433 (4.4)	70 (1.0)	476 (2.7)	**43** (4.5)
Azerbaijan	72 (1.5)	310 (5.3)	28 (1.5)	352 (7.2)	**43** (7.2)
[1] Portugal	61 (1.3)	495 (3.5)	39 (1.3)	535 (2.9)	**40** (3.4)
[1] Kosovo	66 (1.4)	343 (3.6)	34 (1.4)	382 (5.8)	**39** (5.0)
[1] Serbia	59 (1.5)	428 (4.0)	41 (1.5)	467 (4.4)	**39** (4.9)
Germany	71 (1.1)	500 (3.5)	29 (1.1)	539 (4.3)	**39** (4.3)
Greece	46 (1.2)	440 (4.1)	54 (1.2)	478 (3.3)	**38** (3.6)
† Belgium (Flemish)	39 (1.7)	494 (6.1)	61 (1.7)	533 (3.6)	**38** (5.7)
ICILS 2023 average	55 (0.2)	464 (0.7)	45 (0.2)	497 (0.7)	**33** (0.8)
[1] Austria	70 (1.3)	497 (2.8)	30 (1.3)	530 (3.2)	**33** (3.3)
† Uruguay	72 (1.5)	440 (3.7)	28 (1.5)	472 (5.9)	**33** (6.7)
[1] Spain	62 (1.0)	484 (2.2)	38 (1.0)	517 (2.3)	**32** (2.6)
[1] Sweden	35 (1.2)	489 (3.6)	65 (1.2)	521 (3.1)	**32** (3.9)
France	63 (1.3)	490 (2.8)	37 (1.3)	519 (3.1)	**30** (2.9)
Chinese Taipei	42 (1.0)	499 (3.4)	58 (1.0)	529 (3.4)	**30** (3.8)
[1] Kazakhstan	63 (1.2)	398 (3.4)	37 (1.2)	424 (4.0)	**26** (4.4)
† Korea, Republic of	38 (1.3)	527 (3.0)	62 (1.3)	552 (2.8)	**26** (3.2)
†[1] Denmark	60 (1.3)	512 (2.6)	40 (1.3)	537 (3.0)	**25** (3.1)
Malta	55 (0.9)	469 (2.7)	45 (0.9)	494 (3.9)	**25** (3.8)
[1] Slovenia	45 (1.3)	473 (2.7)	55 (1.3)	498 (2.5)	**25** (2.9)
Oman	51 (1.0)	369 (2.9)	49 (1.0)	394 (4.1)	**24** (4.1)
[1] Norway (Grade 9)	27 (1.0)	490 (3.9)	73 (1.0)	514 (2.6)	**24** (3.4)
[1] Czech Republic	58 (1.0)	516 (2.5)	42 (1.0)	540 (1.9)	**24** (2.3)
Finland	38 (1.0)	497 (3.7)	62 (1.0)	520 (3.5)	**23** (3.4)
[1] Latvia	54 (1.7)	500 (4.4)	46 (1.7)	522 (4.5)	**22** (4.0)
Italy	68 (1.2)	485 (2.7)	32 (1.2)	507 (3.3)	**22** (3.5)
[1] Croatia	54 (1.6)	482 (3.9)	46 (1.6)	498 (4.7)	**17** (4.1)
Benchmarking participant					
[1] North Rhine-W. (Germany)	69 (1.2)	482 (4.1)	31 (1.2)	521 (5.0)	**39** (5.4)
Country not meeting sample participation requirements					
‡ United States	54 (1.8)	465 (7.1)	46 (1.8)	513 (7.6)	**48** (8.0)

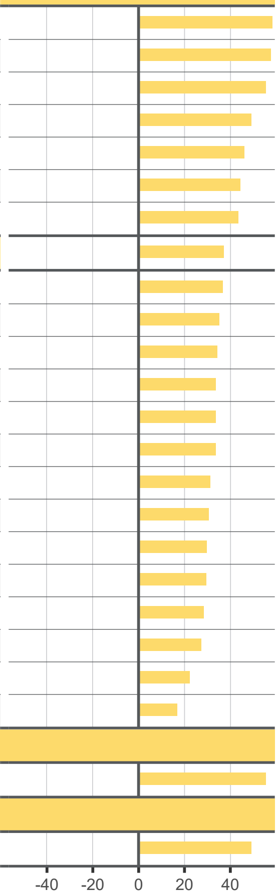


Difference between groups statistically significant (p<0.05)
Difference between groups not statistically significant

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant differences (p<0.05) between subgroups are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Countries are ranked in descending order of the CIL score difference between groups.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.

Table 6.8: CT achievement by parental education

Country	Below Bachelor-level		Bachelor-level or above		Difference CT score averages
	Percentage	Average score	Percentage	Average score	Bachelor-level or above - Below Bachelor-level
Slovak Republic	62 (1.4)	477 (3.6)	38 (1.4)	535 (5.2)	**58** (5.0)
Germany	71 (1.1)	472 (3.9)	29 (1.1)	529 (6.2)	**58** (6.1)
Luxembourg	48 (1.0)	453 (3.3)	52 (1.0)	509 (3.6)	**55** (4.8)
¹ Austria	70 (1.3)	464 (4.0)	30 (1.3)	513 (5.6)	**49** (5.3)
¹ Portugal	61 (1.3)	467 (4.3)	39 (1.3)	513 (4.8)	**46** (4.8)
¹ Sweden	35 (1.2)	462 (5.6)	65 (1.2)	506 (5.0)	**44** (5.6)
† Belgium (Flemish)	39 (1.7)	489 (7.1)	61 (1.7)	533 (5.8)	**43** (6.1)
ICILS 2023 average	53 (0.3)	469 (1.0)	47 (0.3)	506 (1.1)	**37** (1.2)
France	63 (1.3)	490 (3.9)	37 (1.3)	526 (4.8)	**37** (4.1)
¹ Czech Republic	58 (1.0)	512 (3.3)	42 (1.0)	547 (3.1)	**35** (3.5)
¹ Serbia	59 (1.5)	409 (5.0)	41 (1.5)	444 (6.6)	**34** (6.1)
†¹ Denmark	60 (1.3)	492 (3.9)	40 (1.3)	526 (4.2)	**34** (4.9)
Chinese Taipei	42 (1.0)	530 (4.2)	58 (1.0)	563 (4.4)	**34** (4.1)
† Korea, Republic of	38 (1.3)	518 (4.3)	62 (1.3)	552 (3.6)	**34** (4.8)
Finland	38 (1.0)	487 (5.3)	62 (1.0)	518 (5.4)	**31** (4.8)
† Uruguay	72 (1.5)	413 (4.3)	28 (1.5)	444 (7.2)	**31** (7.5)
Malta	55 (0.9)	430 (3.8)	45 (0.9)	459 (4.8)	**30** (5.6)
Italy	68 (1.2)	474 (3.1)	32 (1.2)	503 (4.0)	**30** (4.2)
¹ Norway (Grade 9)	27 (1.0)	469 (5.7)	73 (1.0)	497 (3.6)	**28** (5.4)
¹ Croatia	54 (1.6)	418 (4.9)	46 (1.6)	445 (5.7)	**27** (6.1)
¹ Slovenia	45 (1.3)	439 (3.9)	55 (1.3)	461 (3.7)	**22** (4.2)
¹ Latvia	54 (1.7)	487 (6.2)	46 (1.7)	503 (7.6)	**17** (7.0)
Benchmarking participant					
¹ North Rhine-W. (Germany)	69 (1.2)	452 (4.7)	31 (1.2)	507 (5.3)	**55** (6.3)
Country not meeting sample participation requirements					
‡ United States	54 (1.8)	441 (7.3)	46 (1.8)	490 (10.2)	**49** (9.6)



Difference between groups statistically significant (p<0.05)
Difference between groups not statistically significant

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant differences (p<0.05) between subgroups are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements. Countries are ranked in descending order of the CT score difference between groups.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
¹ National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

SES differences in CT

The relationship between the three SES indicators and student CT achievement is presented, as it was above with respect to student CIL achievement.

The CT achievement scores of students who have at least one parent with a university degree was, on average, 506 CT scale score points in comparison to 469 scale score points for students whose parents' highest level of education is short-cycle tertiary or below (Table 6.8). This corresponds to a statistically significant difference of 37 scale score points. The differences in CT scale scores between the groups are statistically significant in all countries and range from 17 scale score points in Latvia up to 58 scale score points in the Slovak Republic.

In Appendix H, the same patterns of difference associated with parental occupation observed for student CIL achievement are evident for CT achievement (Table H.3). On average across countries, the CT achievement scores of students whose parents' highest occupation rated as ISEI 50 or higher was 516 CT scale score points compared to 467 scale score points for students whose parents' highest occupation was rated below ISEI 50. This corresponds to a statistically significant difference of 49 scale score points. Statistically significant differences were found between the two groups in all countries. These differences ranged from 25 scale score points in Korea (Rep. of) to 73 scale score points in Luxembourg.

As was also reported with respect to CIL achievement, the CT achievement scores of students with fewer than 26 books in the home were consistently lower than those of students with 26 or more books in the home. On average across countries, the CT achievement scores of students reporting to have more than 26 books in the home was 506 CT scale score points in comparison to 445 scale score points for students reporting to have fewer than 26 books in the home. This corresponds to a statistically significant difference. The differences between the two groups were statistically significant in all countries and ranged from 41 scale score points in Latvia to 88 scale score points in North Rhine-Westphalia (Germany).

6.5 Achievement differences by students' access to ICT resources

There is evidence 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). Past cycles of ICILS provide evidence for these claims in many participating countries, however, in some highly developed countries smaller effects were observed (Fraillon et al., 2014, 2020). Having access to multiple ICT devices in the home allows students more time to practice ICT skills assessed in ICILS (see Fraillon & Rožman, 2024). Furthermore, results from ICILS 2023 indicate that most students learn about ICT-related topics outside of school, rather than in school. Without easy access to a computer in the home, students would have fewer opportunities to learn the skills tested on the CIL and CT assessments. Furthermore, student access to ICT resources is also closely tied to family SES. Due to financial constraints, households with lower SES have less access to ICT devices, infrastructure (such as stable high-speed internet connections), and software resources to provide children with opportunities to practice ICT skills in the home.

The results of ICILS 2018 showed that availability of computers at home was a positive predictor of CIL and CT in most countries but the relationship weakened after controlling for personal and social background likely indicating the close link between SES and device availability (Fraillon et al., 2020). Specifically, having more ICT devices in the home was associated with higher CIL and CT achievement.

The ICILS student questionnaire gathers information about the digital resources in students' homes. In order to take into account changes in technology and use of digital devices, the set of items for measuring digital home resources includes computers, tablet devices and smartphones. In this section, we report on a range of ICT access indicators. To capture student access to ICT resources we focus our discussion on one measure. Students were asked whether they have access to PC devices in the home when needed for their schoolwork. This acknowledges that it is not only important to have computers in the home, but that they should be available to students when needed for school. Students were grouped into two categories: those where PC devices are not always accessible and those where they are always accessible.

In addition, we make use of the extensive information collected in the student questionnaire to identify other indicators of student access to ICT resources. These results are reported in Appendix H. First, students reported on how often their home internet is disrupted (disconnected or is slow). This captures the quality of internet connection at home which is an important resource for school. We classified students, among those who report having access to internet at the home, into those who report that their home internet gets disrupted never or almost never (i.e., "Not disrupted") and students who report that their home internet get gets disrupted weekly or more including those who reported having no internet connection (i.e., "Internet disrupted weekly or more"). As a second measure, we also looked at the number of desktop and laptop computers students reported to have in their homes. This has been reported on in prior ICILS reports (Fraillon et al., 2014, 2020) We classified students into those who reported to have two or more of these devices and those who reported to have one or none. However, having computers in the home does not always mean that students are able to use those devices for their schoolwork.

The following is a discussion of the associations between students' reported access to each of these three categories of ICT resources and students' CIL and CT achievement.

Home ICT access differences in CIL

There was considerable variation in students' reported access to computers for schoolwork in the home (Table 6.9). On average across countries, 59 percent of students reported that home PC devices were always accessible to them when they needed them for schoolwork. However, this varied across countries, ranging from 22 percent of students in Azerbaijan to 88 percent of students in Denmark. Having ICT devices in the home is not entirely sufficient for students if they are not available to them for use for school-related activities.

A clear connection between home computer accessibility and CIL can be observed (Table 6.9). The average CIL scale score of students who reported that a PC was always accessible in the home for schoolwork is 497 CIL scale score points compared to an average of 456 scale score points for students where a PC was not always accessible. This corresponds to a statistically significant difference of 41 scale score points. The difference between the two groups was statistically significant in all countries, with the differences ranging from 22 scale score points in France to 67 scale score points in Romania.

In Appendix H, we look at two other indicators of student ICT resources. On average across countries, 60 percent of students indicated that their home internet was not disrupted (disconnected or slow), with 40 percent reporting that it was disrupted weekly or more. However, the quality of the internet varied considerably across countries. In Kosovo, 79 percent of students reported that they experienced internet disruption at least weekly compared to just 17 percent in Korea (Rep. of). These differences likely lead to variation in the types of opportunities students have to interact with online interfaces in their home.

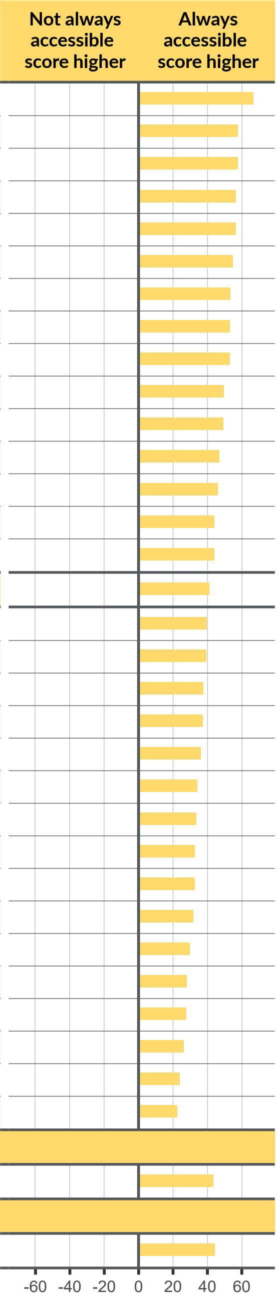
On average across countries, students who reported experiencing fewer internet issues at home tended to score higher in CIL (490 scale score points) than students that did report having issues with their home internet connectivity (468 scale score points). The difference of 22 scale score points (Table H.5) is statistically significant. The difference between the two groups was statistically significant in all but one country, Korea (Rep. of). The statistically significant differences ranged from 9 CIL scale score points in Chinese Taipei to 58 CIL scale score points in Romania.

ICILS 2018 reported that "students with more computers at home tended to have higher CIL scores" (Fraillon et al., 2020, p. 85). The same appears to be true in ICILS 2023 (Table H.6). On average across countries, students with two or more computers at home scored 490 CIL scale score points compared to students with fewer than two computers at home who scored 455 scale score points. This corresponds to a statistically significant difference of 36 scale score points. The difference between the two groups was statistically significant in all countries, ranging from a 19 scale score points in France to 64 scale score points in Belgium (Flemish).

The results are also indicative of differences in computer access across countries. In several countries (Denmark, Belgium (Flemish), Sweden, and Norway) over 85 percent of students lived in homes with two or more computers. In contrast, access was more limited in countries like Azerbaijan and Kazakhstan, where fewer than 35 percent of students reported having two or more computers at home.

Table 6.9: CIL achievement by access to computers to do schoolwork

Country	Not always accessible		Always accessible		Difference CIL score averages
	Percentage	Average score	Percentage	Average score	Always accessible - Not always accessible
† 1 2 Romania	52 (1.7)	394 (5.6)	48 (1.7)	460 (4.1)	**67** (5.5)
Cyprus	46 (1.4)	434 (3.9)	54 (1.4)	492 (3.3)	**58** (5.5)
Malta	34 (1.0)	443 (3.7)	66 (1.0)	501 (3.0)	**57** (4.4)
1 Kosovo	67 (1.2)	341 (4.0)	33 (1.2)	397 (5.3)	**57** (5.1)
Greece	52 (1.2)	437 (3.6)	48 (1.2)	494 (3.1)	**56** (3.5)
Hungary	33 (1.3)	470 (6.4)	67 (1.3)	525 (2.7)	**55** (6.4)
Azerbaijan	78 (1.0)	315 (4.8)	22 (1.0)	368 (8.2)	**53** (7.8)
1 Kazakhstan	73 (1.0)	396 (3.1)	27 (1.0)	449 (4.2)	**53** (4.2)
† Uruguay	53 (1.3)	429 (3.9)	47 (1.3)	482 (4.0)	**53** (4.6)
† Belgium (Flemish)	21 (1.3)	473 (7.0)	79 (1.3)	522 (3.9)	**49** (5.4)
Slovak Republic	35 (1.0)	469 (3.9)	65 (1.0)	518 (2.8)	**49** (4.2)
3 Bosnia and Herzegovina	45 (1.3)	420 (4.8)	55 (1.3)	467 (4.1)	**47** (5.5)
Oman	75 (0.8)	372 (2.7)	25 (0.8)	418 (4.5)	**46** (4.1)
Germany	41 (1.1)	482 (4.9)	59 (1.1)	526 (3.1)	**44** (4.3)
1 Croatia	38 (1.3)	464 (5.5)	62 (1.3)	508 (3.4)	**44** (5.4)
ICILS 2023 average	41 (0.2)	456 (0.8)	59 (0.2)	497 (0.6)	**41** (0.8)
1 Portugal	26 (1.0)	482 (4.6)	74 (1.0)	522 (2.7)	**40** (4.3)
1 Serbia	45 (1.2)	426 (4.0)	55 (1.2)	465 (3.8)	**39** (4.1)
Italy	50 (1.1)	473 (3.2)	50 (1.1)	511 (2.4)	**38** (3.2)
† 1 Denmark	12 (0.7)	488 (6.2)	88 (0.7)	525 (2.3)	**37** (5.8)
Luxembourg	49 (0.8)	479 (2.3)	51 (0.8)	515 (2.2)	**36** (2.6)
1 Spain	43 (1.0)	479 (2.6)	57 (1.0)	512 (1.9)	**34** (2.7)
1 Latvia	30 (1.2)	488 (4.9)	70 (1.2)	521 (3.2)	**34** (3.8)
1 Sweden	22 (1.1)	483 (5.1)	78 (1.1)	516 (2.6)	**33** (4.9)
1 Austria	26 (0.8)	483 (4.5)	74 (0.8)	516 (2.2)	**32** (3.7)
Finland	28 (0.9)	488 (4.7)	72 (0.9)	520 (2.9)	**32** (3.5)
1 Norway (Grade 9)	25 (1.1)	485 (4.1)	75 (1.1)	515 (2.5)	**30** (3.7)
1 Czech Republic	27 (0.7)	506 (3.2)	73 (0.7)	534 (1.7)	**28** (2.8)
Chinese Taipei	38 (0.9)	499 (3.5)	62 (0.9)	527 (2.9)	**28** (2.9)
† Korea, Republic of	27 (0.7)	523 (3.2)	73 (0.7)	550 (2.7)	**26** (3.6)
1 Slovenia	34 (1.0)	470 (3.4)	66 (1.0)	494 (2.4)	**24** (3.6)
France	49 (1.0)	488 (3.0)	51 (1.0)	511 (2.9)	**22** (2.7)
Benchmarking participant					
1 North Rhine-W. (Germany)	45 (1.6)	467 (5.1)	55 (1.6)	510 (3.9)	**43** (4.5)
Country not meeting sample participation requirements					
‡ United States	45 (1.6)	463 (8.3)	55 (1.6)	507 (6.6)	**44** (7.6)



Difference between groups statistically significant (p<0.05)
Difference between groups not statistically significant

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant differences (p<0.05) between subgroups are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Countries are ranked in descending order of the CIL score difference between groups.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
2 Country surveyed target grade in the first half of the school year.
3 National defined population covers 61% of the national target population.

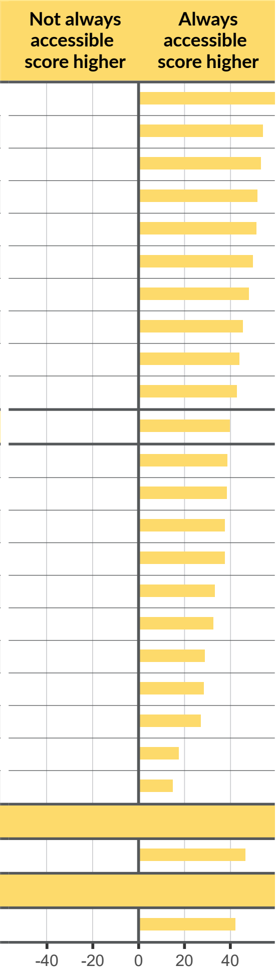
Home ICT access differences in CT

Here, the relationship between students' access to ICT resources and student CT achievement is presented, as it was above with respect to student CIL achievement.

As was reported with respect to CIL, access to PCs in the home for schoolwork is also related to student CT scores (Table 6.10). The average CIL scale score of students who reported that a PC was always accessible in the home is 500 CT scale score points compared to an average of 460 scale score points for students where a PC was not always accessible. This corresponds to a statistically significant difference of 40 scale score points. The difference between the two groups was statistically significant in all countries, with the differences ranging from 15 scale score points in Korea (Rep. of) to 60 scale score points in the Slovak Republic.

Table 6.10: CT achievement by access to computers to do schoolwork

Country	Not always accessible		Always accessible		Difference CT score averages
	Percentage	Average score	Percentage	Average score	Always accessible - Not always accessible
Slovak Republic	35 (1.0)	461 (5.1)	65 (1.0)	521 (3.8)	**60** (5.1)
Malta	34 (1.0)	409 (5.2)	66 (1.0)	463 (3.9)	**54** (6.4)
Germany	41 (1.1)	454 (5.4)	59 (1.1)	508 (4.2)	**53** (5.6)
† Uruguay	53 (1.3)	403 (4.1)	47 (1.3)	455 (5.2)	**52** (5.2)
1 Sweden	22 (1.1)	450 (7.5)	78 (1.1)	501 (4.4)	**51** (6.7)
†1 Denmark	12 (0.7)	461 (8.9)	88 (0.7)	511 (3.2)	**50** (8.6)
† Belgium (Flemish)	21 (1.3)	473 (8.2)	79 (1.3)	521 (6.1)	**48** (6.5)
1 Croatia	38 (1.3)	404 (6.4)	62 (1.3)	449 (4.5)	**45** (6.9)
Italy	50 (1.1)	461 (3.4)	50 (1.1)	505 (3.3)	**44** (3.7)
1 Latvia	30 (1.2)	467 (6.3)	70 (1.2)	510 (5.2)	**43** (5.2)
ICILS 2023 average	34 (0.2)	460 (1.2)	66 (0.2)	500 (0.9)	**40** (1.2)
Luxembourg	49 (0.8)	460 (2.8)	51 (0.8)	498 (3.0)	**39** (3.4)
1 Portugal	26 (1.0)	457 (5.3)	74 (1.0)	496 (3.8)	**38** (4.6)
1 Serbia	45 (1.2)	407 (5.0)	55 (1.2)	445 (5.5)	**37** (4.8)
1 Norway (Grade 9)	25 (1.1)	462 (5.4)	75 (1.1)	499 (3.5)	**37** (5.3)
Finland	28 (0.9)	482 (6.2)	72 (0.9)	515 (4.8)	**33** (4.6)
1 Austria	26 (0.8)	454 (6.3)	74 (0.8)	487 (3.6)	**33** (4.8)
Chinese Taipei	38 (0.9)	532 (4.8)	62 (0.9)	560 (3.7)	**29** (4.0)
1 Czech Republic	27 (0.7)	507 (4.0)	73 (0.7)	536 (2.8)	**28** (3.9)
France	49 (1.0)	488 (4.2)	51 (1.0)	515 (4.2)	**27** (3.7)
1 Slovenia	34 (1.0)	439 (5.2)	66 (1.0)	456 (3.1)	**18** (5.0)
† Korea, Republic of	27 (0.7)	529 (5.2)	73 (0.7)	544 (3.3)	**15** (5.1)
Benchmarking participant					
1 North Rhine-W. (Germany)	45 (1.6)	441 (5.0)	55 (1.6)	487 (4.0)	**46** (5.2)
Country not meeting sample participation requirements					
‡ United States	45 (1.6)	441 (8.4)	55 (1.6)	483 (8.7)	**42** (8.5)



Difference between groups statistically significant (p<0.05)
Difference between groups not statistically significant

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant differences (p<0.05) between subgroups are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements. Countries are ranked in descending order of the CT score difference between groups.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

In Appendix H, we present results for two other indicators of student ICT resources. Home internet quality is associated with student CT scale scores as it was with CIL scale scores (Table H.7). The average CT scale score of students with better home internet connections is 495 CT scale points, in comparison to 473 scale score points for students who reported disruptions at least weekly. This corresponds to a statistically significant difference of 22 CT scale score points. The difference between the two groups was statistically significant in all but three countries: Korea (Rep. of), Italy, and Chinese Taipei. The CT differences that were statistically significant ranged from 12 scale score points in Portugal and Slovenia to 40 scale score points in France and Denmark.

The number of PC devices reported in the home were also found to relate to CT achievement (Table H.8). On average across countries, students with two or more computers at home scored 496 CT scale score points compared to students with fewer than two computers at home who scored 455 CIL scale score points. This corresponds to a statistically significant difference of 41 scale score points. Similar to CIL, the differences by ICT home access between the two groups were statistically significant in all countries. These differences ranged from 22 scale score points France and Serbia to 65 scale score points in Belgium (Flemish).

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Chapter 7:

Students' engagement with information and communications technologies

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Chapter Highlights

Behavioral engagement: Students' use of information and communication technology (ICT).

- Half of the students across countries had been using digital devices for at least 5 years. In most countries, the average computer and information literacy (CIL) and computational thinking (CT) scale scores of students using digital devices at least 5 years were significantly higher than of those with less experience (Table 7.1 and Table 7.2).
- ICT use is prevalent among students. Three out of four students across countries reported daily ICT use outside school for other (i.e., non school-related) purposes on school days and on non-school days (Table 7.3).
- On average across participating countries administering this question, more than half of the students reported having no screen time limit set by their parents on school days, and three-quarters reported this on non-school days (Table 7.4).
- Very frequent engagement in academic-media multitasking, a concept referring to the simultaneous digital engagement in academic tasks and media-related activities, was reported by more than two-thirds of the students on average across countries (Table D.1).
- General software applications (such as word processing software) are used more often in lessons than specialist classroom applications (such as simulation, or concept mapping software). There is considerable variation among countries in students' reported frequency of use of software applications in lessons (Table 7.7 and Table 7.8).

Cognitive engagement: Students' learning how to use ICT in and outside of school.

- More than half of students across countries reported having learned about ICT (such as organizing files, editing documents or presentations) and CT tasks (such as making diagrams that explain concepts, detect patterns in data) at school, with the exception of programming which was reportedly learned at school less than general ICT and CT activities (Table 7.10 and Table 7.11).
- Students reported having more opportunities to learn about internet related tasks, specifically about safe and responsible use, outside of school than at school (Appendix D, Table D.7 and Table D.9). There is substantial variation across and within countries regarding both these learning opportunities at and outside schools.
- At least two-thirds of the students reported they have learned about different issues regarding ICT use and health at school, on average across countries (Appendix D, Table D.11).

Emotional engagement: Students' perceptions of ICT.

- In all countries, there was a weak statistically significant correlation between students' ICT self-efficacy in using general applications and their performance in CIL and CT achievement, reaffirming the findings from earlier ICILS cycles (Table 7.15).

- Across all countries, over 80 percent of students tended to agree or strongly agree with statements highlighting the positive societal value of ICT. Yet, there was also a high level of agreement with statements reflecting potentially negative perceptions of ICT (Appendix D, Table D.19 and Table D.21).

7.1 Introduction

This chapter focuses on a subset of contextual information collected from grade 8 students during the International Computer and Information Literacy Study (ICILS) 2023, namely information on various types of student engagement with information and communication technology (ICT). We report on young people's experience with digital devices, their perceptions about the use of computing technologies, and the circumstances of their learning about ICT, at school, and outside school. We examine students' access to, familiarity with, and self-reported proficiency in using computers. For these topics, the current cycle of ICILS builds on the findings of the previous two cycles by maintaining the relevant measures of students' current use of ICT. However, ICILS 2023 has expanded on some topics that are also growing in importance. Specifically, we present measures related to digital citizenship (including cybersecurity, privacy, and online safety), digital footprint, and cyberbullying. We also shed light on the importance of understanding copyright and fair use, developing skills for critically evaluating online information, and maintaining mental and physical well-being in the context of ICT use. Through this analysis, we seek to provide an understanding of the factors that shape students' digital literacy and their ability to navigate the digital world responsibly and effectively.

In the ICILS 2023 assessment framework (Fraillon & Rožman, 2024), we distinguish between four contexts relevant for student learning: wider community, schools and classrooms, home environment, and the individual level. Further, the status of contextual factors within the learning process is important as well. Factors can be classified either as antecedents or processes.

Antecedents are contextual factors that are not directly influenced by learning process variables or outcomes. At the individual level these are, for example, learner characteristics (such as socioeconomic status). These have already been described and presented in detail in Chapter 6. Processes are those factors that directly influence computer and information literacy (CIL) and computational thinking (CT) learning and may be constrained by antecedents and factors at higher levels. In ICILS 2023, processes included variables such as students' reported activities in class associated with CIL/CT learning in the classroom, and students' use of computers at home. In this chapter, we focus on student-level and school/classroom level processes represented by students' engagement with ICT.

We address Research Question 5 for CIL and CT: *What are the relationships between students' levels of access to, familiarity with, and self-reported proficiency in using computers and their CIL/CT?*

The chapter begins with a brief description of forms of engagement with ICT and how engagement was measured in ICILS. This is followed by the presentation of findings on the following aspects of student engagement and partly also their relationship with achievement:

- Behavioral engagement: Students' use of ICT
- Cognitive engagement: Students' learning how to use ICT in and outside of school
- Emotional engagement: Students' perceptions of ICT

The ICILS 2023 data reported in this chapter include 32 countries and one benchmarking participant, North Rhine-Westphalia (Germany). Twenty-two of these countries and the benchmarking participant conducted the CT assessment. The averages reported in this chapter are calculated based on the countries that met sampling participation requirements, excluding Romania because of late testing. When statements are made describing the data in this chapter, the term "countries" refers to the countries and benchmarking participant that met the ICILS sampling requirements. See Chapter 1 for further details.

Forms of engagement with ICT

Student engagement has been found to be related to academic outcomes, such as achievement and continuation of schooling. However, there is considerable debate among researchers regarding the conceptualization and definition of student engagement. Our examination of student engagement with ICT was informed by the opportunity to learn, a construct that has been used in large-scale international assessment studies by IEA over a long period of time (Elliott & Bartlett, 2016; Scheerens, 2017; Schmidt et al., 2014). Furthermore, since the first cycle in 2013, ICILS has used the term *engagement* to describe behavioral, emotional, and cognitive engagement following the taxonomy proposed by Fredricks et al. (2004). In this chapter we focus on these three components of engagement. The behavioral component, which refers to how students use ICT or how often they use it, the cognitive component, which describes the extent to which they have learned a specific ICT task, and the emotional component, which refers to students' perceived values of ICT.

Behavioral engagement with ICT refers to the observable actions and behaviors that indicate how individuals interact with, and utilize digital tools and technologies. In educational settings, this type of engagement includes how students use computers, software applications, and other digital resources for learning and completing tasks. As students' use of ICT and experience with computers were consistently positively related to both CIL and CT in ICILS 2018 (Fraillon et al., 2020), ICILS 2023 also collected related information: for how long students use ICT, how often they use it, whether their parents limit their screen time, and whether they use it while doing other tasks; their use of ICT in school, more specific the use of ICT during school lessons and use of ICT in different subjects. Interestingly, there is also some evidence that ICT use can be negatively related to school learning and student outcomes specifically in developing countries (Vargas-Montoya et al., 2023).

According to Fredricks et al. (2004), cognitive engagement represents a student's level of investment in learning. It involves thoughtfulness and a willingness to make the effort necessary to understand complex ideas and master difficult skills. It can range from simple memorization to the use of self-regulated learning strategies that promote deep understanding and expertise. The cognitive aspect of engagement has been covered in ICILS by examining learning about different ICT and CT tasks in school, learning to use the internet as a reliable source of information, and learning about safe and responsible use of ICT. Previous ICILS results show that students' reports of having been taught CIL-related tasks at school and of having used general ICT applications in class tended to be positively related to students' CIL in a number of countries. In contrast, students' reports of having been taught CT-related tasks tended to be negatively associated with CT scores (Fraillon et al., 2020). This somewhat counterintuitive finding was explained in 2018 as possibly potentially resulting from students' interpretation of the meaning of the CT-related activities being influenced by their level of CT, and/or the targeted use of CT-related activities in remedial and academic support programs (Fraillon et al., 2020).

Emotional engagement includes positive and negative reactions towards somebody or something. Some conceptualizations include values as well. In ICILS 2023 we focused on two main aspects of students' perceptions of ICT. Firstly, students' perceptions of themselves in relation to ICT, namely ICT self-efficacy, and second, their perceptions of ICT in relation to learning and use, expectations for future use of ICT, and positive and negative beliefs about ICT and society.

Student engagement is relevant for student learning outcomes (Fraillon et al., 2020; Goldhammer et al., 2016). According to the Commission et al. (2019), students who engage more frequently in digital activities in and out of school, who have more support to use ICT, and have access to more digital technologies are who evaluate the impact of ICT use in the classroom more positively.

Measuring engagement with ICT

Data on student engagement with ICT were collected using the ICILS student questionnaire. While students typically were presented with a number of response options for each question, in order to simplify reporting of results, for many questions we have combined response categories (e.g., often and very often, or agree and strongly agree). Decisions about how to combine categories were based on the conceptual congruence of categories and the frequency of responses by category.

Many questions presented to students comprised a number of individual statements that were developed, in part, with a view to measuring a common construct or trait (such as ICT self-efficacy). These statements share the question stem and response options. As in previous cycles of ICILS, where deemed feasible based on analyses of the statements and scale properties, they were combined to form a scale. To create the scale scores we used the Rasch partial credit model (Masters & Wright, 1997). For each scale, the scale scores are standardized to have an average of 50 and a standard deviation of 10 within the international pooled datasets, using data from countries that met the participation requirements (excluding Romania). More details on questionnaire scale construction are presented in the ICILS technical report (Fraillon et al., forthcoming). The country data were weighted in a way such that each country contributed equally to the scale. All student scales included in this report are described in item maps in Appendix D. The item maps relate scale scores to expected responses to a statement according to the ICILS scaling model (as shown in the example Figure D.1 in Appendix D). We have used scale scores to illustrate differences between and within countries and to gain insight into the correlation between contextual constructs and the CIL and CT achievement scales.

Only questionnaire scales that have been evaluated to have sufficiently robust measurement properties have been included in this report. The evaluation of the measurement properties of each scale (or potential scale) is established through a series of processes. Firstly, data from the field trial provided initial insights into the functioning of the scales, especially whether their composition was adequate. Based on the results of the field trial, the scale compositions were further refined for the main survey. After analyzing the main survey data, we determined the final scale configurations. We assessed the psychometric characteristics of the scales, for example, the dimensionality (whether the statements were measuring one or more latent traits and which statements contributed sufficiently to each measure), reliability and cross-country validity. The scales included in this report generally have good psychometric properties and can be used for cross-country comparisons. The scales constructed for ICILS 2023 are not comparable to scales from previous ICILS cycles. More details on the specific scale functioning are presented in the ICILS technical report (Fraillon et al., forthcoming). The scales presented in this chapter are listed below in the order they appear in this chapter.

Behavioral engagement: Students' use of ICT:

- academic-media multitasking
- students' use of general ICT applications in class
- students' use of specialist ICT applications in class

Cognitive engagement: Students' learning how to use ICT in and outside of school:

- learning about internet related tasks at school
- learning about internet related tasks outside of school
- learning about safe and responsible ICT use at school

Emotional engagement: Students' perceptions of ICT:

- ICT self-efficacy regarding the use of general applications
- learning with and use of ICT

- expectations for future use of ICT
- positive beliefs about ICT and society
- negative beliefs about ICT and society

7.2 Behavioral engagement: Students' use of ICT

A great many children in contemporary societies are exposed to ICT, directly and indirectly from a young age. Recognizing the potential relationship between exposure and skill development, ICILS has consistently focused on understanding the duration and intensity of ICT usage among grade 8 students, both inside and outside the school environment. This interest is also driven by ongoing debates among educational stakeholders regarding the appropriate level of ICT exposure for children. While a consensus has yet to be reached, it is clear that ICT use brings both opportunities and challenges. Knowing about and understanding responsible and safe use of ICT is acknowledged as an essential skill for students to participate in modern society (European Commission, 2022; Ranguelov, 2010; UNESCO, 2014). An important aspect of responsible and safe use of ICT is finding a balance between the use of digital devices (inside and outside school, for school-related and non-school-related purposes, communication and recreation), and time without using a device (Kovacs et al., 2022; Marciano & Camerini, 2021). Several studies have shown negative impacts of extended screen time on mental and physical health, including the ability to focus, especially for young children and adolescents (Lissak, 2018; Marciano & Camerini, 2021). Furthermore, the simultaneous participation in digital activities (such as chatting or streaming content) while conducting schoolwork on a digital device, a relatively new phenomenon called "academic-media multitasking," has been on the rise (van der Schuur et al., 2020). The role of parents in supporting their children to find such balance by supervising the frequency and duration of media use is of increasing interest.

Students use ICT in various places in and outside of school (Smahel et al., 2020) and there is considerable potential for improving knowledge and skills through the regular use of ICT for different purposes (see, for example Australian Curriculum, Assessment and Reporting Authority, 2015; Fletcher et al., 2012; National Assessment of Educational Progress, 2016). It is reasonable to assume that ICT skills will become an essential requirement for learners in the future as learning content becomes increasingly available through ICT. Furthermore, extending this perspective to include effective participation in workplaces and in society will also increasingly require at least basic ICT skills. Fu (2013) reports on the many benefits of using ICT in education. ICT assists students in accessing digital information efficiently and effectively, supports student-centered and self-directed learning, creates a creative learning environment, and improves the quality of teaching and learning, among others. ICILS 2013 and 2018 showed frequent use of ICT by students for a wide range of activities (Fraillon et al., 2014, 2020). Use of ICT is increasingly becoming standard practice in education and it is an important aspect of preparing young people for participation in modern society. Previous evidence shows a positive impact of ICT use on classroom achievement (Lei et al., 2021). In ICILS 2023, the use of ICT in class was approached from two perspectives. In this section we show results on students' reported use of software applications during lessons and the use of ICT across different subjects.

Experience with ICT

The length of students' experience with ICT has been measured across all cycles of ICILS. However, in light of changes in technology since 2013, the way in which the length of experience with ICT was measured has varied across the ICILS cycles. In 2013, students were asked how long they had been using computers. In 2018, students were asked about how long they had been using desktop computers and separately tablet devices or e-readers and smartphones (excluding their use for texting and calling). In 2023 students were asked about their experience with digital devices focused on computers, but the term included desktop and laptop computers as well as notebooks, netbooks, and tablet devices.

The changes in the question over the cycles of ICILS have been in response to changes in technology, in particular the increasing capacity for smaller ICT devices be used to complete tasks that previously could only be completed on a desktop or laptop computer. The intention of these changes across ICILS cycles has been to maximize the comparability of students reported experiences of using ICT over time. However, readers should keep in mind these slight changes to the question when making and interpreting comparisons across ICILS cycles.

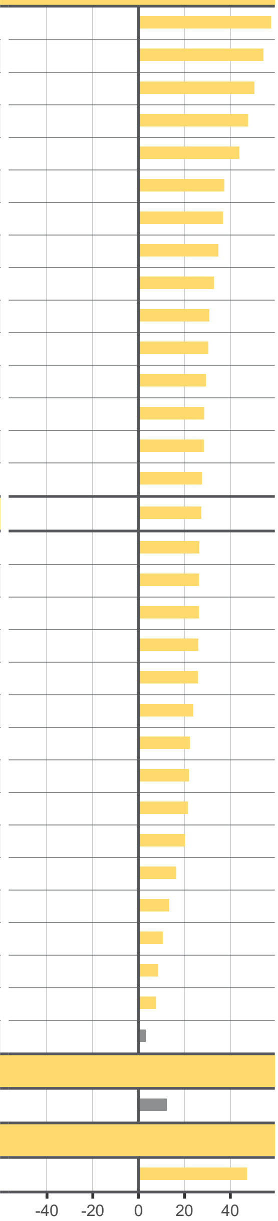
In all the cycles, students reported their experience using five response options ("less than one year" (in 2018 "never" was included in this response option as well), "at least one year but less than three years," "at least three years but less than five years," "at least five years but less than seven years," and "seven years or more"). Data from the five response categories were combined to form two reporting categories "less than five years" and "five years experience or more."

In ICILS 2023, on average across countries, around half of students reported having used digital devices for at least 5 years (Table 7.1). The lowest percentages of students with at least 5 years of experience are observed in Azerbaijan, Kazakhstan, and Kosovo, and the highest in Denmark and Norway. The results of ICILS 2023 show that the length of experience of ICT use is statistically significantly positively related to students' CIL achievement. This was also found in most countries in 2013 and 2018 (Fraillon et al., 2014, 2020). On average across countries, the difference in achievement between students with at least 5 years experience using ICT and those with less than 5 years experience is 27 CIL scale score points, equivalent to a little less than one third of the ICILS international CIL scale standard deviation. The largest difference in CIL achievement is observed in Azerbaijan and Kosovo, where the achievement of students who have used computers for 5 years or more were respectively 58 and 54 CIL scale score points higher than that of students who have used computers for less than 5 years. This corresponds to more than half of the ICILS international CIL scale standard deviation. The difference is smallest (three CIL scale score points) and not statistically significant in Slovenia, and also less than 15 CIL scale points in Austria, the Czech Republic, France, Germany, and North Rhine-Westphalia (Germany).

There is also a positive relationship between the length of experience with ICT use and CT achievement (Table 7.2). On average across countries the difference between students with 5 or more years of experience with ICT was 29 CT scale score points larger than those with less experience. This corresponds to almost one third of the CT scale standard deviation. The difference in CT achievement was statistically significant in all countries except Slovenia (five CT scale score points). The differences were the largest in the Slovak Republic (46 CT scale score points), Uruguay, and Finland (43 CT scale score points each).

Table 7.1: CIL achievement by years of experience using computers

Country	Less than 5 years experience		Five years experience or more		Difference CIL score averages		
	Percentage	Average score	Percentage	Average score	Five years experience or more - Less than 5 years experience	Less than 5 years experience score higher	Five years experience or more score higher
Azerbaijan	69 (1.1)	306 (4.9)	31 (1.1)	364 (6.4)	**58** (5.7)		
[1] Kosovo	68 (1.5)	339 (3.9)	32 (1.5)	394 (5.2)	**54** (4.7)		
†[12] Romania	42 (1.2)	395 (6.4)	58 (1.2)	445 (4.6)	**50** (5.7)		
[1] Kazakhstan	69 (1.1)	393 (3.1)	31 (1.1)	440 (3.9)	**47** (4.0)		
† Uruguay	42 (1.2)	424 (4.6)	58 (1.2)	468 (3.5)	**44** (4.5)		
Malta	35 (1.0)	455 (3.5)	65 (1.0)	492 (3.3)	**37** (4.8)		
[3] Bosnia and Herzegovina	42 (1.3)	421 (4.6)	58 (1.3)	458 (4.0)	**37** (4.6)		
Finland	31 (1.1)	487 (4.6)	69 (1.1)	522 (3.1)	**35** (3.6)		
Greece	46 (0.9)	444 (4.1)	54 (0.9)	477 (3.6)	**33** (4.4)		
[1] Serbia	33 (0.9)	424 (4.6)	67 (0.9)	455 (3.7)	**31** (3.8)		
Oman	54 (0.8)	367 (2.9)	46 (0.8)	398 (3.7)	**30** (3.4)		
Chinese Taipei	65 (0.8)	506 (3.0)	35 (0.8)	535 (3.3)	**29** (2.8)		
[1] Sweden	32 (0.9)	488 (3.7)	68 (0.9)	517 (2.9)	**29** (3.3)		
Slovak Republic	43 (1.1)	483 (3.4)	57 (1.1)	512 (3.0)	**28** (3.4)		
† Belgium (Flemish)	49 (1.2)	498 (5.4)	51 (1.2)	525 (4.2)	**28** (4.4)		
ICILS 2023 average	49 (0.2)	465 (0.7)	51 (0.2)	492 (0.6)	**27** (0.7)		
[1] Croatia	35 (1.2)	473 (5.7)	65 (1.2)	500 (3.5)	**27** (5.5)		
Cyprus	53 (1.2)	452 (3.0)	47 (1.2)	478 (3.4)	**26** (4.0)		
[1] Portugal	43 (0.9)	496 (3.3)	57 (0.9)	522 (3.1)	**26** (3.0)		
[1] Spain	58 (0.8)	486 (2.2)	42 (0.8)	512 (2.1)	**26** (2.1)		
† Korea, Republic of	60 (0.8)	532 (2.6)	40 (0.8)	558 (3.0)	**26** (3.0)		
[1] Norway (Grade 9)	27 (0.8)	490 (3.4)	73 (0.8)	513 (2.8)	**24** (3.7)		
†[1] Denmark	27 (1.2)	504 (4.0)	73 (1.2)	526 (2.5)	**22** (3.7)		
[1] Latvia	38 (1.2)	497 (4.5)	62 (1.2)	519 (3.8)	**22** (4.2)		
Hungary	48 (1.1)	495 (4.7)	52 (1.1)	517 (3.3)	**21** (3.8)		
Italy	57 (1.0)	483 (3.0)	43 (1.0)	503 (2.3)	**20** (2.6)		
Luxembourg	57 (0.7)	489 (2.3)	43 (0.7)	505 (2.4)	**16** (2.7)		
[1] Czech Republic	48 (0.7)	519 (2.7)	52 (0.7)	532 (2.0)	**13** (2.4)		
Germany	60 (1.1)	503 (4.1)	40 (1.1)	513 (4.1)	**10** (4.0)		
France	61 (0.9)	496 (3.1)	39 (0.9)	505 (2.9)	**9** (3.2)		
[1] Austria	62 (1.1)	504 (2.7)	38 (1.1)	511 (3.3)	**8** (3.1)		
[1] Slovenia	55 (1.1)	484 (2.6)	45 (1.1)	487 (2.8)	3 (2.9)		
Benchmarking participant							
[1] North Rhine-W. (Germany)	58 (1.0)	485 (4.3)	42 (1.0)	497 (6.5)	12 (6.8)		
Country not meeting sample participation requirements							
‡ United States	33 (1.7)	455 (7.7)	67 (1.7)	502 (6.8)	**47** (7.4)		



Difference between groups statistically significant (p<0.05)
Difference between groups not statistically significant

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant differences (p<0.05) between subgroups are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Countries are ranked in descending order of the CIL score difference between groups.

† Met guidelines for sampling participation rates only after replacement schools were included.

‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

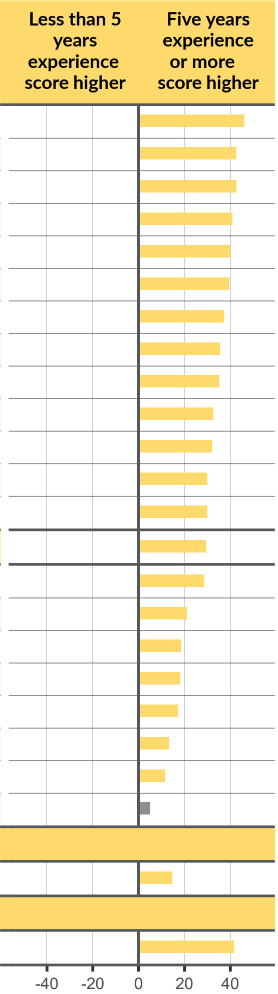
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

[2] Country surveyed target grade in the first half of the school year.

[3] National defined population covers 61% of the national target population.

Table 7.2: CT achievement by years of experience using computers

Country	Less than 5 years experience				Five years experience or more				Difference CT score averages	
	Percentage		Average score		Percentage		Average score		Five years experience or more - Less than 5 years experience	
Slovak Republic	43	(1.1)	473	(4.8)	57	(1.1)	519	(3.9)	**46**	(4.7)
† Uruguay	42	(1.2)	398	(5.2)	58	(1.2)	440	(4.4)	**43**	(5.0)
Finland	31	(1.1)	476	(6.5)	69	(1.1)	519	(4.9)	**43**	(4.9)
1 Sweden	32	(0.9)	461	(5.5)	68	(0.9)	502	(5.0)	**41**	(4.9)
Malta	35	(1.0)	417	(4.0)	65	(1.0)	456	(4.6)	**40**	(6.4)
†1 Denmark	27	(1.2)	476	(5.9)	73	(1.2)	515	(3.4)	**39**	(5.8)
1 Norway (Grade 9)	27	(0.8)	463	(5.2)	73	(0.8)	500	(3.6)	**37**	(5.3)
Chinese Taipei	65	(0.8)	537	(3.8)	35	(0.8)	572	(4.5)	**35**	(3.5)
† Belgium (Flemish)	49	(1.2)	492	(6.5)	51	(1.2)	527	(6.9)	**35**	(5.5)
† Korea, Republic of	60	(0.8)	526	(3.4)	40	(0.8)	559	(4.2)	**32**	(4.3)
1 Portugal	43	(0.9)	467	(4.5)	57	(0.9)	499	(4.0)	**32**	(3.9)
1 Latvia	38	(1.2)	478	(6.3)	62	(1.2)	508	(5.4)	**30**	(5.3)
1 Serbia	33	(0.9)	405	(5.6)	67	(0.9)	434	(5.3)	**30**	(4.5)
ICILS 2023 average	46	(0.2)	468	(1.1)	54	(0.2)	498	(1.0)	**29**	(1.0)
1 Croatia	35	(1.2)	412	(5.9)	65	(1.2)	441	(4.6)	**28**	(6.2)
Italy	57	(1.0)	474	(3.5)	43	(1.0)	495	(3.1)	**21**	(3.6)
Luxembourg	57	(0.7)	470	(3.0)	43	(0.7)	488	(3.3)	**18**	(4.0)
1 Czech Republic	48	(0.7)	518	(3.4)	52	(0.7)	536	(3.1)	**18**	(3.0)
1 Austria	62	(1.1)	471	(4.3)	38	(1.1)	488	(4.6)	**17**	(4.5)
France	61	(0.9)	496	(4.3)	39	(0.9)	509	(4.2)	**13**	(4.1)
Germany	60	(1.1)	479	(5.1)	40	(1.1)	491	(4.9)	**12**	(5.7)
1 Slovenia	55	(1.1)	448	(3.5)	45	(1.1)	453	(4.0)	5	(4.0)
Benchmarking participant										
1 North Rhine-W. (Germany)	58	(1.0)	459	(5.1)	42	(1.0)	474	(5.2)	**15**	(6.6)
Country not meeting sample participation requirements										
‡ United States	33	(1.7)	435	(9.0)	67	(1.7)	476	(8.3)	**42**	(9.2)



Difference between groups statistically significant (p<0.05)
Difference between groups not statistically significant

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant differences (p<0.05) between subgroups are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements. Countries are ranked in descending order of the CT score difference between groups.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

Frequency of ICT use

We asked students how often they used ICT in different places: at school for schoolwork, at school for other purposes, outside of school for schoolwork, and outside of school for other purposes. We further distinguished between school days and non-school days in the questions for students relating to ICT use outside of school. Students had seven response options available ("never," "less than once a month," "at least once a month but not every week," "at least once a week but not every day," "every day less than one hour," "every day at least one but less than two hours," "every day at least two hours and less than three hours," and "every day three hours or more"). For reporting purposes the last four categories have been combined to constitute "daily use."

On average across countries about one third of students reported on daily use of ICT on school days at school for both, school and other purposes (Table 7.3). The responses of students varied across countries. In Slovenia and Chinese Taipei the fewest students reported daily use of ICT at school for schoolwork (11% and 13% respectively), while in Italy and Slovenia the fewest students reported about daily use of ICT at school for other purposes (11% and 13% respectively). On the other hand, daily use of ICT at school was reported by most students in Denmark and Sweden where more than four out of five students reported daily use of ICT for schoolwork and around two out of three for other purposes.

Slightly less than half of students (47%) on average across countries reported daily use of ICT outside of school for schoolwork on school days, with the highest percentages in Belgium (Flemish) and Italy (68% in both countries), and France (66%), and the lowest in Chinese Taipei and Finland (29% and 27% respectively). The student reports on daily use of ICT outside of school for schoolwork are a little lower for non school days than for school days. Across countries slightly more than one third (37%) of students reported daily use of ICT for schoolwork on non-school days, ranging from 15 percent in Finland to 57 percent in Italy and Kazakhstan.

Majorities of students across countries reported daily ICT use outside of school for other (i.e., non school-related) purposes on school days and on non-school days. Three out of four students across countries reported daily ICT use outside school for other purposes on school days, with the lowest percentage in Azerbaijan (55%) and the highest in Austria, Hungary, and Serbia (85% or more). Students' reported daily use of ICT for other purposes outside school on non-school days was very similar to their reported use of ICT for other purposes on school days. The majority of students reported ICT use for purposes excluding schoolwork. In many countries, less students reported using ICT at least daily for schoolwork than for other purposes. This applies to both, at school and outside of school. Further, Denmark, Norway, and Sweden are the only three countries where more than two thirds of the students report daily use of ICT for schoolwork at school. As many students report daily use of ICT for schoolwork outside school on school days in Belgium (Flemish), France, and Italy.

There was variation among countries in the overall reported daily use across the purposes, times, and places. In Latvia and Uruguay the percentage of students reporting daily use for each of the six combinations of purposes, times, and places was statistically significantly higher than the ICILS international average (Table 7.3), in Serbia and Belgium (Flemish) this is true for five out of six combinations. In Chinese Taipei and Korea (Rep. of) the opposite is true. Statistically significantly fewer students, compared to the ICILS international average, reported daily use of ICT for each of the six combinations.

Table 7.3: Students' use of ICT

Country	Percentage of students reporting at least daily ICT use					
	On school days: At school for schoolwork	**On school days: At school for other purposes**	**On school days: Outside of school for schoolwork**	**On school days: Outside of school for other purposes**	**On non school days: Outside of school for schoolwork**	**On non school days: Outside of school for other purposes**
[1] Austria	17 (1.1) ▽	30 (1.5) ▽	37 (1.2) ▽	85 (0.6) ▲	23 (1.0) ▽	79 (0.7) ▲
Azerbaijan	34 (1.0)	[r]21 (0.9) ▽	[s]40 (1.5) ▽	[s]55 (1.8) ▽	[r]41 (1.1) ▲	[r]58 (1.3) ▽
† Belgium (Flemish)	59 (1.7) ▲	43 (1.8) ▲	68 (1.2) ▲	76 (1.0)	51 (1.1) ▲	78 (0.9) ▲
[3] Bosnia and Herzegovina	21 (1.4) ▽	29 (1.8) ▽	44 (1.8)	80 (1.3) ▲	37 (1.4)	77 (1.2) ▲
Chinese Taipei	13 (0.7) ▽	14 (0.8) ▽	29 (1.0) ▽	61 (1.0) ▽	29 (1.0) ▽	67 (0.9) ▽
[1] Croatia	21 (1.1) ▽	38 (1.5) ▲	42 (1.2) ▽	77 (0.9)	31 (1.3) ▽	74 (0.9)
Cyprus	27 (1.1) ▽	41 (1.4) ▲	39 (1.0) ▽	75 (1.0)	33 (0.8) ▽	74 (1.0)
[1] Czech Republic	16 (0.9) ▽	33 (1.5)	40 (0.9) ▽	79 (0.7) ▲	26 (0.6) ▽	78 (0.7) ▲
†[1] Denmark	87 (0.8) ▲	66 (1.3) ▲	41 (1.5) ▽	77 (1.1)	27 (1.2) ▽	78 (1.1) ▲
Finland	30 (1.6)	52 (1.2) ▲	27 (1.0) ▽	70 (1.0) ▽	15 (0.8) ▽	67 (0.9) ▽
France	19 (1.1) ▽	14 (0.8) ▽	66 (1.1) ▲	84 (0.6) ▲	53 (1.0) ▲	84 (0.6) ▲
Germany	25 (2.0) ▽	35 (1.4)	39 (1.5) ▽	84 (0.9) ▲	22 (1.0) ▽	80 (0.9) ▲
Greece	22 (1.0) ▽	18 (0.9) ▽	38 (1.0) ▽	78 (0.9) ▲	32 (1.0) ▽	75 (1.0)
Hungary	15 (1.0) ▽	31 (1.5) ▽	37 (1.1) ▽	85 (0.8) ▲	29 (1.0) ▽	83 (1.1) ▲
Italy	19 (1.3) ▽	11 (0.8) ▽	68 (1.2) ▲	80 (0.8) ▲	57 (1.1) ▲	78 (0.8) ▲
[1] Kazakhstan	56 (1.0) ▲	50 (1.0) ▲	[r]60 (1.2) ▲	[r]70 (0.9) ▽	57 (0.9) ▲	71 (0.9) ▽
† Korea, Republic of	22 (0.9) ▽	30 (1.0) ▽	36 (0.9) ▽	68 (1.0) ▽	32 (0.9) ▽	67 (0.9) ▽
[1] Kosovo	30 (1.1) ▽	22 (0.9) ▽	[y]	[y]	44 (1.1) ▲	58 (1.1) ▽
[1] Latvia	42 (1.2) ▲	55 (1.5) ▲	63 (1.3) ▲	79 (0.9) ▲	51 (1.1) ▲	76 (1.0) ▲
Luxembourg	49 (1.0) ▲	53 (0.9) ▲	53 (1.1) ▲	72 (0.7) ▽	41 (0.9) ▲	70 (0.7) ▽
Malta	21 (0.9) ▽	16 (0.9) ▽	57 (1.1) ▲	74 (0.8) ▽	50 (1.0) ▲	73 (0.8)
[1] Norway (Grade 9)	72 (1.1) ▲	53 (1.2) ▲	49 (1.4)	68 (0.8) ▽	29 (1.0) ▽	67 (0.9) ▽
Oman	37 (0.8) ▲	26 (0.7) ▽	51 (0.8) ▲	60 (0.7) ▽	47 (0.7) ▲	65 (0.7) ▽
[1] Portugal	26 (1.1) ▽	52 (1.1) ▲	38 (1.2) ▽	74 (0.9)	30 (1.1) ▽	73 (0.8)
†[1,2] Romania	29 (1.3) ▽	32 (1.7)	[r]51 (1.4) ▲	[r]74 (1.1)	46 (1.4) ▲	72 (1.4)
[1] Serbia	28 (1.1) ▽	47 (1.2) ▲	52 (1.1) ▲	86 (0.7) ▲	41 (1.2) ▲	83 (0.7) ▲
Slovak Republic	17 (1.0) ▽	24 (1.5) ▽	51 (1.3) ▲	83 (0.7) ▲	34 (1.0) ▽	80 (0.8) ▲
[1] Slovenia	11 (0.6) ▽	13 (0.8) ▽	40 (1.1) ▽	81 (0.7) ▲	33 (1.0) ▽	79 (0.8) ▲
[1] Spain	33 (1.7)	22 (0.8) ▽	60 (1.0) ▲	76 (0.7)	47 (0.9) ▲	74 (0.6)
[1] Sweden	83 (1.1) ▲	63 (1.3) ▲	44 (1.2) ▽	68 (1.0) ▽	29 (1.1) ▽	68 (1.0) ▽
† Uruguay	45 (1.6) ▲	54 (1.8) ▲	[r]53 (1.1) ▲	[r]80 (1.1) ▲	44 (1.1) ▲	[r]80 (1.1) ▲
ICILS 2023 average	33 (0.2)	35 (0.2)	47 (0.2)	75 (0.2)	37 (0.2)	74 (0.2)
Benchmarking participant						
[1] North Rhine-W. (Germany)	33 (2.8)	41 (1.8) ▲	39 (1.8) ▽	82 (1.3) ▲	24 (1.4) ▽	79 (1.3) ▲
Country not meeting sample participation requirements						
‡ United States	72 (1.2) ▲	51 (1.6) ▲	46 (1.7)	59 (1.4) ▽	30 (1.3) ▽	56 (1.4) ▽

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.
[r] indicates data are available for at least 70% but less than 85% of the students.
[s] indicates data are available for at least 50% but less than 70% of the students.
[y] indicates data are available for less than 40% of the students and not reported.

Screen time limit

Parents play an essential role in helping students find a healthy balance for the use of ICT (Alotaibi, 2019; Lee et al., 2022). They can set clear boundaries by establishing rules and limits around screen time and device use (Uludasdemir & Kucuk, 2019). This includes setting specific time limits, as well as guidelines for appropriate content and activities. They can further model healthy digital behavior by demonstrating responsible device use themselves; encouraging open conversations about digital use to understand their children's experiences and concerns; and promote alternatives to ICT use for both learning and other outside-school activities.

In ICILS 2023 students were asked whether their parents or guardians place a limit on the amount of screen time outside of school. Students had to distinguish their response between school days and non-school days (e.g., weekends and holidays). This was an optional question that was administered in 29 countries and the United States, which however did not meet the sampling requirements. The results reveal large variations among countries (Table 7.4). Between 22 percent (Kosovo) and 75 percent (Denmark) of the students report having no screen time limit set by their parents on school days. In addition to Denmark, more than 70 percent of students reported having no screen time limits from the north-European countries Finland, Sweden, and Latvia. On non-school days, the variation between countries regarding screen time limits set by parents is smaller, although overall higher proportions of students reported having no limits. For example, in Kosovo, twice as many students reported to have no screen time limit set on non-school days compared to school days, while just four percent more students reported no limit on non-school days in Denmark (79%). On average across countries, more than half of the students reported having no screen time limit set by their parents on school days, and almost three quarters on non-school days. Additional analysis (not presented in tables in this report) showed that, out of those who reported to have a limit, roughly half stated that it does not include time spent on screen for school work.

We were interested whether having a screen time limit or not is related to CIL achievement. Again, there is noticeable variation across countries (Table 7.5). In 16 of the 29 countries administering this question, we observed statistically significant differences in CIL scores between students with and without a limit on screen time set by parents, on school days. In 14 out of these 16 countries, students without a limit show higher CIL achievement. These differences ranged from eight scale score points in Italy to 41 scale score points in Kazakhstan. In Chinese Taipei and Oman, students with screen time limits demonstrated statistically significantly higher achievement than those without. In 13 countries, the gap was small and insignificant. Further research may help to better understand the differences among countries regarding choices to implement screen time limits, attitudes toward screen time and the expectations of parents with respect to their children's work on computers.

Table 7.4: Students reporting their parents or guardians placing no limit on the amount of screen time, on school days and non-school days

Country	Percentage of students reporting no screen time limit placed by parents or guardians	
	On school days	On non-school days (e.g., weekends and holidays)
[1] Austria	68 (0.9) ▲	81 (0.7) ▲
Azerbaijan	[r]30 (1.2) ▽	[r]45 (1.6) ▽
[3] Bosnia and Herzegovina	52 (1.4) ▽	[r]76 (1.3) ▲
Chinese Taipei	45 (1.0) ▽	62 (0.9) ▽
[1] Croatia	58 (1.3)	[r]77 (1.1) ▲
Cyprus	57 (1.4)	[r]75 (0.9) ▲
[1] Czech Republic	65 (0.8) ▲	76 (0.5) ▲
[†1] Denmark	75 (1.1) ▲	79 (1.1) ▲
Finland	74 (0.8) ▲	82 (0.6) ▲
France	52 (1.1) ▽	69 (0.9) ▽
Greece	47 (1.1) ▽	[r]68 (1.1) ▽
Hungary	66 (1.1) ▲	81 (0.9) ▲
Italy	58 (1.1)	74 (0.9) ▲
[1] Kazakhstan	54 (1.2)	68 (1.0) ▽
[†] Korea, Republic of	69 (0.9) ▲	78 (1.0) ▲
[1] Kosovo	[r]22 (1.0) ▽	[s]45 (1.4) ▽
[1] Latvia	72 (1.1) ▲	80 (0.9) ▲
Luxembourg	57 (0.7)	[r]70 (0.8) ▽
Malta	58 (1.0) ▲	78 (1.0) ▲
[1] Norway (Grade 9)	66 (0.9) ▲	77 (1.0) ▲
Oman	27 (0.7) ▽	53 (0.9) ▽
[1] Portugal	58 (1.1) ▲	77 (0.8) ▲
[†12] Romania	[r]48 (1.6) ▽	[r]71 (1.4)
[1] Serbia	63 (1.1) ▲	[r]78 (1.1) ▲
Slovak Republic	57 (1.1)	71 (0.9)
[1] Slovenia	44 (1.2) ▽	64 (1.1) ▽
[1] Spain	41 (0.7) ▽	68 (0.7) ▽
[1] Sweden	74 (1.2) ▲	83 (1.0) ▲
[†] Uruguay	[r]52 (1.2) ▽	[r]73 (1.1)
ICILS 2023 average	56 (0.2)	72 (0.2)
Country not meeting sample participation requirements		
[‡] United States	61 (1.2) ▲	78 (1.3) ▲

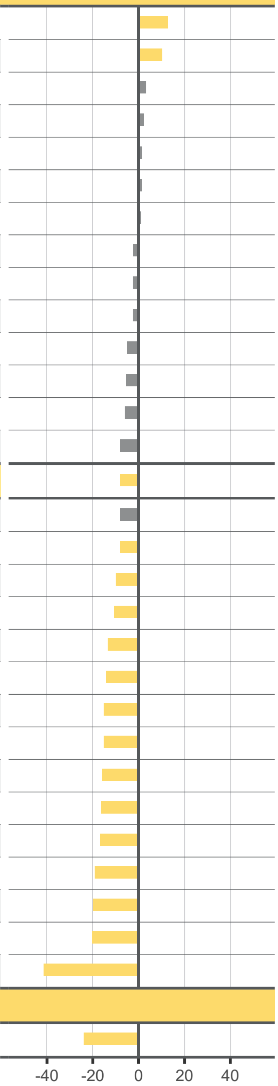
▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. This question was omitted from the questionnaire in Germany and North-Rhine Westphalia (Germany).

[†] Met guidelines for sampling participation rates only after replacement schools were included.
[‡] Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.
[r] indicates data are available for at least 70% but less than 85% of the students.
[s] indicates data are available for at least 50% but less than 70% of the students.

Table 7.5: Percentage of students reporting their parents or guardians placing or not placing a limit on the amount of screen time, on school days, and relation with CIL

Country	No parental limit		With parental limit		Difference CIL score averages		
	Percentage	Average score	Percentage	Average score	With parental limit - No parental limit	No parental limit score higher	With parental limit score higher
Chinese Taipei	45 (1.0)	514 (3.0)	55 (1.0)	526 (3.2)	**13** (2.8)		
Oman	27 (0.7)	377 (4.3)	73 (0.7)	387 (2.9)	**10** (3.7)		
France	52 (1.1)	504 (2.8)	48 (1.1)	507 (2.9)	3 (2.6)		
[1] Slovenia	44 (1.2)	489 (2.6)	56 (1.2)	492 (2.9)	2 (3.3)		
† Korea, Republic of	69 (0.9)	544 (2.5)	31 (0.9)	545 (3.4)	2 (2.9)		
[1] Spain	41 (0.7)	501 (2.2)	59 (0.7)	502 (2.1)	1 (2.5)		
Finland	74 (0.8)	514 (2.7)	26 (0.8)	516 (5.3)	1 (4.2)		
[1] Norway (Grade 9)	66 (0.9)	512 (2.6)	34 (0.9)	509 (3.5)	-2 (3.4)		
[1] Czech Republic	65 (0.8)	530 (1.9)	35 (0.8)	527 (2.5)	-2 (1.7)		
†[1] Denmark	75 (1.1)	524 (2.5)	25 (1.1)	522 (4.4)	-2 (4.5)		
[1] Austria	68 (0.9)	512 (2.5)	32 (0.9)	507 (3.5)	-5 (3.1)		
Slovak Republic	57 (1.1)	506 (2.7)	43 (1.1)	500 (3.6)	-5 (3.6)		
Greece	47 (1.1)	469 (3.7)	53 (1.1)	463 (3.7)	-6 (3.2)		
Hungary	66 (1.1)	512 (3.3)	34 (1.1)	504 (4.7)	-8 (4.1)		
ICILS 2023 average	56 (0.2)	484 (0.7)	44 (0.2)	476 (0.7)	**-8** (0.8)		
[1] Croatia	58 (1.3)	499 (4.3)	42 (1.3)	491 (4.4)	-8 (5.4)		
Italy	58 (1.1)	497 (2.4)	42 (1.1)	489 (3.1)	**-8** (2.8)		
Luxembourg	57 (0.7)	506 (2.3)	43 (0.7)	496 (2.4)	**-10** (2.7)		
[1] Serbia	63 (1.1)	455 (3.6)	37 (1.1)	444 (4.6)	**-11** (3.8)		
Cyprus	57 (1.4)	474 (3.2)	43 (1.4)	460 (3.9)	**-13** (4.6)		
[1] Kosovo	22 (1.0)	375 (6.8)	78 (1.0)	361 (4.1)	**-14** (6.1)		
Malta	58 (1.0)	493 (3.3)	42 (1.0)	478 (3.8)	**-15** (4.1)		
[1] Sweden	74 (1.2)	516 (2.8)	26 (1.2)	501 (4.1)	**-15** (4.2)		
[3] Bosnia and Herzegovina	52 (1.4)	454 (5.0)	48 (1.4)	438 (4.4)	**-16** (5.8)		
[1] Latvia	72 (1.1)	517 (3.4)	28 (1.1)	501 (5.2)	**-16** (4.4)		
† Uruguay	52 (1.2)	467 (4.2)	48 (1.2)	450 (4.2)	**-17** (4.6)		
†[1,2] Romania	48 (1.6)	442 (4.9)	52 (1.6)	423 (5.5)	**-19** (5.0)		
Azerbaijan	30 (1.2)	346 (7.6)	70 (1.2)	326 (4.7)	**-20** (6.3)		
[1] Portugal	58 (1.1)	524 (2.6)	42 (1.1)	504 (3.6)	**-20** (3.0)		
[1] Kazakhstan	54 (1.2)	431 (3.3)	46 (1.2)	390 (3.8)	**-41** (3.8)		
Country not meeting sample participation requirements							
‡ United States	61 (1.2)	503 (6.0)	39 (1.2)	480 (8.5)	**-24** (6.5)		



Difference between groups statistically significant (p<0.05)
Difference between groups not statistically significant

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant differences (p<0.05) between subgroups are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. This question was omitted from the questionnaire in Germany and North-Rhine Westphalia (Germany). Countries are ranked in descending order of the CIL score difference between groups.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.

Academic-media multitasking

Using digital devices to conduct non-school work related activities while conducting school work, a relatively new phenomenon called "academic-media multitasking," has been described by van der Schuur et al. (2020) and Rogobete et al. (2024). Academic-media multitasking refers to the simultaneous engagement in academic tasks (such as studying, reading, or completing assignments) and media-related activities (such as watching TV, browsing the internet, or using social media). This phenomenon has become increasingly common among students, particularly with the proliferation of digital devices and easy access to media content (Hasan & Khan, 2020). Students who engage in academic-media multitasking may switch back and forth between academic tasks and media activities, often dividing their attention among multiple sources of information and activities. While some students may believe that multitasking helps them stay productive or entertained, research suggests that it can actually impair academic performance and cognitive functioning, such as reduced concentration, lower comprehension of academic material, and decreased overall academic achievement (Alho et al., 2022; Braghieri et al., 2022; Marciano & Camerini, 2021). Additionally, excessive multitasking may contribute to feelings of stress, being overwhelmed, and difficulty managing time effectively (Abi-Jaoude et al., 2020).

Educators and researchers are interested in understanding the impact of academic-media multitasking on students' learning and well-being, as well as exploring strategies to help students manage their digital distractions and focus more effectively on academic tasks. In ICILS we asked students to indicate how often, outside of school, they do the following activities not related to their schoolwork at the same time as doing their schoolwork:

- Text chat with others (with any device including smartphones)
- Use social media (e.g., Instagram, TikTok, and Snapchat) to post or view content
- Check social media for new posts or responses to my posts
- Use the internet to find information about things that interest me
- Watch online videos, live streams or television (e.g., YouTube, Twitch, Netflix)
- Listen to music, podcasts, or the radio (on any device)

Students responded by selecting one of the following response options for each activity ("Never," "Almost Never," "Sometimes," "Often," "Very Often").

On average across countries and statements, about two-thirds of the students revealed they did the above-mentioned activities often or very often while doing school work (see Table D.1 in Appendix D). The only exception was *checking social media for new posts or responses to their own posts*, which was still done by only slightly less than half of the students often or very often, with about 30 percent of students reporting that they never or almost never do this. Twenty percent or less of the students reported that they never or almost never completed the other activities while doing schoolwork. These findings reveal that academic-media multitasking is common among students in ICILS countries.

We used data from the academic-media multitasking statements above to create a scale with results shown in Table 7.6. Higher scores on the scale indicate higher reported frequency of academic-media multitasking. The scale was established with an average score of 50 and a standard deviation of 10. The first two columns show the average scale score and the standard deviation for each participating entity with corresponding standard errors. The upward and downward pointing triangles presented with the averages indicate of whether each country average is statistically significantly different from the ICILS 2023 average. The chart in the center of the table shows a graphical representation of average scale score (and confidence interval) of each entity. The entities are sorted by their average scale value from the largest to the smallest. The last two columns show the association between the scale scores with each of CIL and CT scale scores in the form of Pearson's correlation coefficient. Correlation coefficients statistically significantly different from zero are shown in bold.

Even though the phenomenon is reported to be conducted sometimes, often, or very often by students across countries (all bars are located in the light-blue shaded area of the graph), students in Azerbaijan, Oman, and Kazakhstan reported less frequent academic-media multitasking behavior than students other countries (Table 7.6). Their country averages range between 44.0 and 46.4. The highest average scale scores for academic-media multitasking were observed in Malta and Greece (above 53 scale score points).

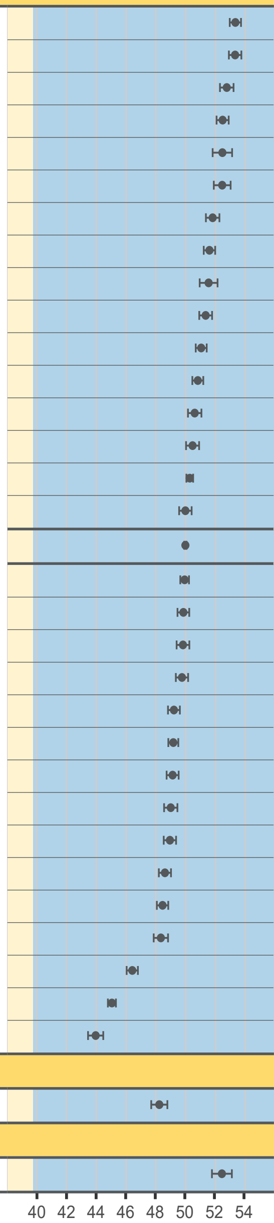
There was considerable variation in the correlations between academic-media multitasking and CIL achievement across countries. In 10 countries, there was a statistically significant negative correlation, meaning that more frequent academic-media multitasking is associated with lower CIL scores. However, these correlation coefficients are very small (all below 0.13). In contrast, in 11 countries the correlation coefficients were positive. The four largest positive associations between academic-media multitasking and CIL achievement were in four of the five countries with the lowest average recorded academic-media multitasking scale scores, Kosovo, Kazakhstan, Oman, and Azerbaijan. These four countries also showed the lowest average CIL scale scores (see Chapter 5, Table 5.1).

In contrast to the variation among countries in the association between academic-media multitasking and CIL achievement, the relationship with CT reveals a homogeneous pattern across countries, with statistically significantly negative coefficients in almost two thirds of the countries that administered the CT test. In 10 of these countries, there was also a statistically significant negative association between CIL achievement and academic-media multitasking scale scores, and in the remaining countries that completed the CT assessment there was no significant relationship between CIL achievement and academic-media multitasking. In eight of the 10 countries that did not administer the CT assessment, there was a statistically significant positive association between CIL achievement and academic-media multitasking. More research is required to better understand and explain the variations in the associations between academic-media multitasking behaviors and CIL and CT achievement among countries.

Table 7.6: National scale score averages indicating the extent of academic-media multitasking, and correlation with CIL and CT achievement

Country	Academic-media multitasking: Average scale score		Std. dev.	Correlation with achievement: CIL	CT
Malta	53.3 (0.2)	▲	11.4 (0.2)	**0.07** (0.03)	-0.04 (0.03)
Greece	53.3 (0.2)	▲	9.9 (0.2)	**0.10** (0.02)	
Cyprus	52.7 (0.2)	▲	11.0 (0.2)	**0.07** (0.02)	
[1] Portugal	52.5 (0.2)	▲	9.7 (0.1)	0.00 (0.02)	**-0.14** (0.02)
[3] Bosnia and Herzegovina	52.5 (0.3)	▲	10.3 (0.2)	**0.19** (0.02)	
[†12] Romania	52.4 (0.3)	▲	10.9 (0.2)	**0.20** (0.02)	
[†] Uruguay	51.8 (0.2)	▲	10.3 (0.2)	**0.13** (0.02)	0.03 (0.02)
Slovak Republic	51.6 (0.2)	▲	8.8 (0.2)	0.04 (0.02)	-0.04 (0.03)
[1] Croatia	51.5 (0.3)	▲	10.6 (0.2)	**0.12** (0.02)	0.04 (0.02)
[†1] Denmark	51.3 (0.2)	▲	10.4 (0.2)	**-0.06** (0.02)	**-0.15** (0.03)
France	51.0 (0.2)	▲	9.7 (0.1)	0.00 (0.02)	**-0.11** (0.02)
[†] Korea, Republic of	50.8 (0.2)	▲	10.0 (0.1)	-0.03 (0.02)	**-0.14** (0.02)
[1] Norway (Grade 9)	50.6 (0.2)	▲	11.1 (0.2)	**-0.04** (0.02)	**-0.13** (0.02)
[1] Serbia	50.5 (0.2)	▲	10.3 (0.2)	0.04 (0.02)	-0.03 (0.02)
[1] Czech Republic	50.3 (0.1)	▲	8.4 (0.1)	-0.03 (0.02)	**-0.11** (0.02)
[†] Belgium (Flemish)	50.0 (0.2)		9.9 (0.2)	**-0.05** (0.02)	**-0.14** (0.02)
ICILS 2023 average	50.0 (0.0)		9.7 (0.0)	**0.03** (0.00)	**-0.11** (0.00)
[1] Spain	49.9 (0.1)		9.6 (0.1)	0.02 (0.01)	
Hungary	49.8 (0.2)		8.8 (0.2)	0.05 (0.03)	
[1] Slovenia	49.8 (0.2)		9.5 (0.2)	0.01 (0.02)	**-0.07** (0.02)
[1] Latvia	49.7 (0.2)		9.7 (0.2)	0.04 (0.02)	-0.04 (0.03)
Italy	49.2 (0.2)	▽	9.2 (0.2)	**-0.05** (0.02)	**-0.14** (0.02)
Luxembourg	49.2 (0.2)	▽	9.2 (0.2)	**-0.09** (0.02)	**-0.16** (0.02)
Chinese Taipei	49.1 (0.2)	▽	11.0 (0.2)	**-0.09** (0.02)	**-0.12** (0.02)
[1] Sweden	49.0 (0.2)	▽	11.1 (0.2)	**-0.11** (0.02)	**-0.22** (0.02)
[1] Austria	48.9 (0.2)	▽	8.5 (0.2)	**-0.05** (0.02)	**-0.14** (0.02)
Finland	48.6 (0.2)	▽	10.6 (0.2)	**-0.12** (0.02)	**-0.19** (0.02)
[1] Kosovo	48.4 (0.2)	▽	8.0 (0.2)	**0.28** (0.02)	
Germany	48.3 (0.2)	▽	9.0 (0.2)	**-0.09** (0.03)	**-0.20** (0.02)
[1] Kazakhstan	46.4 (0.2)	▽	8.9 (0.1)	**0.25** (0.02)	
Oman	45.1 (0.1)	▽	8.6 (0.2)	**0.20** (0.02)	
Azerbaijan	[r] 44.0 (0.3)	▽	8.1 (0.2)	**0.22** (0.02)	
Benchmarking participant					
[1] North Rhine-W. (Germany)	48.2 (0.3)	▽	9.4 (0.3)	-0.02 (0.07)	**-0.13** (0.06)
Country not meeting sample participation requirements					
[‡] United States	52.4 (0.3)	▲	11.1 (0.2)	-0.04 (0.03)	**-0.15** (0.03)

Avg. with confidence interval



▲ Average significantly higher than ICILS 2023 average.

▽ Average significantly lower ICILS 2023 average.

Country average [+/- 95% C.I.]:

On average across items, students with a score in the range with this color have more than 50% probability to indicate:

Never or almost Never

Sometimes, often, or very often

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant correlations (p<0.05) are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Countries are ranked in descending order of the average scale score.

[†] Met guidelines for sampling participation rates only after replacement schools were included.

[‡] Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

[2] Country surveyed target grade in the first half of the school year.

[3] National defined population covers 61% of the national target population.

[r] indicates data are available for at least 70% but less than 85% of the students.

Use of ICT during school lessons

ICT use can be conceptualized and organized in two ways (Goldhammer et al., 2016). The first is a tool-oriented approach, which refers to the use of various software and network applications (e.g., word processing, spreadsheets, e-mail, etc.). The second is the task-oriented approach, which refers to how ICT can be used to solve problems or complete tasks (e.g., evaluate, communicate, create information represented by ICT, etc.). Unlike the tool-oriented approach, the task-oriented approach does not depend on how software applications are designed; the task is important by itself regardless of how it is performed at the technical level. In ICILS, we collect information about both the use of tools and the extent to which certain ICT tasks were learned. The use of tools by students is addressed in this section, later in this chapter we address students' perceptions of the degree to which they believe to have learned about a range of digital-literacy related tasks.

The use of various software tools during lessons has been measured in previous ICILS cycles. In ICILS 2018 we asked students about the use of digital tools and software during lessons. The software tools used by students were classified as either general or specialist applications (Fraillon et al., 2020). For ICILS 2023 we modified and extended the list of digital tools to account for changes in technology since 2018. Students were asked to report how often they had used each of the listed tools during lessons throughout the school year. Students responded by selecting one of the available response options for each statement ("in some lessons," "in most lessons," and "in every lesson or almost every lesson").

The following tools were categorized as general tools, and students' responses were summarized into a scale that reflected students' use of general ICT applications in class (examples of tools are included that could be adapted by national centers to fit their national context):

- Word-processing software (e.g., Microsoft Word, Apple Pages, Google Docs)
- Presentation software (e.g., Microsoft PowerPoint, Apple Keynote, Google Slides)
- Spreadsheets (e.g., Microsoft Excel, Apple Numbers, Google Sheets)
- Computer-based information resources (e.g., websites, wikis, encyclopedia)

The following tools were categorized as specialist tools, and students' responses were summarized into a scale that reflected students' use of specialist ICT applications in class (examples of tools are included that could be adapted by national centers to fit their national context):

- Multimedia production tools (e.g., video editing, audio/music mixing, animation)
- Concept mapping software (e.g., Inspiration, Webspiration)
- Tools that capture real-world data (e.g., speed, temperature) digitally for analysis
- Simulations and modeling software (e.g., physics simulators)
- Interactive digital learning resources (e.g., learning games or apps)
- Drawing and graphic design software (e.g., logo design, poster design, character illustration)
- A video conferencing system (e.g., Zoom, WebEx GoTo Meeting, Google Meet)
- A computer programming/coding environment (e.g., Python, LUA, Javascript, Scratch)

The tool *learning management system* was included in the question but resulting data did not contribute to either of the two scales. The results based on pooled international data for items included in the scale describing general tools are presented with the item maps in Appendix D (see Table D.3). On average across countries, one in three students reported to have used *Word-processing*, *presentation software*, or *computer based information resources* at least in most lessons. One in five students on average across countries reported on the use of *spreadsheets* in at least most lessons. Few students reported never using the four tools during lessons, 14 percent for *presentation software*, 21 percent for *Word processing software* and 23 percent for *computer based information resources*. However, about one third of students reported never using *spreadsheets*. Taken together, these results suggest that general tools are often used during lessons across countries. There were large differences between countries in the frequency of use of general tools (see Table D.4 in Appendix D). For example, in Norway, 86 percent of students reported using *presentation software* in at least most of the lessons, while in Chinese Taipei 13 percent of students reported this. These two countries also have the highest and lowest percentages of students who reported using other general tools at least most of the lessons. Across all four items, 74 percent of Norwegian students reported using the general tools at least in most lessons. In Chinese Taipei, however, 11 percent of students reported using these general tools.

Using data associated with the four general tools we created the scale *students' use of general ICT applications in class* that showed acceptable psychometric properties. As described at the beginning of this chapter, the scale was established with an average of 50 and a standard deviation of 10 based on equally weighted data from countries meeting the participation requirements (excluding Romania). Higher scale scores indicate a more frequent use of general tools during lessons. The scale averages of the use of general applications in class and their relation to achievement vary across countries (Table 7.7). While students from Chinese Taipei, Korea (Rep. of), Germany, North Rhine-Westphalia (Germany), and Slovenia show the lowest average scale values (45.5 or lower), by far the most frequent use was reported by the Norwegian students (62.3).

The correlation between *students' use of general ICT applications in class* scale scores and achievement is presented in the last two columns of Table 7.7. The magnitude of the correlation coefficients of the scale values with CIL achievement are very low, between -0.09 and 0.14, in all participating entities but Norway. In 23 countries the correlation is, however, statistically significant. In Norway the correlation exceeds 0.2. A very similar pattern is observed for the correlations of the *students' use of general ICT applications in class* scale scores and CT. In 12 out of 22 entities the correlation is statistically significant but very low (between -0.11 and 0.10), with the exception of Norway, where the correlation again exceeds 0.2. It seems that in Norway general ICT applications are used often compared to other countries and we can observe a positive relationship with achievement.

In contrast to the general applications, the specialist applications serve a more narrow purpose for more specialized tasks. As expected, and consistent with ICILS 2018 (Fraillon et al., 2020), the use of specialist ICT applications in class was less frequent than the use of the general ones (see Table D.5 in Appendix D). According to the pooled international results students across countries reported on a rather less frequent use of *concept mapping software*, 63 percent of students reported that they never use it in class. *Simulations and modeling software* were also mainly never used in lessons, as reported by 58 percent of students across countries. The most commonly used specialist applications were *interactive digital learning resources*, more than two-thirds of the students reported their use in at least some lessons. The differences between the countries in the use of specialist tools are smaller than the differences in the use of general tools (see Table D.6 in Appendix D). Among the specialist tools, we observe the lowest percentage of students (3 or 4%) who reported using *concept mapping software* in at least most lessons in Chinese Taipei, Germany, and North Rhine-Westphalia (Germany). The highest percentage is observed in Norway where 70 percent of students reported using *interactive digital learning resources*.

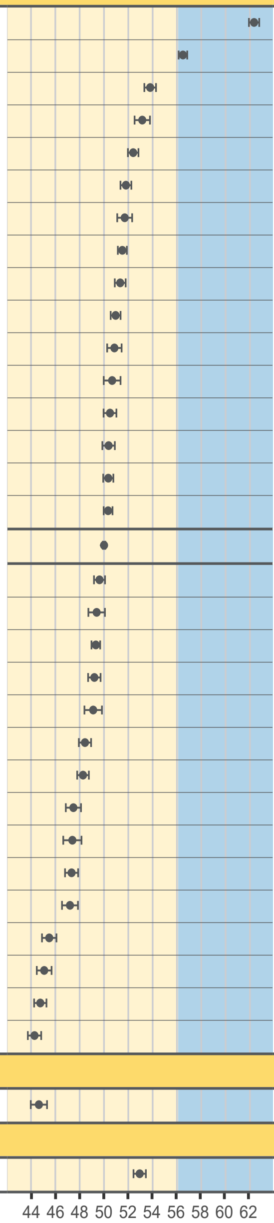
The results for the scale *students' use of specialist ICT applications in class* are presented in Table 7.8. The scale was established with an average score of 50 and a standard deviation of 10. Similar to what has been observed for the general applications, students from Austria, Germany, North Rhine-Westphalia (Germany), and Slovenia reported the least use of specialist tools (with average scores of 46.1 or less), and again students from Norway reported the most use (56.7).

The association between the reported use of specialist tools and student achievement is very different to that previously reported between general tools and achievement. The relationship is negative and statistically significant in all but one participating education system, i.e., students reporting more frequent use of specialist applications in the classroom have lower achievement in each of CIL and CT. The correlation coefficient exceeds -0.2 in eight countries and is highest in Hungary, Portugal, Sweden, and Uruguay, when focusing on CIL. We observed a similar pattern for the relationship with CT, where the correlation coefficient exceeded -0.2 in Denmark, Luxembourg, Portugal, Sweden, and Uruguay. A similar negative relationship between achievement and specialists applications was already found in ICILS 2018 (Fraillon et al., 2020). This finding calls for further in-depth investigation although one possible explanation could be that the listed specialist applications are more frequently used by lower achieving students than higher achieving students as learning support tools.

Table 7.7: National scale score averages indicating the extent of students' use of general ICT applications in class, and correlation with CIL and CT achievement

Country	Students' use of general ICT applications in class: Average scale score		Std. dev.	Correlation with achievement: CIL	CT
[1] Norway (Grade 9)	62.3 (0.2)	▲	8.3 (0.2)	**0.25** (0.02)	**0.23** (0.02)
[†1] Denmark	56.5 (0.2)	▲	7.5 (0.2)	**0.14** (0.02)	**0.10** (0.02)
[1] Sweden	53.8 (0.2)	▲	8.2 (0.2)	**0.08** (0.03)	**0.06** (0.03)
[1] Kazakhstan	53.1 (0.3)	▲	10.3 (0.2)	**0.09** (0.02)	
[1] Portugal	52.4 (0.2)	▲	8.4 (0.2)	0.02 (0.02)	-0.04 (0.02)
[1] Latvia	51.8 (0.2)	▲	7.7 (0.2)	**0.13** (0.02)	**0.09** (0.02)
[1] Kosovo	51.7 (0.3)	▲	10.0 (0.2)	**0.11** (0.03)	
Oman	51.5 (0.2)	▲	10.2 (0.1)	0.00 (0.02)	
Slovak Republic	51.3 (0.2)	▲	9.2 (0.2)	**0.11** (0.02)	**0.09** (0.02)
Finland	51.0 (0.2)	▲	7.4 (0.1)	**0.13** (0.02)	**0.11** (0.02)
[†12] Romania	50.9 (0.3)	▲	10.5 (0.3)	0.04 (0.03)	
[1] Croatia	50.7 (0.4)		10.5 (0.3)	**0.05** (0.02)	0.03 (0.02)
[†] Uruguay	50.5 (0.3)		8.9 (0.2)	0.00 (0.02)	0.00 (0.03)
Hungary	50.4 (0.3)		9.1 (0.2)	**0.12** (0.03)	
[†] Belgium (Flemish)	50.4 (0.2)		7.0 (0.2)	0.05 (0.04)	0.03 (0.03)
[1] Serbia	50.3 (0.2)		10.0 (0.2)	**0.10** (0.02)	**0.07** (0.02)
ICILS 2023 average	50.0 (0.0)		9.3 (0.0)	**0.07** (0.00)	**0.03** (0.01)
Cyprus	49.6 (0.2)		11.1 (0.2)	**0.11** (0.03)	
Greece	49.4 (0.3)		11.0 (0.2)	**0.10** (0.02)	
Luxembourg	49.3 (0.2)	▽	8.4 (0.1)	**-0.06** (0.02)	**-0.09** (0.02)
[1] Spain	49.2 (0.3)	▽	9.3 (0.1)	**0.07** (0.02)	
[3] Bosnia and Herzegovina	49.1 (0.4)	▽	10.9 (0.2)	**0.08** (0.03)	
France	48.4 (0.3)	▽	8.3 (0.2)	**0.06** (0.02)	0.03 (0.03)
Malta	48.3 (0.2)	▽	10.8 (0.2)	0.02 (0.03)	-0.01 (0.03)
[1] Czech Republic	47.5 (0.3)	▽	9.1 (0.2)	**0.09** (0.02)	**0.08** (0.02)
Azerbaijan	[r] 47.4 (0.4)	▽	12.0 (0.2)	**0.10** (0.03)	
[1] Austria	47.3 (0.3)	▽	8.4 (0.2)	**-0.09** (0.02)	**-0.11** (0.03)
Italy	47.2 (0.3)	▽	9.4 (0.2)	0.05 (0.03)	0.02 (0.03)
[†] Korea, Republic of	45.5 (0.3)	▽	9.5 (0.2)	0.00 (0.02)	-0.01 (0.02)
Germany	45.1 (0.3)	▽	8.4 (0.2)	0.03 (0.03)	0.01 (0.03)
Chinese Taipei	44.8 (0.3)	▽	9.7 (0.2)	**0.10** (0.02)	**0.09** (0.02)
[1] Slovenia	44.3 (0.3)	▽	9.9 (0.2)	**-0.05** (0.02)	-0.03 (0.02)
Benchmarking participant					
[1] North Rhine-W. (Germany)	44.6 (0.3)	▽	8.9 (0.2)	**0.12** (0.03)	**0.11** (0.03)
Country not meeting sample participation requirements					
[‡] United States	52.9 (0.3)	▲	9.2 (0.3)	**0.10** (0.03)	0.03 (0.03)

Avg. with confidence interval



▲ Average significantly higher than ICILS 2023 average.

▽ Average significantly lower ICILS 2023 average.

Country average [+/- 95% C.I.]:

On average across items, students with a score in the range with this color have more than 50% probability to indicate:

Never or in some lessons

In most lessons, in every or almost every lesson

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant correlations (p<0.05) are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Countries are ranked in descending order of the average scale score.

[†] Met guidelines for sampling participation rates only after replacement schools were included.

[‡] Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

[2] Country surveyed target grade in the first half of the school year.

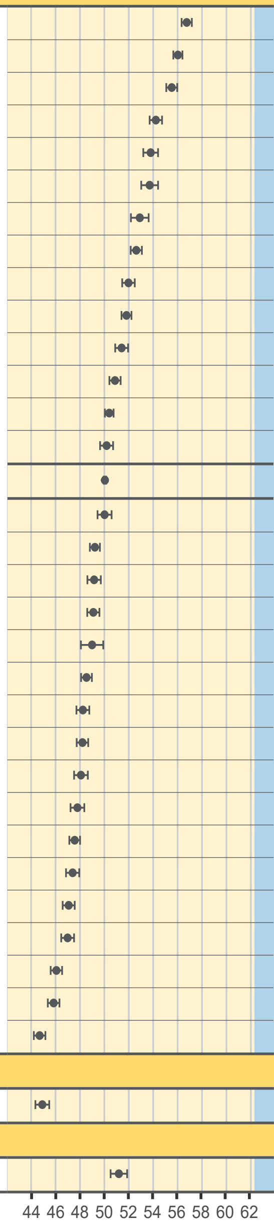
[3] National defined population covers 61% of the national target population.

[r] indicates data are available for at least 70% but less than 85% of the students.

Table 7.8: National scale score averages indicating the extent of students' use of specialist ICT applications in class, and correlation with CIL and CT achievement

	Students' use of specialist ICT applications in class			Correlation with achievement	
Country	**Average scale score**		**Std. dev.**	**CIL**	**CT**
[1] Norway (Grade 9)	56.7 (0.2)	▲	7.7 (0.2)	**-0.12** (0.02)	**-0.13** (0.02)
Oman	56.0 (0.2)	▲	10.1 (0.2)	**-0.21** (0.02)	
[1] Kazakhstan	55.5 (0.2)	▲	9.4 (0.2)	**-0.14** (0.02)	
[1] Kosovo	54.2 (0.3)	▲	10.1 (0.2)	**-0.16** (0.02)	
[†12] Romania	53.8 (0.3)	▲	11.1 (0.3)	**-0.17** (0.03)	
Azerbaijan	[r] 53.7 (0.4)	▲	11.4 (0.3)	**-0.08** (0.03)	
[1] Croatia	52.9 (0.4)	▲	10.8 (0.2)	**-0.12** (0.02)	**-0.12** (0.02)
[†] Uruguay	52.6 (0.2)	▲	9.0 (0.2)	**-0.26** (0.03)	**-0.23** (0.03)
[1] Serbia	52.0 (0.3)	▲	10.2 (0.2)	**-0.14** (0.02)	**-0.18** (0.02)
[1] Latvia	51.8 (0.2)	▲	7.7 (0.2)	**-0.16** (0.03)	**-0.16** (0.02)
[1] Portugal	51.4 (0.3)	▲	9.4 (0.2)	**-0.25** (0.02)	**-0.27** (0.02)
Malta	50.9 (0.2)	▲	10.9 (0.2)	**-0.14** (0.03)	**-0.15** (0.03)
Chinese Taipei	50.4 (0.2)		8.5 (0.2)	-0.02 (0.02)	-0.02 (0.02)
Cyprus	50.2 (0.3)		11.4 (0.2)	**-0.18** (0.02)	
ICILS 2023 average	50.0 (0.0)		9.5 (0.0)	**-0.17** (0.00)	**-0.16** (0.01)
Greece	50.0 (0.3)		10.8 (0.2)	**-0.17** (0.02)	
[1] Spain	49.2 (0.2)	▽	9.6 (0.2)	**-0.16** (0.02)	
[1] Sweden	49.2 (0.3)	▽	9.7 (0.3)	**-0.25** (0.03)	**-0.22** (0.03)
Slovak Republic	49.1 (0.3)	▽	9.2 (0.2)	**-0.18** (0.02)	**-0.17** (0.02)
[3] Bosnia and Herzegovina	49.0 (0.5)	▽	11.3 (0.2)	**-0.14** (0.03)	
Luxembourg	48.5 (0.2)	▽	9.8 (0.2)	**-0.24** (0.02)	**-0.22** (0.02)
[†] Korea, Republic of	48.2 (0.3)	▽	9.5 (0.2)	**-0.18** (0.02)	**-0.18** (0.02)
[†1] Denmark	48.2 (0.2)	▽	8.6 (0.2)	**-0.23** (0.02)	**-0.25** (0.02)
[†] Belgium (Flemish)	48.1 (0.3)	▽	8.2 (0.3)	**-0.22** (0.04)	**-0.16** (0.03)
Italy	47.8 (0.3)	▽	8.9 (0.2)	**-0.16** (0.03)	**-0.14** (0.02)
France	47.6 (0.2)	▽	8.8 (0.2)	**-0.15** (0.02)	**-0.14** (0.02)
[1] Czech Republic	47.4 (0.3)	▽	8.5 (0.1)	**-0.14** (0.02)	**-0.13** (0.02)
Finland	47.1 (0.3)	▽	9.0 (0.2)	**-0.18** (0.02)	**-0.15** (0.02)
Hungary	47.0 (0.3)	▽	9.1 (0.2)	**-0.29** (0.03)	
[1] Slovenia	46.1 (0.2)	▽	10.1 (0.2)	**-0.18** (0.02)	**-0.14** (0.02)
[1] Austria	45.8 (0.2)	▽	8.9 (0.2)	**-0.19** (0.02)	**-0.18** (0.02)
Germany	44.7 (0.2)	▽	8.7 (0.2)	**-0.12** (0.03)	**-0.10** (0.03)
Benchmarking participant					
[1] North Rhine-W. (Germany)	44.9 (0.3)	▽	9.0 (0.2)	**-0.08** (0.03)	-0.06 (0.03)
Country not meeting sample participation requirements					
[‡] United States	51.2 (0.3)	▲	10.2 (0.3)	**-0.28** (0.03)	**-0.28** (0.03)

Avg. with confidence interval



▲ Average significantly higher than ICILS 2023 average.

▽ Average significantly lower ICILS 2023 average.

Country average [+/- 95% C.I.]:

On average across items, students with a score in the range with this color have more than 50% probability to indicate:

Never or in some lessons

In most lessons, in every or almost every lesson

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant correlations (p<0.05) are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Countries are ranked in descending order of the average scale score.

† Met guidelines for sampling participation rates only after replacement schools were included.

‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

2 Country surveyed target grade in the first half of the school year.

3 National defined population covers 61% of the national target population.

r indicates data are available for at least 70% but less than 85% of the students.

Use of ICT across subject areas

For a number of years, the research literature has suggested that there are differences between subject areas in the extent to which ICT is used (Fraillon et al., 2014, 2020; Howard et al., 2015). Since the first ICILS cycle in 2013, we asked students how often they used ICT during lessons in subjects or subject areas. Students responded by selecting one of the following response options for each statement ("never," "in some lessons," "in most lessons," "in every or almost every lesson," and "I don't study this subject/these subjects"). When presenting the results, student responses in the last category were treated as missing responses. The list of subjects or subject areas that students had to consider was based on a list developed for the OECD Teaching and Learning International Study (OECD, 2014):

- Language arts: test language
- Language arts: foreign or other national languages
- Mathematics
- Sciences (general science and/or physics, chemistry, biology, geology, earth sciences)
- Human sciences or humanities or social studies (history, geography, civics, law, economics, etc.)
- Creative arts (visual arts, music, dance, drama, etc.)
- Information technology, computer studies, or similar
- Practical or vocational studies
- Other (e.g., moral/ethics, physical education, personal and social development)

ICT is most commonly used in information technology, computer studies, or similar subjects (Table 7.9). On average across countries, more than half of the students report using ICT in these subjects in most or all lessons. For all other listed subjects, approximately one in four students or less reported using ICT in most lessons. There is considerable variation in ICT use across different subjects among countries.

In Austria, Bosnia and Herzegovina, Chinese Taipei, the Czech Republic, Germany, Greece, Hungary, Latvia, Portugal, the Slovak Republic, and Slovenia, statistically significantly lower percentages of students than the ICILS 2023 average were reported to use ICT in at least seven of the nine subjects. The lowest use of ICT across all subjects was found in Slovenia, where less than 10 percent of the students reported using ICT in most, every or all lessons for all subjects except the creative arts (12%). In Azerbaijan, Denmark, Kazakhstan, Kosovo, and Oman, statistically significantly higher percentages of students than the ICILS 2023 average were reported to use ICT in at least seven of the nine subjects.

Comparing the results with previous cycles, there is an increase in the use of ICT in teaching as reported by students from the 2013 cycle (Fraillon et al., 2014), but no major changes can be observed compared to ICILS 2018 (Fraillon et al., 2020).

Table 7.9: Students' reported frequency of ICT use during lessons in specified subject areas

Country	Percentage of students reporting ICT use in most, almost every or every lesson									
	Language arts: test language		Language arts: foreign or other national languages		Mathematics		Sciences (general science and/or physics, chemistry, biology, geology, earth sciences)		Information technology, computer studies, or similar	
[1] Austria	8 (1.0)	▽	9 (0.8)	▽	8 (0.9)	▽	15 (1.4)	▽	50 (1.5)	▽
Azerbaijan	[r]59 (1.1)	▲	[r]41 (1.0)	▲	[r]55 (1.4)	▲	[r]39 (1.3)	▲	[r]48 (1.5)	▽
† Belgium (Flemish)	20 (1.7)	▽	26 (2.1)		17 (2.0)	▽	26 (2.1)		74 (2.3)	▲
[3] Bosnia and Herzegovina	20 (1.1)	▽	19 (1.3)	▽	20 (1.1)	▽	20 (1.3)	▽	48 (1.4)	▽
Chinese Taipei	15 (0.9)	▽	18 (1.0)	▽	14 (1.1)	▽	18 (1.1)	▽	62 (1.2)	▲
[1] Croatia	16 (1.2)	▽	19 (1.4)	▽	14 (0.9)	▽	19 (1.1)	▽	63 (1.3)	▲
Cyprus	22 (1.1)	▽	22 (1.2)	▽	26 (1.2)	▲	27 (1.3)		60 (1.1)	▲
[1] Czech Republic	10 (0.5)	▽	15 (1.0)	▽	10 (1.1)	▽	14 (0.8)	▽	68 (1.1)	▲
†[1] Denmark	86 (1.0)	▲	68 (1.7)	▲	75 (1.8)	▲	71 (1.2)	▲	63 (2.0)	▲
Finland	27 (1.5)		22 (1.8)	▽	16 (1.4)	▽	26 (1.6)		49 (2.0)	▽
France	22 (1.1)	▽	20 (0.9)	▽	23 (1.1)		19 (1.2)	▽	55 (1.2)	
Germany	19 (1.7)	▽	20 (1.5)	▽	18 (1.7)	▽	21 (1.7)	▽	44 (1.8)	▽
Greece	13 (0.8)	▽	17 (0.8)	▽	15 (0.8)	▽	21 (1.0)	▽	58 (1.1)	
Hungary	7 (0.7)	▽	13 (1.0)	▽	9 (1.0)	▽	14 (1.3)	▽	64 (1.3)	▲
Italy	20 (1.1)	▽	22 (1.2)	▽	21 (1.3)		21 (1.5)	▽	35 (1.9)	▽
[1] Kazakhstan	29 (0.9)	▲	34 (1.0)	▲	31 (0.8)	▲	33 (0.9)	▲	52 (1.2)	▽
† Korea, Republic of	14 (0.9)	▽	19 (1.2)	▽	16 (1.3)	▽	17 (1.4)	▽	63 (1.6)	▲
[1] Kosovo	34 (1.1)	▲	32 (0.9)	▲	32 (1.5)	▲	[r]40 (1.3)	▲	63 (1.3)	▲
[1] Latvia	19 (1.0)	▽	17 (1.0)	▽	20 (1.2)	▽	27 (1.2)		53 (1.3)	▽
Luxembourg	32 (1.2)	▲	29 (1.1)	▲	31 (1.4)	▲	31 (1.5)	▲	51 (1.2)	▽
Malta	27 (1.1)		25 (1.0)		26 (1.1)	▲	28 (1.1)		65 (1.2)	▲
[1] Norway (Grade 9)	65 (1.6)	▲	56 (1.7)	▲	37 (2.1)	▲	52 (2.0)	▲	36 (1.4)	▽
Oman	58 (0.9)	▲	44 (0.9)	▲	52 (1.0)	▲	47 (0.8)	▲	48 (0.8)	▽
[1] Portugal	21 (1.3)	▽	19 (1.3)	▽	18 (1.0)	▽	23 (1.3)	▽	73 (1.2)	▲
†[12] Romania	27 (1.4)		32 (1.7)	▲	27 (1.5)	▲	29 (1.5)		40 (1.4)	▽
[1] Serbia	14 (0.9)	▽	20 (1.0)	▽	12 (0.8)	▽	16 (0.9)	▽	58 (1.2)	
Slovak Republic	13 (1.1)	▽	19 (1.2)	▽	12 (1.0)	▽	21 (1.3)	▽	76 (1.3)	▲
[1] Slovenia	7 (0.5)	▽	9 (0.7)	▽	7 (0.5)	▽	8 (0.6)	▽		
[1] Spain	21 (1.5)	▽	27 (1.6)		19 (1.2)	▽	26 (1.7)		51 (1.9)	▽
[1] Sweden	64 (1.7)	▲	72 (1.5)	▲	18 (1.4)	▽	69 (1.6)	▲		
† Uruguay	26 (1.7)		31 (1.5)	▲	22 (1.4)		29 (1.5)		67 (1.4)	▲
ICILS 2023 average	27 (0.2)		27 (0.2)		23 (0.2)		28 (0.2)		57 (0.3)	
Benchmarking participant										
[1] North Rhine-W. (Germany)	23 (2.2)		25 (2.4)		23 (2.3)		27 (2.4)		[r]39 (3.2)	▽
Country not meeting sample participation requirements										
‡ United States	55 (1.6)	▲	38 (2.0)	▲	46 (2.0)	▲	58 (1.9)	▲	56 (2.0)	

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Students not studying the indicated subject are removed from the table estimations.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.
[r] indicates data are available for at least 70% but less than 85% of the students.

Table 7.9: Students' reported frequency of ICT use during lessons in specified subject areas (cont'd)

Country	Percentage of students reporting ICT use in most, almost every or every lesson			
	Human sciences, humanities, or social studies	**Creative arts (visual arts, music, dance, drama, etc.)**	**Practical or vocational**	**Other (e.g., moral/ethics, physical education, personal and social development)**
[1] Austria	17 (1.3) ▽	26 (1.6)	12 (1.0) ▽	10 (0.9) ▽
Azerbaijan	[r]39 (1.2) ▲	[r]31 (1.2) ▲	[r]29 (1.5) ▲	[r]36 (1.4) ▲
[†] Belgium (Flemish)	31 (2.1)	21 (2.0)	26 (2.8)	14 (2.1) ▽
[3] Bosnia and Herzegovina	20 (1.3) ▽	22 (1.3) ▽	18 (1.1) ▽	20 (1.1)
Chinese Taipei	18 (1.0) ▽	19 (0.9) ▽	13 (1.0) ▽	12 (0.6) ▽
[1] Croatia	18 (1.3) ▽	30 (1.5) ▲	19 (1.1) ▽	19 (1.1)
Cyprus	25 (1.1) ▽	23 (0.8)	23 (0.8)	19 (0.7)
[1] Czech Republic	13 (0.7) ▽	25 (1.1)	10 (0.7) ▽	5 (0.4) ▽
[†1] Denmark	76 (1.2) ▲	19 (1.2) ▽	19 (1.0) ▽	26 (1.2) ▲
Finland	23 (1.8) ▽	19 (1.1) ▽	12 (0.8) ▽	32 (1.6) ▲
France	22 (1.3) ▽	17 (1.1) ▽	[r]17 (1.2) ▽	[s]23 (1.4) ▲
Germany	23 (1.6) ▽	18 (1.3) ▽	14 (1.5) ▽	14 (0.9) ▽
Greece	22 (0.9) ▽	17 (0.7) ▽	26 (1.1) ▲	12 (0.8) ▽
Hungary	11 (1.2) ▽	19 (1.2) ▽	9 (1.1) ▽	11 (1.0) ▽
Italy	26 (1.5)	28 (1.6) ▲		15 (1.0) ▽
[1] Kazakhstan	29 (0.8)	27 (0.9) ▲	28 (0.9) ▲	27 (0.8) ▲
[†] Korea, Republic of	13 (0.9) ▽	28 (1.7) ▲	21 (1.4)	13 (1.0) ▽
[1] Kosovo	[r]36 (1.1) ▲	32 (1.1) ▲	61 (1.5) ▲	30 (1.1) ▲
[1] Latvia	22 (1.3) ▽	26 (1.2)	13 (1.0) ▽	12 (0.9) ▽
Luxembourg	27 (1.3)	20 (0.8) ▽	[r]18 (1.0) ▽	24 (1.1) ▲
Malta	24 (1.1) ▽	[r]23 (1.4)	[r]31 (1.4) ▲	19 (1.1)
[1] Norway (Grade 9)	60 (1.9) ▲	19 (1.1) ▽		25 (1.2) ▲
Oman	42 (0.8) ▲	34 (0.8) ▲	42 (0.9) ▲	47 (0.9) ▲
[1] Portugal	22 (1.3) ▽	23 (1.3)	16 (0.9) ▽	13 (0.8) ▽
[†12] Romania	28 (1.6)	31 (1.4) ▲	23 (0.9)	21 (1.0) ▲
[1] Serbia	21 (1.1) ▽	32 (1.5) ▲	29 (1.5) ▲	18 (1.0)
Slovak Republic	20 (1.3) ▽	24 (1.2)	12 (1.1) ▽	9 (0.7) ▽
[1] Slovenia	9 (0.7) ▽	12 (1.0) ▽	8 (0.7) ▽	6 (0.4) ▽
[1] Spain	27 (1.6)	21 (1.1) ▽	40 (1.8) ▲	13 (0.7) ▽
[1] Sweden	73 (1.7) ▲	42 (1.7) ▲		29 (1.7) ▲
[†] Uruguay	31 (1.7)	28 (1.5) ▲	[r]24 (1.6)	14 (0.9) ▽
ICILS 2023 average	28 (0.2)	24 (0.2)	22 (0.2)	19 (0.2)
Benchmarking participant				
[1] North Rhine-W. (Germany)	30 (2.3)	23 (1.6)	18 (2.3)	19 (1.7)
Country not meeting sample participation requirements				
[‡] United States	53 (2.0) ▲	30 (1.7) ▲	[r]31 (1.5) ▲	26 (1.3) ▲

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Students not studying the indicated subject are removed from the table estimations.
[†] Met guidelines for sampling participation rates only after replacement schools were included.
[‡] Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.
[r] indicates data are available for at least 70% but less than 85% of the students.
[s] indicates data are available for at least 50% but less than 70% of the students.

7.3 Cognitive engagement: Students' learning how to use ICT in and outside of school

In Chapter 2 we describe how learning about ICT and its use is explicitly and implicitly emphasized in the plans, policies, and curricula of ICILS countries. Given the digitization of education, learning to use ICT is the basis of using ICT for learning, which is similar to the concept of learning to read in early grades in order to be able to learn by reading at later stages of education (Mullis & Martin, 2019). Learning how to use ICT can take place in a separate subject specifically dedicated to ICT, or can be integrated in other subjects as well, but in both instances ICT is also often used *for* learning.

Learning about various topics can take place in- and outside of schools. However, since the integration of teaching and learning about ICT in the school curriculum is still relatively new, there is evidence that students acquire relevant knowledge outside of school as well (Fraillon et al., 2020).

Learning about ICT encompasses various different topics. This section will start elaborating the reported opportunities of students learning about specific ICT tasks such as organizing files, editing documents, spreadsheets, slide shows, or media files. A section on students' learning about topics related to computational thinking follows. Next, we present data on students' learning how to use the internet as reliable source, and how to use ICT safely and responsibly. Digital communication can expose young people to threats such as cyberbullying, scams, and exposure to inappropriate content (Masrom et al., 2021; Zulqadri et al., 2022). Learning about responsible online behavior can help students to navigate safely through online materials. Understanding responsible ICT use includes awareness of ethical use of technology and (digital) rights which fosters, among other dimensions, good digital citizenship (Choi, 2016; Gleason & Von Gillern, 2018). Critical thinking and the ability to judge the trustworthiness of digital contents are essential for discerning reliable information from misinformation. These are concepts and skills that are prevalent in the ICILS conceptualization and measurement of CIL (Fraillon & Rožman, 2024). As students prepare for their future careers, responsible ICT use is crucial for meeting many employers' expectations of digital proficiency. Overall, integrating education on appropriate and responsible ICT use equips students with vital skills for navigating the digital world responsibly and effectively (Janssen et al., 2013).

Learning about ICT tasks at school

With rapid developments in technology, learning about the use of ICT evolves and its measurement in ICILS did so as well. In ICILS 2013 and 2018 students were asked who mainly taught them different tasks ("I mainly taught myself," "my teachers," "my family," "my fiends," "I have never learned this"). In the current cycle the focus was shifted to include the place (at school or outside of school) and the extent of students' learning about ICT-related tasks. In addition, the number of tasks was expanded in comparison to previous ICILS cycles. We asked students to indicate to what extent they have learned how to do specific ICT related tasks at school, and outside of school. In this part of the section we focus on student responses regarding the knowledge acquired at school. Students responded by selecting one of the following response options for each task ("to a large extent," "to a moderate extent," "to a little extent," and "not at all"). The ICT tasks presented to students were:

- Organize files (such as documents or media) stored on a digital device
- Edit the layout and formatting of documents or slideshow presentations
- Edit digital media files including any of images, photos, animations, or videos
- Complete calculations using a spreadsheet
- Create computer programs using a visual programming editor (e.g., Alice, GameMaker, Kodu, Lego Mindstorms, MIT App Inventor, Scratch)
- Write computer programs using a text-based programming language (e.g., Python, JavaScript, Lua, Swift)

Table 7.10: Students learning of how to do ICT-related tasks at school

Country	Percentage of students reporting they have learned how to do ICT-related tasks at school (to a moderate extent or to a large extent)					
	Organize files stored on a digital device	Edit the layout and formatting of documents or slideshow presentations	Edit digital media files including any of images, photos, animations, or videos	Complete calculations using a spreadsheet	Create computer programs using a visual programming editor	Write computer programs using a text-based programming language
[1] Austria	63 (1.2)	73 (1.2)	38 (1.3) ▽	54 (1.7)	28 (1.4) ▽	21 (1.0) ▽
Azerbaijan	[r]58 (1.4) ▽	[s]58 (1.7) ▽	[s]55 (1.4)	[s]62 (1.3) ▲	[s]46 (1.4)	[s]53 (1.7) ▲
[†] Belgium (Flemish)	79 (0.9) ▲	80 (1.1) ▲	48 (1.5) ▽	42 (1.6) ▽	46 (1.6)	28 (1.5) ▽
[3] Bosnia and Herzegovina	[r]57 (1.6) ▽	[r]67 (1.3) ▽	[r]54 (1.5)	[r]52 (1.5) ▽	[r]36 (1.6) ▽	[r]42 (1.9) ▲
Chinese Taipei	76 (0.9) ▲	74 (0.9) ▲	67 (0.8) ▲	54 (0.9) ▽	62 (0.8) ▲	35 (0.9) ▽
[1] Croatia	75 (1.1) ▲	77 (1.0) ▲	63 (1.1) ▲	65 (1.2) ▲	56 (1.4) ▲	64 (1.2) ▲
Cyprus	67 (0.8)	71 (1.0)	60 (1.1) ▲	62 (1.0) ▲	43 (1.1) ▽	40 (1.1) ▲
[1] Czech Republic	63 (0.9) ▽	68 (1.0) ▽	44 (0.9) ▽	53 (1.2) ▽	38 (1.4) ▽	26 (0.8) ▽
[†1] Denmark	75 (1.1) ▲	88 (0.7) ▲	42 (1.2) ▽	88 (0.8) ▲	32 (1.1) ▽	23 (0.9) ▽
Finland	56 (1.0) ▽	80 (0.7) ▲	43 (1.0) ▽	49 (1.3) ▽	32 (1.3) ▽	28 (1.6) ▽
France	58 (1.3) ▽	62 (1.2) ▽	38 (0.9) ▽	53 (1.3) ▽	51 (1.4) ▲	28 (1.1) ▽
Germany	58 (1.3) ▽	69 (1.3) ▽	33 (1.1) ▽	49 (1.6) ▽	31 (1.4) ▽	25 (1.1) ▽
Greece	69 (1.1) ▲	69 (1.0) ▽	63 (1.2) ▲	59 (1.4)	42 (1.4) ▽	37 (1.1)
Hungary	67 (1.0)	79 (0.8) ▲	48 (1.1) ▽	69 (1.4) ▲	44 (1.7)	27 (1.4) ▽
Italy	56 (1.4) ▽	63 (1.3) ▽	47 (1.5) ▽	60 (1.1) ▲	31 (1.3) ▽	23 (1.0) ▽
[1] Kazakhstan	72 (0.9) ▲	76 (1.0) ▲	68 (0.9) ▲	75 (1.0) ▲	56 (1.0) ▲	75 (0.9) ▲
[†] Korea, Republic of	52 (1.4) ▽	57 (1.3) ▽	48 (1.2) ▽	35 (1.3) ▽	70 (1.2) ▲	32 (1.2) ▽
[1] Kosovo	[r]71 (1.2) ▲	[r]71 (1.2)	[r]59 (1.3) ▲	[r]54 (1.4) ▽	[r]45 (1.3)	[r]47 (1.3) ▲
[1] Latvia	76 (1.0) ▲	84 (0.9) ▲	69 (1.1) ▲	67 (1.3) ▲	51 (1.4) ▲	48 (1.5) ▲
Luxembourg	63 (0.7) ▽	72 (0.8)	[r]44 (0.9) ▽	[r]48 (0.7) ▽	[r]37 (0.9) ▽	[r]32 (0.9) ▽
Malta	[r]64 (0.9)	[r]63 (0.9) ▽	[r]57 (1.1) ▲	[r]38 (1.0) ▽	[r]49 (1.0) ▲	[r]36 (1.1)
[1] Norway (Grade 9)	78 (1.1) ▲	88 (0.7) ▲	56 (1.0) ▲	78 (0.9) ▲	43 (1.4)	36 (1.6)
Oman	64 (0.7)	68 (0.8) ▽	55 (0.7) ▲	59 (0.9) ▲	57 (0.8) ▲	[r]51 (0.7) ▲
[1] Portugal	75 (1.1) ▲	78 (1.1) ▲	59 (1.3) ▲	65 (1.2) ▲	60 (1.5) ▲	46 (1.4) ▲
[†12] Romania	[r]71 (1.2) ▲	[r]75 (1.2) ▲	[r]64 (1.4) ▲	[r]69 (1.3) ▲	[r]60 (1.5) ▲	[r]54 (1.4) ▲
[1] Serbia	61 (1.1) ▽	68 (1.1) ▽	55 (1.3)	61 (1.1) ▲	64 (1.2) ▲	66 (1.1) ▲
Slovak Republic	67 (1.2)	73 (1.2)	61 (1.1) ▲	57 (1.4)	44 (1.5)	28 (1.2) ▽
[1] Slovenia	48 (1.3) ▽	52 (1.3) ▽	42 (1.2) ▽	40 (1.2) ▽	33 (1.2) ▽	24 (0.9) ▽
[1] Spain	64 (1.1)	75 (1.1) ▲	52 (1.1)	54 (0.9) ▽	41 (0.9) ▽	27 (0.9) ▽
[1] Sweden	[r]63 (1.1) ▽	[r]82 (0.8) ▲	[r]43 (1.2) ▽	[r]63 (1.0) ▲	[r]45 (1.3)	[r]29 (1.2) ▽
[†] Uruguay	[r]73 (1.0) ▲	[r]79 (1.1) ▲	[r]61 (1.0) ▲	[r]56 (1.4)	[r]53 (1.4) ▲	[r]41 (1.4) ▲
ICILS 2023 average	66 (0.2)	72 (0.2)	52 (0.2)	57 (0.2)	46 (0.2)	37 (0.2)
Benchmarking participant						
[1] North Rhine-W. (Germany)	56 (1.5) ▽	68 (1.4) ▽	[r]34 (2.0) ▽	46 (1.5) ▽	23 (1.3) ▽	[r]22 (1.2) ▽
Country not meeting sample participation requirements						
[‡] United States	64 (1.2)	83 (1.2) ▲	52 (1.5)	48 (1.2) ▽	31 (1.4) ▽	25 (1.2) ▽

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
[†] Met guidelines for sampling participation rates only after replacement schools were included.
[‡] Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.
[r] indicates data are available for at least 70% but less than 85% of the students.
[s] indicates data are available for at least 50% but less than 70% of the students.

We present the percentages of students who responded that they have learned at least to a moderate extent the specific task at school (Table 7.10). The first four tasks have a more general ICT focus, while the last two relate to programming. The results show that across countries, according to students perspective, programming receives a little less attention than general ICT activities. Less than half of the students across countries reported that they have learned at least to a moderate extent about how to create a program at school, compared to more than half of students responding the same for the other ICT tasks. According to the results about two thirds or more of students stated they learned how to organize files and edit documents or presentations at school at least to a moderate extent.

Producing computer programs has changed since the availability of block-based or visual based programming. Block-based coding environments are useful for teaching CT competencies, especially to beginners. This is confirmed by ICILS 2023 results as well. Writing programs using a visual programming editor is from student perspective acquired at school more often in 26 out of 32 countries (Table 7.10).

In Croatia, Kazakhstan, Latvia, Portugal, Romania, and Uruguay, statistically significantly higher percentages of students than the ICILS 2023 average were reported to learn to a moderate or large extent at least five out of the six ICT tasks. In the Czech Republic, Finland, France, Germany, Italy, Korea (Rep. of), Luxembourg, North Rhine-Westphalia (Germany), and Slovenia, the opposite is true. Statistically significantly lower percentages of students than the ICILS 2023 average were reported to learn to a moderate or large extent at least five out of the six ICT tasks. The smallest within-country variation across the various tasks can be observed in Azerbaijan, Oman, and Serbia, where a similar percentage of students for all the tasks reported they have learned the tasks at school to at least moderate extent. We can observe considerable variation between tasks in Austria, Belgium (Flemish), Norway, and especially Denmark. Within these countries the least frequently acquired knowledge at school according to student reports is related to writing a computer program.

Learning about computational thinking at school

In ICILS CT is defined as the ability to recognize and solve real-world problems using computers. It is strongly represented in the plans, policies, and curricula of ICILS countries, although with a slightly lesser degree of explicit reference than CIL (Chapter 2). In the student questionnaire, we asked students to what extent they had learned various CT-related tasks at school. For each of the the tasks listed below, students could select one of the response options ("to a large extent," "to a moderate extent," "to a small extent," or "not at all"):

- Use a solution that works for one problem to help solve a different problem
- Solve a hard problem by splitting it into a few easier problems
- Make diagrams that explain concepts or systems (e.g., electric circuits, plant growth, the water cycle)
- Plan tasks by making a list of the tasks in the order they need to be completed
- Detect patterns in data
- Use simulations to help understand concepts or systems (e.g., electric circuits, plant growth, growth of cities in a virtual world)
- Make flow diagrams to show how a computer program should work
- Systematically test computer programs to find bugs, errors, or other problems
- Use data to better understand real-world problems

The percentages of students who reported having studied the tasks to a moderate or large extent are presented in Table 7.11. The first part of Table 7.11 shows the students' responses to the first five tasks. Out of the five tasks, on average across countries the most students reported to have learned how to *use a solution that works for one problem to help solve a different problem* and the fewest how to *detect patterns in data*. On average across countries, more than two thirds of the students reported having attained knowledge in school at least to a moderate extent about how to *use a solution that works for one problem to help solve a different problem*, *solve a hard problem by splitting it into a few easier problem*, or how to *plan tasks by making a list of the tasks in the order they need to be completed*.

Examining the results at the country level, there is a considerable variation in the learning about CT tasks at school among ICILS countries. In Austria, Belgium (Flemish), the Czech Republic, Germany, Luxembourg, North Rhine-Westphalia (Germany), and Portugal statistically significantly lower percentages of students compared to the ICILS 2023 average were reported to have learned all the five CT tasks at school to at least a moderate extent. In Azerbaijan, Croatia, Cyprus, Kazakhstan, Korea (Rep. of), Kosovo, Oman, and Romania the opposite is true. Statistically significantly higher percentages of students compared to the ICILS 2023 average were reported to have learned all the five CT tasks at school to at least a moderate extent. Across participating countries, in Portugal the least students and in Kazakhstan the most students reported they have learned to a large or moderate extent how to do the five CT-related tasks at school.

The second part of Table 7.11 (cont'd) shows the results for the last four tasks. On average across countries how to *use data to better understand real-world problems* is the most frequently reported among the four tasks. About 63 percent of students across countries that met the participation requirements reported to have learned about it to a large or moderate extent at school. The lowest ICILS average across items can be observed for the following two tasks, *make flow diagrams to show how a computer program should work* and *systematically test computer programs to find bugs, errors, or other problems*. About 51 percent of students across countries that met participation requirements reported to have learned them at least to a moderate extent at school.

In Azerbaijan, Bosnia and Herzegovina, Chinese Taipei, Croatia, Cyprus, Greece, Kazakhstan, Kosovo, Latvia, Oman, Romania, and Serbia statistically significantly higher percentages of students compared to the ICILS 2023 average were reported to have learned all four CT tasks at school to at least a moderate extent. In Kazakhstan the percentage of students is the highest for these four tasks among the mentioned countries. Statistically significantly lower percentages of students compared to the ICILS 2023 average were reported to have learned all four CT tasks at school to at least a moderate extent in Austria, Belgium (Flemish), the Czech Republic, Denmark, Finland, Germany, Luxembourg, North Rhine-Westphalia (Germany), Portugal, and Sweden. The fewest students that responded they have learned the four tasks at least to a moderate extent in school come from Portugal.

Table 7.11: Percentages of students reporting to learn CT tasks at least to a moderate extent at school

Country	Percentage of students reporting they have learned how to do CT-related tasks at school (to a moderate extent or to a large extent)				
	Use a solution that works for one problem to help solve a different problem	**Solve a hard problem by splitting it into a few easier problems**	**Make diagrams that explain concepts or systems**	**Plan tasks by making a list of the tasks in the order they need to be completed**	**Detect patterns in data**
[1] Austria	67 (1.0) ▽	57 (1.2) ▽	54 (1.1) ▽	51 (1.2) ▽	40 (1.0) ▽
Azerbaijan	[r]82 (0.8) ▲	[r]83 (0.9) ▲	[s]72 (1.2) ▲	[s]79 (1.2) ▲	[s]79 (1.1) ▲
† Belgium (Flemish)	73 (1.1) ▽	63 (1.1) ▽	53 (1.2) ▽	67 (1.1) ▽	43 (1.2) ▽
[3] Bosnia and Herzegovina	79 (1.2) ▲	76 (1.6) ▲	64 (1.7)	[r]71 (1.4)	[r]65 (1.5) ▲
Chinese Taipei	86 (0.6) ▲	79 (0.8) ▲	63 (1.0)	78 (0.7) ▲	80 (0.7) ▲
[1] Croatia	85 (0.7) ▲	78 (1.0) ▲	73 (1.0) ▲	79 (1.0) ▲	75 (1.0) ▲
Cyprus	[r]83 (0.8) ▲	[r]76 (1.0) ▲	[r]70 (1.0) ▲	[r]74 (1.0) ▲	[r]66 (1.1) ▲
[1] Czech Republic	75 (0.6) ▽	64 (0.7) ▽	49 (1.0) ▽	64 (0.7) ▽	46 (0.9) ▽
†[1] Denmark	82 (0.8) ▲	77 (0.9) ▲	75 (0.9) ▲	72 (1.0) ▲	51 (1.1) ▽
Finland	80 (0.7) ▲	75 (0.8) ▲	63 (0.9)	68 (0.9)	45 (1.2) ▽
France	74 (0.7) ▽	[r]64 (1.0) ▽	[r]69 (0.9) ▲	[r]63 (0.8) ▽	[r]49 (1.1) ▽
Germany	62 (1.0) ▽	55 (1.0) ▽	61 (1.0) ▽	[r]54 (1.2) ▽	[r]45 (1.1) ▽
Greece	81 (0.8) ▲	74 (0.9) ▲	63 (1.0)	72 (0.9) ▲	65 (1.0) ▲
Hungary	62 (1.1) ▽	55 (1.1) ▽	67 (1.0) ▲	67 (1.0) ▽	66 (1.0) ▲
Italy	72 (1.0) ▽	68 (1.1) ▽	56 (1.2) ▽	65 (1.1) ▽	67 (1.1) ▲
[1] Kazakhstan	88 (0.6) ▲	84 (0.8) ▲	78 (0.8) ▲	81 (0.9) ▲	78 (0.8) ▲
† Korea, Republic of	81 (0.8) ▲	76 (1.0) ▲	69 (1.0) ▲	77 (0.9) ▲	67 (0.9) ▲
[1] Kosovo	82 (0.9) ▲	[r]75 (1.0) ▲	[r]67 (1.2) ▲	[r]75 (1.0) ▲	[r]73 (1.0) ▲
[1] Latvia	80 (1.1) ▲	72 (1.1)	70 (1.0) ▲	76 (1.0) ▲	71 (1.1) ▲
Luxembourg	[r]74 (0.7) ▽	[r]66 (0.8) ▽	[r]58 (1.0) ▽	[r]64 (0.8) ▽	[r]49 (0.9) ▽
Malta	[r]80 (1.0) ▲	[r]76 (0.9) ▲	[r]67 (0.9) ▲	[r]70 (0.8)	[r]55 (1.2) ▽
[1] Norway (Grade 9)	81 (0.9) ▲	75 (1.0) ▲	62 (1.2)	[r]67 (1.0)	[r]56 (1.0) ▽
Oman	83 (0.5) ▲	76 (0.5) ▲	71 (0.7) ▲	71 (0.6) ▲	63 (0.8) ▲
[1] Portugal	53 (1.2) ▽	46 (1.1) ▽	38 (1.0) ▽	51 (1.1) ▽	38 (1.2) ▽
†[12] Romania	81 (0.9) ▲	[r]75 (0.9) ▲	[r]69 (1.2) ▲	[r]76 (1.0) ▲	[r]69 (1.4) ▲
[1] Serbia	77 (0.8)	71 (0.9)	62 (1.0)	69 (0.9)	66 (0.9) ▲
Slovak Republic	73 (1.0) ▽	64 (0.9) ▽	58 (1.0) ▽	68 (0.9)	68 (1.0) ▲
[1] Slovenia	72 (0.9) ▽	67 (0.9) ▽	54 (1.0) ▽	63 (0.9) ▽	60 (1.1)
[1] Spain	[r]80 (0.6) ▲	[r]72 (0.6) ▲	[r]63 (0.9)	[r]75 (0.6) ▲	[r]52 (0.9) ▽
[1] Sweden	[r]79 (0.9) ▲	[r]76 (0.9) ▲	[r]73 (1.1) ▲	[r]70 (1.1)	[r]49 (1.4) ▽
† Uruguay	[r]83 (0.9) ▲	[r]74 (1.0) ▲	[r]60 (1.3) ▽	[r]75 (1.0) ▲	[r]56 (1.2) ▽
ICILS 2023 average	77 (0.2)	70 (0.2)	63 (0.2)	69 (0.2)	59 (0.2)
Benchmarking participant					
[1] North Rhine-W. (Germany)	[r]66 (1.3) ▽	[r]58 (1.5) ▽	[r]59 (1.3) ▽	[r]54 (1.1) ▽	[r]49 (1.5) ▽
Country not meeting sample participation requirements					
‡ United States	[r]86 (1.2) ▲	[r]78 (1.2) ▲	[r]65 (1.5)	[r]72 (1.4)	[r]60 (1.6)

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.
[r] indicates data are available for at least 70% but less than 85% of the students.
[s] indicates data are available for at least 50% but less than 70% of the students.

Table 7.11: Percentages of students reporting to learn CT tasks at least to a moderate extent at school (cont'd)

Country	Percentage of students reporting they have learned how to do CT-related tasks at school (to a moderate extent or to a large extent)			
	Use simulations to help understand concepts or systems	Make flow diagrams to show how a computer program should work	Systematically test computer programs to find bugs, errors, or other problems	Use data to better understand real-world problems
[1] Austria	38 (1.2) ▽	32 (1.1) ▽	33 (1.1) ▽	46 (1.2) ▽
Azerbaijan	[s]73 (1.2) ▲	[r]72 (1.2) ▲	[s]73 (1.1) ▲	[r]74 (1.1) ▲
[†] Belgium (Flemish)	41 (1.4) ▽	30 (1.3) ▽	36 (1.2) ▽	53 (1.3) ▽
[3] Bosnia and Herzegovina	[r]63 (1.8) ▲	[r]63 (1.3) ▲	[r]65 (1.6) ▲	[r]73 (1.3) ▲
Chinese Taipei	58 (1.0) ▲	63 (0.9) ▲	56 (0.9) ▲	75 (0.7) ▲
[1] Croatia	72 (1.1) ▲	71 (1.2) ▲	70 (1.2) ▲	78 (0.9) ▲
Cyprus	[r]65 (1.1) ▲	[r]61 (1.1) ▲	[r]62 (1.1) ▲	[r]69 (0.9) ▲
[1] Czech Republic	46 (0.8) ▽	43 (0.8) ▽	44 (0.8) ▽	61 (0.8) ▽
[†1] Denmark	48 (1.1) ▽	31 (1.1) ▽	35 (1.1) ▽	58 (0.9) ▽
Finland	46 (1.2) ▽	39 (1.2) ▽	39 (1.2) ▽	49 (1.1) ▽
France	[r]54 (1.0)	[r]50 (1.1)	[r]42 (1.3) ▽	[r]54 (1.0) ▽
Germany	[r]41 (1.0) ▽	[r]36 (1.1) ▽	[r]32 (0.9) ▽	[r]45 (1.1) ▽
Greece	61 (1.0) ▲	55 (0.9) ▲	66 (0.9) ▲	71 (1.0) ▲
Hungary	52 (1.0) ▽	51 (1.3)	45 (1.2) ▽	57 (1.1) ▽
Italy	53 (1.2)	40 (1.3) ▽	42 (1.0) ▽	64 (1.3)
[1] Kazakhstan	74 (0.8) ▲	76 (0.8) ▲	76 (0.8) ▲	83 (0.7) ▲
[†] Korea, Republic of	59 (1.1) ▲	53 (1.1)	47 (1.1) ▽	62 (1.0)
[1] Kosovo	[r]67 (0.9) ▲	[r]68 (1.2) ▲	[r]68 (1.0) ▲	[r]72 (1.0) ▲
[1] Latvia	58 (1.2) ▲	58 (1.2) ▲	55 (1.3) ▲	73 (1.1) ▲
Luxembourg	[r]48 (0.9) ▽	[r]43 (1.1) ▽	[r]42 (0.9) ▽	[r]54 (0.9) ▽
Malta	[r]58 (1.1) ▲	[r]54 (0.9) ▲	[r]52 (0.9)	[r]64 (1.0)
[1] Norway (Grade 9)	[r]49 (1.3) ▽	[r]41 (1.3) ▽	[r]42 (1.4) ▽	[r]65 (1.0) ▲
Oman	68 (0.7) ▲	66 (0.7) ▲	67 (0.7) ▲	69 (0.7) ▲
[1] Portugal	35 (1.2) ▽	30 (1.2) ▽	32 (1.1) ▽	45 (1.0) ▽
[†12] Romania	[r]68 (1.4) ▲	[r]69 (1.1) ▲	[r]66 (1.3) ▲	[r]72 (1.3) ▲
[1] Serbia	62 (1.1) ▲	62 (1.1) ▲	64 (1.1) ▲	71 (1.0) ▲
Slovak Republic	50 (1.1) ▽	47 (1.2) ▽	48 (1.3) ▽	66 (1.1) ▲
[1] Slovenia	53 (1.1)	49 (1.1)	48 (1.1) ▽	59 (0.9) ▽
[1] Spain	[r]56 (0.9)	[r]46 (0.9) ▽	[r]50 (0.9)	[r]67 (0.7) ▲
[1] Sweden	[r]51 (1.3) ▽	[r]43 (1.4) ▽	[r]42 (1.3) ▽	[r]56 (1.3) ▽
[†] Uruguay	[r]54 (1.4)	[r]51 (1.4)	[r]53 (1.3) ▲	[r]67 (1.3) ▲
ICILS 2023 average	55 (0.2)	51 (0.2)	51 (0.2)	63 (0.2)
Benchmarking participant				
[1] North Rhine-W. (Germany)	[r]42 (1.5) ▽	[r]38 (1.7) ▽	[r]33 (1.4) ▽	[r]45 (1.4) ▽
Country not meeting sample participation requirements				
[‡] United States	[r]54 (1.7)	[r]42 (1.6) ▽	[r]43 (1.9) ▽	[r]67 (1.8)

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
[†] Met guidelines for sampling participation rates only after replacement schools were included.
[‡] Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.
[r] indicates data are available for at least 70% but less than 85% of the students.
[s] indicates data are available for at least 50% but less than 70% of the students.

Learning to use the internet as reliable source of information

This section addresses the extent to which students learn within school and outside of school about internet related tasks such as, critically evaluating online information and sources, understanding of intellectual property rights, proper referencing of digital content, and measures to protect personal information and devices from cyber threats (including the importance of safeguarding personal data).

The internet has become an important resource for the workplace and people's private lives, including that of young people. Many adolescents have grown up with this resource and can no longer imagine a world without it. However, the internet presents some risks, such as cyberbullying, online scams, identity theft, and exposure to inappropriate content. The ICILS CIL construct includes content related to navigating the internet safely and responsibly (Fraillon & Duckworth, 2024). Students need to understand the importance of safeguarding their personal information, learning about privacy settings, secure passwords, and the risks of sharing too much information about themselves. These then can help them to maintain their privacy and security online.

Further, the perceived instant availability of contents may induce instant reactions and challenge users that lack the skills to appropriately evaluate the information. Students should be aware about their rights and responsibilities in the digital world, including respecting others' intellectual property, practicing online etiquette, and contributing positively to online communities. Critical thinking as part of digital literacy should be an important part of education. Students should learn to distinguish between reliable sources and misinformation, which is particularly important in times of fake news and online propaganda (McGrew, 2020).

As students prepare for their future careers, understanding how to use ICT responsibly becomes increasingly important. Many employers expect their staff to have strong digital skills and to use technology ethically and securely in the workplace. Overall, incorporating education about safe and responsible use of ICT into the curriculum could equip students with essential skills and knowledge for navigating the digital world effectively and responsibly (Falloon, 2020; Janssen et al., 2013). According to previous studies, however, not all students are taught this content at school. ICILS 2018 shows, for example, large variation in the percentage of students reporting they have learned to work out whether to trust information from the internet to a large or moderate extent, across 14 education systems Fraillon et al. (2020). The lowest percentage was observed in Germany (39%), while no less than 86 percent of students stated this in their neighboring country Denmark.

In an attempt to investigate the opportunities of grade 8 students learning about how to navigate the internet safely, we asked them to what extent they have learned how to do the following internet related tasks:

- Use the internet to find information (e.g., by using websites, databases, archives, digital libraries, search engines)
- Refine internet searches, so the results better match what you are looking for
- Evaluate the reliability (trustworthiness) of information on the internet
- Include accurate references to internet sources
- Judge whether a message from someone is a scam (e.g., a message that tricks you into downloading a virus)
- Manage privacy settings for internet accounts and ICT devices (e.g., control who can contact you and what information about you is shared with advertising companies).

Students were asked to report the extent to which they had learned how to do each of the task at school, and outside school. Students responded by selecting one of the following four response options for each task ("to a large extent," "to a moderate extent," "to a small extent," and "not at all").

Students' responses to these questions allow us to investigate to what extent they reported to have learned about these important topics, and whether they have learned it at school or outside of school. ICILS 2023 data shows, that more than 85 percent of students, on average across countries, reported they have learned about the first four topics listed above at least to a small extent at school (see Table D.7 in Appendix D). In contrast, more than one in five students on average across countries reported that they did not learn at all how to *judge whether a message is a scam* or how to *manage privacy settings*, although over half of the students indicated they had learned about these two topics to a moderate or large extent at school.

More students typically reported learning about internet related activities to a moderate or to a large extent outside of school than at school. The largest differences were for managing privacy settings (21%), finding information (19%), and judging whether a message is a scam (18%). A smaller difference was evident for evaluating the reliability of information (5%). Including accurate references was the only activity for which, on average across countries, more students reported learning about to a moderate or large extent at school than outside of school. This difference, however, was two percent only (see Table D.9 in Appendix D). Taken together, these findings suggest that, although many education systems indicate they cover internet use-related topics in their curricula (see Chapter 2), there may still be challenges in fully implementing these intentions in the classroom. It also raises questions about what exactly students learn outside of school, from whom or what sources, and the potential consequences of this learning in comparison to the curriculum directed learning at school.

To investigate the extent that this learning varied across countries, we derived two scales based on student responses to the six topics shown above, one for learning about internet related tasks *at school*, and one for learning about internet related tasks *outside school*. Higher scores on the scales indicate a greater extent of learning the topics. The scales were established with an average score of 50 and a standard deviation of 10 for countries meeting the ICILS participation requirements (excluding Romania).

Students in 12 countries stated significantly more often than the ICILS 2023 average they had learned about these tasks *at* school (Table 7.12). The average scale scores in Sweden, Latvia, Norway (grade 9), Chinese Taipei, and Portugal exceed the ICILS 2023 average by more than one third of a standard deviation. In contrast, France, Bosnia and Herzegovina, Slovenia, and Azerbaijan had average scale scores more than a third of a standard deviation below the ICILS 2023 average. This might indicate that the extent to which countries have successfully implemented teaching these topics at school varies more than moderately. The table also presents the correlation coefficients of the scale with CIL and CT, which are all—even though often statistically significant—close to zero. The correlations are positive in some countries, while negative in others, proposing there is no consistent pattern on how opportunities to learn specifically those topics at school, as reported by students, relate to students' achievement in either CIL or CT.

Table 7.13 gives information on students' opportunities to learn about these topics *outside of school*, using the respective scale scores. Notably, across the statements and countries, more students were likely to respond they had learned about internet related topics outside school (compared to at school) to a large or moderate extent. This can be seen by the presence of all country averages and confidence intervals in the blue area of Table 7.13, in comparison to Table 7.12 where not all are shown within the blue area (see also Table D.9 in Appendix D). In the five countries with the highest average scale scores (Slovenia, Romania, the Slovak Republic, Portugal, and Latvia) students indicated most often to have learned about safe internet use outside school. On the contrary, Korea (Rep. of), Belgium (Flemish), Austria, Oman, and Luxembourg had the lowest average scale scores points, i.e., more students stated that they have not acquired this knowledge or have only acquired it to a limited extent outside of school. The correlation coefficients show a consistent direction regarding the relationship between this scale and students' achievement in CIL, and CT respectively: they are all positive, and statistically significant except for one country each (namely, Portugal regarding the relationship with CT). On average across countries, the correlation coefficient between this scale and CIL is 0.17, and 0.12 with CT. Students' reported learning about internet use outside of school seems to be more positively associated than their reported learning about internet use at school with both CIL and CT achievement.

Table 7.12: National scale score averages indicating the extent of learning about internet related tasks at school, and correlation with CIL and CT achievement

Country	Learning about internet related tasks at school: Average scale score		Std. dev.	Avg. with confidence interval	Correlation with achievement: CIL	CT
[1] Portugal	55.2 (0.3)	▲	9.3 (0.2)		**-0.05** (0.02)	**-0.10** (0.02)
Chinese Taipei	54.7 (0.2)	▲	8.9 (0.2)		**0.19** (0.02)	**0.15** (0.02)
[1] Norway (Grade 9)	54.6 (0.2)	▲	8.5 (0.2)		**0.08** (0.02)	0.03 (0.02)
[1] Latvia	53.8 (0.2)	▲	9.3 (0.2)		**0.16** (0.02)	**0.12** (0.03)
[1] Sweden	53.4 (0.2)	▲	9.0 (0.2)		**0.08** (0.02)	**0.05** (0.02)
[1] Kazakhstan	52.9 (0.2)	▲	9.0 (0.2)		**0.06** (0.02)	
[†] Uruguay	52.4 (0.2)	▲	8.2 (0.2)		0.04 (0.03)	0.00 (0.02)
[†1] Denmark	52.2 (0.2)	▲	7.4 (0.2)		0.00 (0.02)	**-0.05** (0.02)
[†] Korea, Republic of	51.7 (0.2)	▲	9.8 (0.2)		-0.03 (0.02)	**-0.04** (0.02)
[1] Croatia	51.2 (0.3)	▲	10.1 (0.2)		**0.09** (0.02)	0.00 (0.02)
[†12] Romania	[r] 50.8 (0.4)	▲	11.5 (0.3)		0.04 (0.04)	
Finland	50.6 (0.2)	▲	8.4 (0.2)		**0.05** (0.02)	-0.01 (0.02)
[†] Belgium (Flemish)	50.2 (0.2)		7.9 (0.2)		**0.09** (0.03)	**0.06** (0.03)
Slovak Republic	50.2 (0.3)		10.3 (0.2)		-0.02 (0.03)	-0.01 (0.03)
ICILS 2023 average	49.9 (0.0)		9.6 (0.0)		**0.03** (0.00)	0.01 (0.00)
[1] Czech Republic	49.7 (0.2)		10.2 (0.1)		**0.04** (0.02)	0.02 (0.02)
Luxembourg	49.5 (0.1)	▽	8.7 (0.1)		**0.07** (0.02)	0.03 (0.02)
Cyprus	49.5 (0.2)	▽	11.4 (0.2)		**0.10** (0.02)	
[1] Kosovo	[r] 49.5 (0.3)		9.1 (0.2)		0.00 (0.03)	
Greece	49.3 (0.3)	▽	11.7 (0.2)		**0.09** (0.03)	
[1] Spain	49.1 (0.2)	▽	9.7 (0.2)		0.02 (0.02)	
Oman	48.6 (0.1)	▽	9.4 (0.2)		-0.02 (0.02)	
[1] Serbia	48.4 (0.3)	▽	11.2 (0.2)		0.04 (0.03)	0.03 (0.02)
Italy	47.9 (0.3)	▽	10.3 (0.2)		0.04 (0.02)	-0.01 (0.02)
Malta	47.7 (0.2)	▽	11.6 (0.2)		**0.12** (0.02)	**0.10** (0.02)
Germany	47.6 (0.2)	▽	8.3 (0.2)		0.00 (0.03)	**-0.05** (0.02)
[1] Austria	47.5 (0.2)	▽	8.4 (0.2)		**-0.05** (0.02)	**-0.08** (0.02)
Hungary	47.1 (0.3)	▽	9.8 (0.2)		**-0.08** (0.02)	
Azerbaijan	[r] 46.2 (0.4)	▽	11.3 (0.3)		**-0.12** (0.03)	
[1] Slovenia	46.2 (0.2)	▽	10.1 (0.2)		**-0.07** (0.02)	**-0.05** (0.02)
[3] Bosnia and Herzegovina	46.0 (0.3)	▽	10.7 (0.2)		**-0.05** (0.02)	
France	44.8 (0.2)	▽	9.0 (0.2)		0.02 (0.02)	-0.01 (0.02)
Benchmarking participant						
[1] North Rhine-W. (Germany)	48.0 (0.3)	▽	8.1 (0.2)		-0.03 (0.04)	-0.06 (0.03)
Country not meeting sample participation requirements						
[‡] United States	52.9 (0.3)	▲	8.4 (0.2)		**0.19** (0.03)	**0.12** (0.03)

44 46 48 50 52 54 56

▲ Average significantly higher than ICILS 2023 average.

▽ Average significantly lower ICILS 2023 average.

Country average [+/- 95% C.I.]

On average across items, students with a score in the range with this color have more than 50% probability to indicate:

To a small extent or not at all

To a large extent or to a moderate extent

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant correlations (p<0.05) are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Countries are ranked in descending order of the average scale score.

† Met guidelines for sampling participation rates only after replacement schools were included.

‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

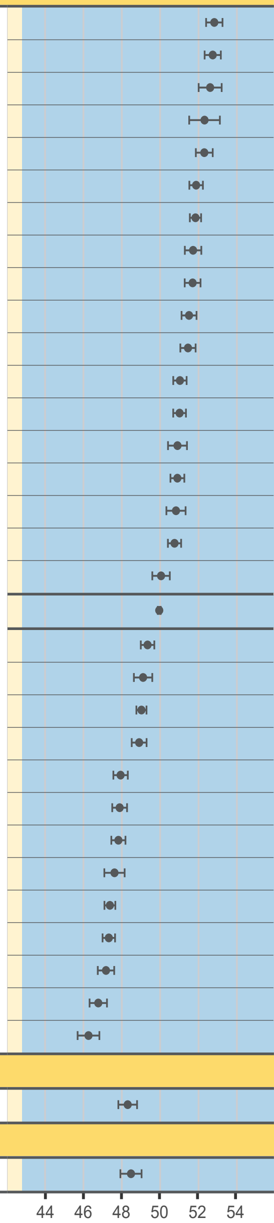
[2] Country surveyed target grade in the first half of the school year.

[3] National defined population covers 61% of the national target population.

[r] indicates data are available for at least 70% but less than 85% of the students.

Table 7.13: National scale score averages indicating the extent of learning about internet related tasks outside school, and correlation with CIL and CT achievement

Country	Learning about internet related tasks outside of school: Average scale score		Std. dev.	Avg. with confidence interval	Correlation with achievement: CIL	CT
[1] Latvia	52.8 (0.2)	▲	10.1 (0.2)		**0.20** (0.02)	**0.17** (0.02)
[1] Portugal	52.7 (0.2)	▲	9.5 (0.2)		**0.07** (0.02)	-0.02 (0.02)
Slovak Republic	52.6 (0.3)	▲	10.6 (0.2)		**0.20** (0.03)	**0.18** (0.03)
[†1,2] Romania	52.3 (0.4)	▲	11.4 (0.3)		**0.32** (0.02)	
[1] Slovenia	52.3 (0.2)	▲	10.7 (0.2)		**0.07** (0.02)	**0.09** (0.02)
Italy	51.9 (0.2)	▲	8.6 (0.1)		**0.17** (0.02)	**0.12** (0.02)
[1] Czech Republic	51.8 (0.1)	▲	10.0 (0.1)		**0.26** (0.01)	**0.21** (0.02)
[1] Croatia	51.7 (0.2)	▲	10.2 (0.2)		**0.14** (0.02)	**0.11** (0.02)
Greece	51.7 (0.2)	▲	10.0 (0.2)		**0.21** (0.02)	
[1] Serbia	51.5 (0.2)	▲	10.5 (0.2)		**0.22** (0.02)	**0.18** (0.02)
Cyprus	51.5 (0.2)	▲	11.1 (0.2)		**0.21** (0.02)	
[1] Norway (Grade 9)	51.0 (0.2)	▲	9.0 (0.1)		**0.12** (0.02)	**0.07** (0.02)
[1] Kazakhstan	51.0 (0.2)	▲	9.5 (0.1)		**0.27** (0.02)	
Hungary	50.9 (0.3)	▲	10.0 (0.2)		**0.20** (0.02)	
Chinese Taipei	50.9 (0.2)	▲	11.0 (0.2)		**0.20** (0.02)	**0.16** (0.02)
Malta	50.8 (0.3)	▲	10.5 (0.2)		**0.27** (0.02)	**0.20** (0.02)
Finland	50.7 (0.2)	▲	9.3 (0.1)		**0.10** (0.02)	**0.10** (0.02)
[1] Sweden	50.0 (0.2)		9.7 (0.2)		**0.16** (0.02)	**0.13** (0.02)
ICILS 2023 average	50.0 (0.0)		9.7 (0.0)		**0.17** (0.00)	**0.12** (0.00)
[†1] Denmark	49.3 (0.2)	▽	7.9 (0.2)		**0.04** (0.02)	**0.06** (0.02)
[3] Bosnia and Herzegovina	49.1 (0.2)	▽	9.4 (0.2)		**0.25** (0.03)	
[1] Spain	49.0 (0.1)	▽	9.8 (0.1)		**0.12** (0.01)	
[†] Uruguay	48.9 (0.2)	▽	9.1 (0.2)		**0.15** (0.02)	**0.13** (0.02)
[1] Kosovo	[r] 47.9 (0.2)	▽	8.1 (0.2)		**0.26** (0.02)	
Germany	47.9 (0.2)	▽	8.6 (0.2)		**0.13** (0.02)	**0.10** (0.02)
France	47.8 (0.2)	▽	9.5 (0.2)		**0.12** (0.02)	**0.07** (0.02)
Azerbaijan	[r] 47.6 (0.3)	▽	9.2 (0.2)		**0.26** (0.03)	
Luxembourg	47.4 (0.1)	▽	9.5 (0.1)		**0.14** (0.02)	**0.12** (0.02)
Oman	47.3 (0.2)	▽	9.2 (0.1)		**0.20** (0.02)	
[1] Austria	47.2 (0.2)	▽	9.1 (0.2)		**0.06** (0.02)	**0.06** (0.02)
[†] Belgium (Flemish)	46.8 (0.2)	▽	9.1 (0.2)		**0.11** (0.03)	**0.12** (0.03)
[†] Korea, Republic of	46.3 (0.3)	▽	13.1 (0.2)		**0.09** (0.02)	**0.07** (0.02)
Benchmarking participant						
[1] North Rhine-W. (Germany)	48.3 (0.2)	▽	8.9 (0.3)		**0.16** (0.04)	**0.10** (0.03)
Country not meeting sample participation requirements						
[‡] United States	48.5 (0.3)	▽	9.3 (0.2)		**0.18** (0.02)	**0.13** (0.02)



▲ Average significantly higher than ICILS 2023 average.

▽ Average significantly lower ICILS 2023 average.

Country average [+/- 95% C.I.]: ●

On average across items, students with a score in the range with this color have more than 50% probability to indicate:

To a small extent or not at all ☐

To a large extent or to a moderate extent ☐

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant correlations (p<0.05) are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Countries are ranked in descending order of the average scale score.

† Met guidelines for sampling participation rates only after replacement schools were included.

‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

[2] Country surveyed target grade in the first half of the school year.

[3] National defined population covers 61% of the national target population.

[r] indicates data are available for at least 70% but less than 85% of the students.

Learning about safe and responsible ICT use

The relationship between students' use of ICT and their well-being has become a pertinent topic which has increased in significance even since the COVID-19 pandemic (Kovacs et al., 2022; Lee et al., 2022). The relationship is complex and multifaceted. While digital devices offer opportunities for learning, communication, and entertainment, excessive or inappropriate use can lead to a range of issues affecting the well-being of students (Braghieri et al., 2022; Guedes et al., 2018; Jackson, 2012). Establishing a balanced approach to the use of digital devices, promoting healthy screen time habits, and emphasizing the importance of physical activity and face-to-face interactions are essential for safeguarding students' overall well-being in the digital age (Hou et al., 2019).

ICILS identified several aspects related to well-being and hence determines important learning areas for adolescents. Social media platforms play a significant role in today's adolescents' lives (Braghieri et al., 2022). Teaching them how to use these platforms responsibly and respectfully helps them to protect themselves and respect the rights of others. In this context, cyberbullying is a prevalent issue that can have serious consequences for students' mental health and well-being (Alotaibi, 2019; Giumetti & Kowalski, 2022; Siddiqui & Schultze-Krumbholz, 2023; Smale et al., 2021). Educating young people how to recognize cyberbullying can help them identify and address inappropriate behavior, which in turn aids promoting a safer online environment. Further, excessive screen time and sedentary behavior associated with ICT use can negatively impact students' physical health (Lissak, 2018). Teaching them about the importance of balancing screen time with physical activity encourages healthier habits and reduces the risk of selected physical health problems (such as neck and back soreness or excessive weight gain). Finally, excessive or inappropriate use of ICT can also have adverse effects on adolescents' psychological health, such as sleep disturbance, increased stress, anxiety, and depression (Holland & Tiggemann, 2016; Lissak, 2018; Memmedova & Selahattin, 2018). Educating them about the potential risks of excessive screen time and promoting strategies for managing their digital lives in a healthy way can support their overall well-being (Smale et al., 2021).

In ICILS, students were asked to what extent they have learned about the following topics at school:

- Responsible and respectful use of social media (including the use of images and personal information)
- How to recognize cyberbullying
- How to report cyberbullying
- Physical health and ICT use
- Psychological health and ICT use

Students responded to each statement by selecting one of four response options ("to a large extent," "to a moderate extent," "to a small extent," and "not at all").

On average across countries, about three out of four students reported they have learned to a moderate or large extent about the responsible and respectful use of social media and how to recognize cyberbullying at school (see Table D.11 in Appendix D). Only very few students—13 percent or less—on average across countries—reported they have not learned about these topics at school at all. About two thirds of the students stated they have learned about physical and psychological health and ICT use, and how to report cyberbullying at school to a moderate or large extent. These findings suggest that the topics investigated here are relatively well covered at school, at least on average across the countries participating in ICILS 2023.

We observe some variation across and within countries. In order to visualize such variations, four of the five statements were used to establish a scale (Table 7.14), the statement "How to report cyberbullying" was not included. As for previous scales on acquiring knowledge, higher scores correspond to a higher extent of learning the topics as per student reports. The scale was established with an average score of 50 and a standard deviation of 10. The location of most bars in the light blue-shaded area of the graph indicate that the majority of students stated they had learned about the topics captured by the scale to a moderate or large extent at school. The arrows in the table reveal, however, that 12 countries had significantly higher or, respectively, lower average scores compared to the ICILS 2023 average. Chinese Taipei clearly stands out with more students reporting having learning opportunities than students in other countries, with a difference of 4.3 scale score points between Chinese Taipei and the next highest country, Korea (Rep. of). In contrast, Portugal, Hungary, France, and Germany have average scores below 47 scale score points. According to students in those countries, the topics are being covered less than in other ICILS 2023 countries. No clear pattern can be observed regarding the correlations of students' reported learning about these topics with CIL and CT achievement. All correlation coefficients are small: 0.23 in Kazakhstan and Oman but 0.18 or below in other countries; some are negative while others are positive. About half of the correlation coefficients are significantly different from zero.

Table 7.14: National scale score averages indicating the extent of learning about safe and responsible ICT use at school, and correlation with CIL and CT

Country	Learning about safe and responsible ICT use at school: Average scale score			Std. dev.		Avg. with confidence interval	Correlation with achievement: CIL		CT	
Chinese Taipei	57.6	(0.2)	▲	9.3	(0.1)		**0.18**	(0.02)	**0.14**	(0.02)
[†] Korea, Republic of	53.3	(0.2)	▲	9.5	(0.1)		**0.11**	(0.02)	**0.09**	(0.02)
Greece	52.8	(0.3)	▲	10.3	(0.1)		**0.13**	(0.02)		
[1] Kazakhstan	52.6	(0.2)	▲	9.3	(0.1)		**0.23**	(0.02)		
Italy	52.6	(0.2)	▲	8.5	(0.1)		0.02	(0.02)	0.00	(0.02)
[1] Croatia	52.3	(0.3)	▲	10.6	(0.2)		**0.08**	(0.02)	0.00	(0.02)
Malta	52.0	(0.2)	▲	10.3	(0.2)		**0.16**	(0.02)	**0.13**	(0.02)
Cyprus	51.1	(0.2)	▲	11.3	(0.2)		**0.12**	(0.03)		
[†] Uruguay	51.1	(0.2)	▲	8.9	(0.1)		0.01	(0.02)	0.00	(0.03)
Finland	50.9	(0.2)	▲	9.9	(0.1)		**0.05**	(0.02)	0.01	(0.02)
Oman	50.9	(0.2)	▲	9.1	(0.1)		**0.23**	(0.02)		
[1] Kosovo	50.9	(0.2)	▲	8.5	(0.1)		**0.17**	(0.02)		
[†][1,2] Romania	50.5	(0.3)		10.5	(0.2)		0.06	(0.03)		
[1] Norway (Grade 9)	50.4	(0.2)		10.0	(0.1)		0.03	(0.02)	-0.03	(0.02)
[1] Spain	50.1	(0.2)		9.8	(0.1)		**0.06**	(0.01)		
[3] Bosnia and Herzegovina	50.1	(0.3)		9.3	(0.2)		0.05	(0.03)		
ICILS 2023 average	50.0	(0.0)		9.6	(0.0)		**0.05**	(0.00)	0.00	(0.00)
[1] Latvia	50.0	(0.3)		9.6	(0.2)		**0.14**	(0.02)	**0.09**	(0.03)
[1] Serbia	49.6	(0.3)		10.7	(0.2)		0.01	(0.02)	0.04	(0.02)
Slovak Republic	49.6	(0.2)		10.0	(0.2)		0.02	(0.03)	0.01	(0.03)
[1] Sweden	49.6	(0.3)		10.9	(0.1)		0.02	(0.02)	-0.02	(0.02)
Azerbaijan	[r] 49.2	(0.2)	▽	9.7	(0.2)		0.03	(0.03)		
[†] Belgium (Flemish)	48.7	(0.2)	▽	8.3	(0.1)		0.00	(0.03)	-0.02	(0.03)
[1] Czech Republic	48.7	(0.2)	▽	9.9	(0.1)		**-0.04**	(0.02)	**-0.05**	(0.02)
Luxembourg	48.6	(0.1)	▽	9.5	(0.1)		**0.03**	(0.02)	0.02	(0.02)
[1] Slovenia	48.2	(0.2)	▽	10.7	(0.2)		**0.04**	(0.02)	**0.06**	(0.02)
[1] Austria	48.0	(0.3)	▽	10.0	(0.2)		**-0.12**	(0.02)	**-0.15**	(0.02)
[†][1] Denmark	47.0	(0.2)	▽	8.3	(0.2)		**-0.06**	(0.02)	**-0.10**	(0.02)
Germany	46.9	(0.2)	▽	9.4	(0.2)		**-0.08**	(0.03)	**-0.11**	(0.03)
France	46.3	(0.2)	▽	9.3	(0.1)		0.01	(0.02)	-0.01	(0.02)
Hungary	46.1	(0.3)	▽	10.0	(0.2)		**-0.10**	(0.02)		
[1] Portugal	44.5	(0.3)	▽	8.2	(0.2)		**-0.11**	(0.02)	**-0.13**	(0.03)
Benchmarking participant										
[1] North Rhine-W. (Germany)	47.3	(0.3)	▽	9.8	(0.2)		-0.09	(0.04)	**-0.14**	(0.04)
Country not meeting sample participation requirements										
[‡] United States	51.9	(0.4)	▲	9.8	(0.2)		**0.12**	(0.03)	**0.07**	(0.03)

44 46 48 50 52 54 56 58

▲ Average significantly higher than ICILS 2023 average.

▽ Average significantly lower ICILS 2023 average.

Country average [+/- 95% C.I.]:

On average across items, students with a score in the range with this color have more than 50% probability to indicate:

To a small extent or not at all

To a large extent or to a moderate extent

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant correlations (p<0.05) are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Countries are ranked in descending order of the average scale score.

[†] Met guidelines for sampling participation rates only after replacement schools were included.

[‡] Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

[2] Country surveyed target grade in the first half of the school year.

[3] National defined population covers 61% of the national target population.

[r] indicates data are available for at least 70% but less than 85% of the students.

7.4 Emotional engagement: Students' perceptions of ICT

In this section, we examine students' emotional engagement with ICT. The emotional component of students' engagement includes their perceptions of and feelings about ICT. Emotional engagement involves interest, values, and emotions and includes positive and negative reactions to e.g., teachers, classmates, subjects, and the school (Fredricks et al., 2004). It also encompasses the concept of self-efficacy, as the belief in one's ability to succeed in specific tasks plays a crucial role in shaping emotions and attitudes. It is assumed that emotional engagement affects the motivation to complete school work. Early research on emotional engagement has focused, for example, on students' attitudes (Epstein & McPartland, 1976; Yamamoto et al., 1969) and students' interests and values (Eccles (Parsons) et al., 1983).

ICILS investigates students' attitudes towards ICT. Students were asked about their ICT self-efficacy, their perceptions of ICT in relation to learning and use, their expectations for the future use of ICT as well as their positive and negative beliefs about ICT in relation with society.

ICT self-efficacy regarding the use of general applications

Students' perceptions of their own capacity to use ICT describe their ICT self-efficacy. Perceived self-efficacy is assumed to be central for human ability to act, determining their thinking, feeling, and behavior (Bandura, 1982; Bandura & Wessels, 1994). The construct of self-efficacy refers to a person's perceptions that they are capable of organizing and executing a course of action in order to achieve certain results (Bandura & Wessels, 1994). This in turn affects their decisions in relation to taking on tasks, the effort they put into them and the extent to which they persevere with a task. As in ICILS 2013 and ICILS 2018, we referred to ICT self-efficacy in basic ICT skills as the construct of *ICT self-efficacy regarding the use of general applications*. This construct was based on student confidence in performing general ICT-based tasks such as creating or editing digital text for a school assignment, or searching for relevant information for a school project on the internet. ICILS 2013 and 2018 showed that ICT-based self-efficacy in basic ICT skills was positively associated with CIL achievement (Fraillon et al., 2014, 2020). This means that students who reported higher confidence in their performance in general ICT-based tasks also tended to show higher CIL achievement, or that students with higher CIL achievement report higher confidence.

As part of the ICILS 2023 student questionnaire we asked students to report how well they can do each of the following ICT-based tasks:

- Edit digital photographs or other graphic images
- Write or edit text for a school assignment
- Search for relevant information for a school project on the internet
- Change the settings on a device to suit your needs and preferences
- Create a multi-media presentation (with sound, pictures, or video)
- Upload text, images, or video to an online profile
- Insert an image into a document or message
- Install a program or app
- Judge whether you can trust information you find on the internet
- Find the original sources of information referred to in an article on the internet, if the URL is not given

Students answered by choosing one of the following response options for each statement ("very well," "moderately well," "I have never done this, but I could work out how to do it," or "I do not think I could do this"). On average across the statements and countries, the majority of students indicated they can do these 10 general ICT tasks very well (approximately 45%) or moderately well (approximately 38%), whereas less than five percent reported that they do not think they could do this (see Table D.13 in Appendix D). *Finding the original sources of information referred to in an article on the internet, if the URL is not given* was a task that a comparatively small percentages of students reported to master very well (approximately 24% on average across countries) or moderately well (approximately 39% on average across countries).

We formed a scale based on these statements to explore differences in students' ICT self-efficacy regarding the use of general applications between countries. High scores in students' ICT self-efficacy indicate strong confidence in their ability to successfully use and manage ICT for general applications, whereas low scores suggest that students have less confidence in their ability to use ICT effectively. The scale was established with an average score of 50 and a standard deviation of 10. The lowest average scores on the ICT self-efficacy scale was observed in Azerbaijan (46.5) and the highest average scale in Croatia (54.8) (see Table 7.15).

Students' ICT self-efficacy regarding the use of general applications was statistically significantly correlated with CIL and CT achievement in all countries, confirming findings of earlier cycles of ICILS. Across countries, the average correlation coefficient was 0.24, with the highest correlation (equal or above 0.30) in Bosnia and Herzegovina, Malta, Romania, and Uruguay and lowest (below 0.20) in Austria, Finland, Slovenia, Spain, and Sweden. The correlation between students' ICT self-efficacy and CT achievement was on average lower than the correlation with CIL achievement. We found the highest correlation in Malta (0.25) and Serbia (0.24) and the lowest in Austria (0.11), Germany (0.12), and North Rhine-Westphalia (Germany) (0.13).

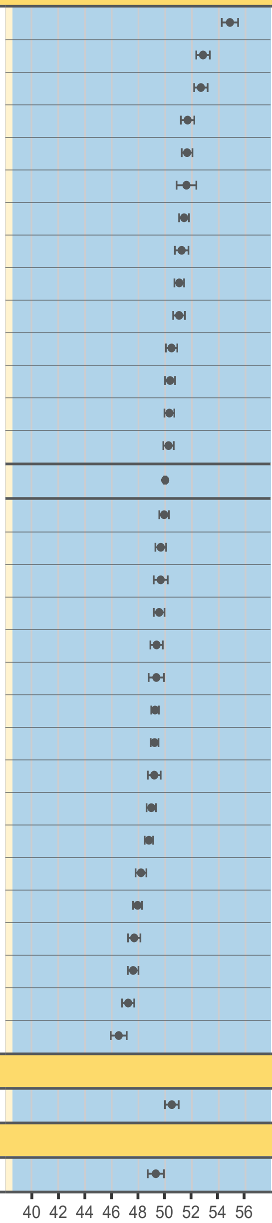
In contrast to the positive associations between each of CIL and CT and students' general ICT self-efficacy within countries, across countries the associations are somewhat different and warrant further investigation. Generally, countries with high CIL and/or CT average achievement tended to have relatively low average ICT self-efficacy scores. For example, none of the 10 countries in which average student CIL or CT achievement was highest (see Chapter 5, Table 5.1 & Table 5.5) are among the 10 countries listed in Table 7.15 with the highest student general ICT self-efficacy. In contrast, six of the countries with CIL achievement in the top 10 countries (Korea, (Rep. of), Chinese Taipei, Belgium (Flemish), the Czech Republic, Finland, and Latvia) were in the bottom 10 countries with respect to student ICT self-efficacy listed in Table 7.15. These same six countries also were in the 10 countries with the highest average CT achievement scores and are the countries with the lowest ICT general self-efficacy in which CT was completed listed in Table 7.15. Across countries, ICT general self-efficacy was negatively associated with CIL achievement (r_s= -0.2)[31] and with CT (r_s= -0.7).[32]

31 Spearman's rank correlation was used with countries' CIL achievement and self-efficacy ranks from highest to lowest for each variable.
32 Spearman's rank correlation was used with countries' CT achievement and self-efficacy ranks from highest to lowest for each variable.

Table 7.15: National scale score averages indicating students' ICT self-efficacy regarding the use of general applications, and correlation with CIL and CT achievement

Country	ICT self-efficacy regarding the use of general applications: Average scale score		Std. dev.	Correlation with achievement: CIL	CT
[1] Croatia	54.8 (0.3)	▲	12.4 (0.2)	**0.26** (0.03)	**0.19** (0.03)
Cyprus	52.8 (0.3)	▲	11.8 (0.2)	**0.24** (0.02)	
Greece	52.7 (0.3)	▲	10.7 (0.1)	**0.29** (0.02)	
Malta	51.7 (0.3)	▲	11.5 (0.2)	**0.32** (0.02)	**0.25** (0.02)
France	51.6 (0.2)	▲	9.4 (0.2)	**0.25** (0.02)	**0.16** (0.02)
[3] Bosnia and Herzegovina	51.6 (0.4)	▲	11.1 (0.2)	**0.31** (0.03)	
Hungary	51.4 (0.2)	▲	9.2 (0.1)	**0.21** (0.02)	
[1] Serbia	51.2 (0.3)	▲	11.9 (0.2)	**0.29** (0.02)	**0.24** (0.02)
Italy	51.0 (0.2)	▲	8.6 (0.1)	**0.23** (0.02)	**0.14** (0.02)
[1] Slovenia	51.0 (0.2)	▲	10.4 (0.2)	**0.16** (0.02)	**0.14** (0.02)
[1] Portugal	50.5 (0.2)	▲	9.5 (0.2)	**0.28** (0.02)	**0.19** (0.02)
[1] Sweden	50.4 (0.2)		9.7 (0.2)	**0.19** (0.02)	**0.16** (0.03)
Oman	50.3 (0.2)		10.8 (0.1)	**0.23** (0.02)	
[1] Norway (Grade 9)	50.2 (0.2)		9.5 (0.2)	**0.25** (0.02)	**0.22** (0.02)
ICILS 2023 average	50.0 (0.0)		9.8 (0.0)	**0.24** (0.00)	**0.18** (0.00)
Germany	49.9 (0.2)		8.6 (0.2)	**0.22** (0.02)	**0.12** (0.02)
[†1] Denmark	49.7 (0.2)		7.9 (0.1)	**0.22** (0.02)	**0.19** (0.02)
[†] Uruguay	49.7 (0.3)		9.2 (0.2)	**0.30** (0.02)	**0.22** (0.02)
[1] Austria	49.5 (0.2)	▽	8.5 (0.2)	**0.17** (0.03)	**0.11** (0.03)
Slovak Republic	49.4 (0.2)	▽	9.5 (0.2)	**0.22** (0.02)	**0.18** (0.02)
[†12] Romania	49.3 (0.3)	▽	11.2 (0.2)	**0.31** (0.02)	
[1] Spain	49.2 (0.1)	▽	9.2 (0.2)	**0.19** (0.02)	
Luxembourg	49.2 (0.1)	▽	9.5 (0.1)	**0.26** (0.01)	**0.18** (0.02)
[1] Latvia	49.2 (0.2)	▽	9.6 (0.2)	**0.25** (0.02)	**0.18** (0.02)
Finland	49.0 (0.2)	▽	9.2 (0.2)	**0.18** (0.02)	**0.15** (0.02)
[1] Czech Republic	48.8 (0.2)	▽	9.1 (0.1)	**0.22** (0.01)	**0.16** (0.02)
[†] Belgium (Flemish)	48.2 (0.2)	▽	8.1 (0.2)	**0.27** (0.02)	**0.20** (0.02)
Chinese Taipei	47.9 (0.2)	▽	9.3 (0.2)	**0.22** (0.02)	**0.16** (0.02)
[1] Kosovo	47.7 (0.2)	▽	9.5 (0.2)	**0.28** (0.03)	
[1] Kazakhstan	47.6 (0.2)	▽	10.0 (0.2)	**0.22** (0.02)	
[†] Korea, Republic of	47.2 (0.2)	▽	10.1 (0.2)	**0.27** (0.02)	**0.19** (0.02)
Azerbaijan	[r] 46.5 (0.3)	▽	10.3 (0.2)	**0.23** (0.04)	
Benchmarking participant					
[1] North Rhine-W. (Germany)	50.5 (0.3)		8.9 (0.2)	**0.25** (0.02)	**0.13** (0.03)
Country not meeting sample participation requirements					
[‡] United States	49.3 (0.3)	▽	10.1 (0.3)	**0.33** (0.03)	**0.23** (0.03)

Avg. with confidence interval:



▲ Average significantly higher than ICILS 2023 average.

▽ Average significantly lower ICILS 2023 average.

Country average [+/- 95% C.I.]: ⊢●⊣

On average across items, students with a score in the range with this color have more than 50% probability to indicate:

I have never done this, but I could work out how to do, or I do not think I could do this ▢ (yellow)

Very well or moderately well ▢ (blue)

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant correlations (p<0.05) are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Countries are ranked in descending order of the average scale score.

† Met guidelines for sampling participation rates only after replacement schools were included.

‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

2 Country surveyed target grade in the first half of the school year.

3 National defined population covers 61% of the national target population.

r indicates data are available for at least 70% but less than 85% of the students.

Perceptions of ICT - learning with and use of ICT

Students' perceptions and beliefs are important in explaining their current and future actions (Breen & Goldthorpe, 1997; Morgan, 2002). According to the Theory of Planned Behavior, attitudes towards a behavior combine with subjective norms and perceived control to predict an individual's intentions and subsequent actions (Ajzen, 1985; Madden et al., 1992). Additionally, expectancy-value theory suggests that students' beliefs about the value and outcomes of their actions determine their motivation and engagement in activities, influencing both current behavior and future aspirations (Wigfield & Eccles, 2000). We were therefore also interested in the students' perceptions of their current and future learning and using of ICT, but also their perceptions of the value of ICT in society as part of their emotional engagement with ICT.

Regarding their current learning and use of ICT, we asked students to indicate the degree to which they agreed or disagreed with the following statements:

- Using ICT at school makes learning more fun
- It is important for students to learn how to use ICT at school
- It is important for students to learn programming at school
- It is important for students to keep up to date with changes in ICT

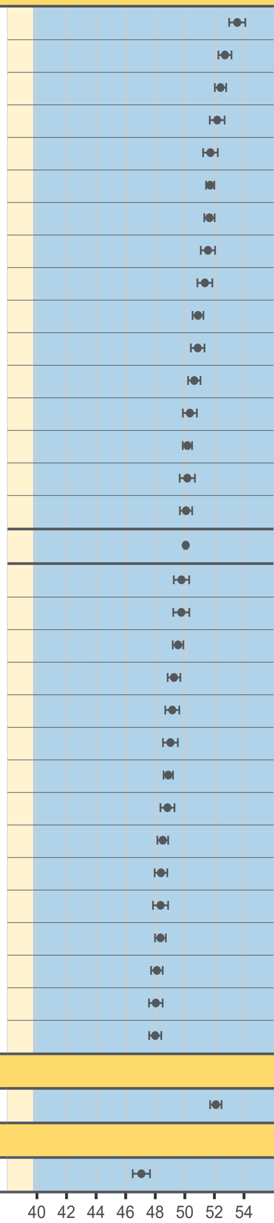
Students could choose between four response categories ("strongly agree," "agree," "disagree," and "strongly disagree"). On average across the statements and countries, approximately 80 percent of the students indicated to strongly agree or agree to the statements (ranging between 72% and 87% for the statements; see Table D.15 in Appendix D).

We developed a scale from these statements to examine variations in students' perceptions of their ICT learning and use across different countries. Higher scores represent more positive perceptions of students regarding their current ICT learning and use. The scale was established with an average score of 50 and a standard deviation of 10. We observed averages mostly between 48 and 52 scale score points. In Kosovo, Portugal, Italy, and Romania the average scores were above 52 scale score points, and the lowest averages were found in Denmark, Slovenia, and Latvia (48.1 scale score points or lower; see Table 7.16). The correlation between students' perceptions of their current use and learning of ICT and their CIL achievement/CT achievement was positive and statistically significant in all countries except for North Rhine-Westphalia (Germany). On average, the correlation coefficient across countries was 0.15 for CIL achievement and 0.13 for CT achievement, with Oman showing the highest correlation of 0.26 with CIL achievement and with Korea (Rep. of) showing the highest correlation of 0.20 with CT achievement. The lowest correlation with CIL achievement was found in Austria and Denmark (0.07) and with CT achievement in France and Italy (0.07).

Table 7.16: National scale score averages indicating students' perceptions of their learning with and use of ICT, and correlation with CIL and CT achievement

Country	Students' perceptions of their learning with and use of ICT: Average scale score		Std. dev.	Correlation with achievement: CIL	CT
[1] Kosovo	[r] 53.5 (0.3)	▲	10.6 (0.1)	**0.23** (0.02)	
[1] Portugal	52.6 (0.2)	▲	9.4 (0.1)	**0.19** (0.02)	**0.18** (0.02)
Italy	52.3 (0.2)	▲	9.1 (0.1)	**0.12** (0.02)	**0.07** (0.02)
[†12] Romania	52.1 (0.3)	▲	11.1 (0.2)	**0.22** (0.02)	
Germany	51.7 (0.3)	▲	9.9 (0.2)	**0.12** (0.03)	**0.10** (0.02)
[1] Czech Republic	51.6 (0.1)	▲	9.9 (0.1)	**0.19** (0.01)	**0.18** (0.01)
[1] Spain	51.6 (0.2)	▲	10.1 (0.1)	**0.16** (0.02)	
Greece	51.5 (0.2)	▲	10.2 (0.1)	**0.21** (0.02)	
Cyprus	51.3 (0.3)	▲	10.9 (0.1)	**0.20** (0.02)	
[†] Korea, Republic of	50.8 (0.2)	▲	9.5 (0.1)	**0.19** (0.02)	**0.20** (0.02)
[1] Kazakhstan	50.8 (0.2)	▲	9.8 (0.1)	**0.13** (0.02)	
Oman	50.6 (0.2)	▲	10.9 (0.1)	**0.26** (0.02)	
[1] Austria	50.3 (0.2)		10.2 (0.1)	**0.07** (0.02)	**0.08** (0.02)
Chinese Taipei	50.1 (0.2)		9.6 (0.1)	**0.11** (0.02)	**0.12** (0.02)
[3] Bosnia and Herzegovina	50.1 (0.3)		10.4 (0.2)	**0.19** (0.03)	
France	50.0 (0.2)		10.0 (0.1)	**0.11** (0.02)	**0.07** (0.02)
ICILS 2023 average	50.0 (0.0)		9.9 (0.0)	**0.15** (0.00)	**0.13** (0.00)
[†] Uruguay	[r] 49.7 (0.3)		9.5 (0.2)	**0.17** (0.03)	**0.15** (0.03)
Azerbaijan	[r] 49.7 (0.3)		10.8 (0.2)	**0.18** (0.03)	
Slovak Republic	49.5 (0.2)	▽	9.4 (0.1)	**0.14** (0.02)	**0.13** (0.02)
Malta	49.2 (0.2)	▽	11.3 (0.2)	**0.17** (0.02)	**0.17** (0.02)
[1] Sweden	[r] 49.1 (0.2)	▽	9.6 (0.2)	**0.10** (0.03)	**0.12** (0.02)
[†] Belgium (Flemish)	49.0 (0.3)	▽	8.6 (0.2)	**0.14** (0.03)	**0.13** (0.03)
Luxembourg	[r] 48.8 (0.2)	▽	9.4 (0.1)	**0.11** (0.02)	**0.12** (0.02)
[1] Croatia	48.8 (0.2)	▽	10.5 (0.2)	**0.13** (0.03)	**0.09** (0.03)
[1] Norway (Grade 9)	48.5 (0.2)	▽	9.7 (0.1)	**0.16** (0.02)	**0.16** (0.02)
Hungary	48.3 (0.2)	▽	9.2 (0.2)	**0.12** (0.02)	
[1] Serbia	48.3 (0.3)	▽	10.7 (0.2)	**0.18** (0.02)	**0.19** (0.02)
Finland	48.3 (0.2)	▽	9.6 (0.2)	**0.12** (0.02)	**0.14** (0.02)
[†1] Denmark	48.1 (0.2)	▽	8.3 (0.1)	**0.07** (0.02)	**0.08** (0.02)
[1] Slovenia	48.0 (0.2)	▽	10.5 (0.2)	**0.11** (0.02)	**0.11** (0.02)
[1] Latvia	48.0 (0.2)	▽	8.9 (0.1)	**0.12** (0.03)	**0.10** (0.02)
Benchmarking participant					
[1] North Rhine-W. (Germany)	52.0 (0.2)	▲	9.9 (0.2)	0.07 (0.04)	0.01 (0.03)
Country not meeting sample participation requirements					
[‡] United States	[r] 47.0 (0.3)	▽	8.9 (0.2)	**0.11** (0.04)	**0.10** (0.03)

Avg. with confidence interval



▲ Average significantly higher than ICILS 2023 average.

▽ Average significantly lower ICILS 2023 average.

Country average [+/- 95% C.I.]: ●

On average across items, students with a score in the range with this color have more than 50% probability to indicate:

Disagree or strongly disagree

Strongly agree or agree

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant correlations (p<0.05) are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Countries are ranked in descending order of the average scale score.

[†] Met guidelines for sampling participation rates only after replacement schools were included.

[‡] Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

[2] Country surveyed target grade in the first half of the school year.

[3] National defined population covers 61% of the national target population.

[r] indicates data are available for at least 70% but less than 85% of the students.

Perceptions of ICT - expectations for future use of ICT

We also asked students about their expectations for future use of ICT. Students were presented with five statements:

- I would like to study subjects related to ICT after secondary school
- I hope that using ICT is a very important part of my future job
- I hope that my future job involves programming
- Learning how to use ICT applications will help me to do the work I am interested in
- Learning how to use ICT well will help me get a well-paid job

Students responded to each statement by selecting one of four response options ("strongly agree," "agree," "disagree," and "strongly disagree").

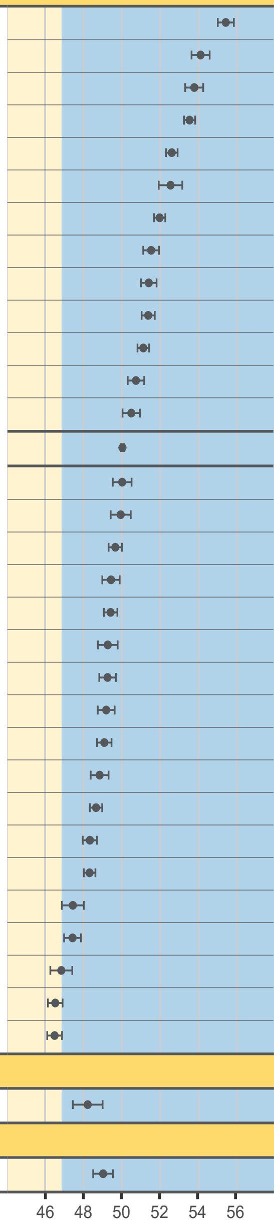
While slightly less than half of students on average across all countries indicated to agree or strongly agree with the statement *I hope that my future job involves programming* (approximately 44%), three out of four students indicated to agree or strongly agree with the statement *learning how to use ICT well will help me get a well-paid job* (77%; see Table D.17 in Appendix D). This illustrated varying endorsement across the different statements.

We formed a scale based using the student response data to the statements. Higher scores indicate more positive expectations of the students with regard to their future use of ICT, lower scores indicate less positive expectations. The scale was established with an average score of 50 and a standard deviation of 10. Kosovo (55.4), Azerbaijan (54.1), Romania (53.8), and Oman (53.5) were among the countries with the highest average scores. In contrast, Belgium (Flemish) (46.8), Finland (46.5), and Denmark (46.5) showed the lowest average scores (see Table 7.17). In the majority of countries, students' perceptions of future use of ICT were not consistently associated with CIL achievement, with correlation coefficients ranging from 0.13 to -0.12, nor with CT achievement, with correlation coefficients ranging from 0.09 to -0.06.

Table 7.17: National scale score averages indicating students' perceptions of expectations for future use of ICT, and correlation with CIL and CT achievement

Country	Students' perceptions of expectations for future use of ICT					Correlation with achievement			
	Average scale score			Std. dev.		CIL		CT	
[1] Kosovo	[r] 55.4	(0.2)	▲	9.2	(0.1)	**0.13**	(0.03)		
Azerbaijan	[r] 54.1	(0.2)	▲	9.6	(0.2)	**0.11**	(0.03)		
[†1,2] Romania	53.8	(0.2)	▲	10.3	(0.2)	**0.06**	(0.03)		
Oman	53.5	(0.1)	▲	9.1	(0.1)	**0.10**	(0.02)		
[1] Kazakhstan	52.6	(0.2)	▲	8.6	(0.1)	0.01	(0.02)		
[3] Bosnia and Herzegovina	52.5	(0.3)	▲	10.2	(0.2)	**0.10**	(0.02)		
[1] Spain	52.0	(0.1)	▲	9.5	(0.1)	**-0.05**	(0.02)		
[1] Portugal	51.5	(0.2)	▲	9.4	(0.1)	**-0.05**	(0.02)	-0.02	(0.02)
Cyprus	51.4	(0.2)	▲	10.5	(0.2)	0.03	(0.02)		
Italy	51.4	(0.2)	▲	9.0	(0.1)	**-0.04**	(0.02)	-0.03	(0.02)
Chinese Taipei	51.1	(0.2)	▲	9.1	(0.1)	-0.03	(0.02)	0.02	(0.02)
Greece	50.7	(0.2)	▲	9.5	(0.1)	0.01	(0.02)		
[1] Croatia	50.5	(0.2)	▲	10.6	(0.2)	-0.02	(0.03)	0.00	(0.03)
ICILS 2023 average	50.0	(0.0)		9.7	(0.0)	**-0.01**	(0.00)	**0.02**	(0.00)
[†] Uruguay	[r] 50.0	(0.2)		9.3	(0.2)	-0.01	(0.02)	0.04	(0.03)
[1] Serbia	49.9	(0.3)		10.9	(0.2)	**0.06**	(0.03)	**0.09**	(0.03)
[†] Korea, Republic of	49.7	(0.2)	▽	9.2	(0.1)	0.01	(0.02)	**0.05**	(0.02)
Malta	49.4	(0.2)	▽	11.9	(0.2)	0.00	(0.02)	**0.07**	(0.02)
Slovak Republic	49.4	(0.2)	▽	9.4	(0.1)	0.00	(0.02)	0.02	(0.02)
[1] Latvia	49.3	(0.3)	▽	9.2	(0.2)	0.00	(0.03)	0.04	(0.03)
[1] Sweden	[r] 49.3	(0.2)	▽	10.0	(0.2)	-0.05	(0.03)	0.03	(0.02)
France	49.2	(0.2)	▽	9.8	(0.1)	**-0.08**	(0.02)	-0.04	(0.02)
Hungary	49.1	(0.2)	▽	10.0	(0.1)	**-0.05**	(0.02)		
[1] Slovenia	48.8	(0.2)	▽	10.3	(0.2)	**-0.04**	(0.02)	0.04	(0.02)
[1] Czech Republic	48.7	(0.2)	▽	10.0	(0.1)	0.02	(0.01)	**0.07**	(0.01)
Luxembourg	48.3	(0.2)	▽	9.8	(0.1)	**-0.12**	(0.02)	**-0.06**	(0.02)
[1] Norway (Grade 9)	48.3	(0.2)	▽	9.2	(0.2)	-0.02	(0.02)	0.03	(0.02)
[1] Austria	47.4	(0.3)	▽	10.6	(0.2)	**-0.06**	(0.02)	0.00	(0.02)
Germany	47.4	(0.2)	▽	10.2	(0.2)	-0.03	(0.02)	0.03	(0.02)
[†] Belgium (Flemish)	46.8	(0.3)	▽	9.4	(0.2)	**-0.09**	(0.03)	0.00	(0.03)
Finland	46.5	(0.2)	▽	10.2	(0.1)	**-0.05**	(0.02)	0.02	(0.02)
[†1] Denmark	46.5	(0.2)	▽	8.7	(0.2)	**-0.05**	(0.02)	0.01	(0.02)
Benchmarking participant									
[1] North Rhine-W. (Germany)	48.2	(0.4)	▽	10.8	(0.3)	-0.01	(0.04)	0.00	(0.03)
Country not meeting sample participation requirements									
[‡] United States	[r] 49.0	(0.3)	▽	9.0	(0.2)	-0.05	(0.03)	-0.02	(0.03)

Avg. with confidence interval



▲ Average significantly higher than ICILS 2023 average.

▽ Average significantly lower ICILS 2023 average.

Country average [+/- 95% C.I.]: ●

On average across items, students with a score in the range with this color have more than 50% probability to indicate:

Disagree or strongly disagree 🟨

Strongly agree or agree 🟦

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant correlations (p<0.05) are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Countries are ranked in descending order of the average scale score.

[†] Met guidelines for sampling participation rates only after replacement schools were included.

[‡] Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

[2] Country surveyed target grade in the first half of the school year.

[3] National defined population covers 61% of the national target population.

[r] indicates data are available for at least 70% but less than 85% of the students.

Perceptions of ICT - positive and negative beliefs about ICT and society

It is important to ask young people about their views on ICT and its use in society or in the workplace, as this can enrich our understanding of their experiences and needs in relation to their ICT use. In addition, young people's perspectives can help to identify both the opportunities and challenges associated with ICT use. This knowledge serves as a basis for efforts to harness the potential of technology for positive outcomes while mitigating the risks and removing barriers that may hinder young people's access or participation. Involving young people in discussions about ICT and their role in society or the workplace encourages their ownership, improves our understanding of their digital experiences and needs, and contributes to more informed and inclusive decision-making around technology.

With regard to the societal value of ICT, we presented the students with eight statements in which positive and negative views of ICT were balanced. As with the two previous sets of questions, students responded to each statement by selecting one of four response options ("strongly agree," "agree," "disagree," and "strongly disagree").

The four positive statements about ICT in society were:

- Advances in ICT usually improve people's living conditions
- ICT helps us to understand the world better
- ICT is valuable to society
- Advances in ICT bring many social benefits

The four negative statements about ICT in society were:

- Using ICT makes people more isolated in society
- With more ICT there will be fewer jobs
- People spend far too much time using ICT
- Using ICT may be dangerous for people's health

On average across countries, more than 80 percent of students tended to agree or strongly agree with the positive perceptions of the societal value of ICT (see Table D.19 in Appendix D). However, we also observed a relatively high level of agreement with the statements that expressed negative perceptions of ICT. Approximately 59 percent of students on average across countries expressed agreement with the statement *With more ICT there will be fewer jobs* (see Table D.21 in Appendix D). In addition, 83 percent of students, on average across countries, endorsed the view that *People spend far too much time using ICT*.

We developed separate scales representing students' positive and negative perceptions of ICT and society. The scales were established with an average score of 50 and a standard deviation of 10. When examining students' positive perceptions of ICT and society, the three countries in which students showed the most positive beliefs were Chinese Taipei (54.6), Korea (Rep. of) (52.8), and Kosovo (52.4) (see Table 7.18). In contrast, the average scores of students in Belgium (Flemish) (47.7), Luxembourg (47.6), Serbia (47.3), and Slovenia (47.0) were all lower than 48 scale score points. In almost all countries, students' positive perceptions were significantly positively associated with their CIL and CT achievement (see Table 7.18).

In terms of students' negative perceptions of ICT, the strongest negative perceptions were observed in the Czech Republic (52.2). Whereas students from Oman (47.8), Malta (47.7), and Norway (47.4) tended to indicate comparatively less pronounced negative views (see Table 7.19). The correlation of students' negative perceptions of ICT and CIL achievement was again positive and statistically significant in about three quarters of the participating countries (except for North Rhine-Westphalia (Germany), see Table 7.19). We found the highest correlation for Serbia (with a correlation of 0.19). Students' negative perceptions of ICT and CT achievement showed no clear correlation across countries.

Table 7.18: National scale score averages indicating students' perceptions of positive beliefs about ICT and society, and correlation with CIL and CT achievement

Country	Students' perceptions of positive beliefs about ICT and society: Average scale score		Std. dev.	Avg. with confidence interval	Correlation with achievement: CIL	Correlation with achievement: CT
Chinese Taipei	54.6 (0.2)	▲	10.1 (0.1)		**0.22** (0.02)	**0.22** (0.02)
† Korea, Republic of	52.8 (0.2)	▲	9.7 (0.1)		**0.19** (0.02)	**0.20** (0.02)
[1] Kosovo	52.4 (0.2)	▲	9.9 (0.1)		**0.17** (0.02)	
[1] Sweden	[r] 51.7 (0.3)	▲	10.2 (0.1)		**0.20** (0.02)	**0.21** (0.02)
[1] Kazakhstan	51.7 (0.2)	▲	9.6 (0.1)		**0.20** (0.02)	
†[1,2] Romania	51.4 (0.2)	▲	11.0 (0.2)		**0.19** (0.03)	
Oman	51.2 (0.2)	▲	10.5 (0.1)		**0.23** (0.01)	
[1] Spain	51.1 (0.1)	▲	9.9 (0.1)		**0.13** (0.02)	
[1] Portugal	51.1 (0.2)	▲	9.3 (0.1)		**0.11** (0.02)	**0.09** (0.02)
Finland	51.0 (0.2)	▲	9.9 (0.2)		**0.18** (0.02)	**0.18** (0.02)
Azerbaijan	[r] 50.9 (0.2)	▲	10.6 (0.2)		**0.18** (0.02)	
Italy	50.4 (0.2)	▲	9.3 (0.1)		**0.10** (0.02)	**0.08** (0.02)
Cyprus	50.4 (0.2)	▲	10.8 (0.2)		**0.16** (0.02)	
Greece	50.4 (0.3)		9.8 (0.2)		**0.14** (0.02)	
Malta	50.3 (0.2)		11.1 (0.1)		**0.19** (0.02)	**0.19** (0.02)
France	50.0 (0.2)		10.0 (0.1)		**0.12** (0.02)	**0.08** (0.02)
ICILS 2023 average	50.0 (0.0)		9.8 (0.0)		**0.13** (0.00)	**0.11** (0.00)
Slovak Republic	49.7 (0.2)		9.3 (0.1)		**0.12** (0.02)	**0.10** (0.02)
†[1] Denmark	49.6 (0.2)		8.9 (0.1)		**0.05** (0.02)	**0.10** (0.02)
Germany	49.5 (0.2)	▽	9.8 (0.1)		**0.05** (0.02)	**0.05** (0.02)
[1] Latvia	49.5 (0.2)	▽	9.3 (0.2)		**0.11** (0.02)	**0.08** (0.02)
[1] Norway (Grade 9)	49.4 (0.2)	▽	9.6 (0.2)		**0.15** (0.02)	**0.15** (0.02)
[1] Czech Republic	49.3 (0.1)	▽	9.8 (0.1)		**0.10** (0.01)	**0.10** (0.01)
† Uruguay	[r] 49.1 (0.2)	▽	9.1 (0.2)		**0.16** (0.02)	**0.14** (0.02)
[3] Bosnia and Herzegovina	48.7 (0.3)	▽	10.2 (0.2)		**0.10** (0.03)	
Hungary	48.7 (0.2)	▽	9.4 (0.2)		**0.07** (0.02)	
[1] Croatia	48.4 (0.3)	▽	10.8 (0.2)		**0.07** (0.03)	0.05 (0.03)
[1] Austria	48.2 (0.2)	▽	10.1 (0.1)		0.01 (0.02)	0.01 (0.02)
† Belgium (Flemish)	47.7 (0.2)	▽	8.7 (0.2)		**0.10** (0.03)	**0.10** (0.03)
Luxembourg	47.6 (0.2)	▽	9.3 (0.1)		**0.05** (0.02)	**0.06** (0.02)
[1] Serbia	47.3 (0.3)	▽	10.7 (0.2)		**0.10** (0.02)	**0.10** (0.02)
[1] Slovenia	47.0 (0.2)	▽	10.0 (0.2)		**0.07** (0.02)	**0.11** (0.02)
Benchmarking participant						
[1] North Rhine-W. (Germany)	49.6 (0.3)		10.1 (0.1)		0.05 (0.05)	0.01 (0.04)
Country not meeting sample participation requirements						
‡ United States	48.5 (0.3)	▽	9.4 (0.2)		**0.16** (0.03)	**0.14** (0.03)

Chart scale: 40 42 44 46 48 50 52 54

▲ Average significantly higher than ICILS 2023 average.

▽ Average significantly lower ICILS 2023 average.

Country average [+/- 95% C.I.]

On average across items, students with a score in the range with this color have more than 50% probability to indicate:

Disagree or strongly disagree

Strongly agree or agree

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant correlations (p<0.05) are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Countries are ranked in descending order of the average scale score.

† Met guidelines for sampling participation rates only after replacement schools were included.

‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

[2] Country surveyed target grade in the first half of the school year.

[3] National defined population covers 61% of the national target population.

[r] indicates data are available for at least 70% but less than 85% of the students.

Table 7.19: National scale score averages indicating students' perceptions of negative beliefs about ICT and society, and correlation with CIL and CT achievement

Country	Students' perceptions of negative beliefs about ICT and society: Average scale score	Std. dev.	Avg. with confidence interval	Correlation with achievement: CIL	CT
[1] Czech Republic	52.2 (0.2) ▲	10.0 (0.1)		**0.11** (0.02)	**0.07** (0.01)
[1] Sweden	ʳ 51.8 (0.2) ▲	10.2 (0.2)		**0.13** (0.02)	**0.08** (0.03)
Greece	51.8 (0.2) ▲	10.5 (0.2)		**0.10** (0.02)	
[1] Croatia	51.6 (0.2) ▲	11.1 (0.2)		**0.08** (0.03)	0.02 (0.02)
[3] Bosnia and Herzegovina	51.4 (0.4) ▲	10.3 (0.2)		**0.15** (0.03)	
Slovak Republic	51.3 (0.2) ▲	9.0 (0.1)		**0.17** (0.02)	**0.14** (0.02)
Chinese Taipei	51.3 (0.2) ▲	9.8 (0.1)		0.01 (0.02)	-0.01 (0.02)
France	51.3 (0.2) ▲	10.1 (0.2)		**0.11** (0.02)	**0.06** (0.02)
[1] Spain	51.1 (0.1) ▲	10.0 (0.1)		**0.07** (0.02)	
[†] Korea, Republic of	51.1 (0.2) ▲	9.0 (0.2)		0.02 (0.02)	-0.03 (0.02)
[1] Serbia	51.0 (0.3) ▲	11.1 (0.2)		**0.19** (0.02)	**0.17** (0.02)
[1] Austria	50.8 (0.2) ▲	10.0 (0.2)		**0.05** (0.02)	-0.01 (0.02)
[1] Slovenia	50.7 (0.2) ▲	11.0 (0.2)		**0.15** (0.02)	**0.12** (0.02)
[†] Uruguay	ʳ 50.6 (0.2) ▲	10.0 (0.2)		**0.13** (0.02)	**0.10** (0.03)
Luxembourg	50.4 (0.2) ▲	9.4 (0.1)		**0.08** (0.02)	**0.03** (0.02)
Germany	50.4 (0.2)	9.8 (0.2)		-0.05 (0.03)	**-0.09** (0.03)
Cyprus	50.3 (0.2)	11.1 (0.2)		**0.08** (0.02)	
ICILS 2023 average	50.0 (0.0)	9.9 (0.0)		**0.08** (0.00)	**0.04** (0.00)
[†12] Romania	49.8 (0.2)	11.5 (0.2)		**0.07** (0.02)	
[1] Latvia	49.5 (0.2) ▽	8.7 (0.2)		**0.11** (0.02)	**0.08** (0.02)
Italy	49.5 (0.2) ▽	9.5 (0.1)		-0.02 (0.02)	**-0.05** (0.02)
[1] Kosovo	49.2 (0.2) ▽	10.3 (0.2)		**0.13** (0.02)	
[1] Kazakhstan	49.0 (0.2) ▽	8.9 (0.2)		0.02 (0.02)	
[1] Portugal	48.8 (0.2) ▽	9.8 (0.2)		**0.07** (0.02)	**0.04** (0.02)
Finland	48.6 (0.2) ▽	9.7 (0.2)		**0.04** (0.02)	0.03 (0.02)
[†] Belgium (Flemish)	48.5 (0.2) ▽	8.4 (0.2)		0.04 (0.03)	0.00 (0.03)
[†1] Denmark	48.4 (0.2) ▽	8.8 (0.2)		0.02 (0.02)	0.00 (0.02)
Azerbaijan	ʳ 48.3 (0.3) ▽	10.4 (0.2)		**0.11** (0.03)	
Hungary	48.0 (0.2) ▽	9.2 (0.2)		0.02 (0.02)	
Oman	47.8 (0.1) ▽	10.4 (0.1)		**0.10** (0.02)	
Malta	47.7 (0.2) ▽	10.7 (0.2)		**0.06** (0.02)	0.04 (0.02)
[1] Norway (Grade 9)	47.4 (0.2) ▽	9.3 (0.2)		**0.06** (0.02)	0.03 (0.02)
Benchmarking participant					
[1] North Rhine-W. (Germany)	50.3 (0.4)	10.2 (0.3)		**-0.09** (0.03)	**-0.10** (0.03)
Country not meeting sample participation requirements					
[‡] United States	48.0 (0.2) ▽	9.6 (0.2)		**0.09** (0.03)	0.03 (0.02)

Axis: 44 46 48 50 52

▲ Average significantly higher than ICILS 2023 average.

▽ Average significantly lower ICILS 2023 average.

Country average [+/- 95% C.I.]

On average across items, students with a score in the range with this color have more than 50% probability to indicate:

Disagree or strongly disagree

Strongly agree or agree

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant correlations (p<0.05) are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Countries are ranked in descending order of the average scale score.

† Met guidelines for sampling participation rates only after replacement schools were included.

‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

2 Country surveyed target grade in the first half of the school year.

3 National defined population covers 61% of the national target population.

ʳ indicates data are available for at least 70% but less than 85% of the students.

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Chapter 8:

Reflections on ICILS 2023

Julian Fraillon

Introduction

In this chapter we reflect on the implications of the findings of the International Computer and Information Literacy Study 2023 (ICILS 2023) with respect to computer and information literacy (CIL) and computational thinking (CT) education. We discuss implications of selected findings for CIL and CT education policy and practice and suggest topics and directions for future CIL and CT education research. These reflections on ICILS 2023 are in the broader context of ICILS data collected over three cycles, spanning 10 years.

ICT device use is high, but achievement is not increasing

The findings across three cycles of ICILS reveal that, despite students in grade 8 having reported increased use of information and communication technology (ICT) both within and outside of school over a period of 10 years, this increased usage has not translated into higher achievement.[33] In ICILS 2013 and 2018, we questioned the appropriateness of labeling young people as *digital natives* as introduced by Prensky (2001), and challenged the related assumption that their lifelong exposure to digital technologies would naturally result in proficient use of these technologies. In Chapter 5, we reported that in the highest performing ICILS 2023 countries, between a quarter and a third of students' CIL achievement fell below CIL Level 2 (Table 5.2). In countries with lower achievement, the proportions of students who performed below CIL Level 2 were significantly higher. Similar results were reported in each of ICILS 2018 (Fraillon et al., 2020, p. 76), and 2013 (Fraillon et al., 2014, p. 98). These students exhibit little more than rudimentary CIL skills, that they may be able to complete under instruction but not independently. Furthermore, and perhaps most alarmingly, they are not demonstrating the ability to make basic judgments about the credibility, relevance, and usefulness of digital information skills that are essential for effective and safe participation in a world where they encounter digital information from myriad diverse sources.

These consistent data across three cycles of ICILS, present confronting evidence of grade 8 students who, despite coming from a generation with high levels of use of digital technologies, have not developed the necessary capabilities to use digital information effectively, both as consumers and producers of digital information. Unfortunately, until now there is no evidence from ICILS that this situation is improving. Since 2013, student CIL achievement has consistently decreased across ICILS countries (Table 5.3). Since 2018, for CIL and CT the pattern is less clear, but still not positive. A generous assessment would be that CIL and CT achievement have tended to remain stable, a less generous assessment would be that there remains a tendency for them to decrease (Table 5.3 and Table 5.7). Certainly data collected in the next cycle of ICILS, in 2028, will help to provide a clearer picture of patterns in CIL and CT achievement since 2018.

While the ongoing monitoring of young people's digital literacy remains essential, and will continue with future cycles of ICILS, the immediate concern remains very real. As the use of digital information

33 In ICILS 2013, 87 percent of students reported at least weekly use of computers at home (Fraillon et al., 2014, p. 131). In ICILS 2018 and 2023, 70 and 74 percent of students respectively reported daily use of ICT outside of school for non school-related purposes (Fraillon et al., 2020, p. 121 & Table 7.3). On average across countries, in ICILS 2013, 54 percent of students reported at least weekly use of computers at school (Fraillon et al., 2014, p. 131). In ICILS 2018 and 2023, 18 and 33 percent of students respectively reported daily use of ICT at school for school-related purposes (Fraillon et al., 2020, p. 121 & Table 7.3).

sources and our reliance on digital technologies continues to increase, so will the need for people to be able to act as informed users of these resources. The public are aware of these issues, with fake news, online fraud and the use and misuse of personal information, reported as leading concerns among internet users (World Risk Poll, 2020, 2021). The need for associated competencies is reflected in the relative prevalence in the plans and policies of ICILS countries of the *development of information literacy, ICT-based skills in critical thinking, collaboration and communication*, and *responsible and ethical uses of digital devices, including cyber-security* (Appendix B, Table B.1). Concomitant to the need for the development of digital literacy skills clearly reflecting recognized societal needs and concerns, is the question of what are the consequences of an ongoing stagnation of, or even reduction of students' digital literacy. The clear danger is that the gap could widen between the magnitude of the digital literacy challenges associated with safe and effective participation in an increasingly digital world, and emerging citizens' capability to meet these challenges.

Digitally-supported remote learning took place, but digital literacy skills did not improve

The COVID-19 pandemic affected schooling during the period between ICILS 2018 and ICILS 2023. In almost all ICILS countries, digitally supported remote learning was implemented in schools accounting for more than 50 percent of students, during at least one school year between 2019 and 2022. Conventional wisdom, or perhaps a desire to seek some good from what was a very challenging time, has suggested that the transition to digitally supported remote learning during the pandemic may have resulted in improvements in students' digital literacy. On average across ICILS countries, principals in schools accounting for almost all students believed that teachers' willingness to use ICT in their teaching, the effectiveness of teachers' use of ICT in their teaching, and students' digital literacy skills either did not change or increased during the pandemic. This was in contrast with principals in schools accounting for less than 60 percent of students expressing beliefs that students' learning progress would at least remain the same. What we have seen in ICILS is, at best, no change in students' digital literacy-related skills between 2018 and 2023. This is arguably a more positive outcome than the achievement decreases reported for other learning areas in international large-scale assessments (ILSA), with data collection cycles spanning the pandemic period (Jakubowski et al., 2024; Mullis et al., 2023; OECD, 2023; Schulz et al., 2023). However, it does not represent the increase in digital literacy-related skills that many people had anticipated or at least hoped for. From this perspective, it is important to note that the skills that students apply when participating in digitally-supported remote learning across a range of subject areas, are not necessarily those that are fundamental to CIL and CT. It is ill-advised and potentially counter-productive to conflate students' use of digital platforms and resources, with the development of the specific reasoning and problem solving skills that are core to CIL and CT. These are skills that likely require explicit teaching rather than passive exposure to technology in order to develop productively in most students.

Evidence of the digital divide warrants further investigation

The reduction of the digital divide between groups of students was reported as one of plans programs and goals with the highest degree of emphasis across countries (Table B.4). However, despite this, variations within countries of student CIL and CT achievement remain large, and variations in students' socioeconomic status (SES), and their access to ICT at home are associated with variations in and CIL and CT achievement.

In ICILS 2023, within all ICILS countries we observed considerable differences in achievement between the highest and lowest achieving students. For CIL the average difference between the lowest performing students (bottom 10%) and the highest performing students (top 10%) within ICILS countries was more than 200 CIL scale score points, and similar to the difference between the average CIL scores of the highest and lowest achieving countries. For CT, the range of achievement within countries was considerably larger than the range of average achievement across countries. Large differences between the achievement of the highest and lowest performing students in CIL and CT were reported in

ICILS 2018, and in CIL in ICILS 2013[34] (Fraillon et al., 2014, 2020). Also consistent with previous cycles of ICILS, in ICILS 2023, significant achievement differences were found between groups of students across a range of socioeconomic (SES), cultural background, and ICT access measures. Achievement was consistently higher for students from higher SES backgrounds (Table 6.7, Table H.1, Table H.2, Table 6.8, Table H.3, and Table H.4), who speak the language of testing at home (Table 6.4 and Table 6.6) and who are not from an immigrant background (Table 6.3 and Table 6.5).

The digital divide is a "multilayered phenomenon" (Ritzhaupt & Hohlfeld, 2022, p. 2) without a "clear and commonly accepted definition" (Ragnedda, 2019, p. 28). Hohlfeld et al., 2008 provided a framework for "understanding the dynamics of the Digital Divide in formal educational settings" (Ritzhaupt & Hohlfeld, 2022, p. 1). The framework posits three levels: school infrastructure; technology use in the classroom; and student empowerment (Hohlfeld et al., 2008). Van Dijk, 2020 describes three levels in the evolution of "scholarly perspectives of digital divide" (Van Dijk, 2020, p. 7), the first level relates to inequality of physical access, the second on skills and usage, and the third on outcomes (García-Martín & García-Sánchez, 2022; Van Dijk, 2020). These two are examples of frames of reference for interpreting the ICILS 2023 data, and as possible bases for further research into manifestations of the digital divide as evidenced within ICILS data. Each framework includes the concept of prerequisite access to technology underpinning the development of digital competencies, which in turn can support the development of self-realizing opportunities to learn and engage with society. While ICILS was not developed to reflect a given model of the digital divide, CIL and CT proficiency as described in ICILS (see Chapter 3 and Chapter 4), that are postulated to develop within levels of contextual influence (see Chapter 1 or Fraillon and Rožman, 2024) are amenable to interpretation with such models.

In ICILS 2023 student home access to ICT resources was measured indirectly through their years experience using computers, and directly through the number of computers students reported having at home, the quality of their internet access, and their access to use a computer for schoolwork when needed. Student achievement scores in CIL and CT were direct measures of student skills. Achievement scores were higher for students with more than 5 years experience using computers, with more than two computers at home, who reported not to have regular problems with their home internet, and who were able to access a digital device for schoolwork at home when they needed to (Table 7.1, Table H.6, Table H.5, Table 6.9, Table 7.2, Table H.8, Table H.7, and Table 6.10). Of particular note across these four access measures was that the largest differences in CIL and CT achievement within countries were evident with respect to students' home access to a digital device when needed for schoolwork. There is clear evidence in this report of the existence of a digital divide within countries with respect to access to ICT resources at home.

It is, however, beyond the scope of this report to investigate in detail the nature and effect of the digital divide within and across ICILS countries. The ICILS data offer the potential to explore this further, not just in terms of infrastructure provision and access to ICT, but to probe differences in approaches to the teaching and learning of CIL and CT in schools and how they relate to student outcomes. The ICILS student, teacher and school-level data offer a resource to be investigated from this perspective and to inform development and refinement of evidence-based policies and practices that may more successfully address this ongoing issue into the future. The preliminary data in this report suggest that the explicit policy aspirations in many countries to reduce the digital divide may not yet have been achieved, and that more needs to be done to address the impact of the digital divide with respect to students' CIL and CT achievement. A future report using ICILS international data is also planned to examine equity and the digital divide in greater detail.

34 CT was not included in ICILS 2013.

Digital literacy representation in curriculums is not matched by requirements for assessment

What we can see from reports from national centers in ICILS 2023 is that CIL and CT are generally well represented in national and system-level teaching programs. In the large majority of ICILS countries, both areas are available to be taught, at least as part of one subject in each of primary, lower-secondary, and upper-secondary schooling. However, teaching of each of CIL and CT was more frequently reported to be compulsory in secondary schooling rather than primary schooling (Chapter 2 and Table 2.2). It is possible therefore, that in the years leading up to students' participation in ICILS, that in some countries CIL and CT are not being taught consistently, as they are not compulsory. Inconsistent explicit teaching of these areas during the earlier years of schooling could of course contribute to the lack of discernible improvement in grade 8 students' learning outcomes across the cycles of ICILS. Furthermore, it is worth noting that that there was typically, less explicit expectation that the skills of CIL and CT be formally and consistently assessed within countries, even when the areas were explicitly available to or expected to be taught. The degree to which any specific learning areas are expected to be assessed provides tacit indication of their relative value within curriculums and learning programs. Within countries, policymakers may wish to consider the importance attributed to assessing CIL- and CT-related skills, relative to other learning areas, and to evaluate how this affects the relative value placed on development of CIL and CT. Commensurate with this should be consideration of the resourcing and support that are provided for the teaching, learning, and assessment of CIL and CT. Given that there remain large numbers of young people who are able to execute only the most basic CIL and CT skills within countries (Chapter 5, Table 5.2, and Table 5.6), there may be an opportunity for formal schooling to take a more active role in the explicit teaching of the fundamentals of CIL and CT, and demonstrating the value placed on the development of these skills by ensuring that they are required to be assessed and reported on.

Students report learning about internet use outside of school more than at school

In addition to students reporting that they use ICT more frequently outside of school than at school, higher proportions of students reported having learned aspects of searching for, and evaluating digital information outside of school than in school (Table D.8 and Table D.10). Furthermore, while there was no discernible pattern of correlation among countries between students' reported learning about internet-related skills at school and CIL achievement, there was a consistent pattern of weak positive association between students' reported learning about internet-related skills outside of school with CIL achievement (Table 7.12). While these data are not conclusive, they do raise questions about what students believe they are learning at school with respect to a core aspect of CIL, how this compares to what they believe they are learning outside of school, and what the consequences of these differences might be. They also raise questions about whether or not similar patterns of difference and association with other aspects of CIL and with CT achievement also exist. Considerably more work can be done to unpack the somewhat unusual and complex relationship between students' use of ICT outside of school, and how it relates to their learning with and about technology in school. Associated with this are broader questions of how students' learning with and about technology within-schools can be complemented by, and benefit from their high levels of engagement with ICT outside of school.

Productivity software tools continue to be prominent in classrooms

In ICILS 2013 and 2018 we concluded that the main uses of ICT in classrooms were as *digital textbooks*, given the relatively narrow range of information gathering and productivity software being used most frequently in classes. In ICILS 2023, students again reported word-processing, presentation software, and computer based information resources as the ones they used most frequently in classes, and concept mapping, simulations, and modeling software and tools that capture real-world data as least frequently used (Table D.4). The tools reportedly used most commonly in classrooms are also those that were reported by ICT coordinators to be most commonly available in schools. On average across countries, word processing and presentation software were reported to be available in schools accounting for 94 percent and 95 percent of students respectively. In contrast, the smallest proportions of students were in schools where data logging and monitoring tools (20% of students) and adaptive learning systems (23% of students) (Table 2.5) were in use. While it is clearly of great value for students to learn to use productivity applications and internet information sources, and to use them in their work, there is a question of why the use of these tools continue to remain so much more prevalent than other digital learning resources. The rhetoric associated with the potentially transformative benefits of innovative digital resources in classrooms, has not apparently being reflected in their acceptance and use in schools. Questions remain around how schools and teachers are provided the necessary information, and supported to select and use the most appropriate digital tools in teaching and learning for each subject, including CIL and CT. While we do not suggest that digital technology use should be an obligatory part of every lesson, given the very broad and ever-increasing range of digital learning tools and resources that are available, it is somewhat surprising to observe in ICILS 2023 that the relative emphasis on productivity tools remains high, as it was in previous cycles of ICILS. Teacher professional learning (both pre-service and in-service) was reported to be strongly emphasized in the plans and policies of ICILS countries (Table B.3 and Table B.4). A stronger focus in teacher professional learning programs on the effective pedagogical use of digital tools other than productivity applications may also contribute to more extensive realization of the potential of such tools to support teaching and learning.

Future directions for research

This first report of international data from ICILS 2023 has focused on student data with respect to CIL and CT achievement, students' background characteristics, students' uses of ICT within and outside of school, students' experiences of learning with ICT, and their attitudes towards ICT. In addition, we have described aspects of the national contexts in which students' CIL and CT learning are taking place, including system-level and school-level priorities and resourcing of CIL and CT teaching and learning. ICILS 2023 has also collected extensive data from teachers, and schools that have not been presented in this first report, but are planned to be used in subsequent IEA reports using ICILS international data. These future reports will to examine in detail: changes in CIL and CT learning over the cycles of ICILS; aspects of the digital divide that are reflected in ICILS data; the nature of teaching approaches and activities with respect to CIL and CT education; approaches to school-leadership to support the use of technology in teaching and learning; and teacher professional learning (pre-service and in-service) with respect to CIL and CT education.

The data presented in this report, and in the ICILS international databases, provide a rich resource that can be used to support scholars to research CIL, and CT and the contexts in which these essential competences are being developed in young people. The ICILS 2023 results provide the answers to some questions relating to CIL and CT achievement and education, and give rise to many new questions, some that have been touched on previously in this report, and some that will be the subject of future reports using ICILS international data. We hope that further questions will emerge from the engagement with this report and ICILS data by policymakers, scholars and other stakeholders in digital literacy education.

The CIL and CT achievement scales and descriptions presented in this report may be used to support curriculum and syllabus development within and across countries. This may take place both within the contexts of establishing standards associated with the scale content, or as the bases for identifying target areas of need by students or subgroups of students. Further to this, are questions associated with the nature of differences in achievement of subgroups of students in each of CIL and CT. While we have seen clear evidence of digital divides with respect to student achievement, there remain questions about the nature of corresponding digital divides with respect to students' access to, and schools' opportunities to provide CIL and CT learning programs, and of course what actions can be suggested that may help mitigate against this ongoing issue within and across countries.

ICILS has consistently reported gender differences in CIL achievement, with female students outperforming male students. For CT achievement, male students have tended to outperform female students, although this pattern is less clear and consistent across countries than the contrary pattern reported for CIL. There remain many unanswered questions with respect to gender differences in CIL and CT, and by extension, gender differences in students' experiences of ICT use and their experiences of learning about CIL and CT. Why, for example, do the differences occur and how do they relate to CIL and CT learning? Are the gender differences consistent across subgroups of students? The answers to such questions may provide valuable information to inform policy approaches and programs to redress the observed differences.

The question of why student achievement in CIL and CT have not improved over time is essential to ICILS, and should be the catalyst for further research within and across countries. This may be considered within and across countries, and include historical comparisons of students' contexts for learning about CIL and CT within school and outside of school. We have seen in this report, considerable national differences regarding students' use of technology outside of school through, for example, academic-media multitasking and parental screen time limits, and their relationships to CIL and CT achievement (Table 7.5 and Table 7.6). More research is needed to understand how students' attitudes towards ICT and their practices vary across countries, and how these differentially relate to their CIL and CT achievement. While we may accept that the skills students execute when using ICT outside of school may be somewhat different to those of CIL and CT, there is certainly consequential overlap. Further research is required to better understand the intersection of competencies between students' use of ICT outside of school and in school, how best to leverage students' interests and existing competencies to support the development of their critical digital literacy capabilities. This potential comes with associated challenges, such as those previously discussed in the context of the digital divide with respect to managing variability in students' access to ICT, and variability in the quality of their out-of-school interactions with ICT. Questions remain about why many students believe they are learning more about essential aspects of digital literacy outside of school than within school but more importantly, how schools can best integrate students' use of ICT outside of school with their learning about ICT use within school. Students' predisposition to ICT use offers a potential resource that may be better exploited to support their development, of the ICT-based, critical thinking skills and problem-solving competencies at are central to CIL and CT.

Understanding the necessary and most effective support for teachers to best complete this work, in an essential area of further research using ICILS data. In previous cycles of ICILS we have focused on teachers' and students' uses of digital tools in classrooms. In ICILS 2023, this has been extended to include teacher reports of their approaches to teaching with and about technology. There is ample opportunity for scholars to explore the nature of varied approaches to teaching, and in the context of their relationships with student outcomes in CIL and CT. Questions of interest, for example include: What approaches exist and how prevalent are they? In what contexts are they used? How do they vary within and across countries (and across teachers)? Associated with these, are questions relating to the types of leadership and support that teachers (and trainee teachers) experience, and how these relate to their uses of technology and teaching of CIL and CT. Questions such as these will be addressed at the international level in upcoming ICILS publications and represent the starting-off point for further in-depth research within and across countries associated with the nature of teaching and learning with technology in schools.

The fourth cycle of ICILS is planned for 2028. In ICILS 2028 we plan to build on and to extend the work of previous cycles. In ICILS, this includes extending the range of content and contexts in the CIL and CT assessments to ensure that they remain relevant in a rapidly evolving digital environment. With each new cycle of ICILS we review the themes and outcomes of previous cycles, and with reference to the research literature and international policy environment to consider new themes or areas of increased focus. For ICILS 2023 this resulted in the areas of school leadership for technology, and approaches to teaching with and about technology becoming more prominent. The rapid emergence of artificial intelligence (AI) tools after the ICILS 2023 main survey instruments had been developed resulted in us offering an additional set of optional questions for principals about the use of generative AI in their schools (see Addendum). Generative AI will be a strong focus of ICILS 2028. The ICILS 2028 assessment framework will integrate AI into the CIL and CT constructs and the contextual framework that underpin ICILS instrument development. The use of AI tools, including critical evaluation of their use and products, will contribute to the new CIL and CT assessment modules. The contextual questionnaires will include content related to the implementation of AI in policy, resourcing, planning, and teaching and learning in schools. ICILS measures trends in a dynamic area of innovation and change by having identified the core elements of digital literacy that can be measured across cycles, and using contemporary and relevant software tools and contexts to measure these core elements within each new cycle. These complementary processes of integration and renewal across all aspects of the study are what enable ICILS to continue to be at the forefront of research into students' preparedness for life in a rapidly evolving digital world.

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Addendum Ad:

Principals' reports on the use of generative AI tools in schools: ICILS 2023 international option

Julian Fraillon

Ad.1 Introduction

Artificial intelligence (AI) began as a field of study in 1956 (Anyoha, 2017; Wadsworth et al., 2024). While chatbots have existed in various forms since the second half of last century, 2 months after the launch of ChatGPT on 30 November 2022, the generative AI tool had 100 million users (Sabzalieva & Valentini, 2023). The associated rapid development of widespread recognition of, interest in, and use of generative AI around this time resulted in us deciding to include, as an option for countries, a set of questions to collect information about school principals' responses to the introduction of generative AI tools (such as ChatGPT), and principals' beliefs about the potential impact of the use of generative AI tools on the work of teachers and students. The decision to include content at such a late stage of the study, and outside the conventional development practices of the study, was seen as an appropriate and nimble response to the very sudden and dramatic rise to prominence of generative AI tools. We felt that it would be remiss of ICILS 2023 not to offer countries the opportunity to collect such data at the beginning of this potentially significant period of development in the use of generative AI technology in schools, although we also were aware that data collection would not be feasible in all countries.[35]

The ICILS student, teacher, ICT coordinator and principal questionnaires were finalized and made available for translation to ICILS countries in late 2022 around the same time as ChatGPT was launched. The optional questionnaire content was made available to countries in mid-2023, after the main ICILS data collection had been completed in Northern Hemisphere countries and before it had begun in Southern Hemisphere countries. The decision to limit data collection to school principals was primarily made to minimize the operational burden on countries. Principals across 12 ICILS countries completed the optional questions.

In the Northern Hemisphere countries that were able to participate (Chinese Taipei, Cyprus, Denmark, Greece, Norway, Romania, the Slovak Republic, Slovenia, and Sweden), the additional questionnaire data were collected from principals of the sampled schools using an additional questionnaire in the second half of 2023, following the summer vacation period. In all countries except Romania,[36] this corresponded to the beginning of the school year following the school year in which the ICILS data main survey data were collected. In the countries using the Southern Hemisphere school calendar (Korea (Rep. of), Uruguay, and Chile[37]), the additional questions relating to the use of generative AI in schools were administered as part of the principal questionnaire.

Please note, as in Chapter 2, we report the principals' response data as estimates of the national percentages of students derived from the schools where the principals have responded. For the Northern

35 Factors such as staffing and financial resources, contractual agreements and obligations, approval processes, operational procedures, and predetermined timelines, affected the feasibility of the additional data collection across ICILS countries.

36 ICILS main survey data were collected in Romania in the first half of the 2023/24 school year.

37 Due to issues with the ICILS main survey data collection in 2023 in Chile, data from Chilean schools are not included in this report. An additional data collection exercise has subsequently been conducted to contribute the reporting of national data within Chile.

Hemisphere countries (except Romania), the estimated percentages of the number of students in the schools were calculated using the school sample data from the school year before the principals provided their responses. This information should be taken into account when interpreting the results presented in this addendum.

Ad.2 Principals' reports about the use of generative AI tools in schools

Principals responded to a series of questions addressing their experience with and use of generative AI tools, the existence of policies and plans for the use of generative AI in their schools, and their beliefs about the impact of the use of generative AI tools on students and teachers. Given that, at the time of administration, generative AI tools were potentially relatively new to many school principals, we included support information to define generative AI tools for principals. In the questionnaire we referred to the use of "ChatGPT or similar tools" because, at the time of administration, ChatGPT was the most widely known and recognized generative AI tool.

In the introduction to the questions, principals were provided the following information to help them to consider their responses:

In the past year, artificial intelligence tools that analyze and generate text have become readily accessible for use on the internet. At present, the best-known example of these tools is ChatGPT. This set of questions relate to the knowledge of, and approach to managing and using such tools in your school. The phrase 'ChatGPT or similar tools' is used throughout the questions to refer to artificial intelligence tools that analyze and generate text.

Principals' use of generative AI

In order to determine the degree to which generative AI was in the consciousness of principals, they were first asked to indicate how often they used ChatGPT or similar tools for work-related and for non-work related purposes. Principals could select from a set of six frequencies ranging from never to more than once a day. On inspection of the data, we chose to report three categories of frequency: never, less than weekly, and weekly. This already suggests that we found that relatively few principals were reporting very frequent use of generative AI tools.

On average, across all countries, principals in schools accounting for 50 percent of students reported that they never use ChatGPT or similar tools for work-related purposes, and principals in schools accounting for 41 percent of students reported that they use these tools less than weekly (Appendix I, Table I.1). The corresponding percentages with respect to the use of ChatGPT or similar tools for non-work-related purposes were 49 percent (never) and 42 percent (less than weekly). While there was some variation in the reported frequencies of use across countries, overall, it can be observed that the use of generative AI was reported to be somewhat infrequent by principals. The highest reported frequency by principals of weekly use for work-related purposes was in schools accounting for 17 percent of students in each of Cyprus and Romania. Chinese Taipei (16%), Korea (Rep. of) (16%), and Uruguay (15%) are the only three other countries in which this was reported by principals in schools accounting for more than 10 percent of students.

Generative AI in school policies and curriculum

Principals responded to a series of questions examining the degree to which generative AI was being included or referenced in policies (or policy planning) and curriculum in their schools. Given the recency with which generative AI tools had become so broadly accessible to schools at the time of data collection, we assumed that across many schools there would not yet have been time for generative AI to have been included in policies and curriculum. These data were collected, in part, with a view to being baseline measures that can be compared to data collected in the future as the use of generative AI in schools develops and matures.

Below is a summary of the topics covered in the questions asked of principals with respect to the inclusion of generative AI in the policies and curriculum in their schools.

Principals were asked:

- Whether their school had explicit policies regarding the use of ChatGPT or similar tools relating to the work of teachers and to the work of students
- Whether their school had explicit recommendations (for teachers and students) regarding the use of ChatGPT or similar tools relating to the work of teachers and to the work of students
- Whether the curriculum used by their school included explicit reference to ChatGPT or similar tools with respect to:
  - the need for teachers to verify students' work
  - students' learning about the appropriate use of ChatGPT or similar tools to support their work
  - students' learning about ethical issues associated with the use of ChatGPT or similar tools
- Whether their school had received information from a (relevant) education authority about the use of ChatGPT or similar tools

The nascent state of generative AI in schooling at the time of data collection is evident in principals' responses to the questions relating to the inclusion of generative AI in policies and curriculum.

Across countries, principals in schools accounting for more than 90 percent of students on average, reported that there were no explicit policies or recommendations in place regarding the use of ChatGPT with respect to the work of teachers and students (Appendix I, Table I.2, Table I.3, Table I.5, and Table I.4). However, approximately 50 percent of students on average across countries, were in schools where the principals reported that, although there were no explicit policies or recommendations, there were plans to develop them. While the proportions of students in schools where principals reported that policies or recommendations were in place or currently being developed were low (less than 20% of students on average across countries), it is positive sign that many students are in schools where it seems polices and recommendations are likely to be developed in the future.

On average across countries, principals in schools accounting for 23 percent of students reported that they had received information from a (relevant) education authority about the use of ChatGPT or similar tools for each of the work of teachers and the work of students (Table Ad.1). However, some variation in this was reported across countries. In Chinese Taipei and Korea (Rep. of), principals reported that information was received with respect to the work of teachers in schools accounting for 42 percent and 55 percent of students respectively. In Denmark and Korea (Rep. of), principals reported that information was received with respect to the work of students in schools accounting for 50 percent and 48 percent of students respectively. In contrast, in each of Greece, Romania, the Slovak Republic, and Slovenia, principals in schools accounting for less than 10 percent of students reported having received information about the use of ChatGPT or similar tools for teachers or for students.

Table Ad.1: School principal reports on having received information from educational authorities about the use of ChatGPT or similar tools in schools

Country	Percentages of students in schools that have received information from national authorities regarding the use of ChatGPT or similar tools	
	Relating to the work of teachers	Relating to the work of students
Chinese Taipei	42 (4.0) ▲	34 (3.9) ▲
Cyprus	17 (0.8) ▽	r15 (0.8) ▽
†1 Denmark	s21 (4.5)	s50 (5.5) ▲
Greece	s3 (1.7) ▽	s2 (1.4) ▽
† Korea, Republic of	55 (4.6) ▲	48 (4.7) ▲
1 Norway (Grade 9)	x34 (6.7)	x38 (7.2) ▲
†12 Romania	5 (1.9) ▽	5 (1.9) ▽
Slovak Republic	8 (2.1) ▽	8 (2.2) ▽
1 Slovenia	4 (1.6) ▽	3 (1.4) ▽
1 Sweden	s25 (4.4)	s19 (3.7)
† Uruguay	r19 (5.4)	r16 (5.1)
ICILS 2023 average	23 (1.3)	23 (1.3)

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
2 Country surveyed target grade in the first half of the school year.
r indicates data are available for at least 70% but less than 85% of the students.
s indicates data are available for at least 50% but less than 70% of the students.
x indicates data are available for at least 40% but less than 50% of the students. Interpret with caution.

A similar profile of relatively low integration of the use of generative AI in polices was evident with respect to principals' reports of the inclusion of ChatGPT or similar tools in the curriculum used in their schools (Table Ad.2). On average, across countries, principals in schools accounting for 17 percent of students indicated that the curriculum made explicit reference to the inclusion of ChatGPT or similar tools with respect to the need for teachers to verify whether or not work presented by students is their own (i.e., not generated by generative AI tools). Similarly, principals in schools accounting for 20 percent of students on average across countries, reported that the curriculum made explicit reference to the inclusion of ChatGPT or similar tools with respect to students learning how to use ChatGPT or similar tools appropriately to support their work. In contrast, learning about the ethical issues (such as plagiarism or information bias) associated with the use of ChatGPT or similar tools was more strongly reported to be represented, having been reported, on average across countries to be included in curriculum by principals in schools accounting for 30 percent of students.

Table Ad.2: School principal reports on the inclusion of ChatGPT or similar tools in the curriculum

Country	Percentages of students in schools that have included in the syllabus/curriculum		
	With respect to the need for teachers to verify whether work presented by their students is their own (i.e., not generated by [ChatGPT or similar tools])	**With respect to students' learning about how to use [ChatGPT or similar tools] appropriately to support their work**	**With respect to students learning about the ethical issues (such as plagiarism or information bias) associated with the use of [ChatGPT or similar tools]**
Chinese Taipei	36 (4.1) ▲	33 (3.8) ▲	51 (4.2) ▲
Cyprus	13 (2.9)	13 (2.3) ▽	18 (2.6) ▽
†[1] Denmark	[s]12 (2.9)	[s]10 (3.6) ▽	[s]22 (4.7)
Greece	[s]4 (1.8) ▽	[s]6 (2.0) ▽	[s]20 (4.3) ▽
† Korea, Republic of	13 (3.3)	15 (3.4)	19 (3.8) ▽
[1] Norway (Grade 9)	[x]30 (6.9) ▲	[x]43 (7.1) ▲	[x]53 (7.4) ▲
†[1,2] Romania	8 (2.6) ▽	10 (3.0) ▽	16 (3.6) ▽
Slovak Republic	4 (1.4) ▽	6 (1.9) ▽	12 (2.6) ▽
† Uruguay	[s]21 (5.0)	[s]31 (6.0) ▲	[s]44 (6.6) ▲
ICILS 2023 average	17 (1.4)	20 (1.5)	30 (1.7)

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Slovenia used an adapted version of this question and consequently their data are not included in this table.
† Met guidelines for sampling participation rates only after replacement schools were included.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[s] indicates data are available for at least 50% but less than 70% of the students.
[x] indicates data are available for at least 40% but less than 50% of the students. Interpret with caution.

Permission to use generative AI in schools

Principals were asked to indicate whether or not the use of ChatGPT or similar tools was permitted for use by teachers and students in their schools. While the existence of decisions about permission to use generative AI in schools may be indicative of there existing a broader policy framework with respect to the use of generative AI in schools, given the recency with which generative AI tools had been broadly available at the time of data collection, there was also the possibility that schools had implemented some rules governing their use in advance of establishing a broader set of policies. It is therefore possible that there are students in schools where the principals have suggested that there are not yet policies regarding the use of generative AI by students and teachers, but there already exist rules relating to their use.

School principals indicated whether students in their schools were allowed to use ChatGPT or similar tools when completing their schoolwork and whether teachers in their schools were allowed to use ChatGPT or similar tools for work-related purposes. Principals could choose one response for each group: *No*; *Yes but with some restrictions*; or *Yes with no restrictions*.

On average across countries, principals in schools accounting for approximately four-fifths of students indicated that the use of ChatGPT or other tools was either not allowed or allowed with some restrictions (Table Ad.3). Within these groups there remained considerable variation among countries. In the Slovak Republic and Romania, the use of ChatGPT or similar tools was reported by principals to be not allowed in schools accounting for 62 percent and 56 percent of students respectively. In contrast, the use of ChatGPT or similar tools was reported by principals to be not allowed in schools accounting for 18 percent of students in Uruguay and 20 percent of students in Norway. The use of ChatGPT with some restrictions was reported by principals to be available in schools accounting for the largest proportion of students on average across countries (46%). In six of the 11 countries the highest percentages of students in schools were in schools where principals reported that ChatGPT could be used with some restrictions. These percentages ranged from 70 percent in Norway to 21 percent in the Slovak Republic. Permission to use ChatGPT without restrictions was reported to be available by principals in schools accounting for the lowest percentage of students on average across countries (19%). This varied from schools accounting for 44 percent of students in Korea (Rep. of) to three percent of students in Denmark.

Table Ad.3: School principal reports on the use of ChatGPT or similar tools in schoolwork

Country		Students are allowed when completing their schoolwork				Teachers are allowed for work-related purposes		
		Yes, without any restrictions	Yes, but with some restrictions	No		Yes, without any restrictions	Yes, but with some restrictions	No
Chinese Taipei		21 (3.5)	54 (4.3)	24 (3.8)		60 (4.2)	37 (4.3)	2 (1.4)
Cyprus		19 (1.0)	40 (2.9)	41 (3.0)		50 (1.9)	35 (2.0)	15 (1.3)
†1 Denmark	s	3 (1.9)	59 (5.6)	38 (5.6)	s	73 (4.9)	18 (4.2)	9 (3.5)
Greece	s	16 (4.8)	45 (5.4)	39 (5.3)	s	55 (5.4)	28 (5.0)	17 (3.9)
† Korea, Republic of		44 (4.6)	29 (4.0)	27 (4.0)		67 (4.5)	17 (3.2)	16 (3.5)
1 Norway (Grade 9)	x	10 (4.1)	70 (6.6)	20 (5.8)	x	63 (7.2)	34 (7.1)	3 (2.3)
†12 Romania		13 (3.6)	31 (4.8)	56 (5.8)		56 (5.3)	26 (4.1)	17 (4.6)
Slovak Republic		17 (3.1)	21 (3.3)	62 (3.9)		53 (3.9)	18 (3.0)	29 (3.7)
1 Slovenia		18 (3.4)	41 (3.3)	42 (4.0)		74 (3.7)	18 (2.9)	8 (2.0)
1 Sweden	s	10 (3.1)	47 (5.7)	43 (5.6)	s	70 (5.0)	19 (4.6)	11 (3.2)
† Uruguay	r	27 (5.6)	55 (6.5)	18 (4.3)	s	67 (5.7)	21 (5.1)	12 (4.0)
ICILS 2023 average		19 (1.2)	46 (1.6)	36 (1.5)		63 (1.5)	25 (1.4)	12 (1.0)

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Percentages are representative of students' population, based on the school principal's response.
† Met guidelines for sampling participation rates only after replacement schools were included.
1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
2 Country surveyed target grade in the first half of the school year.
r indicates data are available for at least 70% but less than 85% of the students.
s indicates data are available for at least 50% but less than 70% of the students.
x indicates data are available for at least 40% but less than 50% of the students. Interpret with caution.

Across countries, teachers were reported to have greater freedom than students to use ChatGPT. On average, principals in schools accounting for 63 percent and 25 percent of students reported that teachers could use ChatGPT or similar tools for work-related purposes without restriction or with some restrictions respectively (Table Ad.3). In contrast the equivalent reported percentages for students were 19 percent (without restriction) and 46 percent (with some restrictions). In addition, there were fewer students in schools where principals reported that the teachers were not allowed to use ChatGPT (12% on average across countries) in comparison to students (36% on average across countries). Furthermore, there was generally less variation in principals' responses among countries with respect to teachers' permission to use ChatGPT in comparison to students' permission. The range between the lowest and highest reported percentages with respect to teachers' permission across the three response categories was between 20 and 30 percentage points across countries, in contrast to the corresponding range of between 40 and 50 percentage points with respect to students' permission.

Principals' opinions about the potential consequences of the use of generative AI tools on the work of students

Principals were asked to indicate how likely they believed it was that the use of generative AI tools would result in a series of potentially positive and negative consequences with respect to the students' learning in their schools. The statements associated with positive and negative consequences were not separated in the questionnaire, rather they were presented together in a largely alternating sequence. Below they are presented and discussed as separate groups.

The potentially positive consequences of the use of generative AI associated with students' learning presented to principals were:

- help students develop a greater interest in learning
- improve students' learning
- help students to develop logically sequenced research questions
- help students to improve the quality of their written work
- support students' creativity by generating ideas for them to consider
- reduce students' stress about their schoolwork
- improve students' capacity to critically evaluate information
- help students to refine research questions to obtain the most relevant information

The potentially negative consequences of the use of generative AI associated with students' learning presented to principals were:

- make it difficult for students to develop a deep understanding of concepts
- encourage students to submit work that is not their own
- confuse students with false, misleading, or biased information
- make students anxious about the influence of technology on the world
- result in students becoming dependent on the tools rather than learning for themselves

Principals were asked to indicate their belief in the likelihood that the use of ChatGPT or similar tools would result in each of the consequences listed above. Principals were asked to select one indication of likelihood (very unlikely, somewhat unlikely, somewhat likely, very likely) for each consequence.

Positive consequences for students

Across the listed positive consequences, between approximately one half and two thirds of students, on average across countries, were in schools where the principals reported that it was likely (either somewhat likely or very likely) that the use of generative AI would have positive consequences for students (Table Ad.4). The consequence that principals reported to be least likely to occur was that the use of ChatGPT or similar tools will *improve students' capacity to critically evaluate information*. This was reported to be likely, on average across countries by principals in school accounting for 48 percent of students. Two other positive consequences were reported to be likely by principals in schools accounting for less than 60 percent of students on average across countries—*improve students' learning* (54%), and *reduce students' stress about their schoolwork* (55%). The latter of these two was also the consequence for which there was the greatest variation in responses across countries. While principals in schools accounting for 88 percent of students in Greece reported it likely that the use of ChatGPT or similar tools will reduce students' stress about their schoolwork, this was reported by principals in schools accounting for 26 percent of students in Sweden.

The positive consequence with the least variation in principals' reported beliefs was that the use of ChatGPT or similar tools will *help students to develop logically sequenced research questions*. The variation in beliefs that this consequence was likely was 25 percentage points across countries. This ranged from principals in schools accounting for 69 percent of students in Chinese Taipei to 45 percent of students in the Slovak Republic.[38] The three consequences reported to be likely by principals in schools accounting for the greatest numbers of students, on average across countries were: *help students develop a greater interest in learning* (63%), *help students to refine research questions to obtain the most relevant information* (63%), and *support students' creativity by generating ideas for them to consider* (64%) (Table Ad.4).

Across countries, principals in Chinese Taipei and Cyprus tended to report that the positive consequences of ChatGPT on student learning were most likely (Table Ad.4). In Chinese Taipei, the percentages of students in schools where the principals reported that the consequences were likely were statistically significantly higher than the ICILS 2023 average for six of the eight consequences, and for all eight consequences in Cyprus. In contrast, the least positive beliefs were reported by principals in the Slovak Republic and Slovenia, where these percentages were statistically significantly below the ICILS 2023 average in seven and all eight consequences respectively.

Table Ad.4: School principals' perceptions of potentially positive impacts of ChatGPT or similar tools on the work of students

Country	Percentages of students in schools where principals indicated that the use of ChatGPT or similar tools will result in the following outcomes (somewhat likely or very likely)			
	Help students develop a greater interest in learning	Improve students' learning	Help students to develop logically sequenced research questions	Help students to improve the quality of their written work
Chinese Taipei	73 (3.9) ▲	75 (3.4) ▲	69 (4.1) ▲	74 (3.8) ▲
Cyprus	77 (3.2) ▲	72 (2.5) ▲	68 (2.4) ▲	74 (2.5) ▲
†1 Denmark	s55 (6.1)	s43 (6.2)	s60 (5.6)	s53 (6.5)
Greece	s77 (5.4) ▲	s72 (5.7) ▲	s66 (5.4)	s73 (4.7) ▲
† Korea, Republic of	74 (3.4) ▲	63 (4.1) ▲	56 (4.6)	64 (4.5)
1 Norway (Grade 9)	x74 (6.6)	x71 (7.2) ▲	x68 (6.5)	x67 (7.6)
†12 Romania	60 (5.2)	58 (5.8)	58 (5.5)	62 (5.3)
Slovak Republic	43 (4.4) ▽	27 (3.4) ▽	45 (3.8) ▽	31 (3.6) ▽
1 Slovenia	32 (3.7) ▽	19 (3.2) ▽	45 (4.2) ▽	44 (3.7) ▽
1 Sweden	s59 (5.7)	s46 (6.0)	s62 (5.4)	s66 (5.5)
† Uruguay	s66 (6.3)	s50 (6.2)	s56 (6.8)	s64 (6.4)
ICILS 2023 average	63 (1.6)	54 (1.6)	60 (1.6)	61 (1.6)

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
2 Country surveyed target grade in the first half of the school year.
s indicates data are available for at least 50% but less than 70% of the students.
x indicates data are available for at least 40% but less than 50% of the students. Interpret with caution.

38 The difference of 25 percentage points was calculated using unrounded percentages. The unrounded percentage of the Slovak Republic was lower than that of Slovenia.

Table Ad.4: School principals' perceptions of potentially positive impacts of ChatGPT or similar tools on the work of students (cont'd)

Country	Percentages of students in schools where principals indicated that the use of ChatGPT or similar tools will result in the following outcomes (somewhat likely or very likely)			
	Support students' creativity by generating ideas for them to consider	Reduce students' stress about their schoolwork	Improve students' capacity to critically evaluate information	Help students to refine research questions to obtain the most relevant information
Chinese Taipei	85 (3.0) ▲	61 (4.1)	60 (4.2) ▲	66 (4.4)
Cyprus	73 (2.0) ▲	72 (2.1) ▲	67 (2.6) ▲	74 (2.4) ▲
†1 Denmark	s73 (5.1)	s37 (5.4) ▽	s42 (5.6)	s65 (6.1)
Greece	s60 (5.9)	s88 (3.8) ▲	s60 (6.4) ▲	s66 (6.1)
† Korea, Republic of	58 (4.6)	81 (3.7) ▲	35 (4.0) ▽	75 (3.9) ▲
1 Norway (Grade 9)	x79 (5.9) ▲	x43 (7.8)	x65 (7.9) ▲	x67 (6.6)
†12 Romania	65 (5.2)	78 (3.9) ▲	49 (5.5)	62 (5.1)
Slovak Republic	47 (4.3) ▽	57 (4.0)	34 (4.0) ▽	54 (4.1) ▽
1 Slovenia	44 (4.2) ▽	36 (3.5) ▽	29 (3.8) ▽	45 (4.2) ▽
1 Sweden	s60 (6.0)	s26 (4.6) ▽	s43 (5.8)	s58 (5.4)
† Uruguay	s58 (6.5)	s51 (6.4)	s41 (6.7)	s63 (6.5)
ICILS 2023 average	64 (1.6)	55 (1.5)	48 (1.7)	63 (1.6)

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
2 Country surveyed target grade in the first half of the school year.
s indicates data are available for at least 50% but less than 70% of the students.
x indicates data are available for at least 40% but less than 50% of the students. Interpret with caution.

Negative consequences for students

There were typically larger proportions of students in schools where principals reported that the listed negative consequences of the use of generative AI were likely (either somewhat likely or very likely) in comparison to the positive consequences discussed above (Table Ad.4 and Table Ad.5). On average across countries, at least 80 percent of students were in schools accounted for by principals who reported that each of three negative consequences were likely—*confuse students with false, misleading, or biased information* (80%), *result in students becoming dependent on the tools rather than learning for themselves* (80%), and *encourage students to submit work that is not their own* (86%). One of the five negative consequences only was reported to be likely by principals in schools accounting for less than half the students on average across countries—*make students anxious about the influence of technology on the world* (40%). The negative consequence with the largest range of reported likelihood across countries was *make it difficult for students to develop a deep understanding of concepts*. The percentages of students in schools where principals reported this outcome to be likely varied by 39 percentage points, from 83 percent in Romania to 44 percent in Sweden. The negative consequence with the least variation in principals' reported beliefs was that the use of ChatGPT or similar tools will *confuse students with false, misleading, or biased information*. The variation in beliefs that this was a likely consequence was 18 percentage points across countries. It ranged from principals in schools accounting for 88 percent of students in Greece to 70 percent of students in Sweden (Table Ad.5).

Across countries there was generally less variation in principals' reports of the likely negative than the previously reported positive consequences of the use of generative AI on the work of students (Table Ad.4 and Table Ad.5). In Greece and Cyprus, the percentages of students in schools where the principals reported that the negative consequences were likely, were statistically significantly higher than the ICILS 2023 average for four of the five consequences. In no countries were the percentages

Table Ad.5: School principals' perceptions of potentially negative impacts of ChatGPT or similar tools on the work of students

Country	Percentages of students in schools where principals indicated that the use of ChatGPT or similar tools will result in the following outcomes (somewhat likely or very likely)				
	Make it difficult for students to develop a deep understanding of concepts	Encourage students to submit work that is not their own	Confuse students with false, misleading, or biased information	Make students anxious about the influence of technology on the world	Result in students becoming dependent on the tools rather than learning for themselves
Chinese Taipei	76 (3.6) ▲	70 (3.9) ▽	81 (3.2)	47 (4.3)	87 (2.8) ▲
Cyprus	77 (1.4) ▲	92 (0.3) ▲	80 (1.9)	57 (2.1) ▲	93 (0.2) ▲
† 1 Denmark	s 61 (5.6)	s 90 (3.5)	s 84 (4.5)	s 29 (5.5) ▽	s 70 (5.5)
Greece	s 82 (4.6) ▲	s 94 (2.8) ▲	s 88 (4.0) ▲	s 44 (6.2)	s 90 (3.6) ▲
† Korea, Republic of	74 (4.3)	92 (2.3) ▲	82 (3.5)	44 (4.6)	91 (2.5) ▲
1 Norway (Grade 9)	x 56 (7.6)	x 84 (5.7)	x 77 (6.5)	x 41 (7.5)	x 68 (7.1)
† 1 2 Romania	83 (4.1) ▲	89 (3.0)	74 (5.1)	46 (5.3)	88 (3.5) ▲
Slovak Republic	63 (3.6)	85 (3.0)	78 (3.5)	29 (3.6) ▽	83 (2.9)
1 Slovenia	56 (4.2) ▽	90 (2.5)	76 (3.4)	21 (3.6) ▽	76 (3.2)
1 Sweden	s 44 (5.3) ▽	s 84 (3.4)	s 70 (4.8) ▽	s 36 (5.5)	s 66 (5.3) ▽
† Uruguay	s 71 (5.7)	s 82 (5.3)	s 80 (4.5)	s 51 (6.7)	s 72 (6.0)
ICILS 2023 average	66 (1.5)	86 (1.1)	80 (1.3)	40 (1.6)	80 (1.4)

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
2 Country surveyed target grade in the first half of the school year.
s indicates data are available for at least 50% but less than 70% of the students.
x indicates data are available for at least 40% but less than 50% of the students. Interpret with caution.

of students in schools where the principals reported that the negative consequences were likely, statistically significantly lower than the ICILS 2023 average for more than two consequences (Table Ad.5).

Overall, principals tended to report that they saw both positive and negative outcomes of the use of generative AI on the work of students as being likely, with a tendency for the negative outcomes to be reported more often to be likely. With respect to the positive outcomes, the outcomes associated with student interest, the generation of ideas, and the capacity to structure their research were reported to be slightly more likely than those associated with the improvement of students' learning and their capacity to critically evaluate information. This suggests that one potential challenge for principals and teachers is how the more positively perceived benefits of the use of generative AI can be used to enhance the contribution of benefits that were perceived to be less likely to occur.

Principals' opinions about the potential consequences of the use of generative AI tools on the work of teachers

Principals were asked to indicate how likely they believed it was that the use of generative AI tools would result in a series of consequences on the work of teachers in their schools. The consequences reflected three categories—positive, negative, and indicative of potential changes to the breadth and focus of teachers' work. The statements associated with the three categories were not separated in the questionnaire, rather they were presented together in a largely alternating sequence. Below they are presented and discussed as separate groups.

The potentially positive consequences for the work of teachers presented to principals were:

- The use of ChatGPT or similar tools will make it easier for teachers to plan lessons.
- The use of ChatGPT or similar tools will make it easier for teachers to create learning resources.

- The use of ChatGPT or similar tools will make it easier for teachers to create individualized learning programs for their students.
- Teachers will benefit from using ChatGPT or similar tools to help them assess their students' work.
- Teachers will benefit from using ChatGPT or similar tools to help them generate feedback to students about their work.

The potentially negative consequences for the work of teachers presented to principals were:

- The use of ChatGPT or similar tools by students will make it difficult for teachers to judge whether or not the work submitted by students is their own.
- The use of ChatGPT or similar tools will undermine the professional standing of teachers.
- ChatGPT or similar tools will not be useful resources for teaching and learning because they do not function sufficiently in the language or languages of instruction in our school.
- The use of ChatGPT or similar tools will result in teachers using material that includes inaccurate information.
- The use of ChatGPT or similar tools will result in teachers using material that does not accurately represent the curriculum.
- The use of ChatGPT or similar tools will result in teachers using material that does not represent good pedagogy in the subject they are teaching.

The potential consequences on the breadth and focus of teachers' work presented to principals were:

- Teachers will need specific professional learning support on the use of ChatGPT or similar tools to support teaching and learning.
- Students will need to learn about how ChatGPT or similar tools are produced.
- Teachers will need to monitor the degree to which their students depend on ChatGPT or similar tools to complete their classwork.
- Students will need to learn about the potential benefits to society of the use of ChatGPT or similar tools.
- Students will need to learn about the potential risks to society of the use of ChatGPT or similar tools.
- Teachers will need to find ways to assess student learning that prevent the students from using ChatGPT or similar tools.
- Students will need to learn how to decide when to use and when not to use ChatGPT or similar tools.

Principals were asked to indicate their belief in the likelihood that the use of ChatGPT or similar tools would result in each of the consequences listed above. Principals were asked to select one indication of likelihood (very unlikely, somewhat unlikely, somewhat likely, very likely) for each consequence.

Positive consequences for teachers

On average across countries, between approximately 60 percent and 80 percent of students were in schools where the principals reported that it was likely (either somewhat likely or very likely) that the use of generative AI would have the listed positive consequences for the work of teachers (Table Ad.6). The consequence that principals reported to be most likely to occur was that the use of ChatGPT or similar tools will *make it easier for teachers to create learning resources*, which was reported to be likely, on average across countries, by principals in schools accounting for 80 percent of students. The consequence that principals reported to be least likely to occur was that *teachers will benefit from using ChatGPT or similar tools help them assess their students' work*. This was reported to be likely, on average across countries, by principals in schools accounting for 60 percent of students. The positive consequence for teachers with the largest range of reported likelihood by principals across countries was *make it easier for teachers to plan lessons*. The percentages of students in schools where principals reported this outcome to be likely varied 60 percentage points, from 92 percent in Cyprus to 32 percent in Denmark.

Across countries, principals in Chinese Taipei and Cyprus tended to report that the positive consequences of ChatGPT on the work of teachers were most likely. In both countries, the percentages of students in schools where the principals reported that the consequences were likely, were statistically significantly higher than the ICILS 2023 average for four of the five positive consequences. These are the same two countries in which the highest levels of potential positive consequences for the use of ChatGPT were reported for students in the previous section. In contrast, the least positive beliefs were reported by principals in Denmark where these percentages were statistically significantly below the ICILS 2023 average in four of the five consequences, and in Slovenia and Sweden for three of the five consequences. Slovenia was also one of the countries in which principals expressed the lowest levels of potential positive consequences for the use of ChatGPT on the work of students (Table Ad.6).

Table Ad.6: School principals' perceptions of potentially positive impacts of ChatGPT or similar tools on the work of teachers

Country	Percentages of students in schools where principals indicated that the use of ChatGPT or similar tools will have the following consequences (somewhat likely or very likely)				
	Will make it easier for teachers to plan lessons	**Will make it easier for teachers to create learning resources**	**The use of [ChatGPT or similar tools] will make it easier for teachers to create individualized learning programs for their students**	**Teachers will benefit from using [ChatGPT or similar tools] help them assess their students' work.**	**Teachers will benefit from using [ChatGPT or similar tools] to help them generate feedback to students about their work**
Chinese Taipei	91 (2.7) ▲	95 (2.1) ▲	78 (3.7) ▲	70 (3.6) ▲	82 (3.4) ▲
Cyprus	92 (1.6) ▲	96 (2.1) ▲	85 (2.0) ▲	77 (2.7) ▲	86 (2.5) ▲
†1 Denmark	s32 (5.9) ▽	s54 (6.2) ▽	s45 (5.9) ▽	s45 (6.3) ▽	s45 (5.9) ▽
Greece	s84 (4.6) ▲	s89 (4.0) ▲	s76 (4.9)	s68 (5.3)	s78 (5.3) ▲
† Korea, Republic of	83 (3.4) ▲	92 (2.5) ▲	87 (3.3) ▲	65 (4.3)	76 (4.0) ▲
1 Norway (Grade 9)	x75 (5.8)	x79 (5.3)	x77 (5.7)	x63 (6.7)	x61 (7.4)
†12 Romania	75 (4.0)	82 (3.5)	73 (4.4)	66 (4.8)	63 (5.1)
Slovak Republic	62 (4.0) ▽	79 (3.2)	67 (3.6)	46 (4.2) ▽	56 (4.0) ▽
1 Slovenia	46 (4.4) ▽	70 (3.6) ▽	47 (4.4) ▽	52 (4.1)	42 (4.2) ▽
1 Sweden	s60 (5.5) ▽	s60 (5.4) ▽	s46 (6.0) ▽	s43 (5.5) ▽	s50 (5.5) ▽
† Uruguay	s77 (5.5)	s86 (4.4)	s75 (5.9)	s69 (6.3)	s70 (6.3)
ICILS 2023 average	70 (1.4)	80 (1.3)	68 (1.5)	60 (1.6)	64 (1.6)

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
2 Country surveyed target grade in the first half of the school year.
s indicates data are available for at least 50% but less than 70% of the students.
x indicates data are available for at least 40% but less than 50% of the students. Interpret with caution.

Negative consequences for teachers

There was considerable variation in principals' predictions of the likelihood of the range of potential negative consequences of the use of ChatGPT on the work of teachers (Table Ad.7).

On average across countries, 90 percent of students were in schools where the principals reported it to be likely that the use of ChatGPT or similar tools will *make it difficult for teachers to judge whether or not the work submitted by students is their own*. This consequence also shows the least variation in principals' reported beliefs range of eight percentage points only across countries. It ranged from principals in schools accounting for 94 percent of students in Korea (Rep. of) to 86 percent of students in Denmark. In the previous section, similar percentages of students (86% on average across countries) were in schools where principals reported that the use of ChatGPT or similar tools will likely *encourage students to submit work that is not their own*. Taken together, these two reported findings suggest that the challenges associated with verification of the authenticity of students' work following the advent of generative AI is a concern for principals in schools accounting for majorities of students (Table Ad.7) across countries.

Three further negative consequences for the work of teachers were expressed to be likely by principals in schools accounting for more than 50 percent of students on average across countries. These were: *result in teachers using material that includes inaccurate information*, *result in teachers using material that does not represent good pedagogy in the subject they are teaching*, and *result in teachers using material that does not accurately represent the curriculum* (Table Ad.7). These three are all associated with potential problems arising from teachers use of curriculum materials that have been created (in whole or in part) by generative AI.

It is worth noting the potential challenge for principals suggested in the contrast between their relatively high expectation that the use of generative AI will make it easier for teachers to create learning resources (reported above as to be likely by principals in schools accounting for 80% of students on average across countries) and the concerns reported by principals associated with teachers' use of such materials in their teaching.

The two consequences associated with the potential limitations of ChatGPT in the languages of instruction of the school and the risk that the use of chat ChatGPT could undermine the professional standing of teachers were both regarded as relatively less likely by school principals. Each of these was reported to be likely by principals in schools accounting for less than 40 percent of students on average across countries.

Across countries, principals in Greece and Cyprus tended to report that the negative consequences of ChatGPT on the work of teachers were most likely. In both countries, the percentages of students in schools where the principals reported that the consequences were likely were statistically significantly higher than the ICILS 2023 average for four of the six negative consequences (Table Ad.7). These are the same two countries in which the highest levels of potential negative consequences for the use of ChatGPT were reported for students in the previous section. In contrast, in Sweden the lowest levels of perceived likelihood of negative consequences on the work of teachers were reported. The percentages of students in schools where principals reported that the negative consequences were likely, are statistically significantly lower than the ICILS 2023 average for four of the six consequences.

Table Ad.7: School principals' perceptions of potentially negative impacts of ChatGPT or similar tools on the work of teachers

Country	Percentages of students in schools where principals indicated that the use of ChatGPT or similar tools will have the following consequences (somewhat likely or very likely)					
	Will make it difficult for teachers to judge whether or not the work submitted by students is their own	**Will undermine the professional standing of teachers**	**[ChatGPT or similar tools] will not be useful resources for teaching and learning because they do not function sufficiently in the language or languages of instruction in our school**	**Will result in teachers using material that includes inaccurate information**	**Will result in teachers using material that does not accurately represent the curriculum**	**Will result in teachers using material that does not represent good pedagogy in the subject they are teaching**
Chinese Taipei	93 (2.4)	36 (3.9)	35 (4.1)	84 (2.8) ▲	71 (3.4) ▲	67 (3.8) ▲
Cyprus	91 (1.2)	48 (1.9) ▲	46 (2.5) ▲	74 (2.7) ▲	70 (2.7) ▲	72 (2.7) ▲
[†1] Denmark	[s]86 (4.5)	[s]18 (4.9) ▽	[s]37 (6.2)	[s]59 (6.2)	[s]40 (6.0) ▽	[s]47 (6.4)
Greece	[s]93 (2.7)	[s]58 (6.1) ▲	[s]61 (5.9) ▲	[s]74 (5.3) ▲	[s]69 (5.5) ▲	[s]70 (5.3) ▲
[†] Korea, Republic of	94 (2.1)	42 (4.4)	34 (3.9)	83 (3.7) ▲	74 (3.6) ▲	49 (4.6)
[1] Norway (Grade 9)	[x]91 (4.4)	[x]18 (5.6) ▽	[x]27 (6.4) ▽	[x]58 (7.2)	[x]49 (7.8)	[x]45 (8.5)
[†12] Romania	87 (3.6)	57 (5.9) ▲	65 (5.3) ▲	69 (5.2)	65 (5.3) ▲	70 (5.5) ▲
Slovak Republic	92 (1.7)	43 (4.3)	46 (4.5)	55 (4.0) ▽	47 (4.1)	44 (4.2) ▽
[1] Slovenia	88 (2.7)	30 (3.3)	34 (4.2)	43 (3.8) ▽	41 (4.0) ▽	41 (4.1) ▽
[1] Sweden	[s]88 (4.0)	[s]19 (4.3) ▽	[s]24 (5.0) ▽	[s]44 (5.6) ▽	[s]28 (4.7) ▽	[s]37 (4.8) ▽
[†] Uruguay	[s]87 (4.2)	[s]40 (6.9)	[s]46 (6.4)	[s]55 (6.6)	[s]53 (6.9)	[s]44 (6.7)
ICILS 2023 average	90 (1.0)	35 (1.5)	39 (1.6)	63 (1.6)	54 (1.6)	52 (1.7)

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
[†] Met guidelines for sampling participation rates only after replacement schools were included.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[s] indicates data are available for at least 50% but less than 70% of the students.
[x] indicates data are available for at least 40% but less than 50% of the students. Interpret with caution.

Breadth and focus of teachers' work

In general across countries, principals reported that it was likely that the use of ChatGPT would extend the breadth and focus of teachers' work (Table Ad.8).

Across the listed consequences, between approximately 80 percent and 95 percent of students, on average across countries, were in schools where the principals reported that it was likely (either somewhat likely or very likely) that the use of generative AI would result in an increase to the breadth and focus of teachers' work (Table Ad.8). The consequences that principals reported to be most likely to occur was that *students will need to learn about the potential risks to society of the use of ChatGPT or similar tools* and *students will need to learn how to decide when to use and when not to use ChatGPT or similar tools*. These were reported to be likely, on average across countries, by principals in schools accounting for 95 percent of students. The consequence that principals reported to be least likely to occur was that *teachers will need to find ways to assess student learning that prevent the students from using ChatGPT or similar tools*. This was reported to be likely on average across countries, by principals in schools accounting for 81 percent of students. In addition to the relative likelihoods of the reported increases to the breadth and focus, there was typically less variation in these opinions across countries and consequences. The consequence with the largest range of reported likelihood by principals across countries was *students will need to learn about how ChatGPT or similar tools are produced*. The percentages of students in schools where principals reported this consequence to be likely varied 26 percentage points, from 97 percent in Denmark to 71 percent in Greece. The ranges in percentages across countries for each of the remaining six listed consequences were lower than 20 percentage points.

Across countries, principals in Cyprus tended to report that the listed consequences suggesting an increase in the breadth and focus of work of teachers were most likely. For five of the seven listed consequences, principals in Cyprus were in schools accounting for statistically significantly more students than the ICILS 2023 average. In no other country were there statistically significant differences between the percentages reported for that country and the ICILS 2023 international average for more than two of the seven consequences (Table Ad.8).

Table Ad.8: School principals' perceptions of potential impacts of ChatGPT or similar tools on the breadth and focus of teachers' work

Country	Percentages of students in schools where principals indicated that the use of ChatGPT or similar tools will have the following consequences (somewhat likely or very likely)			
	Teachers will need specific professional learning support on the use of [ChatGPT or similar tools] to support teaching and learning	Students will need to learn about how [ChatGPT or similar tools] are produced	Teachers will need to monitor the degree to which their students depend on [ChatGPT or similar tools] to complete their classwork	Students will need to learn about the potential benefits to society of the use of [ChatGPT or similar tools]
Chinese Taipei	96 (1.9)	82 (3.2)	91 (2.6)	98 (1.4) ▲
Cyprus	97 (0.3) ▲	88 (1.4) ▲	95 (1.3) ▲	95 (1.7)
† 1 Denmark	s 92 (3.4)	s 97 (2.1) ▲	s 93 (3.0)	s 93 (3.3)
Greece	s 96 (2.5)	s 71 (5.2) ▽	s 85 (4.2)	s 92 (3.3)
† Korea, Republic of	94 (2.1)	97 (1.6) ▲	97 (1.8) ▲	87 (3.1)
1 Norway (Grade 9)	x 94 (3.6)	x 94 (3.7) ▲	x 95 (3.2)	x 92 (4.1)
† 1 2 Romania	86 (4.1)	80 (3.8)	88 (2.8)	83 (3.9) ▽
Slovak Republic	93 (2.3)	82 (3.4)	87 (2.8) ▽	90 (2.6)
1 Slovenia	86 (2.9) ▽	72 (4.1) ▽	90 (2.3)	93 (1.9)
1 Sweden	s 89 (3.4)	s 87 (3.2)	s 96 (2.1) ▲	s 93 (3.1)
† Uruguay	s 90 (3.9)	s 77 (5.9)	s 91 (3.9)	s 87 (3.5)
ICILS 2023 average	93 (0.9)	85 (1.2)	92 (0.9)	92 (0.9)

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
2 Country surveyed target grade in the first half of the school year.
s indicates data are available for at least 50% but less than 70% of the students.
x indicates data are available for at least 40% but less than 50% of the students. Interpret with caution.

Table Ad.8: Principals' perceptions of potential impacts of ChatGPT or similar tools on the breadth and focus of teachers' work (cont'd)

Country	Percentages of students in schools where principals indicated that the use of ChatGPT or similar tools will have the following consequences (somewhat likely or very likely)		
	Students will need to learn about the potential risks to society of the use of [ChatGPT or similar tools]	**Teachers will need to find ways to assess student learning that prevent the students from using [ChatGPT or similar tools]**	**Students will need to learn how to decide when to use and when not to use [ChatGPT or similar tools]**
Chinese Taipei	97 (1.5)	89 (2.9) ▲	93 (2.4)
Cyprus	98 (0.1) ▲	87 (0.4) ▲	98 (1.0) ▲
†1 Denmark	s93 (3.5)	s80 (5.1)	s96 (2.8)
Greece	s99 (1.4) ▲	s75 (5.7)	s92 (2.7)
† Korea, Republic of	94 (2.2)	83 (3.4)	96 (1.8)
1 Norway (Grade 9)	x96 (3.0)	x74 (6.3)	x93 (4.0)
†12 Romania	90 (2.2) ▽	82 (4.4)	88 (3.1) ▽
Slovak Republic	93 (1.9)	82 (3.4)	93 (2.1)
1 Slovenia	96 (1.6)	73 (3.4) ▽	96 (1.5)
1 Sweden	s95 (1.5)	s92 (3.0) ▲	s98 (1.7)
† Uruguay	s94 (3.0)	s77 (4.9)	s96 (2.5)
ICILS 2023 average	95 (0.7)	81 (1.3)	95 (0.8)

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
2 Country surveyed target grade in the first half of the school year.
s indicates data are available for at least 50% but less than 70% of the students.
x indicates data are available for at least 40% but less than 50% of the students. Interpret with caution.

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Appendix A:

Sampling information and participation rates

Table A.1: Coverage of ICILS 2023 target population

Country	International target population coverage (%)	Exclusions from target population (%)			
		At school level	Within sample		Overall
			All reasons	Estimated due to language issues*	
Austria	100	2.1	5.4	2.8	7.6
Azerbaijan	100	1.9	0.3	0.0	2.2
Belgium (Flemish)	100	1.4	1.3	1.0	2.7
Bosnia and Herzegovina	61	3.9	1.2	0.0	5.2
Chinese Taipei	100	0.3	1.8	0.1	2.1
Croatia	100	0.6	5.2	0.9	5.8
Cyprus	100	0.9	2.0	0.9	2.9
Czech Republic	100	3.0	3.1	2.7	6.2
Denmark	100	3.7	3.2	0.1	6.8
Finland	100	1.3	2.8	1.3	4.2
France	100	3.0	1.8	0.7	4.8
Germany	100	1.6	2.3	1.8	3.9
Greece	100	0.7	2.3	1.2	3.0
Hungary	100	2.4	2.1	0.6	4.5
Italy	100	0.8	3.8	0.0	4.7
Kazakhstan	100	2.2	4.0	3.2	6.1
Korea, Republic of	100	1.7	1.5	0.4	3.2
Kosovo	100	4.9	1.6	1.0	6.5
Latvia	100	5.7	4.0	2.3	9.7
Luxembourg	100	3.6	1.4	0.8	5.0
Malta	100	1.4	2.8	0.1	4.2
Netherlands	100	4.5	0.9	0.1	5.4
Norway (Grade 9)	100	1.9	4.4	0.0	6.3
Oman	100	1.1	0.8	0.1	1.9
Portugal	100	6.2	2.1	1.0	8.2
Romania	100	3.8	3.4	1.2	7.2
Serbia	100	3.8	2.8	2.4	6.6
Slovak Republic	100	0.6	2.8	1.4	3.3
Slovenia	100	2.8	3.5	1.2	6.3
Spain	100	1.3	4.5	1.9	5.8
Sweden	100	1.6	7.1	2.3	8.7
United States	100	0.0	3.5	1.0	3.5
Uruguay	100	0.9	1.2	0.0	2.2
Benchmarking participant					
North Rhine-W., Germany	100	1.7	2.0	1.6	3.7

Notes: Results are rounded to one decimal place.
* Exclusion due to language issues could be due to immigrants, refugees, or minority languages. The 0.0 means that no (or only very few) students were listed as excluded for language issues or that the country did not use this exclusion category and students with language issues could have been reported in other exclusion categories.

Table A.2: Participation rates and sample sizes for student survey

Country	School participation rate (%)			Total number of schools that participated in student survey	Class participation rate (% weighted)	Student participation rate (% weighted)	Total number of students assessed	Overall participation rate (%)	
	Before replacement (weighted)	After replacement (weighted)	After replacement (unweighted)					Before replacement (weighted)	After replacement (weighted)
Austria	99.1	99.3	99.4	154	100.0	92.9	3,448	92.0	92.3
Azerbaijan	94.5	100.0	100.0	164	100.0	92.6	3,634	87.5	92.6
Belgium (Flemish)	64.2	89.1	88.9	136	100.0	92.9	3,365	59.7	82.8
Bosnia and Herzegovina	96.1	98.6	99.1	105	100.0	90.7	1,877	87.2	89.5
Chinese Taipei	98.1	100.0	100.0	169	100.0	95.6	5,112	93.8	95.6
Croatia	82.4	97.2	97.4	148	100.0	92.3	2,911	76.1	89.7
Cyprus	96.8	96.8	96.0	95	100.0	93.5	3,182	90.5	90.5
Czech Republic	100.0	100.0	100.0	210	100.0	94.5	8,169	94.5	94.5
Denmark	79.1	95.3	95.3	141	100.0	86.2	3,038	68.2	82.1
Finland	100.0	100.0	100.0	158	99.6	92.3	4,249	91.9	91.9
France	99.4	99.4	99.3	150	100.0	93.5	3,694	92.9	92.9
Germany	83.6	95.5	96.5	222	100.0	89.1	5,065	74.5	85.2
Greece	86.4	95.9	96.2	179	100.0	93.7	3,576	81.0	89.9
Hungary	97.5	98.7	98.7	155	100.0	94.0	3,491	91.7	92.7
Italy	95.0	100.0	100.0	152	100.0	96.5	3,376	91.7	96.5
Kazakhstan	97.7	100.0	100.0	176	100.0	96.4	4,852	94.2	96.4
Korea, Republic of	77.2	100.0	100.0	152	100.0	95.3	3,723	73.6	95.3
Kosovo	99.3	99.3	99.4	153	100.0	94.8	3,345	94.2	94.2
Latvia	87.7	95.3	95.3	143	100.0	89.2	2,705	78.2	85.0
Luxembourg	100.0	100.0	100.0	41	94.4	90.8	4,703	85.8	85.8
Malta	100.0	100.0	100.0	42	100.0	90.3	3,115	90.3	90.3
Netherlands	15.4	30.5	29.7	46	96.1	88.4	1,288	13.1	25.9
Norway (Grade 9)	95.2	95.9	95.6	153	99.1	86.7	4,436	81.8	82.4
Oman	99.5	100.0	100.0	221	100.0	96.1	6,437	95.7	96.1
Portugal	89.0	100.0	100.0	164	100.0	95.0	3,650	84.5	95.0
Romania	81.1	90.2	90.1	136	100.0	87.2	3,270	70.7	78.7
Serbia	98.6	99.3	99.4	154	100.0	93.1	3,125	91.8	92.5
Slovak Republic	97.9	100.0	100.0	166	100.0	92.9	3,034	91.0	92.9
Slovenia	93.0	96.0	96.0	168	100.0	93.2	3,318	86.7	89.5
Spain	99.3	99.7	99.6	508	100.0	91.0	11,799	90.3	90.7
Sweden	96.1	98.1	98.0	147	99.4	86.0	3,401	82.1	83.8
United States	44.9	65.1	65.9	118	100.0	86.0	2,352	38.6	56.0
Uruguay	90.3	96.8	96.6	144	100.0	80.8	2,933	73.0	78.2
Benchmarking participants									
North Rhine-W., Germany	89.0	98.3	98.2	111	100.0	90.5	2,726	80.5	88.9

Appendix B:

Additional tables from NCS and school principal questionnaire

B.1 NCS details of plans and policies for the use of ICT in education

Table B.1: Emphasis in national plans and policies on aspects of student learning with and about ICT

Country	Extent that plans and policies emphasize improving student learning						
	Subject matter content (language arts, mathematics, science, etc.)	Preparing students for using ICT in their future work	Developing information literacy	ICT-based skills in critical thinking, collaboration, and communication	Increasing access to online courses of study (e.g., for rural students)	Computer programming or developing applications for digital devices	Responsible and ethical use of digital devices including cyber-safety
Austria	●	●	●	●	●	●	●
Azerbaijan	○	○	○	○	○	○	○
Belgium (Flemish)	○	●	●	●	●	●	●
Bosnia and Herzegovina	○	◒	◒	○	◒	○	◒
Chile	◒	●	◒	●	●	◒	◒
Chinese Taipei	●	●	●	●	●	●	●
Croatia	◒	●	●	●	◒	●	●
Cyprus	◒	●	●	●	◒	●	●
Czech Republic	●	●	●	●	◒	○	●
Denmark	●	●	●	●	○	●	●
Finland	●	●	●	●	◒	●	●
France	●	●	●	●	●	●	●
Germany	●	●	●	●	◒	●	●
Greece	●	●	●	●	●	●	●
Hungary	◒	●	●	◒	◒	●	●
Italy	◒	●	●	●	◒	●	●
Kazakhstan	●	●	●	●	◒	◒	●
Korea, Republic of	●	●	●	●	●	●	●
Kosovo	◒	●	◒	◒	◒	◒	◒
Latvia	◒	◒	●	●	◒	●	●
Luxembourg	●	●	●	●	○	●	●
Malta	◒	●	●	●	●	●	●
Netherlands	○	○	◒	○	○	○	○
Norway	◒	●	●	●	◒	●	●
Oman	●	●	●	●	●	●	●
Portugal	●	◒	●	●	●	◒	◒
Romania	◒	●	●	●	○	○	◒
Serbia	◒	●	●	●	○	●	●
Slovak Republic	◒	◒	◒	◒	○	○	○
Slovenia	●	◒	◒	○	◒	○	◒
Spain	●	●	●	●	◒	●	●
Sweden	●	●	●	●	○	●	●
United States	●	◒	●	●	●	●	●
Uruguay	●	◒	●	●	●	●	●
Benchmarking participant							
North Rhine-W. (Germany)	●	●	●	●	●	●	●

Notes: Data collected from ICILS 2023 national contexts survey.
● Explicitly stated in plans and policies
◒ Implicitly stated in plans and policies
○ No emphasis on this aspect in plans and policies

Table B.2: Emphasis in national plans and policies on the importance of ICT infrastructure in education

Country	Extent that plans and policies emphasize the importance of ICT infrastructure in education				
	Provision of computer equipment and other ICT resources	Maintenance of computer equipment and other ICT resources	Renewal, update, and replacement of computer equipment and other ICT resources	Support for teachers for using computer equipment and other ICT resources in their work	Access to digital educational resources
Austria	●	●	●	●	●
Azerbaijan	○	○	○	○	○
Belgium (Flemish)	●	●	●	●	●
Bosnia and Herzegovina	●	●	●	●	○
Chile	●	●	◒	●	●
Chinese Taipei	●	●	●	●	●
Croatia	◒	○	○	◒	◒
Cyprus	●	●	◒	●	◒
Czech Republic	●	●	●	●	●
Denmark	●	●	●	●	●
Finland	●	◒		●	●
France	●	●	●	●	●
Germany	●	●	●	●	●
Greece	●	●	●	●	●
Hungary	◒	◒	◒	●	◒
Italy	●	◒	●	●	●
Kazakhstan	◒	◒	◒	◒	●
Korea, Republic of	●	●	●	●	●
Kosovo	●	◒	◒	◒	◒
Latvia	●	●	●	●	●
Luxembourg	●	●	●	●	●
Malta	◒	◒	◒	◒	◒
Netherlands	○	○	○	○	○
Norway	●	◒	◒	●	●
Oman	●	●	●	●	●
Portugal	●	●	●	●	●
Romania	●	◒	◒	●	●
Serbia	●	●	●	◒	◒
Slovak Republic	●	◒	◒	●	●
Slovenia	●	◒	○	●	●
Spain	●	◒	◒	●	●
Sweden	●	●	●	●	●
United States	●	●	●	●	●
Uruguay	●	●	●	●	●
Benchmarking participant					
North Rhine-W. (Germany)	●	●	●	●	●

Notes: Data collected from ICILS 2023 national contexts survey.
● Explicitly stated in plans and policies
◒ Implicitly stated in plans and policies
○ No emphasis on this aspect in plans and policies

Table B.2: Emphasis in national plans and policies on the importance of ICT infrastructure in education (cont'd)

Country	Extent that plans and policies emphasize the importance of ICT infrastructure in education			
	Internet connectivity	Within-school networking	Home access to school-based digital education resources such as through school-hosted online portals	Local (within your country) development of digital learning materials
Austria	●	●	●	●
Azerbaijan	○	○	○	◒
Belgium (Flemish)	●	◒	●	●
Bosnia and Herzegovina	●	◒	◒	○
Chile	●	◒	◒	◒
Chinese Taipei	●	●	●	●
Croatia	◒	○	○	◒
Cyprus	●	●	●	●
Czech Republic	●	●	○	●
Denmark	●	●	●	●
Finland	●	◒	◒	●
France	◒	●	●	●
Germany	●	●	●	●
Greece	●	●	●	●
Hungary	●	●	●	◒
Italy	●	●	●	●
Kazakhstan	●	●	●	◒
Korea, Republic of	●	●	○	●
Kosovo	●	◒	◒	◒
Latvia	●	◒	◒	●
Luxembourg	●	●	●	●
Malta	◒	◒	◒	○
Netherlands	○	○	○	○
Norway	●	◒	◒	○
Oman	●	●	●	●
Portugal	●	●	●	●
Romania	●	◒	○	●
Serbia	●	◒	◒	◒
Slovak Republic	●	○	●	●
Slovenia	●	◒	○	◒
Spain	●	◒	●	●
Sweden	●	●	●	○
United States	●	●	◒	●
Uruguay	●	○	●	●
Benchmarking participant				
North Rhine-W. (Germany)	●	●	●	●

Notes: Data collected from ICILS 2023 national contexts survey.
● Explicitly stated in plans and policies
◒ Implicitly stated in plans and policies
○ No emphasis on this aspect in plans and policies

Table B.3: Emphasis in national plans and policies on the methods to support student learning

Country	Extent that plans and policies emphasize methods to support student learning				
	Pre-service teacher education in the use of ICT	**In-service teacher education in the use of ICT**	**The use of learning management systems**	**Reporting to parents**	**Providing feedback to students**
Austria	●	●	●	◒	●
Azerbaijan	◒	◒	◒	◒	◒
Belgium (Flemish)	●	●	◒	◒	◒
Bosnia and Herzegovina	◒	◒	◒	●	◒
Chile	◒	◒	○	●	●
Chinese Taipei	●	●	●	●	◒
Croatia	○	◒	○	○	○
Cyprus	◒	◒	◒	●	●
Czech Republic	●	●	○	○	●
Denmark	●	●	●	●	●
Finland	◒	●	○	◒	◒
France	●	●	●	●	●
Germany	●	●	◒	◒	◒
Greece	●	●	●	●	●
Hungary	●	●	◒	○	◒
Italy	●	●	●	◒	◒
Kazakhstan	◒	○	●	◒	●
Korea, Republic of	●	●	●	◒	◒
Kosovo	◒	◒	◒	◒	◒
Latvia	●	●	◒	●	●
Luxembourg	●	●	●	◒	◒
Malta	●	●	◒	◒	◒
Netherlands	○	○	○	○	○
Norway	●	●	●	◒	◒
Oman	●	●	●	●	●
Portugal	○	●	◒	●	●
Romania	●	●	◒	○	◒
Serbia	●	◒	○	●	●
Slovak Republic	●	●	◒	◒	◒
Slovenia	◒	◒	◒	◒	○
Spain	◒	●	●	●	●
Sweden	●	●	●	●	●
United States	●	●	◒	●	●
Uruguay	●	●	●	◒	◒
Benchmarking participant					
North Rhine-W. (Germany)	●	●	●	◒	◒

Notes: Data collected from ICILS 2023 national contexts survey.

● Explicitly stated in plans and policies
◒ Implicitly stated in plans and policies
○ No emphasis on this aspect in plans and policies

Table B.4: Priorities in national plans and policies attributed to aspects of the use of ICT in education

Country	Extent that plans and policies emphasize aspects of CIL in national curriculum				
	Professional development for teachers' pedagogical use of ICT	Sufficient ICT infrastructure and resources in schools	Development of ICT-related competencies in students	Development and provision of digital learning materials	Reduction of the digital divide between groups of students
Austria	●	●	●	●	◒
Azerbaijan	◒	◒	◒	○	○
Belgium (Flemish)	●	●	●	●	●
Bosnia and Herzegovina	◒	◒	◒	○	◒
Chile	◒	●	●	◒	●
Chinese Taipei	●	●	●	●	●
Croatia	◒	●	◒	◒	○
Cyprus	◒	●	●	◒	◒
Czech Republic	●	●	●	◒	●
Denmark	●	●	●	●	◒
Finland	●	●	●	●	●
France	●	●	●	●	●
Germany	●	●	●	●	●
Greece	●	●	●	●	●
Hungary	●	●	●	●	◒
Italy	●	●	●	●	●
Kazakhstan	●	●	●	●	●
Korea, Republic of	●	●	●	●	●
Kosovo	◒	◒	◒	◒	◒
Latvia	○	○	○	○	◒
Luxembourg	●	●	●	●	●
Malta	●	◒	●	●	●
Netherlands	◒	◒	●	●	●
Norway	●	●	●	●	●
Oman	●	●	●	●	●
Portugal	●	●	●	●	●
Romania	●	●	●	●	◒
Serbia	●	●	●	◒	◒
Slovak Republic	●	●	●	◒	●
Slovenia	○	◒	○	◒	●
Spain	●	●	●	●	●
Sweden	●	●	◒	◒	●
United States	●	●	●	●	●
Uruguay	●	●	●	●	●
Benchmarking participant					
North Rhine-W. (Germany)	●	●	●	●	●

Notes: Data collected from ICILS 2023 national contexts survey.
● Explicitly stated in plans and policies
◒ Implicitly stated in plans and policies
○ Not a priority

Table B.4: Priorities in national plans and policies attributed to aspects of the use of ICT in education (cont'd)

Country	Extent that plans and policies emphasize aspects of CIL in national curriculum				
	Improvement of administrative and management systems in schools	Use of ICT to improve communication with parents	Research within schools of the use of ICT in education	Protection of students against emotional/social harm associated with ICT use (e.g., cyberbullying)	Protection of students against physical harm associated with ICT use (e.g., neck pain, eye soreness, fatigue)
Austria	●	◒	○	◒	◒
Azerbaijan	○	○	○	○	○
Belgium (Flemish)	●	●	●	●	◒
Bosnia and Herzegovina	◒	○	○	◒	◒
Chile	◒	○	○	●	●
Chinese Taipei	●	●	●	●	●
Croatia	◒	◒	○	◒	◒
Cyprus	●	●	◒	●	◒
Czech Republic	◒	○	○	◒	○
Denmark	●	●	○	◒	○
Finland	◒	◒	◒	●	◒
France	◒	●	●	●	◒
Germany	●	◒	●	◒	◒
Greece	●	●	●	●	●
Hungary	●	●	◒	●	●
Italy	●	●	◒	●	●
Kazakhstan	-	○	○	●	●
Korea, Republic of	●	●	●	●	◒
Kosovo	◒	◒	◒	◒	◒
Latvia	◒	○	◒	○	○
Luxembourg	◒	◒	◒	●	●
Malta	○	◒	○	●	●
Netherlands	◒	○	●	◒	○
Norway	●	●	●	●	◒
Oman	●	●	●	●	●
Portugal	●	◒	◒	◒	◒
Romania	◒	○	○	◒	○
Serbia	◒	◒	○	◒	◒
Slovak Republic	○	●	◒	○	○
Slovenia	◒	●	●	◒	◒
Spain	●	●	○	●	●
Sweden	◒	◒	○	◒	○
United States	●	●	○	●	○
Uruguay	◒	◒	◒	◒	◒
Benchmarking participant					
North Rhine-W. (Germany)	●	◒	●	◒	◒

Notes: Data collected from ICILS 2023 national contexts survey.
● Explicitly stated in plans and policies
◒ Implicitly stated in plans and policies
○ Not a priority

Table B.5: CIL and CT assessment requirements across countries

Country	CIL and CT assessment policies	
	CIL	CT
Austria	◒	◒
Azerbaijan		
Belgium (Flemish)	◒	◒
Bosnia and Herzegovina	○	○
Chile	◒	○
Chinese Taipei	◒	◒
Croatia	◒	
Cyprus	◒	◒
Czech Republic	○	◒
Denmark	○	○
Finland	○	○
France	◒	◒
Germany	○	○
Greece	◒	
Hungary	○	○
Italy	○	○
Kazakhstan	◒	◒
Korea, Republic of	◒	◒
Kosovo	●	○
Latvia	○	○
Luxembourg	○	○
Malta	●	
Netherlands	○	○
Norway	○	○
Oman	●	●
Portugal	●	●
Romania	◒	◒
Serbia	◒	◒
Slovak Republic	◒	◒
Slovenia	○	○
Spain	◒	
Sweden	○	○
United States	○	○
Uruguay	○	○
Benchmarking participant		
North Rhine-W. (Germany)	○	○

Notes: Data collected from ICILS 2023 national contexts survey.
● Yes, for all students
◒ Yes, using a non-compulsory assessment, or assessment is controlled at the school level
○ No

B.2 School principals' reports on facilitating ICT use for teaching and learning

Table B.6: Principal reports on school influence over ways of facilitating ICT use in teaching and learning

Country	Percentages of students in schools whose principal indicated having influence over the following ways of facilitating ICT use in teaching and learning					
	Increasing the numbers of computers per student in the school	Improving the speed and reliability of internet connectivity	Increasing the variety of digital learning resources available for teaching and learning	Establishing or enhancing an online learning support platform	Supporting participation in professional development on the use of ICT in teaching and learning	Increasing the availability of qualified technical personnel to support the use of ICT
[1] Austria	81 (3.6)	80 (3.6)	93 (2.5)	95 (2.1) ▲	98 (1.3)	68 (3.6) ▽
Azerbaijan	98 (1.2) ▲	99 (0.6) ▲	100 (0.0) ▲	99 (1.1) ▲	99 (1.2) ▲	99 (1.0) ▲
[†] Belgium (Flemish)	95 (2.3) ▲	97 (2.0) ▲	99 (1.0) ▲	98 (1.2) ▲	100 (0.0) ▲	92 (2.0) ▲
[3] Bosnia and Herzegovina	87 (4.3)	91 (3.4) ▲	89 (4.2)	79 (5.3)	92 (3.0)	77 (5.9)
Chinese Taipei	96 (1.8) ▲	95 (1.9) ▲	98 (1.2) ▲	96 (1.6) ▲	97 (1.4)	90 (2.6) ▲
[1] Croatia	82 (3.1)	81 (3.4)	93 (2.0)	89 (2.9)	96 (1.4)	81 (3.6)
Cyprus	62 (1.0) ▽	69 (0.8) ▽	72 (0.7) ▽	70 (1.0) ▽	93 (0.6) ▽	53 (1.4) ▽
[1] Czech Republic	99 (0.6) ▲	95 (1.3) ▲	99 (0.7) ▲	98 (0.9) ▲	99 (0.6) ▲	94 (1.7) ▲
[†1] Denmark	[s]67 (5.2) ▽	[s]50 (5.8) ▽	[s]86 (3.9)	[s]79 (4.6)	[s]96 (2.2)	[s]82 (3.8)
Finland	81 (3.1)	71 (3.8) ▽	90 (2.3)	77 (3.3) ▽	98 (1.4)	75 (3.7)
France	95 (1.8) ▲	93 (2.4) ▲	99 (1.0) ▲	92 (2.6) ▲	96 (2.0)	92 (2.8) ▲
Germany	69 (3.9) ▽	57 (3.8) ▽	87 (3.0)	83 (3.3)	95 (1.9)	44 (4.0) ▽
Greece	86 (3.0)	85 (2.9)	92 (2.1)	79 (3.8) ▽	95 (2.0)	62 (4.3) ▽
Hungary	68 (4.0) ▽	75 (4.0)	90 (3.0)	90 (2.9)	98 (1.3)	73 (4.2)
Italy	100 (0.0) ▲	95 (2.0) ▲	100 (0.0) ▲	98 (1.3) ▲	98 (1.4)	76 (4.0)
[1] Kazakhstan	93 (1.3) ▲	94 (1.4) ▲	93 (1.7)	92 (2.1) ▲	97 (1.1)	95 (1.7) ▲
[†] Korea, Republic of	72 (3.8) ▽	81 (3.3)	89 (2.6)	88 (3.0)	93 (2.2)	77 (4.2)
[1] Kosovo	89 (3.5)	90 (3.4) ▲	92 (3.1)	87 (3.8)	93 (3.0)	87 (3.7) ▲
[1] Latvia	92 (2.4) ▲	94 (2.2) ▲	99 (1.1) ▲	98 (1.3) ▲	100 (0.0) ▲	95 (1.9) ▲
Luxembourg	88 (1.7) ▲	95 (0.2) ▲	94 (1.3)	83 (2.0)	100 (0.0) ▲	75 (1.7)
Malta	78 (0.7) ▽	83 (0.7)	87 (0.5) ▽	78 (0.7) ▽	92 (0.5) ▽	56 (0.7) ▽
[1] Norway (Grade 9)	75 (4.3) ▽	64 (4.6) ▽	91 (2.5)	77 (4.3) ▽	96 (2.0)	83 (3.6)
Oman	63 (3.7) ▽	82 (2.8)	90 (2.4)	78 (3.1) ▽	91 (2.2) ▽	71 (3.4)
[1] Portugal	77 (3.4)	62 (3.9) ▽	88 (2.6)	87 (2.6)	99 (0.6) ▲	71 (3.9)
[†12] Romania	97 (1.7) ▲	99 (1.4) ▲	99 (0.8) ▲	96 (2.1) ▲	100 (0.0) ▲	86 (4.1) ▲
[1] Serbia	84 (3.1)	84 (3.3)	92 (2.5)	88 (2.7)	96 (1.7)	74 (3.3)
Slovak Republic	98 (1.0) ▲	97 (1.4) ▲	97 (1.3) ▲	98 (1.2) ▲	100 (0.0) ▲	91 (2.6) ▲
[1] Slovenia	97 (1.5) ▲	95 (1.8) ▲	96 (1.6) ▲	97 (1.3) ▲	99 (0.9) ▲	95 (1.8) ▲
[1] Spain	77 (2.6) ▽	68 (2.6) ▽	92 (2.2)	82 (2.7)	98 (0.9) ▲	69 (2.6) ▽
[1] Sweden	83 (3.2)	68 (4.3) ▽	91 (2.8)	70 (4.4) ▽	99 (1.1) ▲	82 (3.8)
[†] Uruguay	[r]60 (5.6) ▽	[r]66 (5.3) ▽	[r]77 (5.1) ▽	[r]61 (6.3) ▽	[r]88 (3.5) ▽	[r]62 (6.0) ▽
ICILS 2023 average	83 (0.6)	82 (0.6)	92 (0.4)	86 (0.5)	96 (0.3)	78 (0.6)
Benchmarking participant						
[1] North Rhine-W. (Germany)	57 (4.6) ▽	47 (4.2) ▽	89 (3.2)	80 (3.8)	96 (1.8)	56 (4.1) ▽
Country not meeting sample participation requirements						
[‡] United States	82 (4.1)	75 (4.1)	90 (3.1)	83 (3.7)	93 (2.6)	81 (4.0)

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
[†] Met guidelines for sampling participation rates only after replacement schools were included.
[‡] Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.
[r] indicates data are available for at least 70% but less than 85% of the students.
[s] indicates data are available for at least 50% but less than 70% of the students.

Table B.6: Principal reports on school influence over ways of facilitating ICT use in teaching and learning (cont'd)

Country	Percentages of students in schools whose principal indicated having influence over the following ways of facilitating ICT use in teaching and learning					
	Providing teachers with incentives to integrate ICT use in their teaching	**Providing more time for teachers to prepare lessons in which ICT is used**	**Increasing the professional learning resources for teachers in the use of ICT**	**Fostering collaboration between teachers within the school to support the integration of ICT use in their teaching**	**Fostering collaboration between teachers in this school and with teachers in other schools to support the integration of ICT use in their teaching**	**Developing a shared vision for using ICT to support teaching and learning**
[1] Austria	84 (3.2) ▽	65 (4.4) ▽	88 (3.2)	97 (1.5)	95 (2.0)	98 (1.1)
Azerbaijan	100 (0.0) ▲	98 (1.3) ▲	97 (1.7) ▲	99 (1.0)	99 (0.8) ▲	98 (1.1)
† Belgium (Flemish)	100 (0.0) ▲	82 (3.7)	96 (1.5) ▲	100 (0.0) ▲	100 (0.0) ▲	99 (0.8) ▲
[3] Bosnia and Herzegovina	95 (1.1) ▲	84 (4.5)	92 (2.7)	96 (2.4)	92 (2.6)	95 (3.2)
Chinese Taipei	95 (1.9) ▲	89 (2.7) ▲	95 (1.9) ▲	97 (1.5)	95 (1.9)	98 (1.2)
[1] Croatia	99 (0.9) ▲	80 (3.6)	88 (2.8)	97 (1.6)	94 (1.8)	98 (0.7)
Cyprus	78 (0.7) ▽	61 (1.3) ▽	53 (1.2) ▽	92 (0.6) ▽	88 (0.6) ▽	87 (0.6) ▽
[1] Czech Republic	98 (1.1) ▲	91 (2.5) ▲	98 (1.2) ▲	98 (0.9)	99 (0.7) ▲	98 (0.9) ▲
†[1] Denmark	[s]99 (1.4) ▲	[s]98 (1.2) ▲	[s]100 (0.0) ▲	[s]100 (0.0) ▲	[s]98 (1.8)	[s]97 (1.3)
Finland	88 (2.6)	83 (3.2)	91 (2.6)	99 (1.0)	95 (1.7)	98 (1.1)
France	99 (1.3) ▲	91 (2.4) ▲	93 (2.5) ▲	97 (1.9)	96 (2.0)	97 (1.7)
Germany	85 (2.8) ▽	57 (3.6) ▽	75 (3.5) ▽	97 (1.4)	94 (2.2)	97 (1.4)
Greece	77 (4.1) ▽	70 (4.2) ▽	63 (4.4) ▽	97 (1.5)	91 (2.4)	89 (2.7) ▽
Hungary	97 (1.6) ▲	67 (4.6) ▽	82 (4.1)	98 (1.3)	90 (2.7)	97 (1.4)
Italy	86 (3.3)	84 (3.5)	94 (2.2) ▲	97 (1.5)	96 (1.9)	98 (1.4)
[1] Kazakhstan	97 (1.0) ▲	97 (1.0) ▲	97 (1.2) ▲	98 (0.8)	97 (1.2)	98 (0.7) ▲
† Korea, Republic of	89 (3.0)	92 (2.5) ▲	91 (2.6)	99 (0.9) ▲	95 (2.1)	95 (2.0)
[1] Kosovo	92 (3.1)	95 (2.6) ▲	94 (2.8) ▲	95 (2.6)	93 (3.0)	93 (3.0)
[1] Latvia	99 (1.1) ▲	91 (2.0) ▲	98 (1.3) ▲	99 (1.1)	98 (1.4) ▲	99 (0.8) ▲
Luxembourg	95 (0.2) ▲	62 (1.8) ▽	94 (1.3) ▲	100 (0.0) ▲	93 (1.0)	100 (0.0) ▲
Malta	67 (0.7) ▽	67 (0.7) ▽	80 (0.6) ▽	86 (0.6) ▽	86 (0.6) ▽	92 (0.5) ▽
[1] Norway (Grade 9)	96 (1.6) ▲	100 (0.4) ▲	98 (1.2) ▲	99 (0.8) ▲	97 (1.6)	98 (1.3)
Oman	85 (2.5) ▽	85 (2.5)	89 (2.4)	94 (1.8)	91 (2.2)	94 (1.9)
[1] Portugal	84 (3.0) ▽	77 (3.6)	82 (3.3) ▽	98 (1.1)	94 (2.0)	99 (0.7) ▲
†[1,2] Romania	74 (4.8) ▽	72 (5.0) ▽	94 (2.4) ▲	99 (1.2)	98 (1.7)	98 (1.2)
[1] Serbia	96 (1.7) ▲	90 (2.2) ▲	92 (2.3)	97 (1.6)	95 (1.9)	97 (1.3)
Slovak Republic	100 (0.0) ▲	92 (2.1) ▲	95 (1.9) ▲	99 (0.6) ▲	98 (1.0) ▲	100 (0.0) ▲
[1] Slovenia	99 (0.9) ▲	90 (2.5) ▲	91 (2.4)	99 (1.0)	100 (0.0) ▲	99 (0.8) ▲
[1] Spain	95 (1.3) ▲	66 (2.5) ▽	78 (2.3) ▽	98 (1.0)	90 (2.1) ▽	99 (0.7) ▲
[1] Sweden	98 (1.2) ▲	99 (1.1) ▲	97 (1.4) ▲	100 (0.0) ▲	97 (1.5)	96 (2.2)
† Uruguay	[r]61 (5.9) ▽	[r]66 (6.1) ▽	[r]58 (5.7) ▽	[r]95 (2.8)	[r]88 (4.3)	[r]89 (4.4)
ICILS 2023 average	91 (0.4)	82 (0.5)	88 (0.5)	97 (0.2)	94 (0.3)	96 (0.3)
Benchmarking participant						
[1] North Rhine-W. (Germany)	94 (2.1)	75 (3.9)	77 (4.4) ▽	98 (1.2)	97 (1.7)	99 (0.8) ▲
Country not meeting sample participation requirements						
‡ United States	84 (4.1)	88 (3.6)	89 (3.5)	94 (2.7)	92 (3.2)	94 (2.7)

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.
[r] indicates data are available for at least 70% but less than 85% of the students.
[s] indicates data are available for at least 50% but less than 70% of the students.

Appendix C:

CIL and CT additional tables

Table C.1: Country averages, standard deviation, and percentiles for CIL

Country	Average CIL scale score	Standard deviation	Percentile 10	Percentile 25	Percentile 75	Percentile 90
† Korea, Republic of	540 (2.5) ▲	88 (1.4)	420 (4.8)	486 (3.6)	603 (2.7)	645 (2.9)
1 Czech Republic	525 (2.1) ▲	69 (1.7)	434 (4.9)	485 (3.1)	573 (1.9)	606 (2.1)
†1 Denmark	518 (2.7) ▲	76 (2.0)	416 (7.8)	473 (4.3)	571 (2.3)	606 (2.2)
Chinese Taipei	515 (3.0) ▲	87 (1.9)	397 (5.3)	459 (4.2)	577 (2.9)	620 (3.1)
† Belgium (Flemish)	511 (4.4) ▲	83 (3.2)	394 (10.6)	461 (7.8)	571 (3.0)	606 (2.6)
1 Portugal	510 (3.0) ▲	80 (2.1)	401 (7.2)	460 (4.3)	567 (2.8)	604 (2.9)
1 Latvia	509 (3.6) ▲	79 (1.9)	399 (6.5)	460 (5.4)	566 (3.6)	602 (2.7)
Finland	507 (3.6) ▲	85 (2.2)	387 (7.6)	458 (5.9)	567 (3.1)	604 (2.7)
1 Austria	506 (2.5) ▲	76 (1.8)	402 (4.6)	456 (5.0)	561 (2.0)	597 (2.5)
Hungary	505 (3.8) ▲	84 (3.5)	387 (10.1)	457 (7.1)	565 (2.7)	599 (2.3)
1 Sweden	504 (3.0) ▲	85 (1.7)	384 (6.8)	452 (4.6)	566 (2.5)	603 (2.6)
1 Norway (Grade 9)	502 (2.9) ▲	85 (1.8)	384 (7.1)	451 (3.7)	563 (2.6)	600 (2.8)
Germany	502 (3.5) ▲	87 (2.8)	380 (7.4)	446 (5.3)	565 (2.9)	604 (4.5)
Slovak Republic	499 (2.7) ▲	82 (1.8)	386 (6.3)	448 (5.6)	558 (2.4)	594 (3.5)
France	498 (2.7) ▲	74 (1.6)	395 (6.0)	451 (4.3)	551 (2.1)	586 (2.2)
1 Spain	495 (1.9) ▲	82 (1.3)	382 (4.5)	444 (3.3)	554 (2.0)	592 (2.1)
Luxembourg	494 (2.0) ▲	88 (1.1)	370 (3.7)	436 (3.2)	558 (2.8)	598 (2.8)
Italy	491 (2.6) ▲	75 (2.6)	389 (6.0)	446 (3.6)	543 (2.2)	578 (2.8)
1 Croatia	487 (3.9) ▲	99 (2.4)	349 (9.2)	422 (8.1)	560 (4.0)	603 (3.9)
1 Slovenia	483 (2.3) ▲	82 (1.3)	373 (3.8)	429 (3.4)	543 (2.4)	583 (2.8)
ICILS 2023 average	476 (0.6)	88 (0.4)	357 (1.2)	420 (0.9)	539 (0.6)	582 (0.7)
Malta	475 (2.5)	105 (1.8)	327 (6.4)	405 (5.0)	554 (3.0)	600 (3.6)
Cyprus	460 (2.6) ▽	101 (1.9)	325 (6.1)	391 (4.7)	535 (3.1)	586 (4.3)
Greece	460 (3.3) ▽	91 (1.7)	336 (5.3)	400 (5.1)	526 (3.1)	571 (4.1)
† Uruguay	447 (3.6) ▽	100 (1.8)	310 (7.4)	379 (4.3)	521 (3.6)	572 (4.5)
1 Serbia	443 (3.7) ▽	91 (1.8)	318 (6.9)	381 (5.2)	510 (3.8)	555 (3.0)
3 Bosnia and Herzegovina	440 (3.8) ▽	104 (2.7)	302 (7.8)	369 (6.0)	518 (4.9)	572 (5.3)
†12 Romania	418 (5.3) ▽	103 (2.8)	276 (8.8)	345 (8.2)	495 (4.7)	546 (4.9)
1 Kazakhstan	407 (3.1) ▽	89 (1.6)	293 (4.5)	345 (4.8)	468 (4.9)	527 (5.3)
Oman	379 (3.0) ▽	103 (1.7)	246 (4.6)	310 (3.4)	448 (3.5)	513 (5.6)
1 Kosovo	356 (4.1) ▽	101 (2.1)	224 (7.6)	287 (5.3)	424 (5.9)	489 (6.6)
Azerbaijan	319 (5.1) ▽	100 (3.2)	188 (9.1)	247 (7.0)	387 (5.5)	450 (7.1)
Benchmarking participant						
1 North Rhine-W. (Germany)	485 (4.1) ▲	92 (2.5)	354 (10.4)	427 (6.8)	552 (4.2)	594 (4.1)
Country not meeting sample participation requirements						
‡ United States	482 (6.6)	107 (3.2)	335 (10.9)	407 (9.1)	562 (7.9)	613 (6.5)

▲ Average significantly higher than the ICILS 2023 average.

▽ Average significantly lower than the ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Countries are ranked in descending order of the average CIL scale score.

† Met guidelines for sampling participation rates only after replacement schools were included.

‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

2 Country surveyed target grade in the first half of the school year.

3 National defined population covers 61% of the national target population.

Table C.2: Pairwise comparison of average CIL scores

Country	Average CIL scale score	Korea, Republic of	Czech Republic	Denmark	Chinese Taipei	Belgium (Flemish)	Portugal	Latvia	Finland	Austria	Hungary	Sweden	Norway (Grade 9)	Germany	Slovak Republic	France	Spain	Luxembourg	Italy	Croatia	Slovenia	Malta	Cyprus	Greece	Uruguay	Serbia	Bosnia and Herzegovina	Romania	Kazakhstan	Oman	Kosovo	Azerbaijan	North Rhine-W. (Germany)	United States
† Korea, Republic of	540 (2.5)		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
[1] Czech Republic	525 (2.1)	▽		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
†[1] Denmark	518 (2.7)	▽	▽				▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Chinese Taipei	515 (3.0)	▽	▽							▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
† Belgium (Flemish)	511 (4.4)	▽	▽												▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
[1] Portugal	510 (3.0)	▽	▽	▽											▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
[1] Latvia	509 (3.6)	▽	▽	▽											▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Finland	507 (3.6)	▽	▽	▽												▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
[1] Austria	506 (2.5)	▽	▽	▽	▽											▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Hungary	505 (3.8)	▽	▽	▽	▽												▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
[1] Sweden	504 (3.0)	▽	▽	▽	▽												▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
[1] Norway (Grade 9)	502 (2.9)	▽	▽	▽	▽												▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Germany	502 (3.5)	▽	▽	▽	▽													▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovak Republic	499 (2.7)	▽	▽	▽	▽	▽	▽	▽											▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
France	498 (2.7)	▽	▽	▽	▽	▽	▽	▽	▽	▽										▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
[1] Spain	495 (1.9)	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽							▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Luxembourg	494 (2.0)	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽							▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		
Italy	491 (2.6)	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽						▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		
[1] Croatia	487 (3.9)	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽					▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		
[1] Slovenia	483 (2.3)	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽			▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		
Malta	475 (2.5)	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▽	
Cyprus	460 (2.6)	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽			▲	▲	▲	▲	▲	▲	▲	▲	▽	▽
Greece	460 (3.3)	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽			▲	▲	▲	▲	▲	▲	▲	▲	▽	▽
† Uruguay	447 (3.6)	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽				▲	▲	▲	▲	▲	▽	▽
[1] Serbia	443 (3.7)	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽				▲	▲	▲	▲	▲	▽	▽
[3] Bosnia and Herzegovina	440 (3.8)	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽				▲	▲	▲	▲	▲	▽	▽
†[1,2] Romania	418 (5.3)	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽			▲	▲	▲	▽	▽
[1] Kazakhstan	407 (3.1)	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽			▲	▲	▲	▽	▽
Oman	379 (3.0)	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽		▲	▲	▽	▽
[1] Kosovo	356 (4.1)	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽		▲	▽	▽
Azerbaijan	319 (5.1)	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽		▽	▽
Benchmarking participant																																		
[1] North Rhine-W. (Germany)	485 (4.1)	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽					▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		
Country not meeting sample participation requirements																																		
‡ United States	482 (6.6)	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽						▲	▲	▲	▲	▲	▲	▲	▲	▲	▲		

▲ Achievement significantly higher than in comparison country.

▽ Achievement significantly lower than in comparison country.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Countries are ranked in descending order of the average CIL scale score.

† Met guidelines for sampling participation rates only after replacement schools were included.

‡ Does not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

[2] Country surveyed target grade in the first half of the school year.

[3] National defined population covers 61% of the national target population.

Table C.3: Country averages, standard deviation, and percentiles for CT

Country	Average CT scale score		Standard deviation	Percentile 10	Percentile 25	Percentile 75	Percentile 90
Chinese Taipei	548 (3.9)	▲	110 (2.2)	403 (7.1)	478 (5.7)	626 (4.2)	683 (4.7)
† Korea, Republic of	537 (3.3)	▲	122 (1.9)	375 (5.5)	459 (5.2)	623 (4.8)	687 (5.6)
1 Czech Republic	527 (2.9)	▲	95 (1.9)	407 (4.3)	465 (3.6)	591 (3.8)	647 (3.3)
† Belgium (Flemish)	509 (6.3)	▲	109 (3.2)	363 (10.8)	443 (10.0)	586 (5.6)	642 (6.7)
†1 Denmark	504 (3.5)	▲	112 (2.7)	354 (8.7)	435 (3.9)	582 (4.4)	644 (5.5)
Finland	502 (5.2)	▲	120 (2.9)	344 (10.7)	427 (7.3)	584 (5.0)	649 (4.4)
France	499 (3.9)	▲	103 (2.2)	363 (7.7)	431 (4.8)	572 (4.9)	627 (4.3)
Slovak Republic	498 (3.7)	▲	108 (2.7)	353 (7.4)	433 (5.6)	572 (4.3)	630 (4.6)
1 Latvia	495 (5.2)	▲	111 (2.7)	349 (8.9)	423 (6.7)	571 (6.2)	637 (9.0)
1 Sweden	486 (4.8)		123 (2.5)	324 (7.6)	407 (4.7)	571 (6.2)	643 (5.6)
1 Norway (Grade 9)	485 (3.7)		122 (2.5)	324 (7.1)	407 (4.9)	569 (4.6)	640 (6.1)
1 Portugal	484 (4.0)		95 (2.8)	363 (6.7)	424 (4.3)	548 (4.8)	603 (5.3)
ICILS 2023 average	483 (0.9)		112 (0.5)	336 (1.7)	411 (1.2)	560 (1.0)	623 (1.2)
Italy	482 (3.0)		94 (2.2)	360 (4.6)	424 (4.0)	544 (3.6)	599 (5.2)
Germany	479 (3.8)		111 (2.6)	333 (8.5)	403 (5.1)	556 (5.0)	623 (6.6)
1 Austria	476 (3.9)		107 (2.2)	337 (5.9)	406 (6.2)	549 (4.5)	611 (5.2)
Luxembourg	476 (2.5)	▽	114 (1.6)	326 (5.3)	399 (4.2)	554 (4.0)	622 (5.1)
1 Slovenia	448 (3.2)	▽	106 (1.8)	308 (5.2)	380 (4.2)	520 (5.0)	583 (4.4)
Malta	438 (3.1)	▽	132 (2.2)	258 (8.9)	348 (5.6)	532 (4.4)	603 (5.3)
1 Croatia	429 (4.4)	▽	119 (2.7)	271 (7.9)	352 (7.0)	505 (5.5)	579 (6.4)
1 Serbia	422 (5.1)	▽	115 (2.2)	269 (8.2)	344 (6.9)	499 (4.4)	564 (6.8)
† Uruguay	421 (4.3)	▽	113 (2.3)	272 (8.4)	344 (6.0)	499 (4.3)	565 (6.7)
Benchmarking participant							
1 North Rhine-W. (Germany)	461 (4.1)	▽	111 (2.6)	314 (8.9)	387 (6.7)	538 (4.3)	603 (6.1)
Country not meeting sample participation requirements							
‡ United States	461 (7.1)	▽	123 (3.0)	301 (9.5)	382 (8.2)	545 (8.7)	617 (10.5)

▲ Average significantly higher than the ICILS 2023 average.

▽ Average significantly lower than the ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements. Countries are ranked in descending order of the average CT scale score.

† Met guidelines for sampling participation rates only after replacement schools were included.

‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

Table C.4: Pairwise comparison of average CT scores

Country	Average CT scale score	Chinese Taipei	Korea, Republic of	Czech Republic	Belgium (Flemish)	Denmark	Finland	France	Slovak Republic	Latvia	Sweden	Norway (Grade 9)	Portugal	Italy	Germany	Austria	Luxembourg	Slovenia	Malta	Croatia	Serbia	Uruguay	North Rhine-W. (Germany)	United States
[1] Chinese Taipei	548 (3.9)		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
† Korea, Republic of	537 (3.3)	▽		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Czech Republic	527 (2.9)	▽	▽		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
[1] Belgium (Flemish)	509 (6.3)	▽	▽	▽							▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
[1] Denmark	504 (3.5)	▽	▽	▽							▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
†[1] Finland	502 (5.2)	▽	▽	▽							▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
France	499 (3.9)	▽	▽	▽							▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Slovak Republic	498 (3.7)	▽	▽	▽								▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Latvia	495 (5.2)	▽	▽	▽										▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Sweden	486 (4.8)	▽	▽	▽	▽	▽	▽	▽									▲	▲	▲	▲	▲	▲	▲	▲
† Norway (Grade 9)	485 (3.7)	▽	▽	▽	▽	▽	▽	▽	▽								▲	▲	▲	▲	▲	▲	▲	▲
[1] Portugal	484 (4.0)	▽	▽	▽	▽	▽	▽	▽	▽									▲	▲	▲	▲	▲	▲	▲
Italy	482 (3.0)	▽	▽	▽	▽	▽	▽	▽	▽	▽								▲	▲	▲	▲	▲	▲	▲
Germany	479 (3.8)	▽	▽	▽	▽	▽	▽	▽	▽	▽								▲	▲	▲	▲	▲	▲	▲
[1] Austria	476 (3.9)	▽	▽	▽	▽	▽	▽	▽	▽	▽								▲	▲	▲	▲	▲	▲	
[1] Luxembourg	476 (2.5)	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽						▲	▲	▲	▲	▲	▲	
[1] Slovenia	448 (3.2)	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽		▲	▲	▲	▲	▽	
Malta	438 (3.1)	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽			▲	▲	▽	▽
[1] Croatia	429 (4.4)	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽					▽	▽
[1] Serbia	422 (5.1)	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽				▽	▽
† Uruguay	421 (4.3)	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽				▽	▽
Benchmarking participant																								
[1] North Rhine-W. (Germany)	461 (4.1)	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▲	▲	▲	▲	▲		
Country not meeting sample participation requirements																								
‡ United States	461 (7.1)	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽	▽				▲	▲	▲	▲		

▲ Achievement significantly higher than in comparison country.

▽ Achievement significantly lower than in comparison country.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Countries are ranked in descending order of the average CT scale score.

† Met guidelines for sampling participation rates only after replacement schools were included.

‡ Does not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

Appendix D:

Item maps for selected student questionnaire scales

ICILS 2023 used sets of student and teacher questionnaire items to measure constructs relevant to the learning context for students' acquisition of CIL and CT, and use of ICT for teaching and learning. Typically, this information was obtained using sets of Likert-type items with more than four categories (for example, "strongly agree," "agree," "disagree," and "strongly disagree") or other types of rating scales (for example, "never," "less than once a month," "at least once a month but not every week," "at least once a week but not every school day," and "every school day"). The responses to the items were then recoded so that the scale scores reflected the strength of frequency of the attitudes or perceptions that were measured.

We used the Rasch partial credit model (Masters & Wright, 1997) for scaling and the resulting weighted likelihood estimates (Warm, 1989) were transformed into a metric with a mean of 50 and a standard deviation of 10 for equally weighted ICILS 2023 national samples that met the participation requirements. Further details about the scaling and equating procedures will be provided in the ICILS 2023 technical report (Fraillon et al., forthcoming).

The resulting ICILS 2023 scale scores can be interpreted with regard to the average across countries participating in this study, but they do not reveal the extent to which students endorsed the items used for measurement. However, our application of the Rasch partial credit model allows us to map scale scores to item responses. Thus, it is possible for each scale score to predict the most likely item response for a respondent. For an application of these properties in the previous survey, see Schulz and Friedman (2015) and Schulz and Friedman (2020).

This appendix provides item maps for each questionnaire scale presented in the report. The maps provide a prediction of the minimum coded score (e.g., 0 = "strongly disagree," 1 = "disagree," 2 = "agree," and 3 = "strongly agree") a respondent would obtain on a Likert-type item based on their questionnaire scale score. For example, it can be predicated that students with a certain scale score have a 50 percent probability of at least agreeing (or strongly agreeing) with a particular item (see example item in Figure D.1). For each item, it is possible to determine Thurstonian thresholds; these are the points at which a minimum item score becomes more likely than any lower score, and they determine the boundaries between item categories on the item map.

This information can also be summarized at the scale level by calculating the average thresholds across all of the corresponding scaled items. For example, when using four-point Likert-type scales, this was typically done for the second threshold, making it possible to predict how likely it would be for a respondent with a certain scale score to have (on average across items) responses in the two lower or two upper categories. Using this approach for items measuring agreement made it possible to distinguish between scale scores for the respondents who were most likely to agree or disagree with the average item used for deriving the scale.

Following the figures that present the item map for each scale a table is included. The table shows the percentage of students that selected each of the response options (averaged across countries that met participation requirements) for each statement included in the scale. In addition, in some occasions some statements were part of the question but were excluded from the scale. For these statements we provide the response distribution but note that they were not part of the scale.

In some of the reporting tables with national average scale scores, means are depicted as boxes that indicate their mean values, plus or minus sampling error, as two color graphical displays (see for example

Chapter 7, Table 7.18). If national average scores are represented by the darker shaded area, on average across items students would have had responses in the respective lower item categories (for example, “strongly disagree” or “disagree”). If these scores are represented by the lighter shaded areas, then students’ average item responses would have been in the upper item response categories (for example, “strongly agree” or “agree”).

D.1 Example questionnaire item map

Figure D.1: Example of questionnaire item map

Examples of how to interpret the item-by-score map	
Example 1:	A respondent with score 30 has more than 50% probability to select response option 1 for all four items
Example 2:	A respondent with score 40 has more than 50% probability to choose response option 2 for Items 1, 2, and 4 and response option 1 for Item 3
Example 3:	A respondent with score 50 has more than 50% probability to choose response option 2 for Items 2 and 3 and response option 3 for Item 1 and 4
Example 4:	A respondent with score 60 has more than 50% probability to choose response option 3 for Items 1, 2, and 3 and response option 4 for Item 4
Example 5:	A respondent with score 70 has more than 50% probability to select response option 4 for all four items

D.2 Academic-media multitasking

Figure D.2: Item map for the scale academic-media multitasking

Outside of school, how often do you do the following activities not related to your schoolwork at the same time as doing your schoolwork?

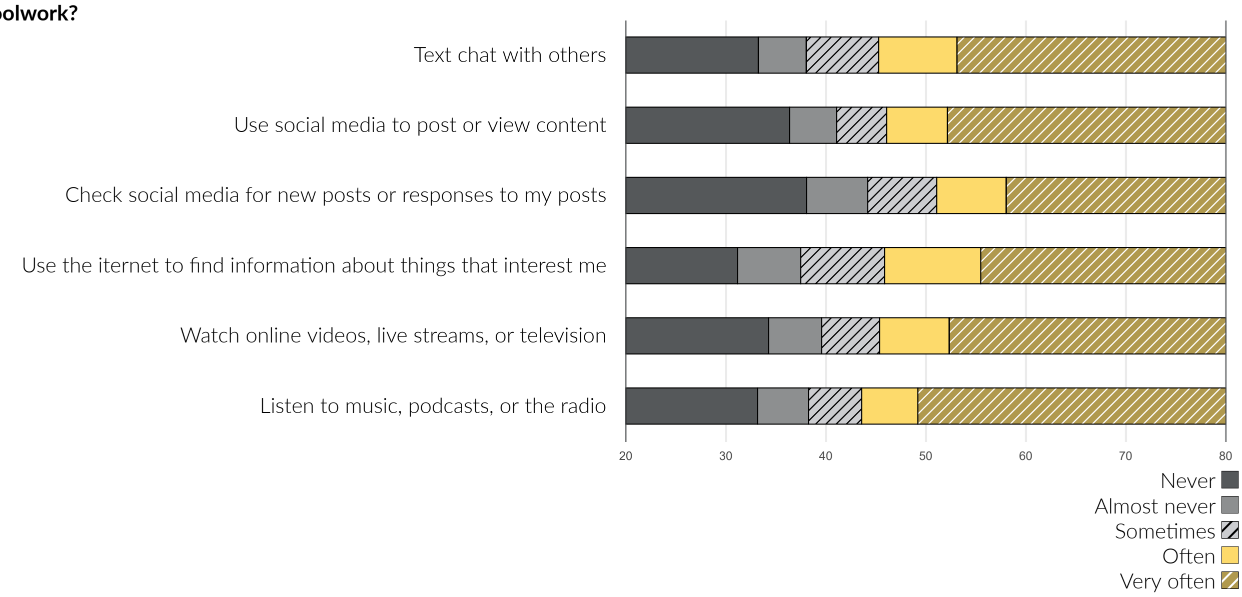

Table D.1: ICILS 2023 average percentage of students selecting each of the response options for statements related to academic-media multitasking

Outside of school, how often do you do the following activities not related to your schoolwork at the same time as doing your schoolwork?	Never	Almost never	Sometimes	Often	Very often
Text chat with others	7	7	22	26	38
Use social media to post or view content	10	10	18	22	40
Check social media for new posts or responses to my posts	15	15	25	21	24
Use the internet to find information about things that interest me	5	8	24	30	32
Watch online videos, live streams, or television	8	9	19	25	40
Listen to music, podcasts, or the radio	6	7	16	21	50

Table D.2: Extent of students academic-media multitasking outside of school

Country	Percentages of students reporting "often" or "very often"											
	Text chat with others		Use social media to post or view content		Check social media for new posts or responses to my posts		Use the internet to find information about things that interest me		Watch online videos, live streams, or television		Listen to music, podcasts, or the radio	
[1] Austria	68 (1.1)	▲	70 (1.0)	▲	36 (1.1)	▽	49 (1.0)	▽	63 (1.0)		71 (1.0)	
Azerbaijan	35 (1.2)	▽	[r]28 (1.4)	▽	[r]30 (1.3)	▽	[r]56 (1.4)	▽	[r]45 (1.5)	▽	[r]55 (1.5)	▽
[†] Belgium (Flemish)	67 (1.0)	▲	66 (0.8)	▲	51 (1.1)	▲	52 (0.9)	▽	65 (1.0)		69 (1.0)	▽
[3] Bosnia and Herzegovina	70 (1.1)	▲	73 (1.3)	▲	53 (1.6)	▲	74 (1.1)	▲	71 (1.2)	▲	74 (1.1)	▲
Chinese Taipei	56 (1.0)	▽	46 (0.9)	▽	40 (0.9)	▽	54 (0.9)	▽	57 (0.9)	▽	71 (0.9)	
[1] Croatia	68 (1.3)	▲	72 (1.0)	▲	51 (1.3)	▲	66 (1.3)	▲	66 (1.2)		71 (1.1)	
Cyprus	76 (0.8)	▲	69 (0.7)	▲	48 (1.0)	▲	71 (0.7)	▲	76 (0.8)	▲	76 (0.9)	▲
[1] Czech Republic	66 (0.7)	▲	71 (0.7)	▲	45 (0.7)		57 (0.7)	▽	72 (0.6)	▲	77 (0.6)	▲
[†1] Denmark	72 (0.8)	▲	64 (1.0)		52 (0.9)	▲	64 (1.0)		68 (1.0)	▲	77 (1.1)	▲
Finland	56 (0.9)	▽	60 (0.9)	▽	44 (0.9)		51 (0.9)	▽	56 (1.1)	▽	67 (0.8)	▽
France	68 (1.0)	▲	64 (0.9)		66 (1.1)	▲	62 (1.0)		65 (0.8)		75 (0.9)	▲
Germany	66 (1.0)		63 (1.1)		33 (1.0)	▽	50 (1.1)	▽	63 (0.9)	▽	68 (1.0)	▽
Greece	79 (0.8)	▲	78 (0.9)	▲	48 (0.9)	▲	73 (0.9)	▲	78 (0.8)	▲	78 (0.7)	▲
Hungary	76 (0.9)	▲	63 (0.9)		34 (1.0)	▽	67 (0.9)	▲	74 (1.1)	▲	74 (0.8)	▲
Italy	64 (1.0)		62 (0.8)		42 (0.9)	▽	67 (1.1)	▲	58 (1.0)	▽	68 (0.9)	▽
[1] Kazakhstan	49 (1.1)	▽	51 (1.2)	▽	33 (0.9)	▽	63 (1.0)		46 (1.0)	▽	56 (1.0)	▽
[†] Korea, Republic of	72 (0.8)	▲	51 (0.8)	▽	43 (0.9)	▽	72 (0.7)	▲	82 (0.7)	▲	75 (0.8)	▲
[1] Kosovo	56 (1.3)	▽	58 (1.0)	▽	40 (1.1)	▽	67 (1.1)	▲	58 (1.2)	▽	69 (1.0)	
[1] Latvia	55 (1.2)	▽	62 (0.9)		42 (1.0)	▽	68 (1.2)	▲	64 (0.9)		73 (0.9)	▲
Luxembourg	67 (0.7)	▲	56 (1.0)	▽	41 (0.8)	▽	56 (0.9)	▽	67 (0.9)	▲	71 (0.6)	
Malta	73 (0.8)	▲	71 (0.8)	▲	59 (0.8)	▲	66 (0.9)	▲	72 (1.0)	▲	75 (0.9)	▲
[1] Norway (Grade 9)	66 (1.0)		67 (0.9)	▲	49 (1.2)	▲	60 (0.8)	▽	62 (0.9)	▽	76 (0.7)	▲
Oman	43 (0.8)	▽	37 (0.8)	▽	35 (0.8)	▽	56 (0.6)	▽	54 (0.7)	▽	42 (0.7)	▽
[1] Portugal	75 (0.9)	▲	65 (1.0)	▲	53 (1.0)	▲	75 (0.9)	▲	76 (0.8)	▲	80 (0.7)	▲
[†12] Romania	68 (1.0)	▲	70 (1.1)	▲	58 (1.3)	▲	72 (1.3)	▲	69 (1.2)	▲	74 (1.2)	▲
[1] Serbia	66 (1.0)		68 (0.9)	▲	43 (1.1)		67 (1.1)	▲	62 (1.0)	▽	71 (1.0)	
Slovak Republic	67 (1.0)	▲	75 (1.0)	▲	54 (1.1)	▲	70 (0.9)	▲	73 (1.0)	▲	78 (0.8)	▲
[1] Slovenia	68 (0.9)	▲	66 (1.0)	▲	39 (1.0)	▽	63 (1.0)		64 (1.0)		71 (1.1)	
[1] Spain	71 (0.6)	▲	65 (0.7)	▲	45 (0.8)		62 (0.6)		58 (0.7)	▽	74 (0.7)	▲
[1] Sweden	58 (1.0)	▽	58 (1.0)	▽	38 (1.0)	▽	54 (1.0)	▽	60 (1.0)	▽	74 (0.9)	▲
[†] Uruguay	64 (1.1)		73 (0.9)	▲	57 (1.1)	▲	66 (1.0)	▲	68 (1.1)	▲	72 (0.9)	
ICILS 2023 average	65 (0.2)		62 (0.2)		45 (0.2)		63 (0.2)		65 (0.2)		71 (0.2)	
Benchmarking participant												
[1] North Rhine-W. (Germany)	66 (1.3)		64 (1.3)		32 (1.1)	▽	51 (1.2)	▽	65 (1.1)		67 (1.1)	▽
Country not meeting sample participation requirements												
[‡] United States	70 (1.1)	▲	64 (1.5)		51 (1.4)	▲	65 (1.2)	▲	75 (1.3)	▲	82 (1.0)	▲

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
[†] Met guidelines for sampling participation rates only after replacement schools were included.
[‡] Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.
[r] indicates data are available for at least 70% but less than 85% of the students.

D.3 Students' use of general ICT applications in class

Figure D.3: Item map for the scale students' use of general ICT applications in class

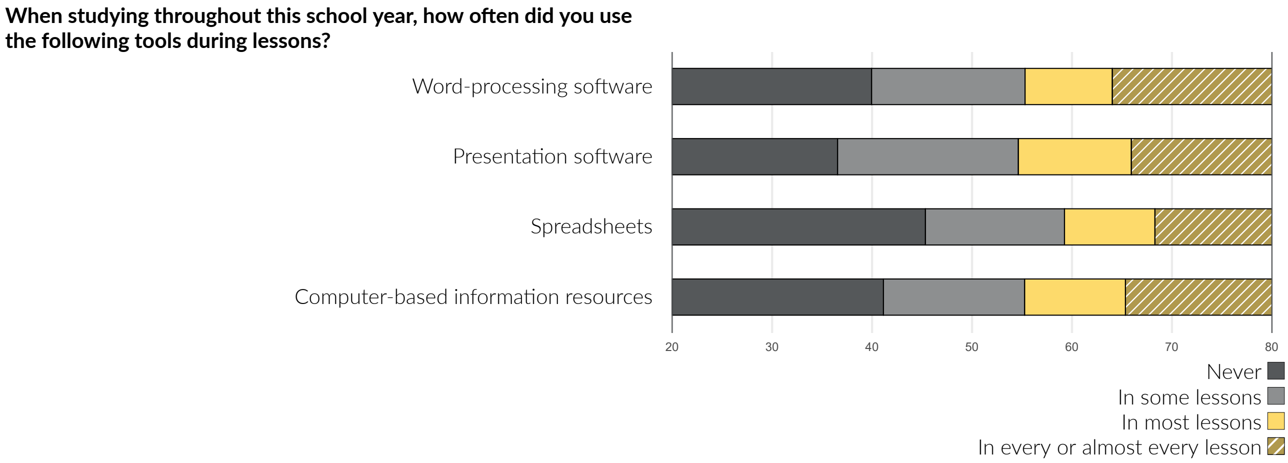

Table D.3: ICILS 2023 average percentage of students selecting each of the response options for statements related to students' use of general ICT applications in class

When studying throughout this school year, how often did you use the following tools during lessons?	Never	In some lessons	In most lessons	In every or almost every lesson
Word-processing software	21	47	22	10
Presentation software	14	51	27	8
Spreadsheets	35	44	16	5
Computer-based information resources	23	44	24	9

Table D.4: Extent of students' use of general ICT applications in class

Country	Percentages of students reported frequency on the use of following tools (in most lessons or in every or almost every lesson)											
	Word-processing software			Presentation software			Spreadsheets			Computer-based information resources		
[1] Austria	28	(1.4)	▽	29	(1.3)	▽	15	(1.0)	▽	12	(0.7)	▽
Azerbaijan	ʳ20	(1.0)	▽	ʳ24	(1.3)	▽	ʳ24	(1.2)	▲	ʳ29	(1.1)	▽
† Belgium (Flemish)	42	(1.4)	▲	32	(1.5)	▽	12	(0.8)	▽	25	(1.2)	▽
[3] Bosnia and Herzegovina	31	(1.6)		38	(1.3)		26	(1.4)	▲	25	(1.4)	▽
Chinese Taipei	9	(0.6)	▽	13	(0.8)	▽	7	(0.5)	▽	17	(0.7)	▽
[1] Croatia	29	(1.5)	▽	39	(1.5)	▲	22	(1.3)		40	(1.5)	▲
Cyprus	25	(1.0)	▽	34	(1.0)		24	(0.8)	▲	29	(1.0)	▽
[1] Czech Republic	16	(0.7)	▽	23	(1.1)	▽	15	(1.1)	▽	33	(1.0)	
†[1] Denmark	81	(0.9)	▲	49	(1.5)	▲	32	(1.4)	▲	45	(1.2)	▲
Finland	42	(1.3)	▲	44	(1.3)	▲	10	(0.8)	▽	42	(1.4)	▲
France	23	(1.1)	▽	23	(1.1)	▽	13	(0.7)	▽	21	(0.9)	▽
Germany	19	(1.1)	▽	22	(1.2)	▽	8	(0.6)	▽	14	(0.9)	▽
Greece	26	(0.9)	▽	29	(1.1)	▽	27	(1.1)	▲	33	(1.0)	
Hungary	28	(1.3)	▽	32	(1.3)	▽	31	(1.2)	▲	27	(1.3)	▽
Italy	18	(1.0)	▽	31	(1.3)	▽	10	(0.7)	▽	29	(1.1)	▽
[1] Kazakhstan	41	(1.2)	▲	44	(1.4)	▲	45	(1.4)	▲	35	(1.1)	▲
† Korea, Republic of	10	(0.7)	▽	17	(1.2)	▽	8	(0.5)	▽	30	(1.2)	▽
[1] Kosovo	35	(1.2)	▲	49	(1.5)	▲	34	(1.2)	▲	ʳ31	(1.1)	
[1] Latvia	33	(1.4)		39	(1.3)	▲	24	(1.1)	▲	30	(1.2)	▽
Luxembourg	32	(1.0)		36	(1.0)		14	(0.6)	▽	26	(0.8)	▽
Malta	31	(1.2)		35	(1.1)		16	(0.9)	▽	26	(0.9)	▽
[1] Norway (Grade 9)	80	(0.9)	▲	86	(0.9)	▲	50	(1.7)	▲	81	(0.8)	▲
Oman	32	(0.7)		40	(0.8)	▲	36	(0.8)	▲	41	(0.7)	▲
[1] Portugal	40	(1.2)	▲	51	(1.2)	▲	16	(0.9)	▽	41	(1.1)	▲
†[12] Romania	29	(1.2)	▽	35	(1.3)		ʳ31	(1.5)	▲	ʳ34	(1.1)	
[1] Serbia	26	(0.9)	▽	37	(1.0)		29	(1.1)	▲	33	(0.9)	
Slovak Republic	31	(1.2)		35	(1.2)		24	(1.0)	▲	36	(1.1)	▲
[1] Slovenia	11	(0.7)	▽	19	(1.1)	▽	8	(0.6)	▽	20	(0.8)	▽
[1] Spain	28	(1.2)	▽	34	(1.1)		14	(0.6)	▽	33	(1.1)	
[1] Sweden	69	(1.4)	▲	37	(1.7)		17	(0.9)	▽	51	(1.5)	▲
† Uruguay	36	(1.4)	▲	32	(1.1)	▽	20	(1.3)		ʳ38	(1.1)	▲
ICILS 2023 average	32	(0.2)		35	(0.2)		21	(0.2)		32	(0.2)	
Benchmarking participant												
[1] North Rhine-W. (Germany)	18	(1.6)	▽	25	(1.7)	▽	7	(0.9)	▽	16	(1.1)	▽
Country not meeting sample participation requirements												
‡ United States	54	(1.9)	▲	47	(1.5)	▲	19	(1.2)		47	(1.7)	▲

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.
ʳ indicates data are available for at least 70% but less than 85% of the students.

D.4 Students' use of specialist ICT applications in class

Figure D.4: Item map for the scale students' use of specialist ICT applications in class

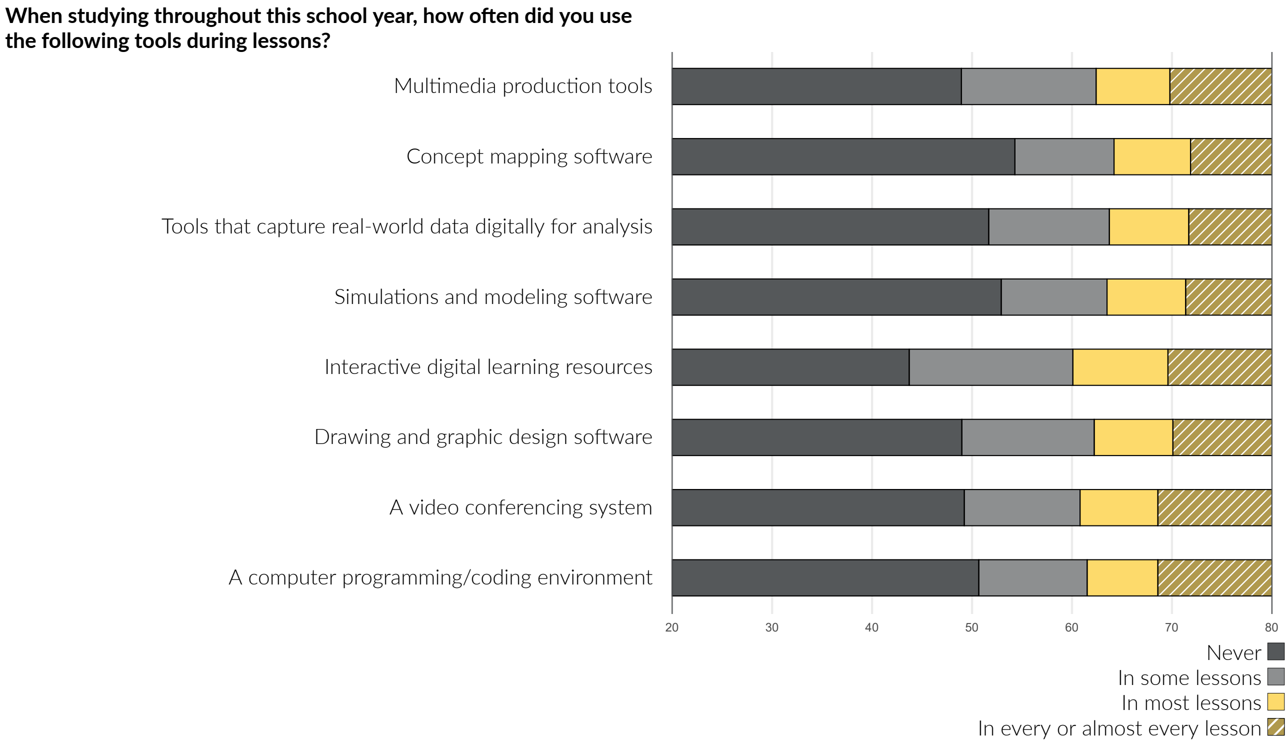

Table D.5: ICILS 2023 average percentage of students selecting each of the response options for statements related to students' use of specialist ICT applications in class

When studying throughout this school year, how often did you use the following tools during lessons?	Never	In some lessons	In most lessons	In every or almost every lesson
Multimedia production tools	47	39	10	4
Concept mapping software	63	27	8	3
Tools that capture real-world data digitally for analysis	55	33	9	3
Simulations and modeling software	58	29	9	3
Interactive digital learning resources	32	47	15	5
Drawing and graphic design software	47	38	11	4
A video conferencing system	47	35	12	5
A computer programming/coding environment	52	33	11	5
A learning management system *	43	32	16	9

Notes: * This statement was not part of the scale.

Table D.6: Extent of students' use of specialist ICT applications in class

Country	**Percentages of students reported frequency on the use of following tools (in most lessons or in every or almost every lesson)**			
	Multimedia production tools	**Concept mapping software**	**Tools that capture real-world data digitally for analysis**	**Simulations and modeling software**
[1] Austria	7 (0.6) ▽	5 (0.5) ▽	5 (0.5) ▽	6 (0.6) ▽
Azerbaijan	[r]26 (1.3) ▲	[s]17 (1.0) ▲	[s]22 (1.0) ▲	[s]20 (1.0) ▲
† Belgium (Flemish)	7 (0.8) ▽	5 (0.5) ▽	6 (0.7) ▽	5 (0.8) ▽
[3] Bosnia and Herzegovina	18 (1.2) ▲	[r]12 (1.0)	12 (1.3)	12 (1.2)
Chinese Taipei	7 (0.5) ▽	4 (0.4) ▽	5 (0.4) ▽	5 (0.4) ▽
[1] Croatia	18 (1.1) ▲	14 (1.0) ▲	16 (1.0) ▲	17 (1.1) ▲
Cyprus	18 (0.9) ▲	12 (0.7) ▲	14 (0.8) ▲	15 (0.8) ▲
[1] Czech Republic	6 (0.4) ▽	5 (0.4) ▽	5 (0.3) ▽	5 (0.4) ▽
†[1] Denmark	8 (0.6) ▽	9 (0.7) ▽	8 (0.7) ▽	6 (0.6) ▽
Finland	7 (0.6) ▽	5 (0.5) ▽	6 (0.6) ▽	8 (0.6) ▽
France	9 (0.7) ▽	5 (0.5) ▽	6 (0.5) ▽	7 (0.6) ▽
Germany	5 (0.4) ▽	3 (0.3) ▽	5 (0.5) ▽	5 (0.5) ▽
Greece	19 (0.8) ▲	12 (0.7)	14 (0.7) ▲	14 (0.7) ▲
Hungary	8 (0.6) ▽	5 (0.5) ▽	7 (0.5) ▽	6 (0.6) ▽
Italy	9 (0.7) ▽	13 (0.9) ▲	7 (0.5) ▽	7 (0.6) ▽
[1] Kazakhstan	27 (1.0) ▲	19 (1.0) ▲	25 (1.0) ▲	22 (0.9) ▲
† Korea, Republic of	8 (0.5) ▽	5 (0.4) ▽	5 (0.4) ▽	5 (0.3) ▽
[1] Kosovo	[r]22 (0.9) ▲	[r]19 (0.9) ▲	[r]27 (1.1) ▲	[r]24 (1.1) ▲
[1] Latvia	13 (0.9)	8 (0.7) ▽	11 (0.7) ▽	9 (0.7) ▽
Luxembourg	11 (0.6) ▽	10 (0.6)	10 (0.6) ▽	9 (0.6) ▽
Malta	19 (0.9) ▲	13 (0.7) ▲	13 (0.9)	15 (0.9) ▲
[1] Norway (Grade 9)	26 (1.1) ▲	24 (1.3) ▲	16 (0.9) ▲	41 (1.7) ▲
Oman	37 (0.8) ▲	28 (0.8) ▲	31 (0.8) ▲	26 (0.8) ▲
[1] Portugal	17 (1.0) ▲	11 (0.7)	14 (0.7) ▲	13 (0.7)
†[12] Romania	25 (1.2) ▲	[r]20 (1.2) ▲	[r]20 (1.1) ▲	[r]20 (1.2) ▲
[1] Serbia	18 (1.0) ▲	13 (0.8) ▲	15 (0.9) ▲	15 (0.8) ▲
Slovak Republic	11 (0.7) ▽	7 (0.6) ▽	10 (0.7) ▽	8 (0.7) ▽
[1] Slovenia	11 (0.8) ▽	6 (0.5) ▽	6 (0.5) ▽	6 (0.5) ▽
[1] Spain	13 (0.6)	10 (0.6)	11 (0.6)	11 (0.5) ▽
[1] Sweden	11 (0.7) ▽	8 (0.7) ▽	11 (0.7)	[r]9 (0.7) ▽
† Uruguay	[r]20 (0.8) ▲	[r]14 (0.7) ▲	[r]16 (1.0) ▲	[r]13 (1.0)
ICILS 2023 average	15 (0.1)	11 (0.1)	12 (0.1)	12 (0.1)
Benchmarking participant				
[1] North Rhine-W. (Germany)	6 (0.6) ▽	4 (0.5) ▽	5 (0.5) ▽	5 (0.6) ▽
Country not meeting sample participation requirements				
‡ United States	15 (1.0)	12 (0.9)	16 (1.3) ▲	15 (1.1) ▲

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.
[r] indicates data are available for at least 70% but less than 85% of the students.
[s] indicates data are available for at least 50% but less than 70% of the students.

Table D.6: Extent of students' use of specialist ICT applications in class (cont'd)

Country	Percentages of students reported frequency on the use of following tools (in most lessons or in every or almost every lesson)				
	Interactive digital learning resources	**Drawing and graphic design software**	**A video conferencing system**	**A computer programming/coding environment**	**A learning management system (*)**
[1] Austria	14 (0.8) ▽	8 (0.6) ▽	13 (0.9) ▽	6 (0.6) ▽	24 (1.4)
Azerbaijan	[r]25 (1.2) ▲	[r]25 (0.9) ▲	[r]23 (1.1) ▲	[r]27 (1.2) ▲	[r]20 (1.1) ▽
[†] Belgium (Flemish)	11 (0.9) ▽	9 (0.8) ▽	20 (1.3)	8 (0.9) ▽	63 (1.5) ▲
[3] Bosnia and Herzegovina	18 (1.1) ▽	21 (1.3) ▲	15 (1.2) ▽	13 (1.0) ▽	12 (1.1) ▽
Chinese Taipei	12 (0.5) ▽	7 (0.5) ▽	19 (0.7)	19 (0.8) ▲	11 (0.7) ▽
[1] Croatia	26 (1.1) ▲	20 (1.0) ▲	27 (1.3) ▲	22 (1.2) ▲	17 (1.3) ▽
Cyprus	20 (0.9)	16 (0.9)	15 (0.8) ▽	14 (0.7) ▽	20 (1.0) ▽
[1] Czech Republic	16 (0.7) ▽	9 (0.4) ▽	10 (0.6) ▽	12 (1.0) ▽	25 (1.2)
[†1] Denmark	10 (0.7) ▽	8 (0.6) ▽	15 (1.3) ▽	5 (0.5) ▽	50 (2.0) ▲
Finland	13 (0.8) ▽	7 (0.6) ▽	8 (0.6) ▽	7 (0.7) ▽	37 (1.8) ▲
France	11 (0.7) ▽	7 (0.5) ▽	5 (0.5) ▽	13 (0.8) ▽	7 (0.7) ▽
Germany	12 (0.7) ▽	7 (0.5) ▽	7 (0.6) ▽	6 (0.4) ▽	12 (1.3) ▽
Greece	22 (0.8)	16 (0.8)	17 (0.9)	16 (0.8)	18 (0.9) ▽
Hungary	19 (1.0)	12 (0.8) ▽	8 (0.7) ▽	9 (0.7) ▽	24 (1.1)
Italy	13 (0.8) ▽	11 (0.8) ▽	12 (0.7) ▽	6 (0.4) ▽	9 (0.7) ▽
[1] Kazakhstan	29 (1.0) ▲	29 (1.0) ▲	22 (0.9) ▲	38 (1.0) ▲	53 (1.1) ▲
[†] Korea, Republic of	14 (0.6) ▽	8 (0.6) ▽	10 (0.6) ▽	12 (0.8) ▽	25 (1.4)
[1] Kosovo	[r]30 (1.1) ▲	[r]31 (1.1) ▲	[r]25 (1.0) ▲	[r]23 (1.0) ▲	[r]21 (0.9) ▽
[1] Latvia	18 (0.8) ▽	13 (0.8) ▽	12 (0.7) ▽	18 (1.1) ▲	9 (1.0) ▽
Luxembourg	14 (0.7) ▽	12 (0.6) ▽	25 (1.0) ▲	11 (0.5) ▽	9 (0.5) ▽
Malta	19 (0.8) ▽	16 (0.9)	28 (1.0) ▲	17 (0.8) ▲	26 (1.0)
[1] Norway (Grade 9)	70 (1.4) ▲	18 (0.9) ▲	45 (2.2) ▲	23 (1.3) ▲	31 (1.6) ▲
Oman	39 (0.8) ▲	35 (0.9) ▲	33 (0.8) ▲	30 (0.9) ▲	31 (1.0) ▲
[1] Portugal	20 (0.9)	17 (0.9) ▲	17 (0.8)	13 (0.8) ▽	16 (1.1) ▽
[†12] Romania	29 (1.1) ▲	25 (1.3) ▲	26 (1.0) ▲	23 (1.1) ▲	20 (1.1) ▽
[1] Serbia	22 (1.0)	20 (0.8) ▲	21 (0.8) ▲	36 (1.2) ▲	15 (1.0) ▽
Slovak Republic	20 (1.0)	13 (0.8) ▽	14 (0.8) ▽	12 (0.9) ▽	39 (1.1) ▲
[1] Slovenia	14 (0.8) ▽	8 (0.6) ▽	9 (0.6) ▽	6 (0.5) ▽	13 (0.8) ▽
[1] Spain	19 (0.9)	14 (0.6)	12 (0.6) ▽	12 (0.6) ▽	39 (1.3) ▲
[1] Sweden	[r]16 (1.0) ▽	11 (0.8) ▽	20 (1.5)	[r]9 (0.7) ▽	25 (1.8)
[†] Uruguay	[r]25 (1.0) ▲	[r]21 (1.0) ▲	[r]15 (0.9) ▽	[r]25 (1.3) ▲	[r]47 (1.8) ▲
ICILS 2023 average	20 (0.2)	15 (0.1)	17 (0.2)	16 (0.2)	25 (0.2)
Benchmarking participant					
[1] North Rhine-W. (Germany)	11 (0.8) ▽	9 (0.8) ▽	10 (0.9) ▽	6 (0.6) ▽	15 (1.6) ▽
Country not meeting sample participation requirements					
[‡] United States	28 (1.3) ▲	21 (1.1) ▲	18 (0.9)	15 (0.9)	30 (2.2) ▲

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. * denotes the item was excluded from the scale estimation.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
2 Country surveyed target grade in the first half of the school year.
3 National defined population covers 61% of the national target population.
r indicates data are available for at least 70% but less than 85% of the students.

D.5 Learning about internet related tasks at school

Figure D.5: Item map for the scale learning about internet related tasks at school

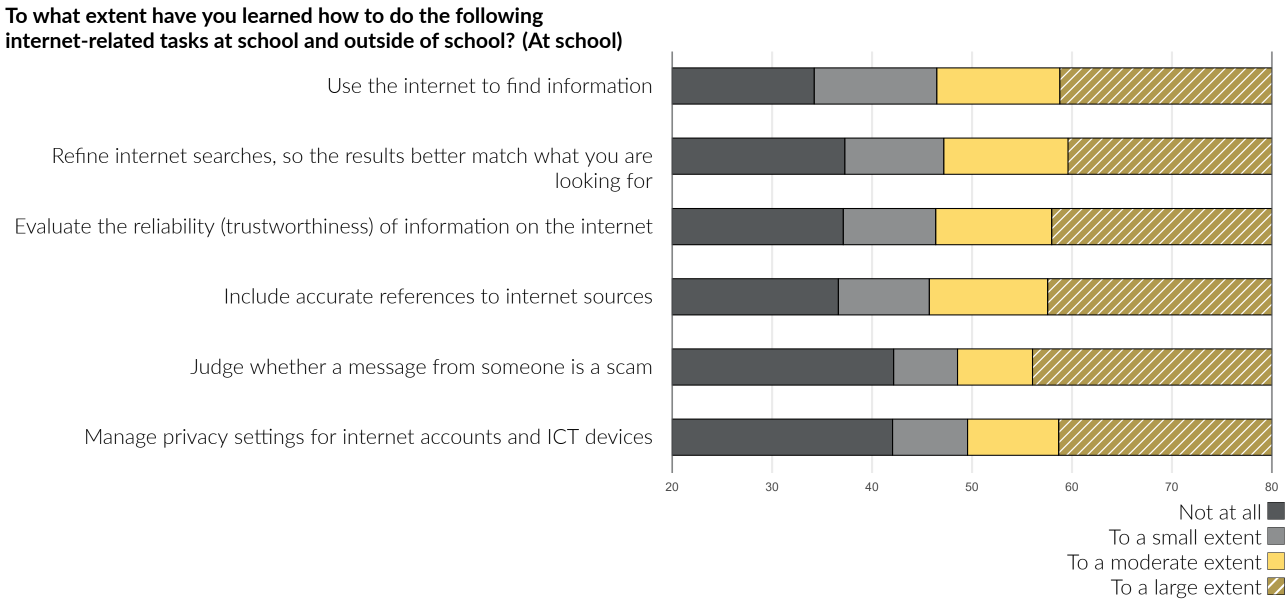

Table D.7: ICILS 2023 average percentage of students selecting each of the response options for statements related to learning about internet related tasks at school

To what extent have you learned how to do the following internet related tasks at school?	Not at all	To a small extent	To a moderate extent	To a large extent
Use the internet to find information	11	27	37	25
Refine internet searches, so the results better match what you are looking for	15	26	37	23
Evaluate the reliability (trustworthiness) of information on the internet	14	23	36	26
Include accurate references to internet sources	13	22	37	27
Judge whether a message from someone is a scam	23	21	26	30
Manage privacy settings for internet accounts and ICT devices	24	24	29	23

Table D.8: Extent of learning about internet related tasks at school

Country	Percentage of students reporting they have learned how to do ICT-related tasks at school (to a moderate extent or to a large extent)					
	Use the internet to find information	Refine internet searches, so the results better match what you are looking for	Evaluate the reliability (trustworthiness) of information on the internet	Include accurate references to internet sources	Judge whether a message from someone is a scam	Manage privacy settings for internet accounts and ICT devices
[1] Austria	56 (1.2) ▽	48 (1.1) ▽	53 (1.1) ▽	58 (1.1) ▽	45 (1.2) ▽	44 (1.2) ▽
Azerbaijan	[r]47 (1.6) ▽	[s]55 (1.5) ▽	[s]56 (1.4) ▽	[s]56 (1.4) ▽	[s]36 (1.7) ▽	[s]45 (1.3) ▽
[†] Belgium (Flemish)	65 (1.1) ▲	58 (1.2)	63 (1.1)	61 (1.0) ▽	55 (1.2)	52 (1.2)
[3] Bosnia and Herzegovina	41 (1.5) ▽	[r]52 (1.8) ▽	[r]47 (1.6) ▽	[r]45 (1.3) ▽	[r]50 (1.6) ▽	[r]46 (1.3) ▽
Chinese Taipei	78 (0.8) ▲	78 (0.7) ▲	82 (0.8) ▲	80 (0.7) ▲	88 (0.6) ▲	74 (0.8) ▲
[1] Croatia	60 (1.0) ▽	62 (1.2)	72 (1.2) ▲	71 (1.0) ▲	66 (1.3) ▲	65 (1.2) ▲
Cyprus	59 (1.0) ▽	59 (1.0)	58 (1.0) ▽	53 (0.9) ▽	59 (1.0) ▲	57 (0.9) ▲
[1] Czech Republic	60 (0.9) ▽	55 (0.8) ▽	56 (0.9) ▽	66 (0.8)	59 (1.0) ▲	54 (0.9) ▲
[†1] Denmark	82 (0.8) ▲	76 (0.9) ▲	84 (0.9) ▲	83 (0.8) ▲	48 (1.1) ▽	37 (1.0) ▽
Finland	74 (0.9) ▲	65 (1.0) ▲	72 (1.0) ▲	70 (1.1) ▲	51 (0.9) ▽	43 (1.1) ▽
France	39 (1.0) ▽	44 (1.1) ▽	44 (1.1) ▽	46 (1.1) ▽	32 (1.0) ▽	[r]27 (1.0) ▽
Germany	52 (1.3) ▽	48 (1.2) ▽	55 (1.2) ▽	66 (1.0)	40 (1.0) ▽	44 (1.3) ▽
Greece	56 (0.9) ▽	57 (1.1) ▽	58 (0.9) ▽	50 (1.1) ▽	64 (1.0) ▲	57 (1.2) ▲
Hungary	56 (1.1) ▽	50 (1.3) ▽	48 (1.2) ▽	53 (1.1) ▽	47 (1.3) ▽	46 (1.1) ▽
Italy	51 (1.5) ▽	55 (1.3) ▽	57 (1.3) ▽	57 (1.2) ▽	48 (1.2) ▽	51 (1.2)
[1] Kazakhstan	73 (0.9) ▲	74 (0.8) ▲	74 (0.8) ▲	72 (0.9) ▲	60 (0.9) ▲	62 (0.9) ▲
[†] Korea, Republic of	62 (1.1)	60 (1.1)	69 (1.2) ▲	84 (0.8) ▲	65 (0.9) ▲	53 (1.1)
[1] Kosovo	[r]58 (1.5) ▽	[r]56 (1.3) ▽	[r]64 (1.1)	[r]71 (1.2) ▲	[r]65 (1.3) ▲	[r]49 (1.3) ▽
[1] Latvia	81 (0.9) ▲	77 (0.9) ▲	69 (1.1) ▲	70 (1.1) ▲	70 (1.1) ▲	67 (1.0) ▲
Luxembourg	62 (0.9)	58 (0.9) ▽	57 (0.9) ▽	63 (0.7) ▽	52 (0.9) ▽	[r]49 (0.9) ▽
Malta	49 (0.9) ▽	[r]47 (0.9) ▽	[r]56 (0.9) ▽	[r]57 (0.7) ▽	[r]56 (0.8)	[r]56 (1.0) ▲
[1] Norway (Grade 9)	89 (0.6) ▲	75 (0.8) ▲	86 (0.7) ▲	81 (0.6) ▲	63 (1.0) ▲	55 (1.0) ▲
Oman	56 (0.7) ▽	58 (0.6) ▽	53 (0.6) ▽	58 (0.7) ▽	[r]49 (0.7) ▽	[r]51 (0.8)
[1] Portugal	74 (1.1) ▲	74 (1.2) ▲	80 (1.0) ▲	82 (0.8) ▲	84 (0.8) ▲	72 (1.2) ▲
[†12] Romania	[r]61 (1.4)	[r]61 (1.3)	[r]61 (1.1)	[r]63 (1.5)	[r]62 (1.3) ▲	[r]61 (1.3) ▲
[1] Serbia	53 (1.1) ▽	55 (1.0) ▽	55 (1.2) ▽	55 (1.1) ▽	54 (1.1) ▽	58 (0.9) ▲
Slovak Republic	63 (1.2)	59 (1.4)	59 (1.2) ▽	66 (1.2)	57 (1.4)	53 (1.3)
[1] Slovenia	34 (1.1) ▽	42 (0.9) ▽	48 (1.1) ▽	61 (1.2) ▽	47 (1.2) ▽	42 (1.1) ▽
[1] Spain	64 (1.2)	55 (1.0) ▽	55 (0.9) ▽	57 (1.0) ▽	49 (0.9) ▽	53 (0.8)
[1] Sweden	84 (0.7) ▲	73 (1.0) ▲	84 (0.7) ▲	82 (0.7) ▲	[r]57 (1.1)	[r]44 (1.1) ▽
[†] Uruguay	81 (1.0) ▲	73 (0.9) ▲	[r]66 (1.1) ▲	[r]65 (1.1)	[r]61 (1.1) ▲	[r]62 (1.0) ▲
ICILS 2023 average	62 (0.2)	60 (0.2)	63 (0.2)	65 (0.2)	56 (0.2)	52 (0.2)
Benchmarking participant						
[1] North Rhine-W. (Germany)	54 (1.3) ▽	51 (1.7) ▽	56 (1.7) ▽	66 (1.6)	42 (1.6) ▽	[r]44 (1.3) ▽
Country not meeting sample participation requirements						
[‡] United States	83 (1.1) ▲	72 (1.0) ▲	71 (1.3) ▲	76 (1.2) ▲	59 (1.5)	55 (1.6)

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
[†] Met guidelines for sampling participation rates only after replacement schools were included.
[‡] Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.
[r] indicates data are available for at least 70% but less than 85% of the students.
[s] indicates data are available for at least 50% but less than 70% of the students.

D.6 Learning about internet related tasks outside of school

Figure D.6: Item map for the scale learning about internet related tasks outside of school

To what extent have you learned how to do the following internet-related tasks at school and outside of school? (Outside of school)

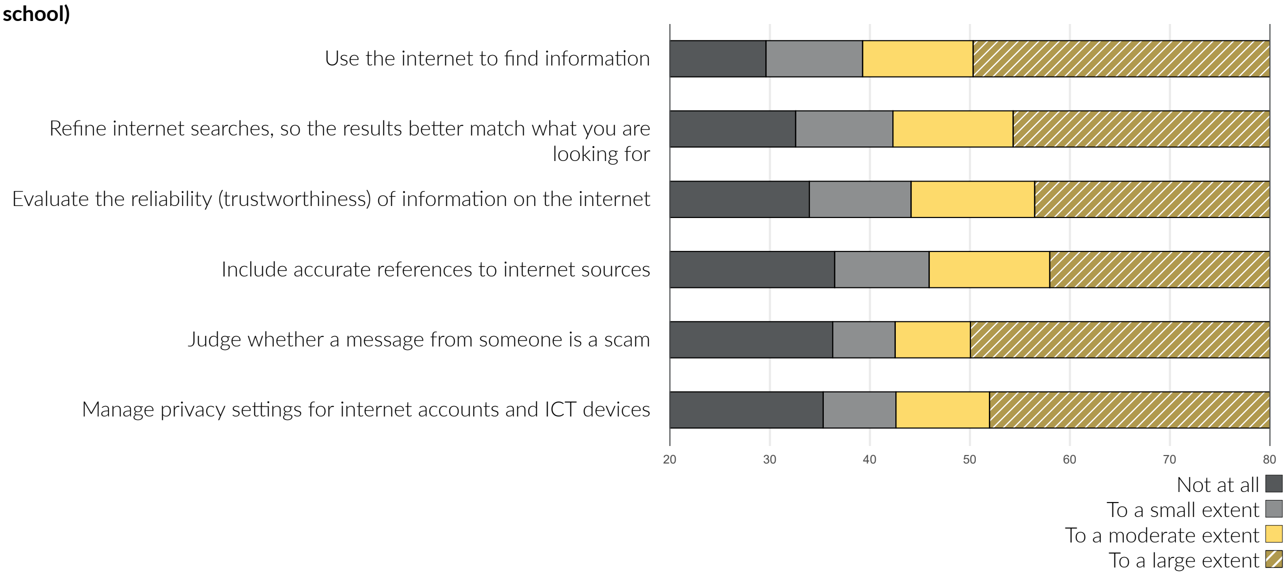

Table D.9: ICILS 2023 average percentage of students selecting each of the response options for statements related to learning about internet related tasks outside of school

To what extent have you learned how to do the following internet related tasks outside of school?	Not at all	To a small extent	To a moderate extent	To a large extent
Use the internet to find information	5	14	34	47
Refine internet searches, so the results better match what you are looking for	8	19	38	36
Evaluate the reliability (trustworthiness) of information on the internet	10	22	38	30
Include accurate references to internet sources	13	24	37	26
Judge whether a message from someone is a scam	11	14	27	47
Manage privacy settings for internet accounts and ICT devices	10	16	32	42

Table D.10: Extent of learning about internet related tasks outside of school

Country	Percentage of students reporting they have learned how to do ICT-related tasks outside of school (to a moderate extent or to a large extent)					
	Use the internet to find information	**Refine internet searches, so the results better match what you are looking for**	**Evaluate the reliability (trustworthiness) of information on the internet**	**Include accurate references to internet sources**	**Judge whether a message from someone is a scam**	**Manage privacy settings for internet accounts and ICT devices**
[1] Austria	77 (0.9) ▽	59 (1.1) ▽	60 (1.2) ▽	47 (1.2) ▽	67 (1.0) ▽	69 (0.9) ▽
Azerbaijan	[r]78 (1.2) ▽	[r]76 (1.1) ▲	[s]71 (1.1) ▲	[s]70 (1.3) ▲	[s]49 (1.4) ▽	[s]58 (1.0) ▽
† Belgium (Flemish)	72 (1.1) ▽	57 (1.2) ▽	54 (1.2) ▽	45 (1.1) ▽	67 (1.1) ▽	69 (1.1) ▽
[3] Bosnia and Herzegovina	80 (1.1)	76 (1.0) ▲	67 (1.4)	[r]62 (1.3)	[r]72 (1.1) ▽	[r]67 (1.4) ▽
Chinese Taipei	81 (0.7)	81 (0.7) ▲	81 (0.7) ▲	78 (0.8) ▲	87 (0.5) ▲	77 (0.8) ▲
[1] Croatia	85 (0.6) ▲	80 (0.9) ▲	76 (0.9) ▲	72 (0.9) ▲	80 (0.9) ▲	80 (0.8) ▲
Cyprus	83 (0.7) ▲	78 (0.7) ▲	72 (0.8) ▲	63 (0.9)	75 (0.9)	76 (0.8) ▲
[1] Czech Republic	86 (0.5) ▲	77 (0.6) ▲	70 (0.7) ▲	72 (0.6) ▲	79 (0.6) ▲	78 (0.5) ▲
†[1] Denmark	80 (0.8)	69 (1.1) ▽	62 (1.0) ▽	47 (1.3) ▽	88 (0.7) ▲	80 (0.9) ▲
Finland	84 (0.6) ▲	77 (0.8) ▲	72 (0.9) ▲	51 (0.9) ▽	84 (0.8) ▲	79 (0.8) ▲
France	78 (0.7) ▽	65 (0.9) ▽	50 (1.0) ▽	44 (1.1) ▽	70 (0.8) ▽	69 (0.7) ▽
Germany	80 (0.9)	65 (1.1) ▽	65 (1.1) ▽	53 (1.2) ▽	69 (1.1) ▽	72 (1.1)
Greece	87 (0.7) ▲	79 (0.8) ▲	72 (0.8) ▲	61 (1.0) ▽	80 (0.8) ▲	78 (1.0) ▲
Hungary	82 (0.9)	75 (0.9)	71 (0.9) ▲	63 (1.0)	79 (0.9) ▲	78 (0.9) ▲
Italy	91 (0.6) ▲	77 (0.9) ▲	70 (0.9) ▲	67 (0.9) ▲	84 (0.7) ▲	87 (0.6) ▲
[1] Kazakhstan	84 (0.7) ▲	83 (0.8) ▲	79 (0.7) ▲	76 (0.8) ▲	67 (0.9) ▽	68 (0.8) ▽
† Korea, Republic of	59 (1.0) ▽	66 (1.0) ▽	60 (1.0) ▽	64 (1.0)	69 (0.9) ▽	60 (1.0) ▽
[1] Kosovo	[r]77 (0.8) ▽	[r]70 (0.9) ▽	[r]69 (0.9)	[r]71 (1.0) ▲	[r]67 (1.0) ▽	[r]61 (1.1) ▽
[1] Latvia	89 (0.7) ▲	86 (0.7) ▲	77 (1.0) ▲	72 (1.1) ▲	79 (1.0) ▲	79 (0.9) ▲
Luxembourg	74 (0.7) ▽	63 (0.8) ▽	58 (0.8) ▽	[r]51 (1.0) ▽	67 (0.9) ▽	68 (0.8) ▽
Malta	81 (0.8)	[r]78 (0.8) ▲	[r]70 (1.1)	[r]69 (1.1) ▲	[r]76 (0.8) ▲	[r]77 (0.9) ▲
[1] Norway (Grade 9)	86 (0.6) ▲	71 (0.9) ▽	77 (0.9) ▲	61 (0.8) ▽	87 (0.8) ▲	74 (0.8)
Oman	71 (0.8) ▽	68 (0.8) ▽	58 (0.8) ▽	62 (0.7)	59 (0.7) ▽	64 (0.8) ▽
[1] Portugal	89 (0.7) ▲	79 (0.9) ▲	76 (0.7) ▲	82 (0.7) ▲	75 (0.9)	88 (0.6) ▲
†[12] Romania	[r]82 (1.3)	[r]79 (1.1) ▲	[r]75 (1.3) ▲	[r]70 (1.3) ▲	[r]78 (1.2) ▲	[r]76 (1.4)
[1] Serbia	86 (0.7) ▲	81 (0.6) ▲	74 (0.9) ▲	69 (1.0) ▲	74 (0.8)	78 (0.9) ▲
Slovak Republic	89 (0.9) ▲	82 (0.9) ▲	72 (0.9) ▲	74 (1.0) ▲	78 (1.0) ▲	76 (1.1)
[1] Slovenia	87 (0.6) ▲	79 (0.8) ▲	71 (0.9) ▲	69 (0.9) ▲	77 (0.8) ▲	79 (0.8) ▲
[1] Spain	79 (0.6) ▽	66 (0.8) ▽	61 (0.8) ▽	59 (0.7) ▽	72 (0.7) ▽	75 (0.6) ▲
[1] Sweden	83 (0.9) ▲	73 (1.0)	[r]68 (1.0)	[r]57 (1.1) ▽	83 (0.8) ▲	[r]71 (0.9) ▽
† Uruguay	77 (0.9) ▽	[r]68 (0.9) ▽	[r]64 (1.1) ▽	[r]56 (1.0) ▽	[r]74 (1.0)	[r]76 (1.0) ▲
ICILS 2023 average	81 (0.1)	73 (0.2)	68 (0.2)	63 (0.2)	74 (0.2)	74 (0.2)
Benchmarking participant						
[1] North Rhine-W. (Germany)	80 (1.1)	66 (1.3) ▽	68 (1.1)	52 (1.6) ▽	69 (1.1) ▽	75 (0.9)
Country not meeting sample participation requirements						
‡ United States	71 (1.3) ▽	65 (1.2) ▽	61 (1.4) ▽	59 (1.5) ▽	78 (1.3) ▲	73 (1.5)

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.
[r] indicates data are available for at least 70% but less than 85% of the students.
[s] indicates data are available for at least 50% but less than 70% of the students.

D.7 Learning about safe and responsible ICT use at school

Figure D.7: Item map for the scale learning about safe and responsible ICT use at school

To what extent have you learned about the following topics at school?

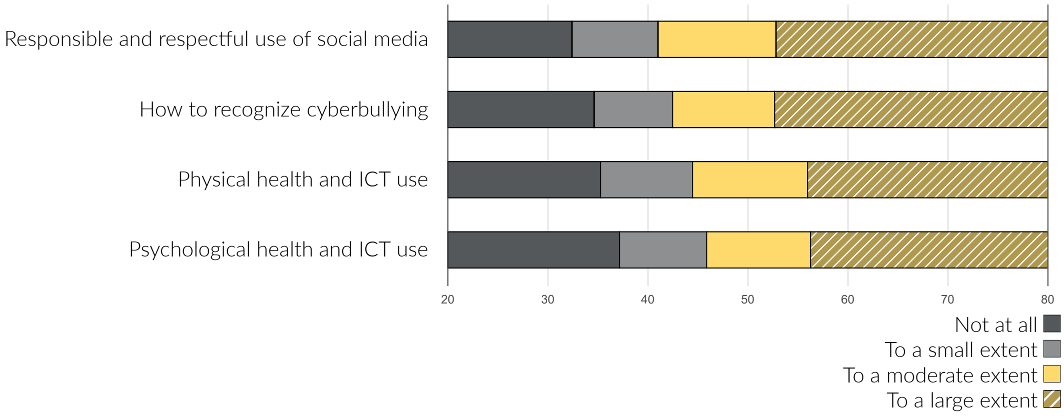

Table D.11: ICILS 2023 average percentage of students selecting each of the response options for statements related to learning about safe and responsible ICT use at school

To what extent have you learned about the following topics at school?	Not at all	To a small extent	To a moderate extent	To a large extent
Responsible and respectful use of social media	6	15	38	41
How to recognize cyberbullying	9	17	34	41
Physical health and ICT use	10	21	37	31
Psychological health and ICT use	13	23	34	30
How to report cyberbullying *	12	21	32	35

Notes: * This statement was not part of the scale.

Table D.12: Extent of students learning about safe and responsible ICT use at school

Country	Percentage of students reporting they have learned how to do ICT-related tasks at school (to a moderate extent or to a large extent)				
	Responsible and respectful use of social media	**How to recognize cyberbullying**	**Physical health and ICT use**	**Psychological health and ICT use**	**How to report cyberbullying (*)**
[1] Austria	77 (1.1)	68 (1.4) ▽	60 (1.2) ▽	54 (1.3) ▽	58 (1.6) ▽
Azerbaijan	82 (1.0) ▲	[r] 54 (1.4) ▽	[r] 76 (0.9) ▲	[r] 71 (1.0) ▲	[r] 52 (1.2) ▽
† Belgium (Flemish)	82 (0.9) ▲	76 (1.1)	67 (1.1)	54 (1.1) ▽	68 (1.2)
[3] Bosnia and Herzegovina	72 (1.4) ▽	78 (1.3) ▲	73 (1.2) ▲	71 (1.2) ▲	73 (1.2) ▲
Chinese Taipei	95 (0.4) ▲	97 (0.3) ▲	89 (0.6) ▲	89 (0.6) ▲	87 (0.6) ▲
[1] Croatia	85 (0.8) ▲	85 (0.8) ▲	76 (0.8) ▲	71 (1.0) ▲	77 (1.0) ▲
Cyprus	79 (1.0)	77 (0.8) ▲	70 (0.9)	66 (0.9)	67 (0.9)
[1] Czech Republic	71 (0.7) ▽	77 (0.8) ▲	64 (0.8) ▽	60 (0.9) ▽	71 (0.9) ▲
†[1] Denmark	80 (1.0)	63 (1.1) ▽	57 (1.1) ▽	52 (1.3) ▽	66 (1.3)
Finland	82 (0.8) ▲	79 (0.8) ▲	74 (0.8) ▲	72 (0.9) ▲	67 (1.1)
France	64 (1.1) ▽	69 (0.9) ▽	52 (1.1) ▽	47 (0.9) ▽	63 (1.0) ▽
Germany	76 (1.1) ▽	67 (1.4) ▽	56 (1.1) ▽	48 (1.1) ▽	55 (1.4) ▽
Greece	84 (0.7) ▲	82 (0.9) ▲	75 (1.0) ▲	71 (1.0) ▲	68 (1.1)
Hungary	69 (1.3) ▽	66 (1.5) ▽	54 (1.0) ▽	50 (1.2) ▽	54 (1.6) ▽
Italy	87 (0.8) ▲	91 (0.8) ▲	76 (0.9) ▲	72 (1.1) ▲	82 (1.2) ▲
[1] Kazakhstan	89 (0.6) ▲	70 (1.1) ▽	83 (0.8) ▲	79 (0.7) ▲	67 (1.1)
† Korea, Republic of	86 (0.8) ▲	95 (0.5) ▲	76 (0.8) ▲	77 (0.7) ▲	92 (0.5) ▲
[1] Kosovo	84 (0.7) ▲	68 (1.0) ▽	83 (0.8) ▲	72 (0.9) ▲	64 (1.1) ▽
[1] Latvia	82 (1.1) ▲	67 (1.4) ▽	75 (1.2) ▲	67 (1.3) ▲	61 (1.4) ▽
Luxembourg	75 (0.8) ▽	72 (0.7) ▽	63 (0.7) ▽	59 (0.8) ▽	65 (0.8) ▽
Malta	87 (0.7) ▲	85 (0.6) ▲	71 (0.9) ▲	65 (1.0)	76 (0.7) ▲
[1] Norway (Grade 9)	81 (0.8) ▲	78 (0.8) ▲	67 (1.1)	67 (1.1) ▲	63 (1.0) ▽
Oman	82 (0.6) ▲	71 (0.7) ▽	74 (0.7) ▲	68 (0.7) ▲	68 (0.8)
[1] Portugal	45 (1.4) ▽	44 (1.3) ▽	44 (1.2) ▽	41 (1.3) ▽	40 (1.4) ▽
†[1][2] Romania	78 (1.3)	73 (1.2)	73 (1.2) ▲	68 (1.3) ▲	66 (1.3)
[1] Serbia	74 (1.0) ▽	77 (1.0) ▲	70 (1.0)	65 (1.2)	73 (1.2) ▲
Slovak Republic	76 (1.0) ▽	78 (0.9) ▲	66 (1.1) ▽	63 (1.1)	69 (1.1) ▲
[1] Slovenia	71 (1.0) ▽	75 (0.9)	59 (1.0) ▽	58 (1.1) ▽	61 (1.2) ▽
[1] Spain	77 (0.8)	75 (0.9)	71 (0.8) ▲	67 (0.8) ▲	63 (1.1) ▽
[1] Sweden	76 (0.9) ▽	73 (1.1)	65 (1.1) ▽	65 (1.0)	57 (1.3) ▽
† Uruguay	81 (0.9) ▲	84 (0.9) ▲	74 (1.0) ▲	69 (1.1) ▲	74 (1.2) ▲
ICILS 2023 average	78 (0.2)	75 (0.2)	69 (0.2)	64 (0.2)	67 (0.2)
Benchmarking participant					
[1] North Rhine-W. (Germany)	76 (1.2) ▽	69 (1.5) ▽	56 (1.2) ▽	48 (1.2) ▽	57 (1.8) ▽
Country not meeting sample participation requirements					
‡ United States	87 (1.0) ▲	82 (1.5) ▲	72 (1.7) ▲	67 (1.7)	76 (1.5) ▲

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. * denotes the item was excluded from the scale estimation.

† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.
[r] indicates data are available for at least 70% but less than 85% of the students.

D.8 ICT self-efficacy regarding the use of general applications

Figure D.8: Item map for the scale ICT self-efficacy regarding the use of general applications

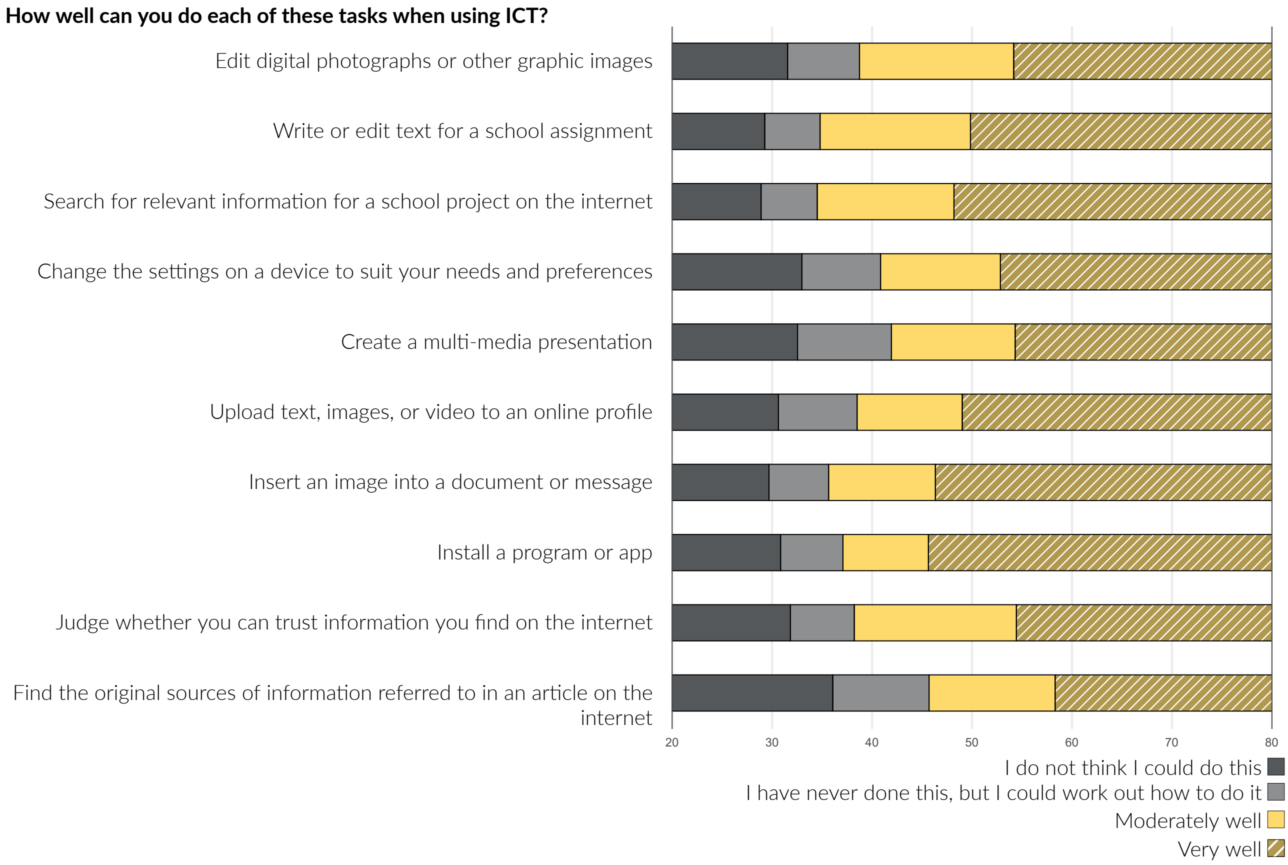

Table D.13: ICILS 2023 average percentage of students selecting each of the response options for statements related to ICT self-efficacy regarding the use of general applications

How well can you do each of these tasks when using ICT?	I do not think I could do this	I have never done this, but I could work out how to do	Moderately well	Very well
Edit digital photographs or other graphic images	5	12	47	36
Write or edit text for a school assignment	3	6	42	49
Search for relevant information for a school project on the internet	3	6	37	54
Change the settings on a device to suit your needs and preferences	6	15	39	39
Create a multi-media presentation	6	18	40	35
Upload text, images, or video to an online profile	4	11	33	51
Insert an image into a document or message	3	7	31	60
Install a program or app	4	8	27	62
Judge whether you can trust information you find on the internet	5	11	49	36
Find the original sources of information referred to in an article on the internet	11	25	39	24

Table D.14: Student's reported ICT self-efficacy regarding the use of general applications

Country	Percentages of students' self-report on how well can do the following tasks (moderately well or very well)									
	Edit digital photographs or other graphic images		Write or edit text for a school assignment		Search for relevant information for a school project on the internet		Change the settings on a device to suit your needs and preferences		Create a multi-media presentation	
[1] Austria	86 (0.7)	▲	94 (0.6)	▲	94 (0.6)	▲	80 (0.8)		68 (1.1)	▽
Azerbaijan	[r]80 (1.0)	▽	[r]82 (1.0)	▽	[r]79 (0.8)	▽	[s]72 (1.1)	▽	[s]73 (1.3)	
† Belgium (Flemish)	82 (0.9)		92 (0.6)	▲	94 (0.6)	▲	78 (1.1)		69 (1.1)	▽
[3] Bosnia and Herzegovina	88 (1.0)	▲	90 (0.8)		90 (1.0)		[r]81 (1.1)	▲	78 (1.6)	
Chinese Taipei	85 (0.5)	▲	89 (0.5)	▽	91 (0.5)		84 (0.6)	▲	82 (0.7)	▲
[1] Croatia	90 (0.9)	▲	92 (0.7)		91 (0.8)		88 (0.9)	▲	86 (1.0)	▲
Cyprus	87 (0.8)	▲	90 (0.6)	▽	89 (0.8)	▽	84 (0.9)	▲	82 (0.7)	▲
[1] Czech Republic	79 (0.6)	▽	86 (0.5)	▽	92 (0.4)		75 (0.6)	▽	68 (0.7)	▽
†[1] Denmark	75 (0.9)	▽	96 (0.4)	▲	96 (0.4)	▲	68 (1.1)	▽	71 (1.3)	▽
Finland	81 (0.7)	▽	95 (0.5)	▲	96 (0.5)	▲	83 (0.7)	▲	68 (0.9)	▽
France	83 (0.7)		94 (0.5)	▲	95 (0.4)	▲	78 (0.8)		79 (0.9)	▲
Germany	87 (0.8)	▲	94 (0.6)	▲	94 (0.5)	▲	83 (0.7)	▲	69 (1.3)	▽
Greece	91 (0.6)	▲	91 (0.6)		90 (0.6)		82 (0.7)	▲	79 (1.0)	▲
Hungary	92 (0.6)	▲	94 (0.6)	▲	95 (0.5)	▲	81 (0.9)	▲	67 (1.2)	▽
Italy	85 (0.9)	▲	92 (0.6)		95 (0.5)	▲	82 (0.8)	▲	84 (0.8)	▲
[1] Kazakhstan	79 (0.9)	▽	86 (0.7)	▽	89 (0.7)	▽	75 (0.9)	▽	72 (0.9)	▽
† Korea, Republic of	74 (0.8)	▽	86 (0.9)	▽	91 (0.6)		71 (0.9)	▽	75 (0.9)	
[1] Kosovo	84 (0.8)		87 (0.7)	▽	[r]84 (1.0)	▽	[r]70 (1.0)	▽	[r]72 (1.1)	▽
[1] Latvia	83 (1.0)		85 (0.9)	▽	91 (0.6)		84 (1.0)	▲	79 (1.0)	▲
Luxembourg	80 (0.6)	▽	90 (0.5)		91 (0.4)		79 (0.6)		75 (0.8)	
Malta	76 (1.1)	▽	90 (0.6)		89 (0.6)	▽	[r]84 (0.7)	▲	79 (0.9)	▲
[1] Norway (Grade 9)	79 (0.8)	▽	93 (0.5)	▲	94 (0.5)	▲	80 (0.8)		77 (1.0)	
Oman	83 (0.6)		88 (0.4)	▽	85 (0.6)	▽	78 (0.8)		79 (0.6)	▲
[1] Portugal	85 (0.8)	▲	95 (0.5)	▲	93 (0.5)	▲	79 (0.7)		79 (0.9)	▲
†[1,2] Romania	83 (0.9)		88 (0.8)	▽	[r]89 (0.9)	▽	[r]79 (0.9)		77 (1.1)	
[1] Serbia	86 (0.7)	▲	88 (0.7)	▽	87 (0.7)	▽	80 (0.9)		78 (0.8)	▲
Slovak Republic	83 (0.9)		93 (0.6)	▲	94 (0.5)	▲	73 (1.0)	▽	66 (1.1)	▽
[1] Slovenia	85 (0.7)	▲	93 (0.5)	▲	94 (0.5)	▲	84 (0.7)	▲	69 (1.1)	▽
[1] Spain	80 (0.5)	▽	94 (0.3)	▲	94 (0.3)	▲	71 (0.7)	▽	83 (0.7)	▲
[1] Sweden	81 (0.8)		95 (0.5)	▲	94 (0.6)	▲	[r]80 (0.9)		[r]70 (1.0)	▽
† Uruguay	82 (0.9)		93 (0.5)	▲	93 (0.7)	▲	[r]70 (1.2)	▽	[r]83 (0.8)	▲
ICILS 2023 average	83 (0.1)		91 (0.1)		91 (0.1)		79 (0.2)		75 (0.2)	
Benchmarking participant										
[1] North Rhine-W. (Germany)	88 (0.6)	▲	93 (0.6)	▲	94 (0.8)	▲	82 (1.2)	▲	74 (1.1)	
Country not meeting sample participation requirements										
‡ United States	72 (1.2)	▽	89 (0.9)		88 (1.1)	▽	83 (1.2)	▲	73 (1.5)	

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.
[r] indicates data are available for at least 70% but less than 85% of the students.
[s] indicates data are available for at least 50% but less than 70% of the students.

Table D.14: Student's reported ICT self-efficacy regarding the use of general applications (cont'd)

Country	Percentages of students' self-report on how well can do the following tasks (moderately well or very well)				
	Upload text, images, or video to an online profile	**Insert an image into a document or message**	**Install a program or app**	**Judge whether you can trust information you find on the internet**	**Find the original sources of information referred to in an article on the internet**
[1] Austria	85 (0.8)	94 (0.5) ▲	92 (0.6) ▲	80 (0.8) ▽	58 (1.1) ▽
Azerbaijan	[s]80 (1.0) ▽	[r]80 (1.1) ▽	[r]72 (1.1) ▽	[r]73 (1.5) ▽	[r]56 (1.4) ▽
† Belgium (Flemish)	84 (0.9)	95 (0.6) ▲	91 (0.8) ▲	84 (0.9)	56 (1.1) ▽
[3] Bosnia and Herzegovina	86 (1.2)	90 (1.0)	91 (0.8) ▲	84 (1.1)	68 (1.6) ▲
Chinese Taipei	91 (0.5) ▲	90 (0.6)	93 (0.4) ▲	90 (0.5) ▲	67 (0.9) ▲
[1] Croatia	89 (0.8) ▲	92 (0.8) ▲	90 (0.9)	89 (1.0) ▲	78 (1.1) ▲
Cyprus	84 (0.7)	87 (0.7) ▽	85 (0.8) ▽	86 (0.7) ▲	68 (0.9) ▲
[1] Czech Republic	81 (0.6) ▽	93 (0.4) ▲	91 (0.5) ▲	86 (0.5) ▲	60 (0.8) ▽
†[1] Denmark	89 (0.7) ▲	97 (0.4) ▲	92 (0.6) ▲	91 (0.7) ▲	72 (0.8) ▲
Finland	81 (1.1) ▽	90 (0.6)	90 (0.6) ▲	93 (0.5) ▲	66 (1.1) ▲
France	87 (0.5) ▲	93 (0.6) ▲	91 (0.6) ▲	82 (0.7) ▽	64 (0.9)
Germany	82 (0.8) ▽	92 (0.6) ▲	92 (0.5) ▲	82 (0.7) ▽	57 (1.1) ▽
Greece	84 (0.8)	87 (0.7) ▽	89 (0.7)	87 (0.6) ▲	67 (1.0) ▲
Hungary	85 (0.8)	95 (0.4) ▲	93 (0.6) ▲	87 (0.7) ▲	63 (1.0)
Italy	86 (0.6)	94 (0.5) ▲	93 (0.5) ▲	89 (0.5) ▲	61 (0.9) ▽
[1] Kazakhstan	83 (0.8) ▽	84 (0.7) ▽	79 (0.9) ▽	80 (0.8) ▽	68 (1.0) ▲
† Korea, Republic of	86 (0.6)	87 (0.7) ▽	88 (0.6)	82 (0.8) ▽	54 (1.0) ▽
[1] Kosovo	[r]80 (0.9) ▽	[r]81 (0.9) ▽	[r]84 (0.9) ▽	[r]75 (1.0) ▽	[r]62 (1.2)
[1] Latvia	88 (0.7) ▲	91 (0.7)	91 (0.8) ▲	85 (0.8)	67 (1.2) ▲
Luxembourg	82 (0.6) ▽	90 (0.5)	86 (0.6) ▽	80 (0.7) ▽	58 (0.9) ▽
Malta	89 (0.7) ▲	90 (0.7)	87 (0.7)	84 (0.8)	61 (1.1) ▽
[1] Norway (Grade 9)	85 (0.6)	94 (0.5) ▲	89 (0.7)	92 (0.6) ▲	49 (1.2) ▽
Oman	80 (0.6) ▽	81 (0.6) ▽	83 (0.6) ▽	74 (0.6) ▽	66 (0.7) ▲
[1] Portugal	89 (0.6) ▲	94 (0.5) ▲	90 (0.7) ▲	87 (0.7) ▲	69 (0.8) ▲
†[12] Romania	[r]84 (0.9)	86 (1.0) ▽	[r]85 (1.1) ▽	80 (1.0) ▽	69 (1.1) ▲
[1] Serbia	85 (0.8)	87 (0.7) ▽	87 (0.7)	81 (0.9) ▽	74 (1.0) ▲
Slovak Republic	83 (0.8) ▽	93 (0.5) ▲	89 (0.6)	85 (0.8)	61 (1.0) ▽
[1] Slovenia	86 (0.7)	93 (0.5) ▲	89 (0.5)	88 (0.6) ▲	72 (0.9) ▲
[1] Spain	84 (0.5)	92 (0.4) ▲	86 (0.6) ▽	76 (0.7) ▽	58 (0.8) ▽
[1] Sweden	[r]83 (0.8) ▽	94 (0.5) ▲	87 (0.7)	[r]92 (0.6) ▲	[r]61 (1.0) ▽
† Uruguay	[r]86 (0.9)	[r]89 (0.8)	86 (0.8) ▽	[r]81 (1.0) ▽	[r]63 (1.1)
ICILS 2023 average	85 (0.1)	90 (0.1)	88 (0.1)	84 (0.1)	63 (0.2)
Benchmarking participant					
[1] North Rhine-W. (Germany)	86 (0.9)	91 (0.8)	91 (0.8) ▲	82 (0.8) ▽	57 (1.3) ▽
Country not meeting sample participation requirements					
‡ United States	87 (1.0) ▲	90 (0.9)	80 (1.3) ▽	85 (1.3)	59 (1.3) ▽

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.
[r] indicates data are available for at least 70% but less than 85% of the students.
[s] indicates data are available for at least 50% but less than 70% of the students.

D.9 Students' perceptions of ICT - learning with and use of ICT

Figure D.9: Item map for the scale students' perceptions of ICT - learning with and use of ICT

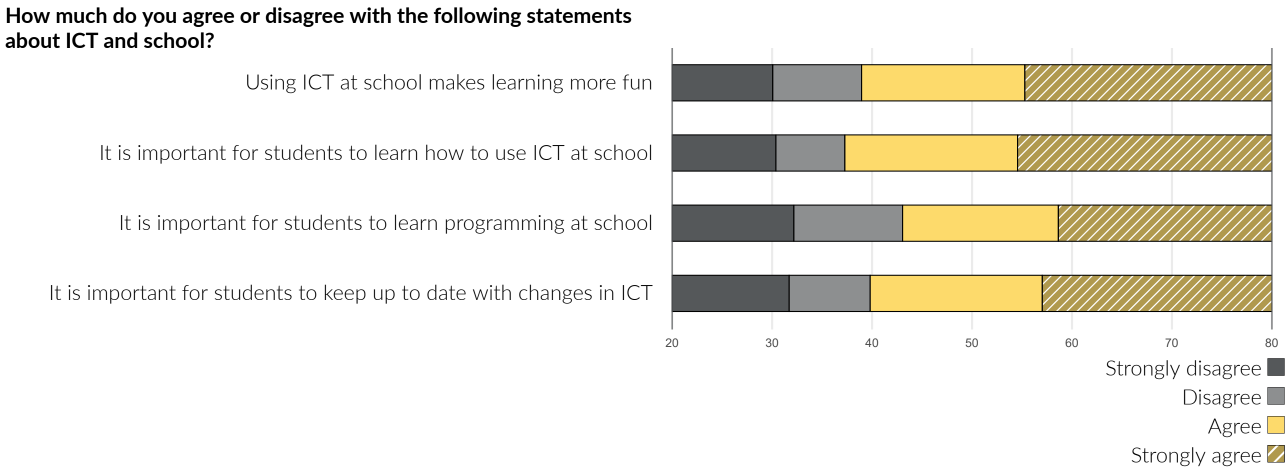

Table D.15: ICILS 2023 average percentage of students selecting each of the response options for statements related to students' perceptions of ICT - learning with and use of ICT

How much do you agree or disagree with the following statements about ICT and school?	Strongly disagree	Disagree	Agree	Strongly agree
Using ICT at school makes learning more fun	3	13	50	33
It is important for students to learn how to use ICT at school	3	10	51	36
It is important for students to learn programming at school	6	22	48	24
It is important for students to keep up to date with changes in ICT	5	14	53	29
I learn better when I use ICT in my lessons at school than when I do not use ICT in my lessons *	6	23	45	26

Notes: * This statement was not part of the scale.

Table D.16: Students' agreement with perceptions of their learning with and use of ICT

Country	Percentages of students' agreement with the following statements (agree or strongly agree)				
	Using ICT at school makes learning more fun	It is important for students to learn how to use ICT at school	It is important for students to learn programming at school	It is important for students to keep up to date with changes in ICT	I learn better when I use ICT in my lessons at school than when I do not use ICT in my lessons (*)
[1] Austria	83 (0.8)	88 (0.8)	56 (1.1) ▽	81 (0.8)	65 (1.1) ▽
Azerbaijan	[r]81 (0.8) ▽	[r]81 (1.0) ▽	[r]79 (1.2) ▲	[s]77 (1.0) ▽	[r]76 (1.0) ▲
[†] Belgium (Flemish)	83 (1.1)	91 (0.8) ▲	64 (1.2) ▽	86 (0.9) ▲	62 (1.1) ▽
[3] Bosnia and Herzegovina	78 (1.3) ▽	[r]84 (1.0) ▽	80 (1.1) ▲	80 (1.2)	65 (1.7) ▽
Chinese Taipei	89 (0.5) ▲	86 (0.5)	77 (0.7) ▲	87 (0.5) ▲	68 (0.9) ▽
[1] Croatia	81 (0.9) ▽	85 (0.8) ▽	71 (1.0)	78 (0.9) ▽	72 (1.1)
Cyprus	83 (0.8)	[r]86 (0.9)	[r]82 (0.8) ▲	[r]82 (0.8)	76 (0.9) ▲
[1] Czech Republic	87 (0.4) ▲	90 (0.5) ▲	69 (0.7) ▽	83 (0.6) ▲	76 (0.5) ▲
[†1] Denmark	78 (1.0) ▽	89 (0.6) ▲	59 (1.2) ▽	85 (0.7) ▲	78 (0.9) ▲
Finland	82 (0.7) ▽	86 (0.6)	59 (0.8) ▽	80 (0.7) ▽	64 (1.0) ▽
France	84 (0.7)	[r]85 (0.7) ▽	[r]75 (0.9) ▲	[r]80 (0.8) ▽	66 (1.0) ▽
Germany	89 (0.8) ▲	90 (0.8) ▲	59 (1.1) ▽	84 (0.9) ▲	74 (1.1) ▲
Greece	85 (0.9) ▲	88 (0.6)	81 (0.7) ▲	82 (0.8)	76 (1.0) ▲
Hungary	83 (0.9)	86 (0.8)	61 (1.1) ▽	76 (0.9) ▽	67 (1.1) ▽
Italy	90 (0.5) ▲	93 (0.5) ▲	82 (0.9) ▲	87 (0.7) ▲	66 (0.9) ▽
[1] Kazakhstan	84 (0.7)	87 (0.6)	87 (0.8) ▲	84 (0.7) ▲	78 (0.7) ▲
[†] Korea, Republic of	85 (0.7) ▲	89 (0.6) ▲	84 (0.7) ▲	90 (0.5) ▲	65 (0.9) ▽
[1] Kosovo	[r]86 (0.8) ▲	[r]88 (0.8) ▲	[r]86 (0.8) ▲	[r]84 (0.8) ▲	85 (0.8) ▲
[1] Latvia	81 (0.9) ▽	87 (0.7)	69 (1.1) ▽	70 (1.1) ▽	68 (1.2) ▽
Luxembourg	80 (0.7) ▽	[r]85 (0.7) ▽	[r]69 (0.9) ▽	[r]80 (0.6)	63 (0.9) ▽
Malta	81 (0.9) ▽	84 (0.8) ▽	63 (0.9) ▽	[r]80 (0.8)	74 (1.0) ▲
[1] Norway (Grade 9)	79 (0.8) ▽	89 (0.6) ▲	59 (0.9) ▽	83 (0.6) ▲	74 (0.9) ▲
Oman	80 (0.6) ▽	81 (0.7) ▽	77 (0.7) ▲	75 (0.7) ▽	83 (0.6) ▲
[1] Portugal	89 (0.7) ▲	94 (0.5) ▲	88 (0.7) ▲	93 (0.6) ▲	78 (0.9) ▲
[†12] Romania	87 (0.8) ▲	[r]87 (0.9)	[r]84 (1.0) ▲	[r]84 (0.9) ▲	85 (0.9) ▲
[1] Serbia	76 (0.8) ▽	82 (1.0) ▽	71 (1.0)	76 (0.9) ▽	63 (1.3) ▽
Slovak Republic	83 (0.8)	88 (0.6) ▲	76 (0.9) ▲	78 (0.8) ▽	69 (0.9) ▽
[1] Slovenia	83 (0.7)	80 (0.8) ▽	66 (0.8) ▽	74 (1.0) ▽	60 (1.0) ▽
[1] Spain	88 (0.5) ▲	89 (0.5) ▲	82 (0.5) ▲	[r]80 (0.8) ▽	75 (0.8) ▲
[1] Sweden	[r]82 (1.0)	[r]90 (0.7) ▲	[r]65 (1.3) ▽	[r]82 (0.8)	[r]78 (1.2) ▲
[†] Uruguay	[r]81 (1.0) ▽	[r]87 (0.8)	[r]81 (0.9) ▲	[r]80 (0.9)	[r]71 (1.1)
ICILS 2023 average	83 (0.1)	87 (0.1)	73 (0.2)	81 (0.1)	71 (0.2)
Benchmarking participant					
[1] North Rhine-W. (Germany)	89 (0.7) ▲	91 (0.7) ▲	62 (1.8) ▽	[r]82 (1.0)	77 (1.1) ▲
Country not meeting sample participation requirements					
[‡] United States	[r]76 (1.5) ▽	[r]85 (1.1)	[r]66 (1.2) ▽	[r]76 (1.5) ▽	[r]73 (1.4)

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. * denotes the item was excluded from the scale estimation.
[†] Met guidelines for sampling participation rates only after replacement schools were included.
[‡] Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.
[r] indicates data are available for at least 70% but less than 85% of the students.
[s] indicates data are available for at least 50% but less than 70% of the students.

D.10 Students' perceptions of ICT - expectations for future use of ICT

Figure D.10: Item map for the scale students' perceptions of ICT - expectations for future use of ICT

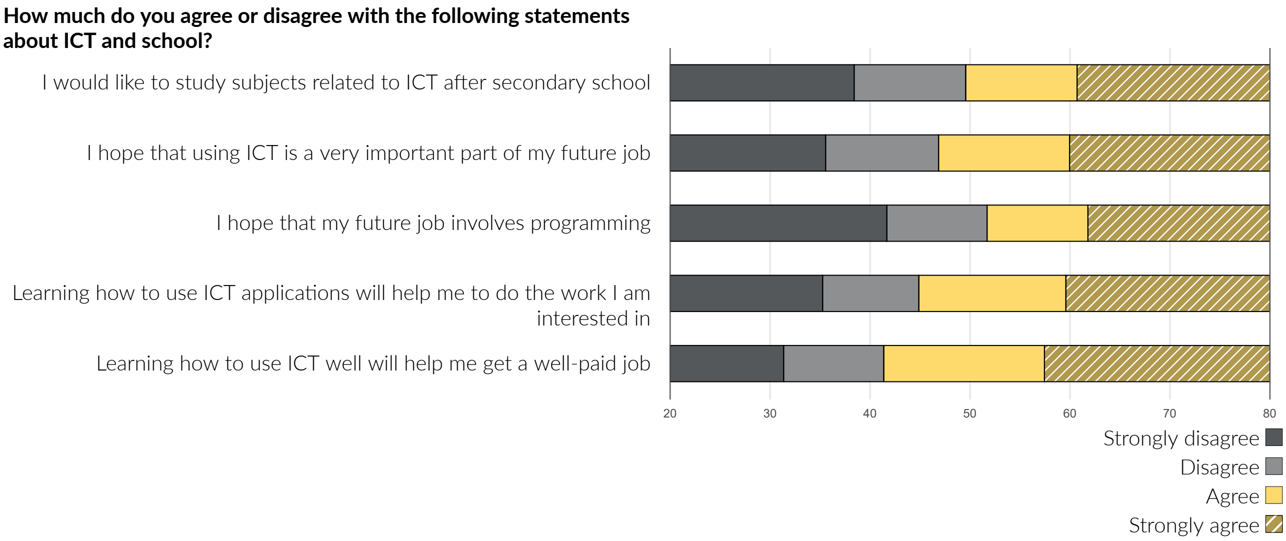

Table D.17: ICILS 2023 average percentage of students selecting each of the response options for statements related to students' perceptions of ICT - expectations for future use of ICT

How much do you agree or disagree with the following statements about ICT and school?	Strongly disagree	Disagree	Agree	Strongly agree
I would like to study subjects related to ICT after secondary school	15	34	34	17
I hope that using ICT is a very important part of my future job	10	30	41	19
I hope that my future job involves programming	23	34	29	15
Learning how to use ICT applications will help me to do the work I am interested in	9	24	46	21
Learning how to use ICT well will help me get a well-paid job	5	18	51	26

Table D.18: Students' agreement with perceptions of expectations for future use of ICT

Country	Percentages of students' agreement with the following statements (agree or strongly agree)				
	I would like to study subjects related to ICT after secondary school	I hope that using ICT is a very important part of my future job	I hope that my future job involves programming	Learning how to use ICT applications will help me to do the work I am interested in	Learning how to use ICT well will help me get a well-paid job
[1] Austria	33 (1.2) ▽	50 (1.1) ▽	32 (1.2) ▽	58 (1.2) ▽	74 (0.9) ▽
Azerbaijan	[r]73 (1.0) ▲	[s]76 (1.1) ▲	[r]71 (1.2) ▲	[r]80 (1.1) ▲	[r]79 (1.1)
[†] Belgium (Flemish)	36 (1.3) ▽	46 (1.5) ▽	31 (1.4) ▽	54 (1.3) ▽	71 (1.1) ▽
[3] Bosnia and Herzegovina	61 (1.7) ▲	69 (1.6) ▲	58 (1.5) ▲	72 (1.1) ▲	79 (1.0) ▲
Chinese Taipei	49 (1.0) ▽	68 (0.8) ▲	46 (1.0) ▲	81 (0.6) ▲	81 (0.6) ▲
[1] Croatia	55 (1.2) ▲	64 (0.9) ▲	51 (1.2) ▲	69 (1.1) ▲	78 (0.8)
Cyprus	56 (1.3) ▲	[r]65 (0.9) ▲	[r]50 (1.2) ▲	[r]70 (0.9) ▲	[r]78 (0.9)
[1] Czech Republic	42 (0.8) ▽	51 (0.7) ▽	31 (0.7) ▽	63 (0.6) ▽	81 (0.6) ▲
[†1] Denmark	33 (1.0) ▽	46 (1.1) ▽	22 (1.0) ▽	55 (1.0) ▽	78 (0.9)
Finland	42 (1.0) ▽	47 (0.9) ▽	29 (1.0) ▽	51 (0.8) ▽	71 (0.9) ▽
France	59 (1.2) ▲	[r]58 (0.9) ▽	[r]40 (1.1) ▽	[r]62 (0.9) ▽	[r]56 (1.0) ▽
Germany	32 (1.1) ▽	57 (1.0) ▽	31 (1.1) ▽	46 (1.1) ▽	79 (1.0) ▲
Greece	48 (1.0) ▽	66 (1.0) ▲	44 (1.1)	68 (1.0)	78 (0.8)
Hungary	46 (1.1) ▽	55 (1.1) ▽	37 (1.0) ▽	67 (0.9)	75 (0.9) ▽
Italy	61 (0.9) ▲	70 (0.9) ▲	44 (0.9)	66 (0.9)	77 (0.8)
[1] Kazakhstan	65 (0.9) ▲	68 (0.8) ▲	61 (1.0) ▲	79 (0.8) ▲	83 (0.7) ▲
[†] Korea, Republic of	50 (0.9)	61 (1.1)	33 (1.0) ▽	66 (0.9)	87 (0.6) ▲
[1] Kosovo	[r]73 (1.1) ▲	[r]81 (0.9) ▲	[r]74 (1.0) ▲	[r]82 (0.9) ▲	[r]81 (0.7) ▲
[1] Latvia	48 (1.2) ▽	58 (1.3)	36 (1.2) ▽	66 (1.3)	79 (1.0) ▲
Luxembourg	[r]46 (1.0) ▽	[r]54 (1.1) ▽	[r]40 (0.8) ▽	[r]56 (0.9) ▽	[r]68 (0.9) ▽
Malta	49 (1.1) ▽	55 (1.0) ▽	[r]39 (1.0) ▽	[r]64 (1.0) ▽	75 (0.9) ▽
[1] Norway (Grade 9)	45 (1.1) ▽	51 (1.1) ▽	31 (0.9) ▽	64 (0.9) ▽	78 (0.7)
Oman	69 (0.7) ▲	72 (0.7) ▲	62 (0.8) ▲	78 (0.6) ▲	78 (0.7)
[1] Portugal	58 (1.1) ▲	69 (0.9) ▲	50 (1.2) ▲	72 (0.9) ▲	82 (0.8) ▲
[†12] Romania	[r]73 (1.1) ▲	[r]72 (1.0) ▲	65 (1.2) ▲	[r]75 (1.0) ▲	[r]82 (0.8) ▲
[1] Serbia	50 (1.1)	61 (1.0)	48 (1.2) ▲	63 (1.0) ▽	74 (0.9) ▽
Slovak Republic	42 (1.0) ▽	56 (1.0) ▽	36 (1.0) ▽	70 (0.9) ▲	81 (0.8) ▲
[1] Slovenia	45 (1.0) ▽	51 (1.0) ▽	41 (1.1) ▽	69 (0.8) ▲	66 (0.9) ▽
[1] Spain	62 (0.7) ▲	63 (0.7) ▲	52 (0.8) ▲	71 (0.7) ▲	80 (0.7) ▲
[1] Sweden	[r]46 (1.3) ▽	[r]56 (1.3) ▽	[r]34 (1.1) ▽	[r]68 (1.1)	[r]82 (0.8) ▲
[†] Uruguay	[r]51 (1.1)	[r]62 (1.2)	[r]43 (1.2)	[r]68 (0.9)	[r]73 (0.9) ▽
ICILS 2023 average	51 (0.2)	60 (0.2)	43 (0.2)	67 (0.2)	77 (0.2)
Benchmarking participant					
[1] North Rhine-W. (Germany)	36 (1.6) ▽	59 (1.7)	35 (1.3) ▽	46 (1.4) ▽	78 (1.1)
Country not meeting sample participation requirements					
[‡] United States	[r]50 (1.2)	[r]54 (1.5) ▽	[r]37 (1.5) ▽	[r]68 (1.4)	[r]76 (1.3)

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
[†] Met guidelines for sampling participation rates only after replacement schools were included.
[‡] Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.
[r] indicates data are available for at least 70% but less than 85% of the students.
[s] indicates data are available for at least 50% but less than 70% of the students.

D.11 Students' perceptions of ICT - positive beliefs about ICT and society

Figure D.11: Item map for the scale students' perceptions of ICT - positive beliefs about ICT and society

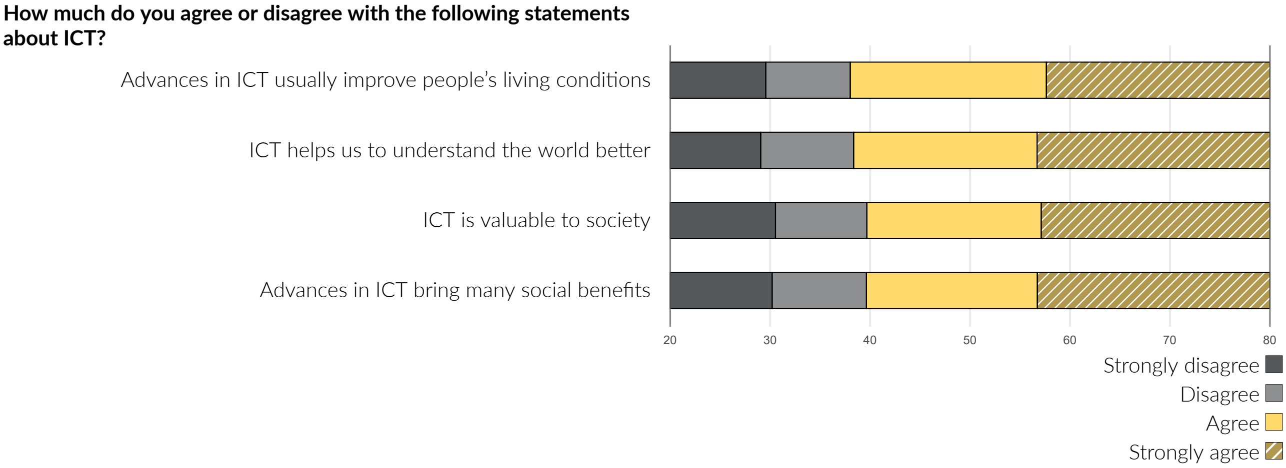

Table D.19: ICILS 2023 average percentage of students selecting each of the response options for statements related to students' perceptions of ICT - positive beliefs about ICT and society

How much do you agree or disagree with the following statements about ICT?	Strongly disagree	Disagree	Agree	Strongly agree
Advances in ICT usually improve people's living conditions	3	12	58	27
ICT helps us to understand the world better	3	13	55	29
ICT is valuable to society	3	15	54	28
Advances in ICT bring many social benefits	3	15	53	29

Table D.20: Students' agreement with perceptions of positive beliefs about ICT and society

Country	Percentages of students' agreement with the following statements (agree or strongly agree)			
	Advances in ICT usually improve people's living conditions	ICT helps us to understand the world better	ICT is valuable to society	Advances in ICT bring many social benefits
[1] Austria	82 (0.8) ▽	78 (0.8) ▽	69 (1.1) ▽	74 (0.8) ▽
Azerbaijan	[r]86 (0.7)	[r]87 (0.8) ▲	[r]83 (0.8)	[r]80 (1.0) ▽
[†] Belgium (Flemish)	84 (0.9)	80 (0.8) ▽	79 (0.9) ▽	75 (0.9) ▽
[3] Bosnia and Herzegovina	88 (1.0) ▲	85 (1.0)	65 (1.4) ▽	79 (0.9) ▽
Chinese Taipei	96 (0.3) ▲	96 (0.3) ▲	96 (0.3) ▲	96 (0.3) ▲
[1] Croatia	81 (1.3) ▽	83 (0.8)	72 (1.2) ▽	80 (1.0) ▽
Cyprus	88 (0.5) ▲	80 (0.7) ▽	84 (0.8) ▲	82 (0.7)
[1] Czech Republic	76 (0.6) ▽	80 (0.6) ▽	80 (0.5) ▽	83 (0.5)
[†1] Denmark	85 (0.6)	90 (0.7) ▲	90 (0.7) ▲	75 (1.0) ▽
Finland	82 (0.7) ▽	91 (0.5) ▲	88 (0.6) ▲	89 (0.6) ▲
France	82 (0.8) ▽	80 (0.7) ▽	82 (0.8)	85 (0.8) ▲
Germany	84 (0.7)	82 (0.7) ▽	74 (1.0) ▽	77 (0.8) ▽
Greece	89 (0.7) ▲	80 (0.8) ▽	83 (0.8)	83 (0.8)
Hungary	77 (0.8) ▽	80 (0.9) ▽	86 (0.7) ▲	84 (0.7) ▲
Italy	87 (0.5) ▲	85 (0.7)	87 (0.6) ▲	83 (0.8)
[1] Kazakhstan	91 (0.5) ▲	90 (0.6) ▲	87 (0.6) ▲	88 (0.6) ▲
[†] Korea, Republic of	96 (0.4) ▲	95 (0.4) ▲	95 (0.5) ▲	90 (0.6) ▲
[1] Kosovo	92 (0.5) ▲	89 (0.7) ▲	[r]79 (0.9) ▽	[r]85 (0.8) ▲
[1] Latvia	87 (0.9)	88 (0.7) ▲	84 (0.8) ▲	81 (0.9)
Luxembourg	77 (0.8) ▽	78 (0.7) ▽	78 (0.8) ▽	77 (0.7) ▽
Malta	83 (0.8) ▽	80 (0.8) ▽	85 (0.7) ▲	81 (0.7)
[1] Norway (Grade 9)	84 (0.8)	86 (0.6) ▲	87 (0.6) ▲	80 (0.9)
Oman	85 (0.5)	83 (0.6) ▽	81 (0.6) ▽	79 (0.6) ▽
[1] Portugal	91 (0.6) ▲	88 (0.8) ▲	92 (0.5) ▲	86 (0.6) ▲
[†12] Romania	89 (0.8) ▲	82 (1.0) ▽	[r]85 (0.9) ▲	83 (1.0)
[1] Serbia	83 (0.8) ▽	76 (0.8) ▽	61 (1.0) ▽	75 (0.8) ▽
Slovak Republic	81 (0.9) ▽	88 (0.7) ▲	89 (0.7) ▲	83 (0.8)
[1] Slovenia	81 (0.9) ▽	83 (0.7) ▽	64 (0.9) ▽	77 (1.0) ▽
[1] Spain	89 (0.5) ▲	87 (0.4) ▲	86 (0.6) ▲	85 (0.5) ▲
[1] Sweden	[r]87 (0.8)	[r]89 (0.6) ▲	[r]89 (0.7) ▲	[r]90 (0.7) ▲
[†] Uruguay	87 (0.7)	[r]82 (0.8) ▽	[r]84 (1.0)	[r]79 (0.8) ▽
ICILS 2023 average	85 (0.1)	85 (0.1)	82 (0.1)	82 (0.1)
Benchmarking participant				
[1] North Rhine-W. (Germany)	82 (0.7) ▽	79 (1.7) ▽	75 (1.1) ▽	77 (1.2) ▽
Country not meeting sample participation requirements				
[‡] United States	80 (1.1) ▽	86 (0.9)	[r]86 (1.2) ▲	[r]78 (1.1) ▽

▲ Percentage significantly higher than ICILS 2023 average.

▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.

[†] Met guidelines for sampling participation rates only after replacement schools were included.

[‡] Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

[2] Country surveyed target grade in the first half of the school year.

[3] National defined population covers 61% of the national target population.

[r] indicates data are available for at least 70% but less than 85% of the students.

D.12 Students' perceptions of ICT - negative beliefs about ICT and society

Figure D.12: Item map for the scale students' perceptions of ICT - negative beliefs about ICT and society

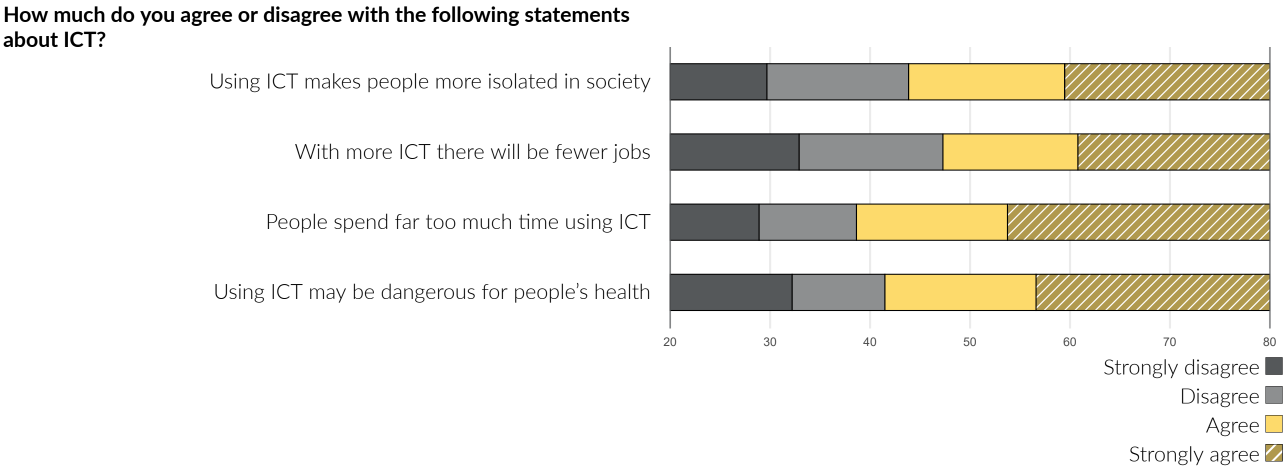

Table D.21: ICILS 2023 average percentage of students selecting each of the response options for statements related to students' perceptions of ICT - negative beliefs about ICT and society

How much do you agree or disagree with the following statements about ICT?	Strongly disagree	Disagree	Agree	Strongly agree
Using ICT makes people more isolated in society	5	26	47	23
With more ICT there will be fewer jobs	8	33	40	19
People spend far too much time using ICT	3	14	45	38
Using ICT may be dangerous for people's health	6	18	47	30

Table D.22: Students' agreement with perceptions of negative beliefs about ICT and society

Country	Percentages of students' agreement with the following statements (agree or strongly agree)							
	Using ICT makes people more isolated in society		With more ICT there will be fewer jobs		People spend far too much time using ICT		Using ICT may be dangerous for people's health	
[1] Austria	70 (1.0)		52 (1.1)	▽	87 (0.7)	▲	78 (0.7)	▲
Azerbaijan	[r]74 (1.3)	▲	[r]58 (1.2)		[r]75 (1.1)	▽	[r]62 (1.2)	▽
† Belgium (Flemish)	72 (1.0)	▲	50 (1.2)	▽	77 (1.0)	▽	75 (1.1)	
[3] Bosnia and Herzegovina	76 (1.3)	▲	67 (1.2)	▲	85 (1.3)		76 (1.5)	
Chinese Taipei	67 (0.9)	▽	65 (1.0)	▲	90 (0.5)	▲	88 (0.5)	▲
[1] Croatia	77 (0.8)	▲	69 (1.1)	▲	83 (0.8)		81 (0.8)	▲
Cyprus	70 (1.0)		63 (1.0)	▲	80 (0.8)	▽	77 (1.1)	
[1] Czech Republic	76 (0.6)	▲	63 (0.7)	▲	88 (0.5)	▲	79 (0.7)	▲
†[1] Denmark	71 (1.0)		66 (1.0)	▲	71 (1.1)	▽	68 (1.0)	▽
Finland	71 (0.8)	▲	53 (0.9)	▽	79 (0.9)	▽	72 (0.9)	▽
France	71 (0.9)	▲	59 (0.9)		87 (0.7)	▲	80 (0.8)	▲
Germany	68 (0.9)		51 (1.0)	▽	87 (0.9)	▲	74 (1.0)	▽
Greece	71 (0.8)	▲	65 (0.9)	▲	86 (0.7)	▲	80 (0.6)	▲
Hungary	42 (1.0)	▽	47 (1.1)	▽	86 (0.7)	▲	82 (0.8)	▲
Italy	65 (0.8)	▽	54 (1.1)	▽	85 (0.7)	▲	75 (0.9)	
[1] Kazakhstan	67 (0.8)	▽	61 (1.0)	▲	82 (0.8)		73 (0.8)	▽
† Korea, Republic of	64 (1.0)	▽	65 (1.0)	▲	94 (0.5)	▲	92 (0.5)	▲
[1] Kosovo	69 (0.9)		[r]60 (1.0)		[r]79 (0.9)	▽	[r]65 (1.1)	▽
[1] Latvia	72 (0.9)	▲	60 (1.2)		84 (0.8)		76 (0.9)	
Luxembourg	71 (0.8)		60 (0.9)		85 (0.6)	▲	79 (0.7)	▲
Malta	65 (0.9)	▽	49 (0.9)	▽	73 (0.8)	▽	72 (1.0)	▽
[1] Norway (Grade 9)	68 (0.9)		51 (1.0)	▽	75 (0.8)	▽	64 (0.8)	▽
Oman	57 (0.8)	▽	54 (0.8)	▽	76 (0.6)	▽	66 (0.7)	▽
[1] Portugal	64 (1.0)	▽	48 (1.1)	▽	83 (0.7)		77 (0.9)	
†[12] Romania	64 (1.1)	▽	67 (0.9)	▲	75 (1.0)	▽	[r]71 (0.9)	▽
[1] Serbia	72 (1.2)	▲	65 (1.0)	▲	83 (1.0)		75 (1.0)	
Slovak Republic	78 (0.9)	▲	63 (1.0)	▲	88 (0.6)	▲	83 (0.8)	▲
[1] Slovenia	76 (0.8)	▲	60 (1.0)		84 (0.6)		77 (0.7)	
[1] Spain	69 (0.7)		60 (0.7)		87 (0.5)	▲	80 (0.5)	▲
[1] Sweden	[r]79 (0.9)	▲	[r]69 (0.8)	▲	[r]82 (0.8)		[r]86 (0.8)	▲
† Uruguay	[r]66 (1.0)	▽	[r]62 (1.3)	▲	[r]87 (0.8)	▲	[r]76 (0.8)	
ICILS 2023 average	69 (0.2)		59 (0.2)		83 (0.1)		76 (0.2)	
Benchmarking participant								
[1] North Rhine-W. (Germany)	66 (1.1)	▽	51 (1.3)	▽	85 (1.0)		72 (1.2)	▽
Country not meeting sample participation requirements								
‡ United States	65 (1.2)	▽	[r]52 (1.4)	▽	[r]75 (1.1)	▽	72 (1.2)	▽

▲ Percentage significantly higher than ICILS 2023 average.
▽ Percentage significantly lower than ICILS 2023 average.

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
[2] Country surveyed target grade in the first half of the school year.
[3] National defined population covers 61% of the national target population.
[r] indicates data are available for at least 70% but less than 85% of the students.

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Appendix E:

CIL release modules

In this appendix, we summarize the content of each task from the two computer and information literacy (CIL) release modules to illustrate how the construct is realized by the test instruments and to convey the nature of the student test experience. Figures E.1 to E.10 represent the test flow and content of the CIL modules. Each figure includes screenshots of the task content presented in the same sequence as was presented to students who completed the modules. Each represented task includes a reference to the respective construct, illustrating the breadth of content assessed by a single module. The screenshots are of the initial state of the stimulus area, but without the test interface. The instructions, usually located in the instructions section of the test interface (see Figure 3.1 in Chapter 3 for information on the ICILS 2023 user interface design), are reproduced in the figures to provide the context necessary to understand what students were expected to do.

E.1 Breathing

In the CIL module Breathing, students manage files and collect and evaluate information to create a presentation explaining the process of breathing to eight-or-nine-year-old students.

Breathing tasks 1 – 3

The first three tasks depicted in Figure E.1 are skill execution tasks, framed as preparation for creating the presentation, focused on file management and application multitasking skills, reflecting CIL strand 1: Understanding computer use.

The first task presented students with a simulated desktop environment with a file browser open for a folder titled 'C:\School Projects' and they were instructed to open the presentation file. Task three relates to CIL aspect 1.1: Foundations of computer use.

In task two, the stimulus presented the presentation file from task one opened in a presentation editor (irrespective of the file opened by the student in task one). The instructions directed students to save the presentation as 'Breathing,' which required them to use the 'Save as' function, assessing their basic file management skills and knowledge, reflecting CIL aspect 1.2: Computer use conventions.

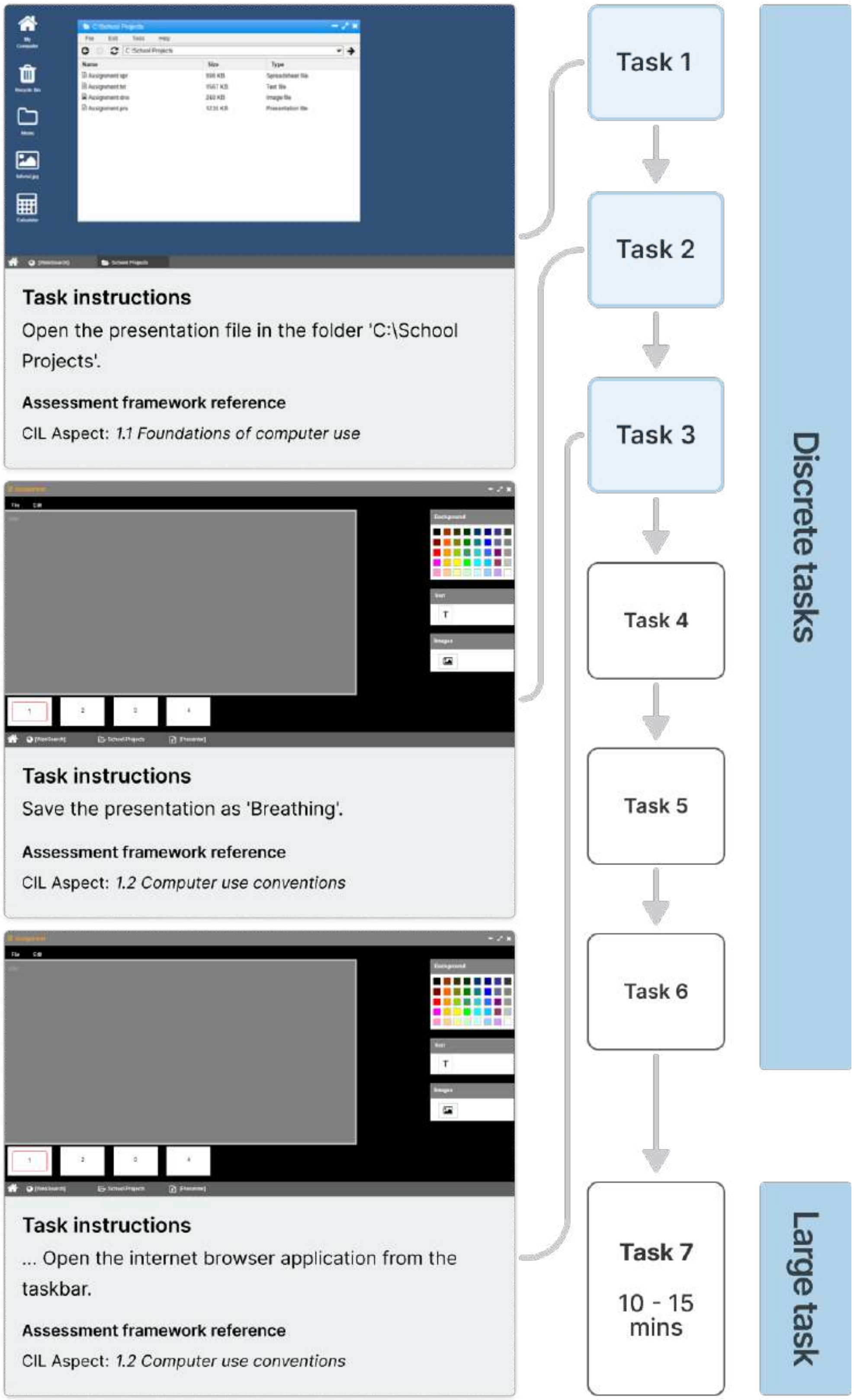
Students could open the application's toolbar menus to locate and click on the 'Save as' option. The interactive stimulus responded by showing a basic file browser dialog with the current file name, which students could edit to reflect the name given in the instructions. Hence, the task assesses a student's understanding of how applications can access a computer's file system and their ability to use that system to create a new file derived from an existing file.

The third task initiated the research context in the narrative by establishing the need to use the internet to find websites that would help in the creation of the presentation and instructed students to open the internet browser from the application taskbar.

In this context, the application taskbar was designed to represent a familiar user interface. The conventions used to depict a taskbar typically involve displaying icons and/or labels for open applications and can include elements such as the title of the currently active tab in a web browser. In alignment with standard interface conventions, the browser was not labeled with its literal application name but with [WebSearch], indicating the active tab's title and reflecting the broader context of the scenario. This required students to recognize the icon and label as indicative of the web browser application.

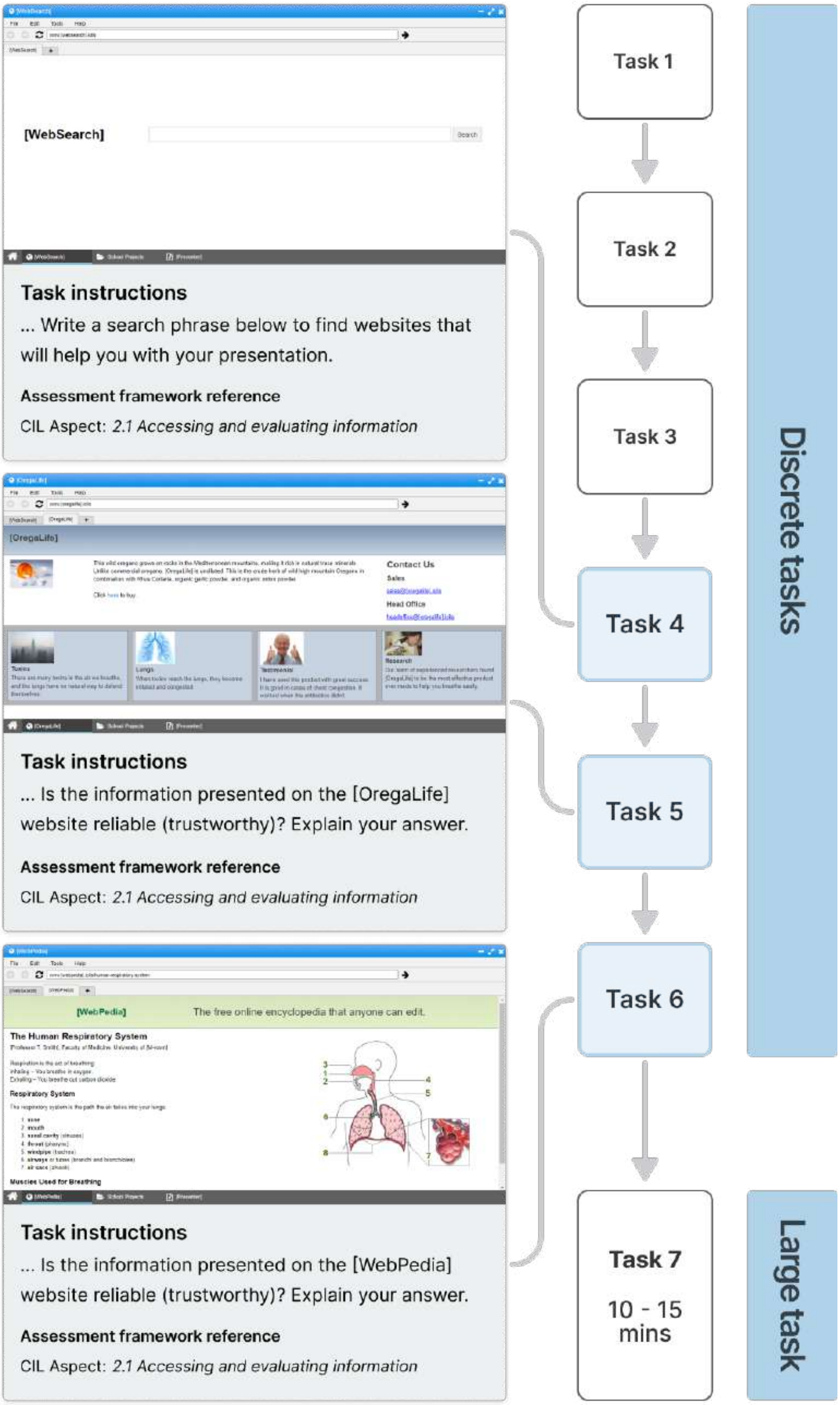
Students could click on any element which, instead of the user interface reacting to the mouse click event, triggered a test interface dialog asserting that an action had been recorded and asked students if they wanted to retry the task or progress to the next task. Students could retry only once, after which their response was recorded as the final response, and they progressed to the next task.

Figure E.1: CIL release module, Breathing tasks 1 – 3



Breathing tasks 4 – 6

Figure E.2: CIL release module, Breathing tasks 4 – 6



Tasks four to six (Figure E.2) emphasize CIL strand 2: Gathering information by introducing an internet search engine and two information sources returned by the search engine as potentially relevant for creating the presentation about breathing. These tasks are information-based response tasks, rather than skill execution tasks, because they required students to interpret scenarios typically encountered when gathering information and then express a written response that demonstrated their ability to access and evaluate information embedded in those scenarios.

Task four presents an internet search page opened in the web browser application referenced in task three. Students were asked to write a search phrase (which could be submitted to the search engine) that would return results relevant for creating the presentation.

Task five shifts the focus from accessing information to evaluating information by presenting the [OregaLife] website search result from task four. The website offers information on a product that is claimed to be derived from wild oregano and promotes its purported benefits for respiratory health. The website uses elements for direct product promotion, such as a product description, images, and contact details, but lacks in-depth evidence or external validations. Students had to explain whether they thought the information presented on the website was reliable[39] by evaluating claims and assessing the credibility of the content.

Like task five, task six also involves a website search result from task four, this time modeled on Wikipedia to display features typical of crowd-sourced information sources, thereby introducing ambiguity concerning the information's reliability. It presents a factual article on the human respiratory system and features an annotated diagram using scientific terminology.

Breathing task 7 (large task)

In the Breathing large task (Figure E.3) students were required to use two applications in parallel to create a presentation to teach younger students about how breathing works. These were the presentation editor (Figure E.4) and the web browser (Figure E.5). Before starting the large task, students were presented with a task detail screen that reminded them of the purpose and audience of the presentation.

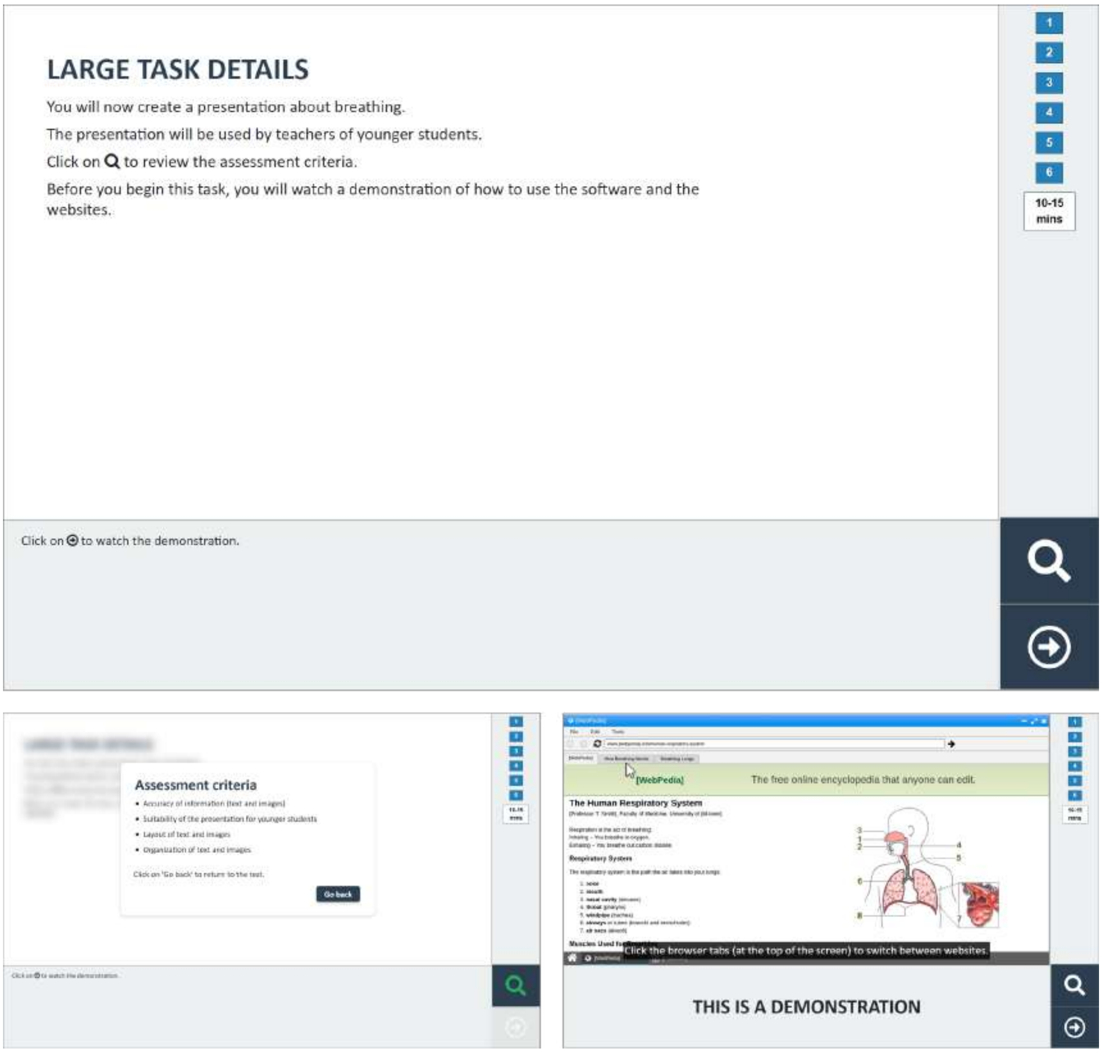
Students could view the assessment criteria from the task details screen, and at any time during their work on the task by clicking the button with the magnifying glass icon (see section 2 of Figure 3.1 in Chapter 3). The criteria, presented in a popover modal, include a simplified summary of the detailed criteria used by the expert scorers (see Table E.1). These were:

- Accuracy of information (text and images)
- Suitability of the presentation for younger students
- Layout of text and images
- Organization of text and images

The task details screen is followed by a short demonstration video designed to familiarize students with the presentation editor's user interface and functions, and the range of information sources available from the web browser.

39 The term 'trustworthy' was added in parentheses after 'reliable' in the test item to reduce the potential confounding effect that vocabulary knowledge might have on the difficulty of the item. This adjustment aims to provide all students with a more equitable opportunity to respond accurately, thereby focusing on their ability to evaluate information rather than their vocabulary breadth.

Figure E.3: CIL release module, Breathing large task details, assessment criteria, and demonstration video



The default state of the presentation Figure E.4 shows four blank slides containing only a text box with placeholder text on the first slide. The user interface design and functionality of the large task presentation editor are consistent with the standard conventions of real-world presentation editing software. The following software tools and functions were available for students to use to create the presentation:

- **Active slide**: The presentation editor features four slides that could be activated for editing by selecting the thumbnails of the slides displayed horizontally below the active slide.
- **Slide color**: The slide background color function utilizes a color picker grid with a predefined palette.
- **Text editor**: The text editor provides students with a familiar user interface that included commonly used text formatting functions (font, size, color, bold, italics, underline, alignment, unordered list, numbered list), presented as a row of buttons on a toolbar. The buttons were styled using universally recognizable icons that denoted the functionality and were used across all national adaptations of the module. The toolbar buttons also included tooltips that named each of the functions and were translated into the language(s) of administration in each country. Students could enter text and style any part of the text using font, size, color, bold, italics, underline,

alignment, unordered lists, and numbered lists.

- **Image gallery**: The image dialog box is a simple gallery of thumbnail images that students could add to the canvas. The images included diagrams depicting the steps involved in the processes of breathing along with some other general diagrams depicting the overall respiratory system and structure of the human lungs.
- **Drag and drop**: Text and image elements added to a slide could be moved by dragging and dropping them. The level of an overlapping element was defined by the last element that was moved, which brought it forward to the top layer.
- **Image resizing**: The images added to the canvas could be moved around the page and resized by dragging the corners or sides of the image's bounding box. To prevent images from being distorted or skewed when resized (which is difficult to correct), the aspect ratio of the images was locked, meaning that the height of the image changed proportionally with changes to the width of the image and vice versa.
- **Undo/Redo:** Changes to content in both the text editor and active slide could be reverted using an undo function (e.g., deleting a selection of text or changing the size of an image), which could be reversed using the redo function.

The text editor and image gallery were presented as popover modals, so that students could preview text and image content before committing it to the active slide.

Figure E.4: CIL release module, Breathing large task presentation editor

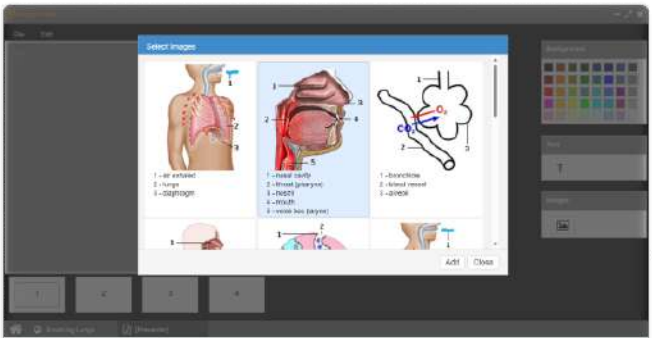
Task instructions

Read the websites and create a presentation to teach students who are 8 or 9 years old about breathing.

Assessment framework reference

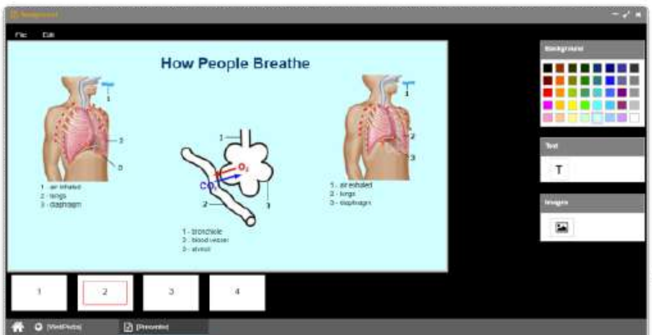
CIL Aspect: 3.1 Transforming information

CIL Aspect 3.2: Creating information



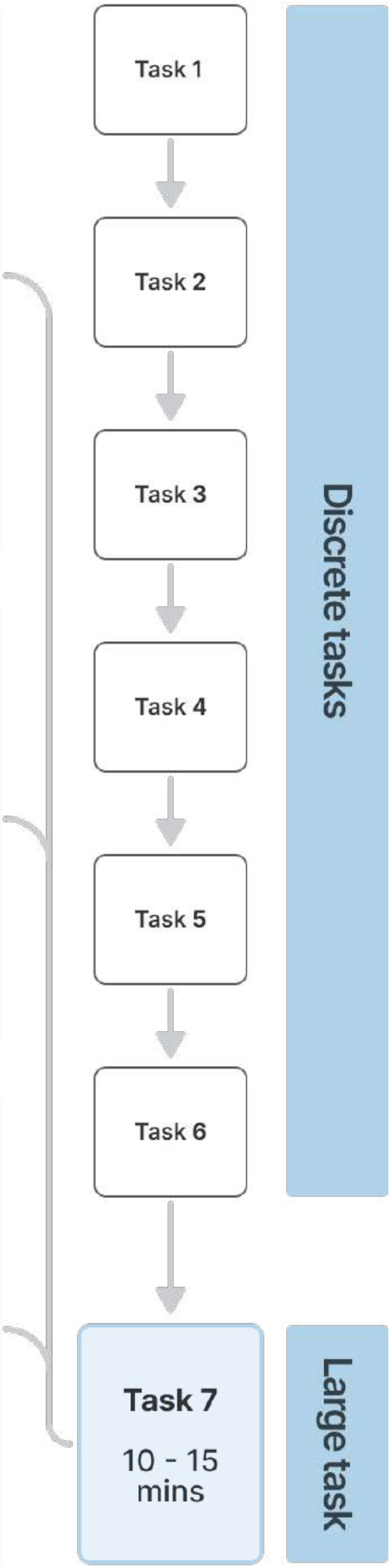
Content summary

Image gallery with predefined images and diagrams that can be added to a slide.



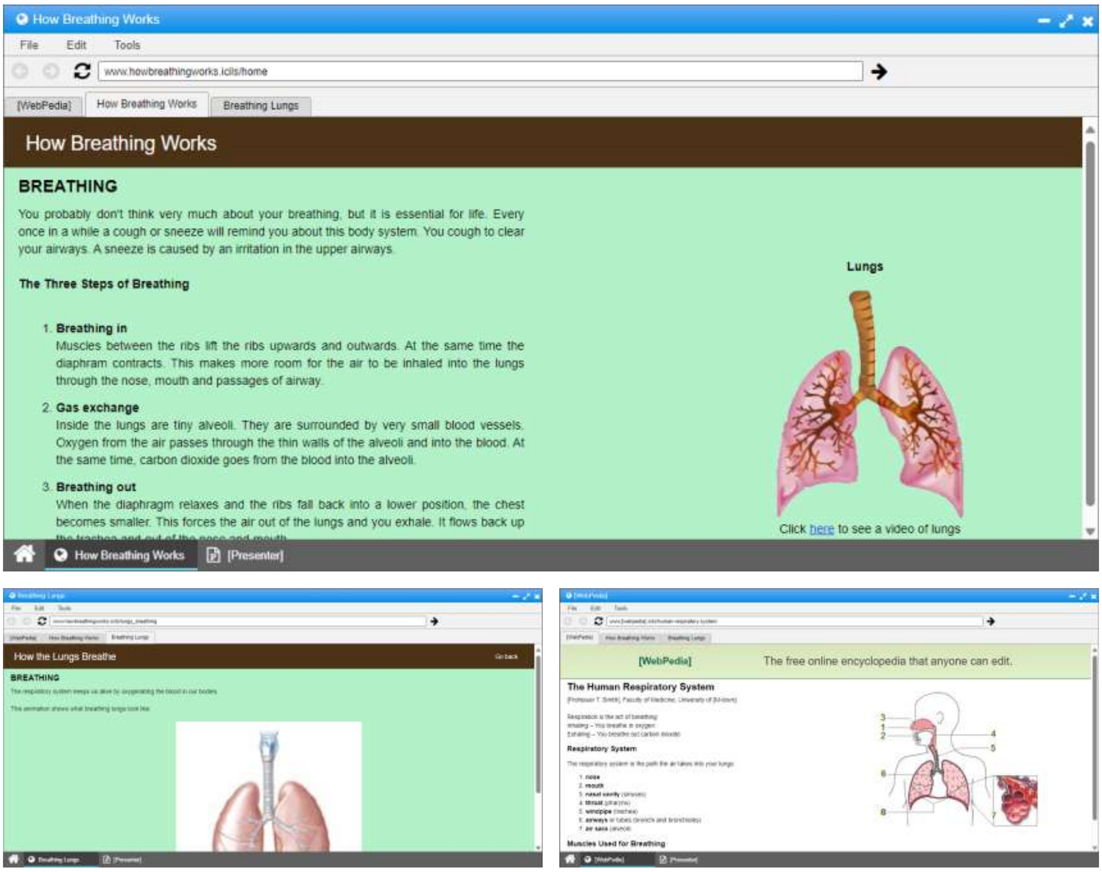
Content summary

A slide with a title, colored background and diagrams depicting the processing of breathing: breathing in; gas exchange; breathing out.



Students could access three relevant webpages from two information sources by switching from the presentation editor (Figure E.4) to the web browser (Figure E.5) using the buttons on the application taskbar at the bottom of the screen. At the top of the web browser were clickable web browser tabs that allowed students to navigate between the three available webpages. The text content from the webpages could be copied from the browser application, pasted in the presentation application, and then edited for use in the presentation. The webpage from the first tab was the scientific [WebPedia] article on the human respiratory system from task six. The second tab webpage was an article not presented in previous tasks that explained the three steps of breathing using easily accessible language for grade 8 students. The third, linked from the second, displayed an animation of breathing lungs.

Figure E.5: CIL release module, Breathing large task information sources



When students had completed their presentations, they clicked on the 'Next task' button, which then displayed a dialog asking them to confirm if they had completed the task or wanted to return to continue working. Once students had exited the module the final version of the presentation was saved in preparation for scoring by trained scorers within each country.

Descriptions of the Breathing large scoring criteria are presented in Table E.1 with reference to their corresponding assessment framework strands and aspects, relevant score category, and maximum score. Criteria 2, 6, 7, and 8 each occupy a single row because they are dichotomous criteria (scored as zero or one). Criteria 1, 3, 4, and 5 are partial-credit criteria (scored as zero, one, or two).

Table E.1: Breathing large task scoring criteria with framework references

#	Criterion	Score	Strand	Aspect	Descriptor
1	Images relevance	1/2	Producing information	Transforming information	One step of breathing is clearly supported by the use of a relevant image in a presentation.
1	Images relevance	2/2	Producing information	Transforming information	At least two of three steps of breathing are supported by the use of relevant images in a presentation.
2	Information adaptation	1/1	Digital com-munication	Sharing information	Adapts information about breathing in a presentation to the target audience.
3	Text information design	1/2	Producing information	Creating information	Text formatting partially supports viewers' understanding of the role of the different text elements in a presentation.
3	Text information design	2/2	Producing information	Creating information	Text formatting consistently supports viewers' understanding of the role of the different text elements throughout a presentation.
4	Color continuity	1/2	Producing information	Creating information	There is some use of color to denote specific purposes of text elements in a presentation.
4	Color continuity	2/2	Producing information	Creating information	Colors have been used to demonstrate the relationships of elements within and across the slides of a presentation.
5	Text contrast	1/2	Producing information	Creating information	The text mostly contrasts with the background within a presentation.
5	Text contrast	2/2	Producing information	Creating information	The text contrasts clearly with the background throughout a presentation.
6	Text position	1/1	Producing information	Creating information	There is clear evidence of planning in the layout of text in a presentation.
7	Information accuracy	1/1	Gathering information	Accessing and evaluating information	Only accurate information about breathing is included in a presentation.
8	Ideas completeness & sequencing	1/1	Digital com-munication	Sharing information	Includes the three specified steps of breathing in a coherent sequence in a presentation.

E.2 School trip

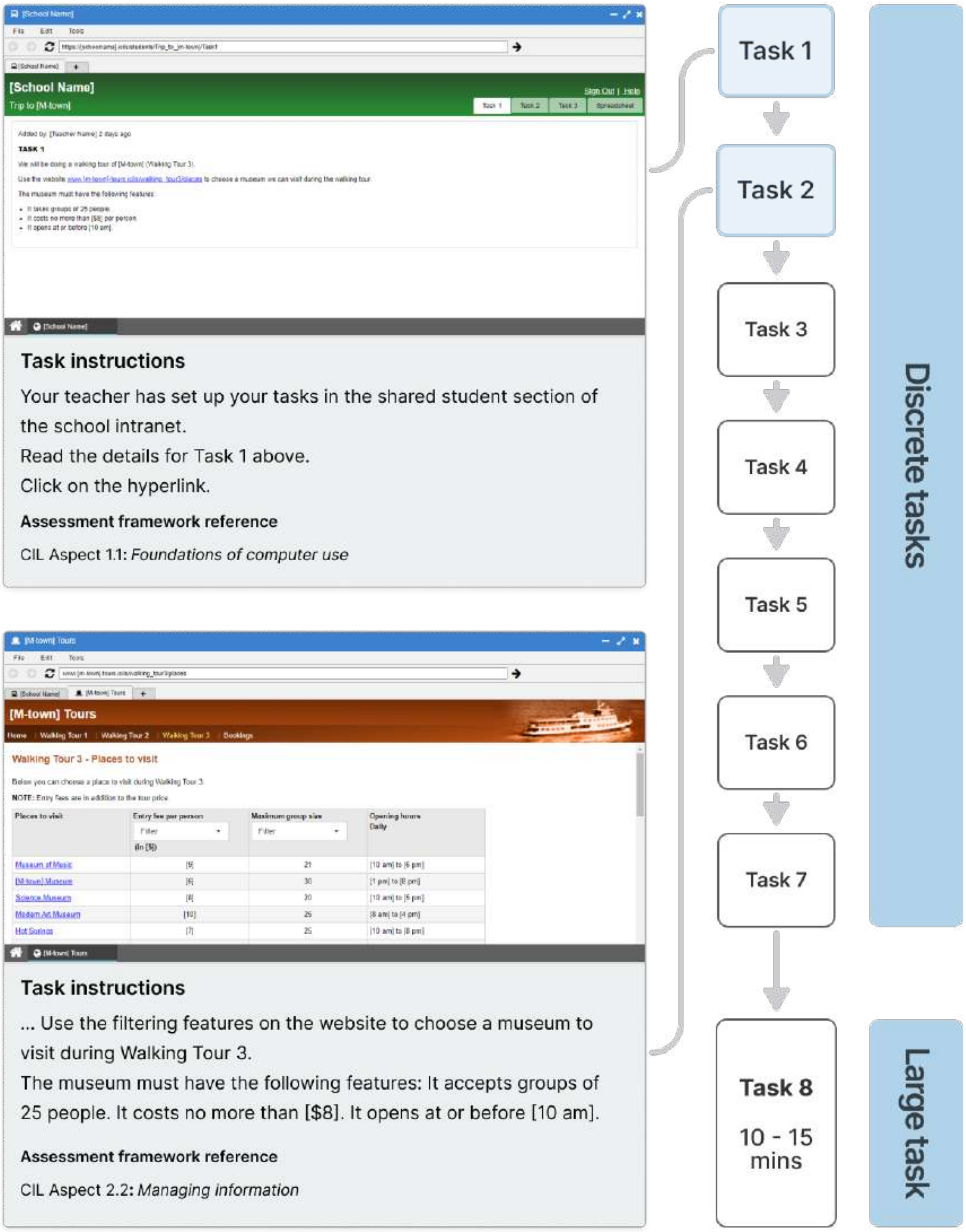
In the CIL module School trip, students help plan a walking tour excursion using online database tools, selecting and adapting information to produce an information sheet for their peers. The information sheet includes a map with tour directions created using a map annotation tool.

School trip task 1 – 2

In task one of the School trip module (Figure E.6), students were presented with an assignment to choose a museum to visit from the [M-town] Tours website and were instructed to "Click on the hyperlink" to access the website. The task assessed the fundamental competencies in using web browsers and understanding the conventions web content and relates to CIL aspect 1.1: Foundations of computer use.

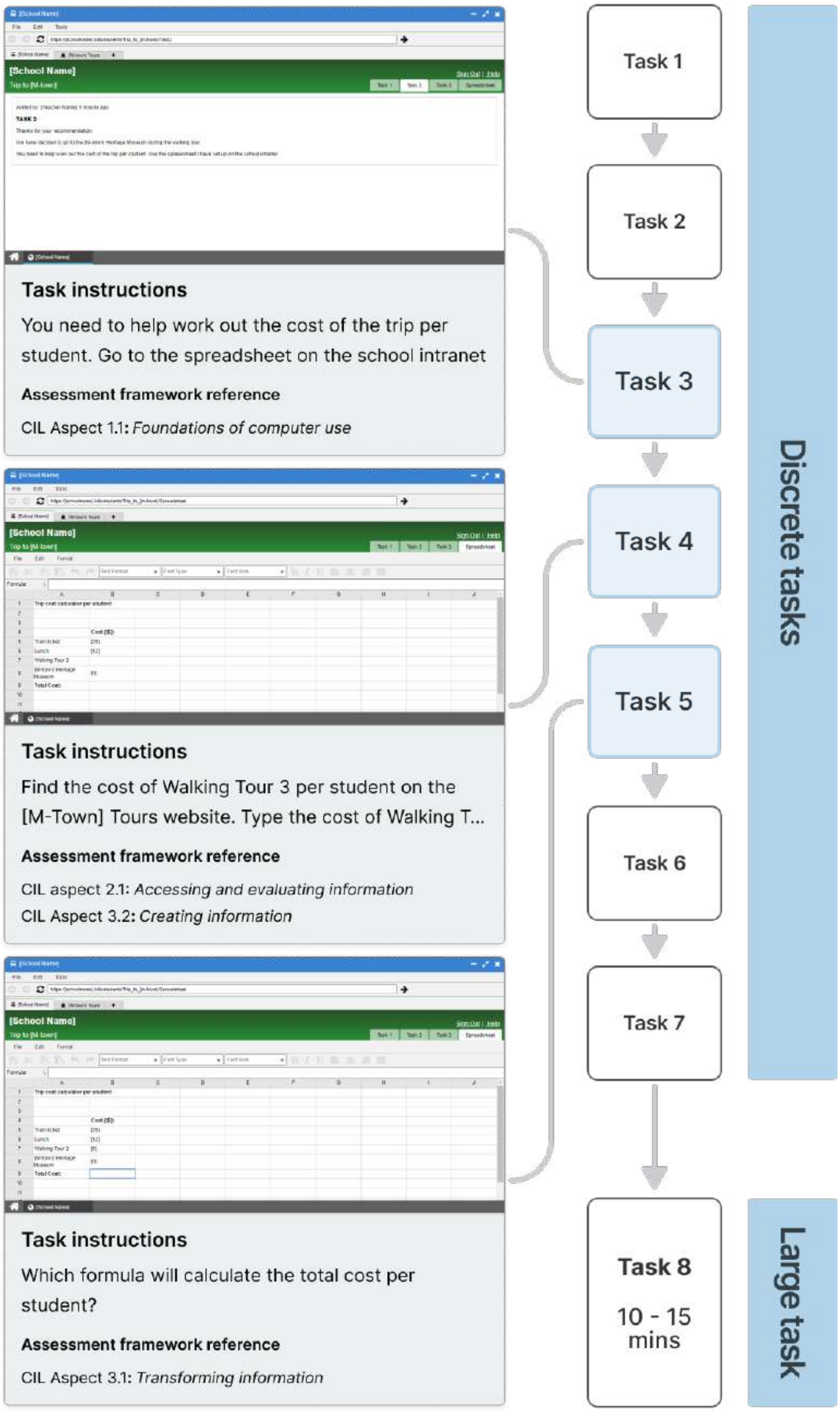
In the second task, students were presented with the [M-town] Tours website and an interactive table comparing local points of interest such as cultural, historical, and artistic attractions and destinations. The table includes the name, entry fee, maximum group size, and opening hours for 30 places. The entry fee and maximum group size columns included select fields with a list of options for filtering the information in the table. Students were instructed to choose a museum that accepted groups of 25 people, cost no more than $8, and opened at or before 10 am. Students could scroll the page to evaluate all 30 places against the three criteria or use column filters to reduce the number of places to 13. The task assessed a student's ability to locate information using web tools efficiently by applying strategies to filter the information effectively and reflects CIL aspect 2.2: Managing information.

Figure E.6: CIL release module, School trip tasks 1 – 2



School trip task 3 – 5

Figure E.7: CIL release module, School trip tasks 3 – 5



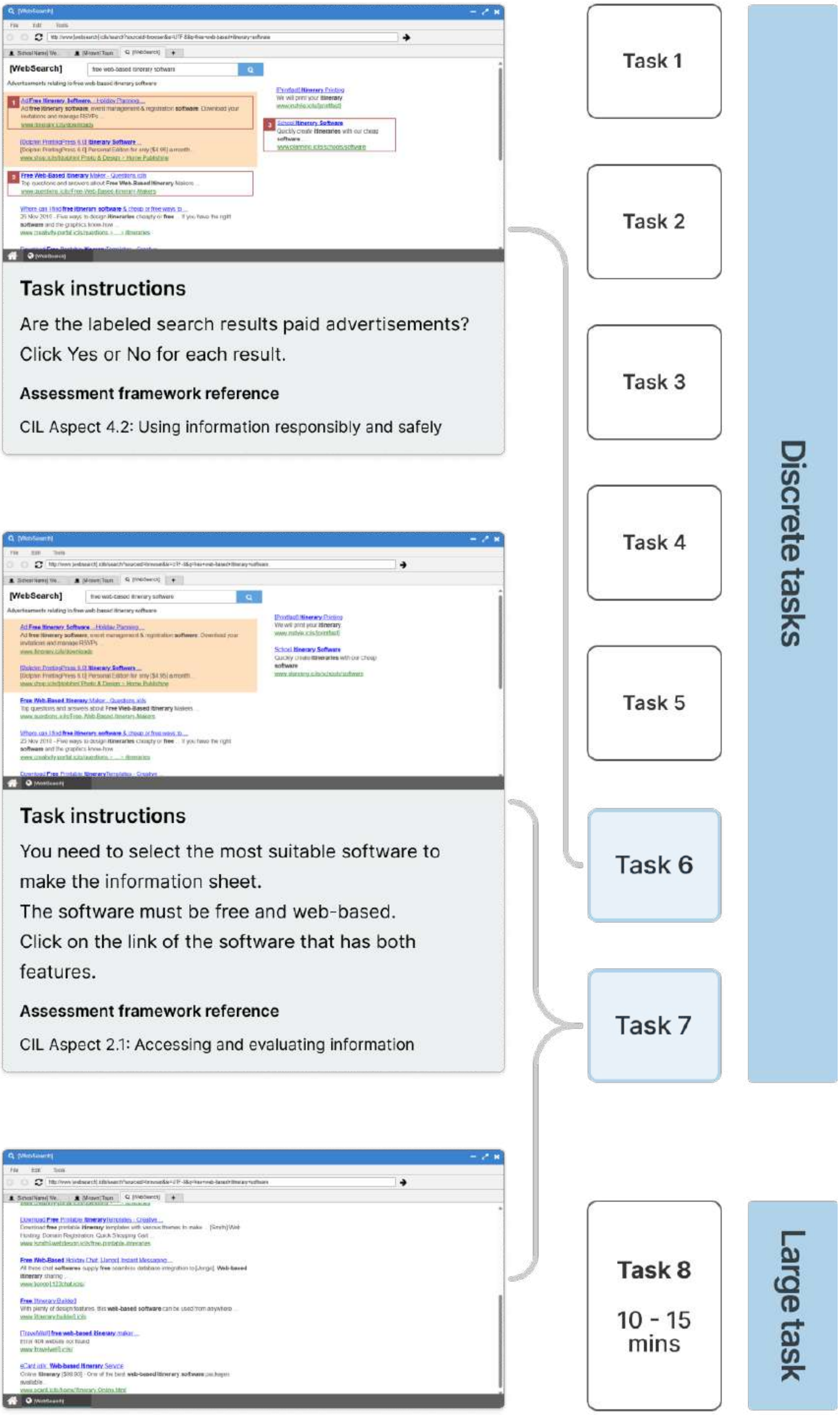
Task three (Figure E.7), presented using the same format as task one, conveys the second assignment, which tasked students with opening a web-based spreadsheet app and using it to calculate the total cost of the school trip per student. However, before the cost could be calculated (task five, Figure E.7), students needed to first locate the cost of “Walking Tour 3” from the [M-town] Tours website and then record it into the appropriate cell of the spreadsheet (task four, Figure E.2). Hence, the first part of task four assessed the skills and knowledge needed for locating information embedded in a website with multiple pages, reflecting CIL aspect 2.1: Accessing and evaluating information, while the second part assessed understanding of spreadsheet conventions and tabular information, reflecting CIL aspect 3.2: Creating information. In task five, the cost of walking tour 3 was correctly entered into the spreadsheet, irrespective of what students did in task four. Presented with a multiple-choice question, in which students were asked to select the formula that should be used to calculate the sum of the costs listed on the worksheet. This reflects CIL aspect 3.1: Transforming information.

School trip task 6 – 7

Task six (Figure E.8) depicts a scenario in which the teacher uses a search engine to find an app to design an itinerary. Presented with an annotated search results page with three of the results labeled, students were asked to identify whether each of the three results were paid advertisements or not. The task assesses students’ ability to recognize that search engines can employ conventions for identifying results that are advertisements. In this case, placement at the top of the page and shading were used to differentiate paid and unpaid results. The task reflects content related to CIL aspect 4.2: Using information responsibly and safely.

As a continuation of the scenario depicting the search for an itinerary design app, task seven presents the same set of search results, but without the labels. Students were asked to identify the result that referred to free web-based itinerary software that could be used to create the information sheet about the walking tour. Ten of the 11 results are irrelevant, even though the keywords in the search phrase “free web-based itinerary software” are reflected. For example, the first result referred to itinerary software for holiday planning that was ad-free (without advertisements). The correct result was third from the bottom, which required students to use the browser’s scroll function to see it. Hence, the task assessed the ability to evaluate search engine results effectively, by using a strategy that ensured all results could be evaluated (scrolling) and to interpret the content of those results with respect to the stated purpose and criteria.

Figure E.8: CIL release module, School trip tasks 6 – 7



School trip task 8 (large task)

The large task (Figure E.9 and Figure E.10) involves students using a simple graphic design app, conveyed as an itinerary builder, to create an information sheet about the walking tour for their classmates. The information sheet includes a map of the local area that could be annotated with arrows. As part of the task, students were required to use a text description of the walking tour to illustrate the route on the map and include the map in the information sheet.

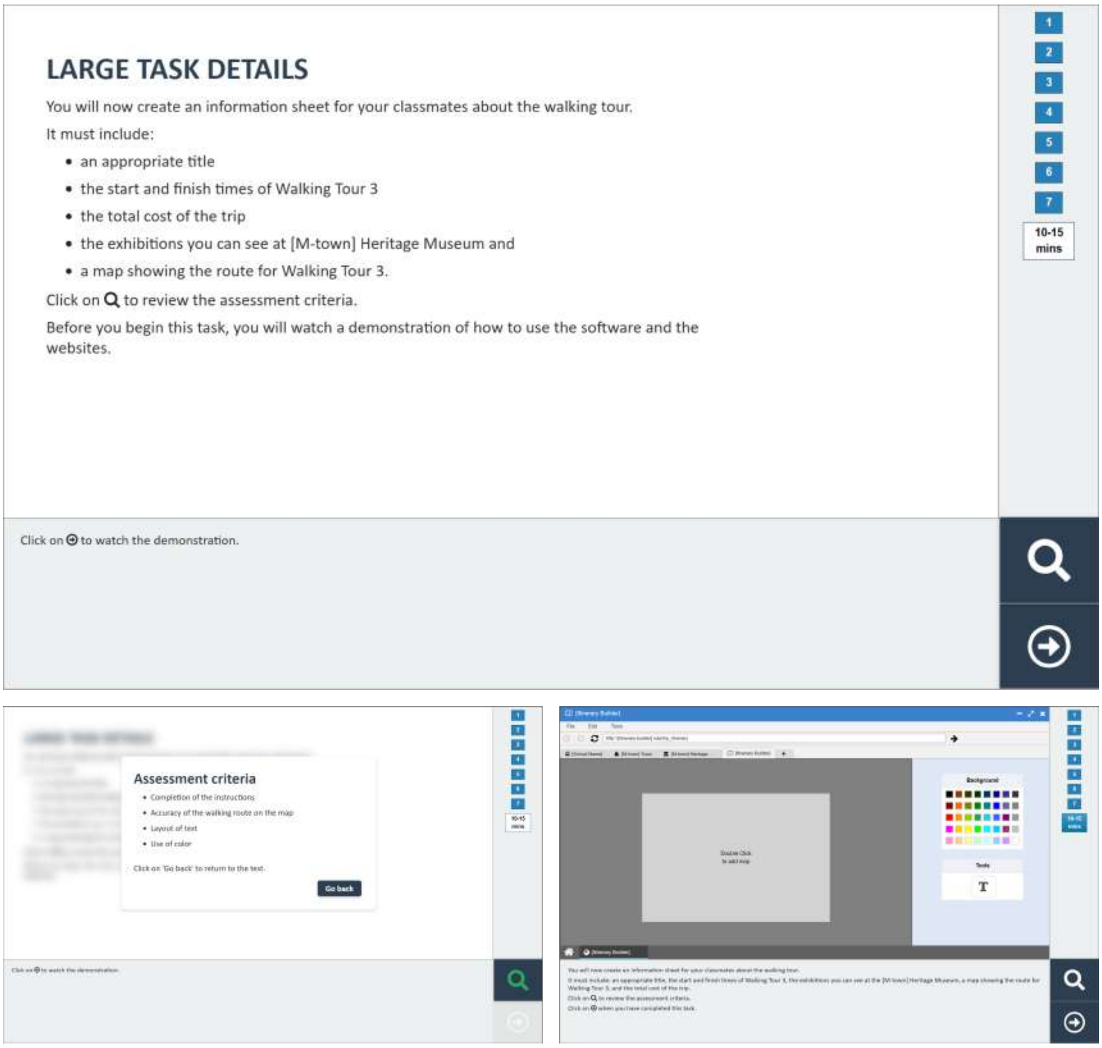
Before starting the large task, students saw a task details screen (Figure E.9) that reminded them of the purpose and audience of the information sheet.

Students could view the assessment criteria from the task details screen and at any time during their work on the task by clicking the button with the magnifying glass icon. The criteria, presented with a popover modal, were a simplified summary of the detailed criteria used by the expert scorers. These were:

- Completeness of the instructions
- Accuracy of the walking route on the map
- Layout of text
- Use of color

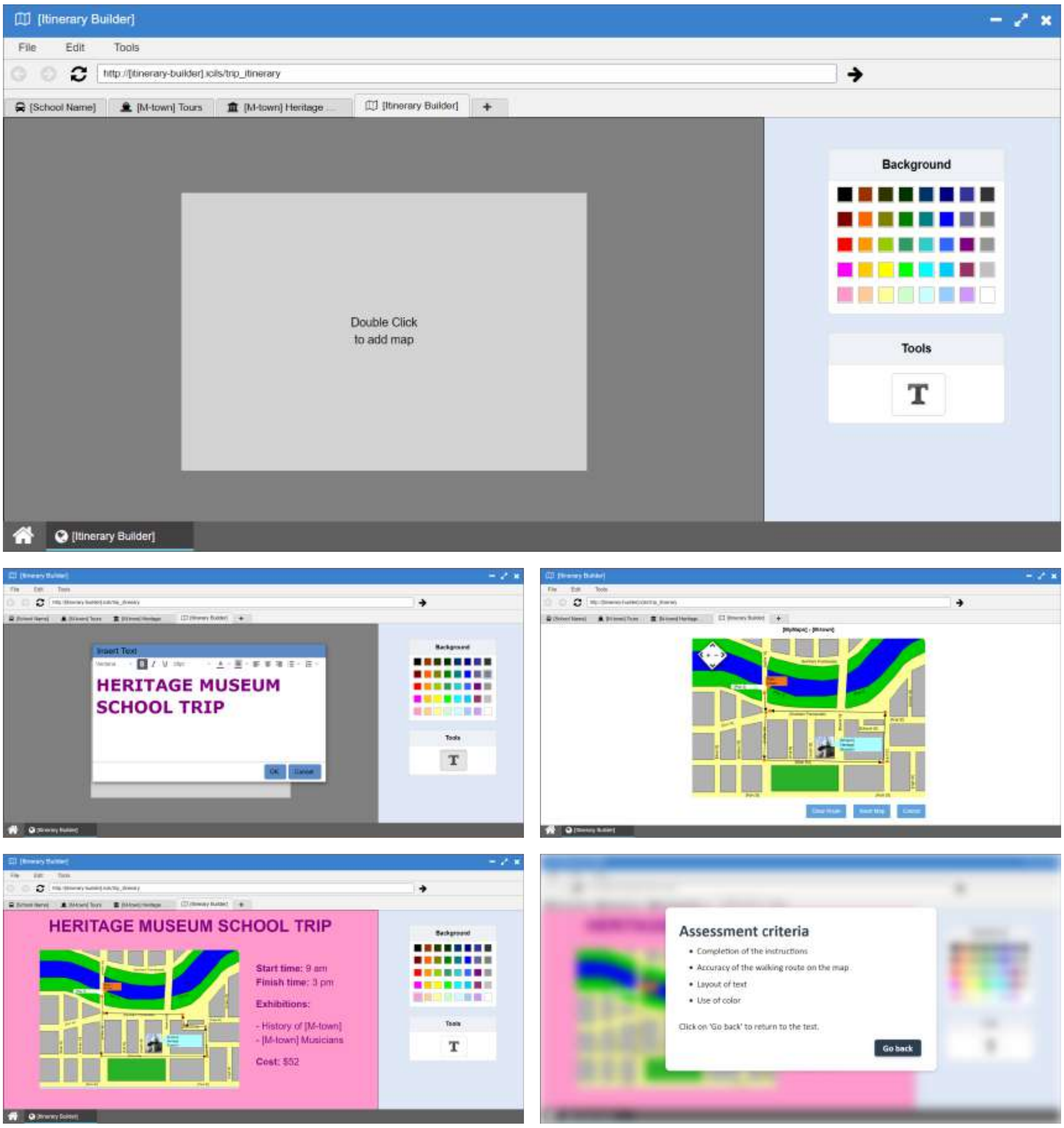
The task details screen was followed by a short demonstration video designed to familiarize students with the application's user interface and functions, and the range of information sources available from the web browser.

Figure E.9: CIL release module, School trip large task details, assessment criteria, and demonstration video



The itinerary builder (Figure E.10) featured a simple user interface and functionality limited to the layout and formatting of text using drag and drop text boxes and changing the color of the canvas using a defined color palette. The text editor was presented as popover modal, so that students could preview text before committing it to the canvas.

Figure E.10: CIL release module, School trip large task itinerary builder



The itinerary builder and two information sources were accessed using web browser tabs. The [M-town Tours] website contains the street directions for the walking tour and the [M-town Heritage Museum] website contains the names of the exhibitions showing at the museum. The text content from the webpages could be copied from the browser application, pasted in the itinerary builder's text editor, and then edited for use in the information sheet.

Table E.2: School trip large task scoring criteria with framework references

#	Criterion	Score	Strand	Aspect	Descriptor
1	Appropriate title	1/1	Producing information	Creating information	Gives an information page an appropriate title.
2	Appropriate times	1/1	Gathering information	Managing information	Locates event times on a website and includes them on an information sheet.
3	Appropriate costs	1/2	Gathering information	Managing information	Locates event costs on a website and includes them on an information sheet.
3	Appropriate costs	2/2	Gathering information	Managing information	Locates event costs on a website and includes them with a total cost on an information sheet.
4	Map route accuracy	1/2	Producing information	Transforming information	Uses a mapping tool to display some but not all of a specified route.
4	Map route accuracy	2/2	Producing information	Transforming information	Uses a mapping tool to display a specified route completely.
5	Information location & relevance	1/2	Producing information	Transforming information	Identifies some relevant information on a website and includes it in an information sheet.
5	Information location & relevance	2/2	Producing information	Transforming information	Identifies all relevant information on a website and includes it, as specified, on an information sheet.
6	Information sheet layout	1/2	Producing information	Creating information	Creates an information sheet with some control of the layout of text and images.
6	Information sheet layout	2/2	Producing information	Creating information	Creates an information sheet with balanced and controlled layout of text and images.
7	Information sheet text contrast	1/2	Producing information	Creating information	The text mostly contrasts with the background within a presentation.
7	Information sheet text contrast	2/2	Producing information	Creating information	The text contrasts clearly with the background throughout a presentation.

Appendix F:

CT release modules

In this appendix, we summarize the content of each task from the two computational thinking (CT) release modules to illustrate how the construct is realized by the test instruments and to convey the nature of the student test experience. Figures F.1 to F.8 represent the test flow and content of the CT release modules. Each figure includes screenshots of the task content presented in the same sequence as was presented to students who completed the modules. Each represented task includes a reference to the CT construct, illustrating the breadth of content assessed by a single module. The screenshots are of the initial state of the stimulus area, but without the test interface. The instructions, usually located in the instructions section of the test interface (see Figure 3.1 in Chapter 3 for information on the ICILS 2023 user interface design), are reproduced in the figures to provide the context necessary to understand what students were expected to do. For the Farm drone screenshots, we also magnified the size of the code blocks to improve readability and to showcase the range of commands, operations, and computational concepts involved in the module. All Farm drone block-based coding tasks included a common criterion that instructed students to use as few code blocks as possible, which we refer to as *efficiency* when describing proficiency on the CT achievement scale. For brevity, the text for this criterion is not included in the figures. Screenshots of all ICILS 2023 release module tasks (including the test interface) are available in Appendix F.

F.1 Automated bus

The Automated bus module was designed primarily to assess competencies associated with CT strand 1: Conceptualizing problems. Assessment tasks related to planning various aspects of a program and configuring the navigation and brake systems to operate a driverless bus. They involved using interactive directed graphs, decision trees, and a simulation.

Automated bus tasks 1 – 2

In task one (Figure F.1), students were presented with an interactive scenario in which they were instructed to creating a set of instructions to guide a bus to follow a specified route on a map using directional and locational commands. The stimulus is divided into two main sections: "Bus guidance settings" and "Bus route." The bus route is depicted as a directed graph, where nodes represent specific locations (e.g., [Male1], [Female1], Sports Event), and directed edges (arrows) indicate the path and direction between these locations.

Students needed to use the menus in the "Bus guidance settings" to select instructions ("turn to" or "move to") and directions/locations for the bus to follow the route indicated by the red arrows on the node graph. The location/direction options corresponded to the locations represented in the node graph if the instruction was "move to," or cardinal directions (North, West, East, South)[40] if the instruction was "turn to." The first two steps were pre-configured to provide students with a scaffolded start. Students had to complete the remaining steps by selecting appropriate pairs of instructions and locations or directions from the menus.

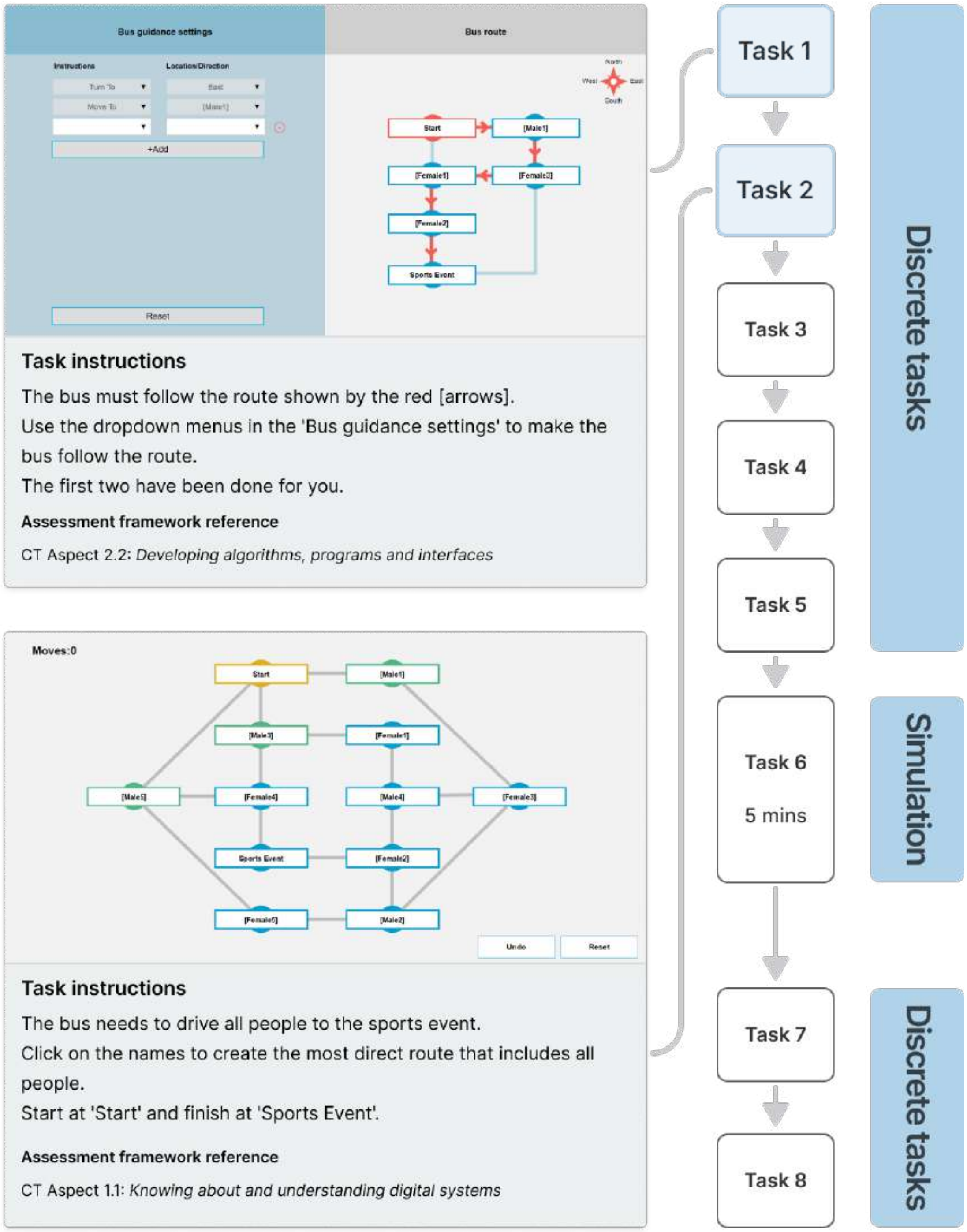
The key CT concepts and cognitive processes involved in task one of the Automated bus module were as follows:

- **Algorithm design**: Creating a step-by-step procedure to achieve the desired outcome (guiding the bus along the specified route).

40 The order of the cardinal direction options corresponds to a left-to-right reading of the compass in the top right corner of the "Bus route" section.

- **Sequencing**: Ensuring that the instructions are given in the correct order to follow the route accurately.
- **Direction-based navigation**: Using directional commands (North, South, East, West) to navigate from one location to another.

Figure F.1: CT release module, Automated bus tasks 1 – 2



In task two, students were required to determine the most direct route for a bus to pick up all people and drive them to a sports event. An undirected graph represented various possible routes from the

"Start" location to the "Sports Event" location. This graph was more complex than the graph presented in task one, due to the addition of six more people (nodes) and the absence of edges (paths) from two sets of adjacent nodes: "[Male1]" to "[Female1]" and "[Female5]" to "Sports Event." Additionally, this graph was interactive. Nodes adjacent to the current node (highlighted in yellow) and connected by undirected edges (gray lines) could be clicked (turning green) to create a directed edge (red arrow) between the nodes, representing paths for the bus to move between named locations. The number of directed edges created by students was counted as "moves" and displayed in the top left corner. Since students could create bi-directional paths between nodes, the number of possible moves was limitless. Students were instructed to create the most direct route by clicking on the named locations. The initial state of the task showed the "Start" node with a yellow fill, indicating the current position. The nodes labeled "[Male1]," "[Male3]," and "[Male5]" were shown with a green fill, indicating that they were valid locations (connected by undirected edges) that could be clicked to create a path between the nodes.

The key CT concepts and cognitive processes involved in task two of the Automated bus module were as follows:

- **Pathfinding**: Identifying a route with an interactive node graph that visits all required nodes (people) and reaches the final destination (sports event).
- **Sequencing**: Ensuring that the sequence of locations visited is correct and follows a logical order.
- **Optimization**: Finding the most efficient path that includes all people with the least amount of travel or moves.

Both tasks one and two emphasized different aspects of the CT construct. Task one focused on logical sequencing of instructions and their instantiation in a user interface (UI), aligning with CT aspect 2.2: Developing algorithms, programs, and interfaces. In contrast, task two required students to internalize properties of the graph and permissible actions by interacting with the graph and observing the interaction of components within the system, reflecting CT aspect 1.1: Knowing about and understanding digital systems.

Automated bus tasks 3 – 4

The third task (Figure F.2) presented a time-weighted variation of the graph from task two, where the edges included labels to convey the time in minutes to travel between connected nodes. This graph was also interactive and used the same conventions established in task three to denote the current node, nodes connected by undirected edges, and directed edges between nodes. However, this graph was a directed *acyclic* graph (DAG), which meant that edges were directed from one node to another, preventing the formation of closed loops and ensuring a single path between nodes. In short, the direction of the route could only go forward and could not go to a node more than once.

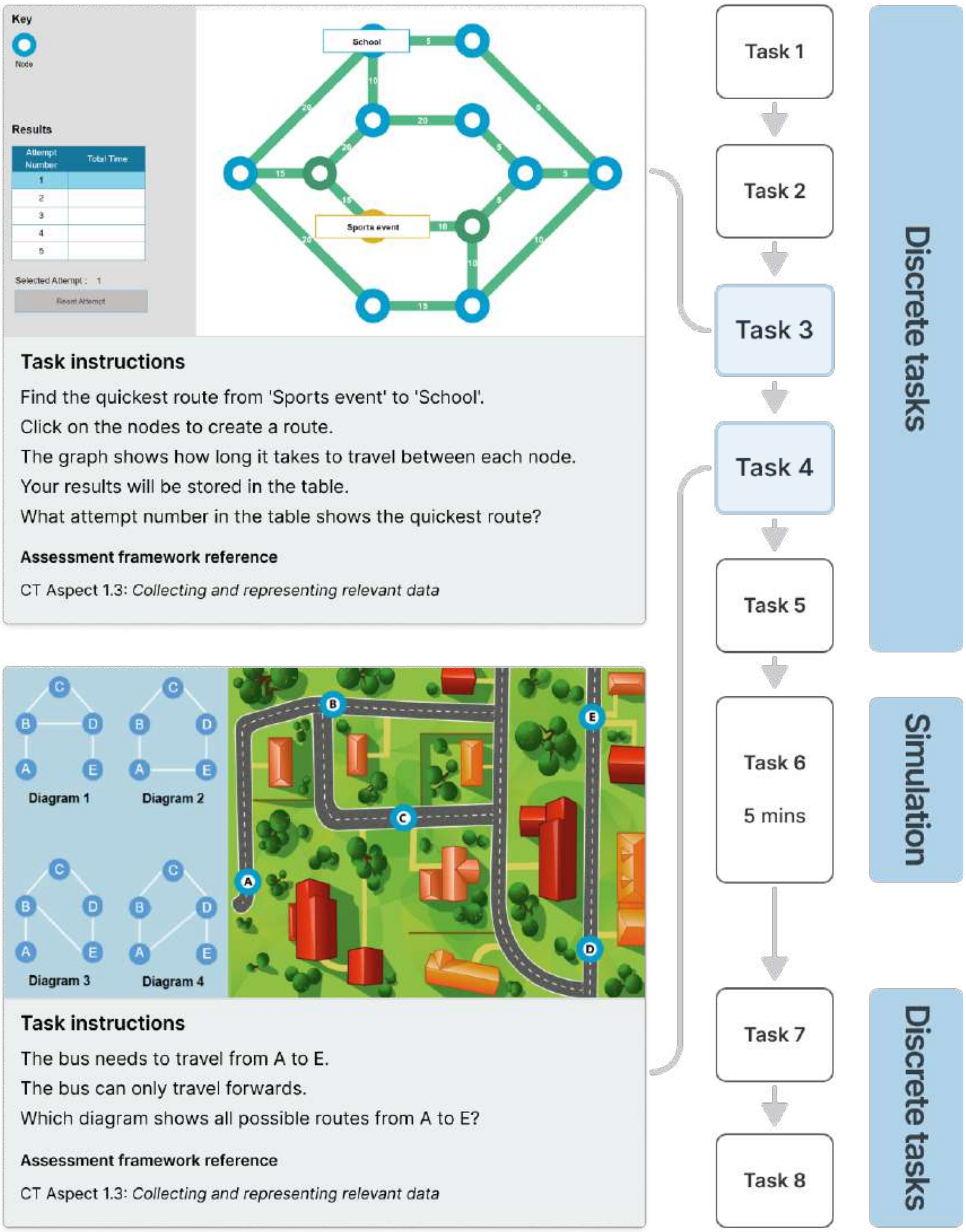
Instead of counting the number of moves, the cumulative time in minutes associated with each directed edge (travel time) was recorded and displayed in the currently selected row (light blue shading) of the results table. Students could record the travel time for up to five different routes by selecting rows in the table. Changing the selected row updated the state of the graph to reflect the route recorded for that entry. While there were only five rows in the table to record results, any row's result could be reset, enabling students to run any number of trials.

Students were instructed to find the quickest route from "Sports Event" to "School" by selecting nodes to create routes and were asked which of the results stored in the table showed the quickest route. This task assessed students' abilities to plan and evaluate solutions by systematically trialing different routes and observing the recorded travel times to identify the optimal result.

The key CT concepts and cognitive processes involved in task three of the Automated bus module were as follows:

- **Shortest pathfinding**: Determining the shortest possible route between two points in a graph based on the given weights (travel times).
- **Graph traversal**: Navigating through the nodes of a graph by following the edges connecting them.
- **Optimization**: Minimizing the total travel time to find the most efficient path.

Figure F.2: CT release module, Automated bus tasks 3 – 4



In task four (Figure F.2), students were presented with a scenario that involved identifying all possible routes for the bus to travel from location A to location E. The stimulus included a map with various roads connecting these locations and undirected graph diagrams, each with different configurations of edges representing routes. Students were required to identify which diagram accurately represented all possible forward routes from A to E.

The key CT concepts and cognitive processes involved in task four of the Automated bus module were as follows:

- **Pathfinding**: Identifying all possible routes from a starting point (A) to a destination point (E).
- **Graph traversal**: Understanding the structure of the routes as a graph where nodes represent intersections or stops and edges represent the paths between them.
- **Logical reasoning**: Ensuring the routes only progress forward and do not include any backward travel.

While tasks three and four both relate to CT aspect 1.3: Collecting and representing relevant data, and shared some CT concepts, each task involved applying two unique CT concepts. Task three concentrated on optimization by minimizing the total travel time to find the most efficient path through iterative testing of a route with simulations. In contrast, task four required a higher level of abstraction to filter out irrelevant information (e.g., winding streets, houses) and understand the structure of the routes as a graph, where nodes represent intersections or stops, and edges represent the paths between them.

Automated bus tasks 5 – 6

Task five (Figure F.3) presented students with a scenario where a computer controlling a driverless bus must make a decision about stopping at the next bus stop. The conditions for stopping the bus included: a passenger wants to disembark and a commuter is waiting to board.

This task involved an interactive drag-and-drop interface where students completed a decision tree. The start event, end event, and decision points were predefined:

- Begin next bus stop check
- End next bus stop check
- Does anyone want to exit the bus?
- Does anyone want to get on the bus?

Students were required to drag and drop the “Yes,” “No,” and “Stop at next bus stop” labels onto the decision tree to accurately complete the control flow.

The key CT concepts and cognitive processes involved in task five of the Automated bus module were as follows:

- **Decision-making**: Evaluating conditions to make a choice (whether the bus should stop).
- **Conditional logic**: Using if-then-else statements to handle different scenarios (if a passenger wants to get on or off the bus).
- **Flow control**: Directing the sequence of operations based on the outcomes of conditions.

Task five assessed CT aspect 1.2: Formulating and analyzing problems, by evaluating students’ ability to structure logical conditions and actions within a decision-making process.

In task six (Figure F.3), students used an object recognition simulator to determine the maximum distance at which a bus could correctly identify a cyclist under specific conditions (night time and raining). The simulator presented a decision tree with the following configurable conditions:

- Is an object detected?
- Is it night time?
- Is it raining?

After setting these conditions, students adjusted the stopping distance from the cyclist and ran the simulation to check if the cyclist was correctly recognized. Students could test different distances and recorded the outcomes, with the goal of identifying the maximum recognition distance. This task was presented in a multiple-choice format with 11 options ranging from 0 meters to 1,000 meters.

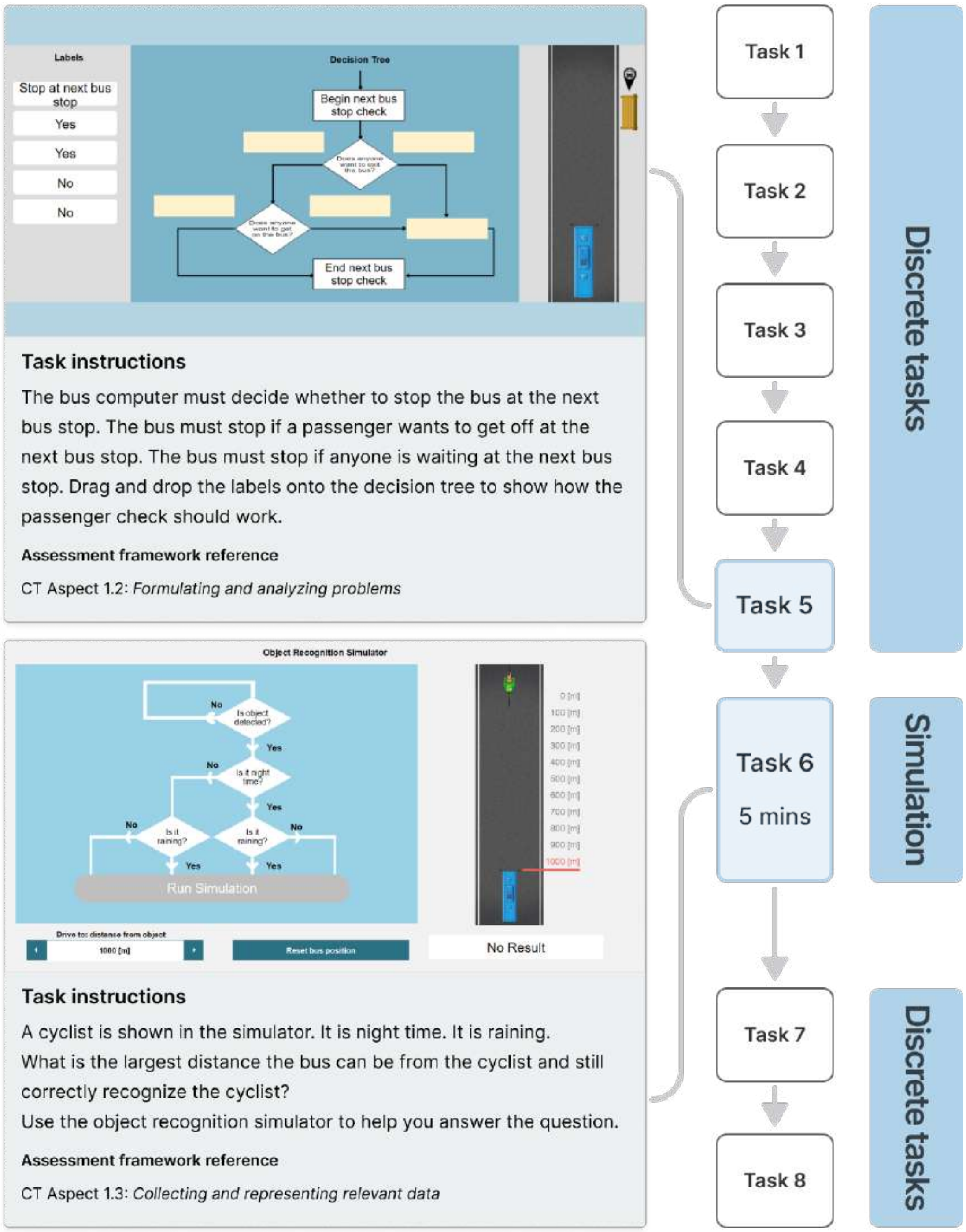
The key CT concepts and cognitive processes involved in task six of the Automated bus module were as follows:

- **Object recognition**: Understanding how an automated system identifies objects in its environment using cameras and algorithms.
- **Conditional logic**: Applying conditional statements to decide actions based on multiple criteria, such as detecting objects, determining the time of day, and assessing weather conditions.
- **Simulation**: Using a simulated environment to test and observe the behavior of the automated system under various conditions.

Task six assessed CT aspect 1.3: Collecting and representing relevant data, requiring students to gather data by systematically testing different distances and observing the outcomes.

The size and layout of the diagrams and location labels in Figure F.3 were modified to improve legibility.

Figure F.3: CT release module, Automated bus tasks 5 – 6



Automated bus tasks 7 – 8

Tasks seven and eight presented constructed response items. Task seven reflected the student's choice from task six, asking them how they worked out their answer. Credit was given to students who could provide a comprehensible explanation of their strategy, this could be through systematic trialing or a form of unsystematic trialing.

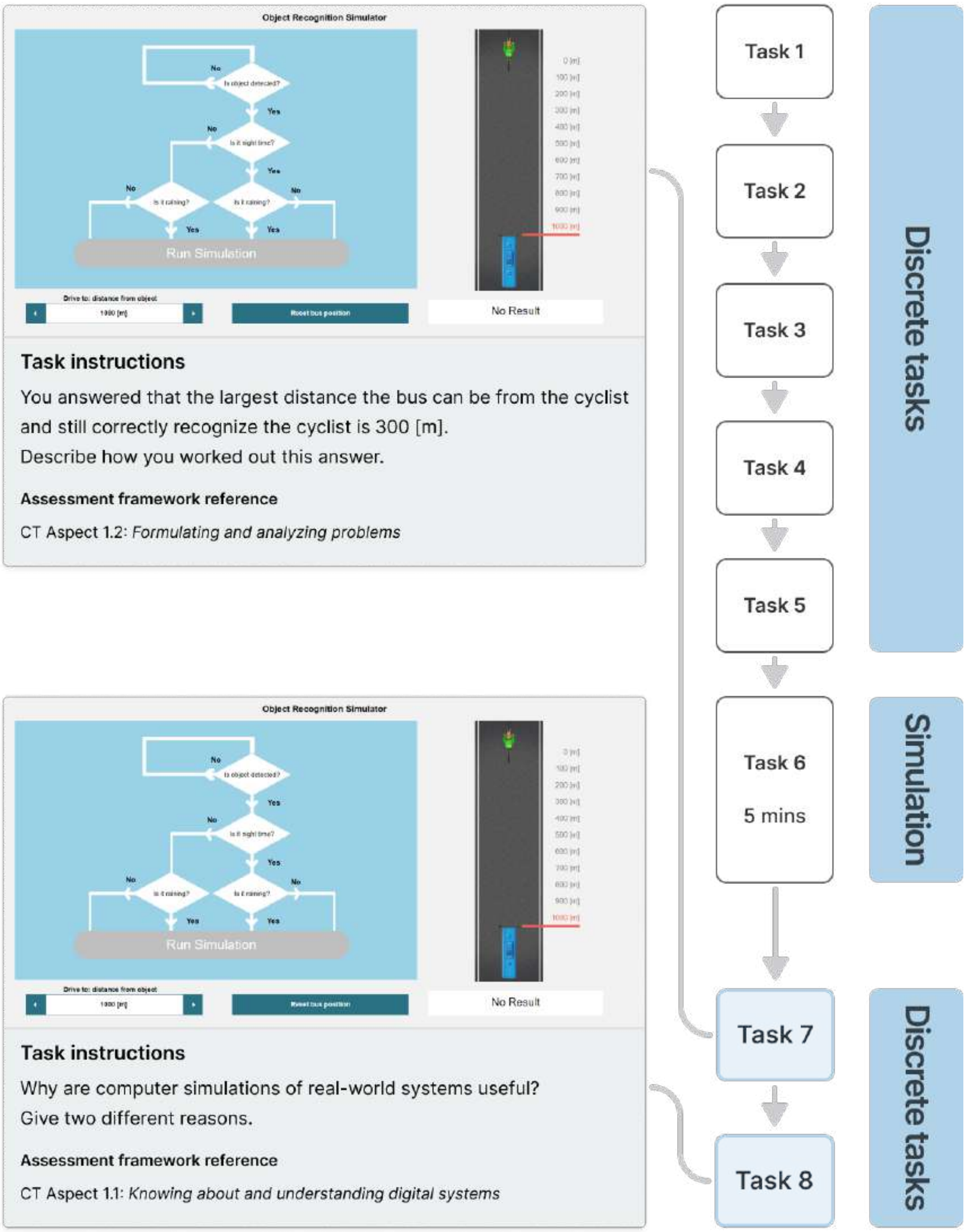
The key CT concepts and cognitive processes involved in task seven of the Automated bus module were as follows:

- **Iteration**: Iteratively testing and refining the simulation to find the largest distance at which the bus can still accurately detect a cyclist.
- **Algorithmic thinking**: Developing a structured sequence of steps (decision tree) to evaluate different conditions (e.g., object detection, night time, raining) that affect object recognition.
- **Simulation**: Using a virtual model to test and analyze the performance of the bus's object recognition system under various scenarios.

The task relates to CT aspect 1.2: Formulating and analyzing problems.

Task eight reflected CT aspect 1.1: Knowing about and understanding digital systems, by asking students to reflect on the purpose of simulating real-world systems, in particular on the potential benefits of using computer simulations to collect information about potential solutions to real-world problems. The key CT concept assessed was computer simulations, and the cognitive process involved was reasoning—specifically, reasoning about how simulations can model real-world systems to test and predict outcomes under various conditions.

Figure F.4: CT release module, Automated bus tasks 7 – 8



F.2 Farm drone

The Farm drone module was designed to assess aspects of CT strand 2: Operationalizing solutions, where students worked in a block-based coding environment to create, test, and debug the conditional logic, loops, and commands that control a farming drone's actions (see Subsection 4.3 for more information about the block-based coding environment).

Farm drone tasks 1 – 3

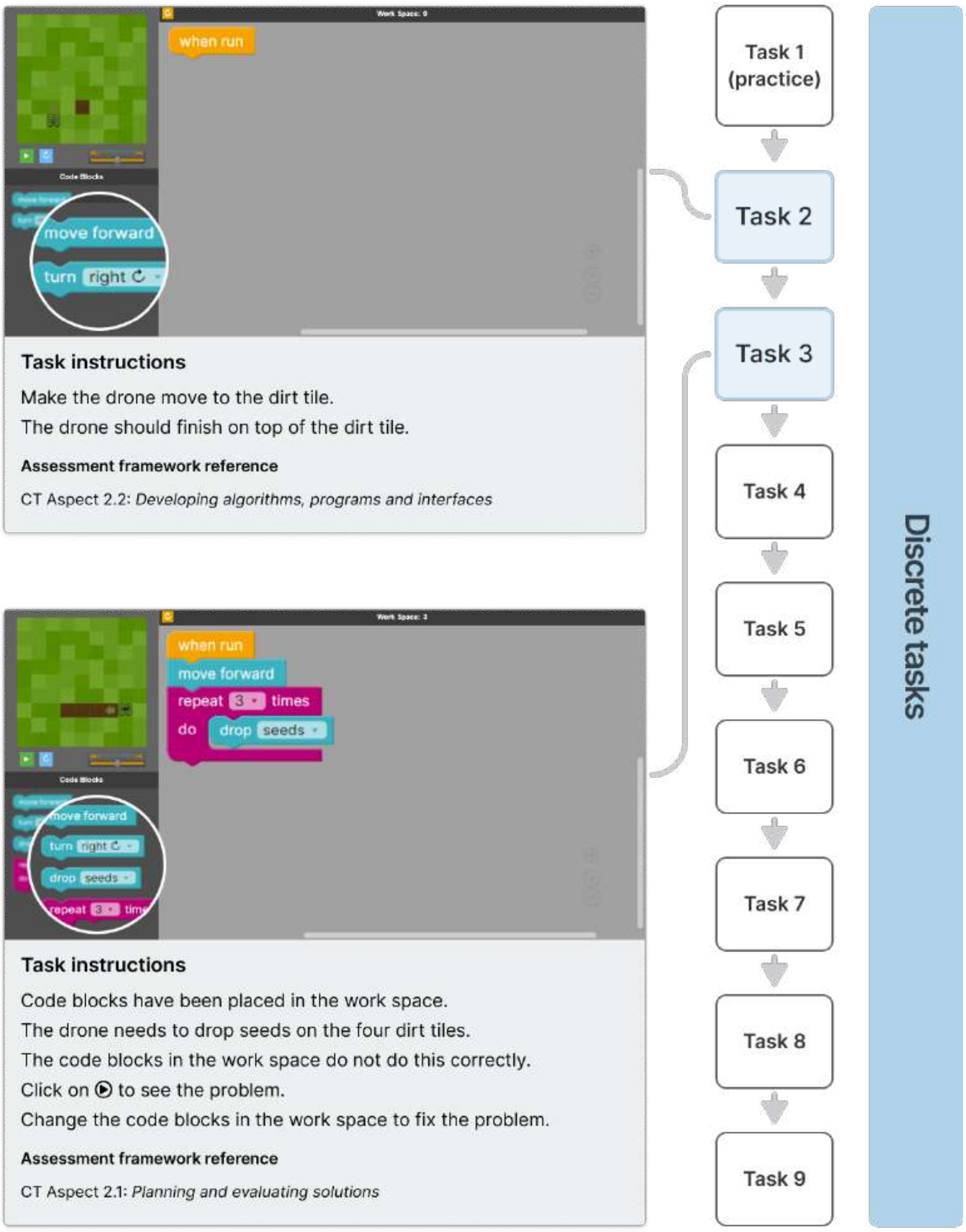
The first task in the Farm Drone module was a practice task that required students to simply make the drone move forward by one tile.

Task two (Figure F.5) was a low-complexity code creation task that required students to create a sequence of "move forward" and "turn left/right" actions that made the drone move to and stop on the dirt tile. The task is of low-complexity because there was only one type of code function (movement) and only one target tile.

The key CT concepts and cognitive processes involved in task two of the Farm drone module were as follows:

- **Sequencing**: Arranging commands in the correct order to achieve the desired outcome.
- **Algorithm design**: Developing a step-by-step solution to navigate the drone to the target tile.
- **Directional movement**: Understanding and applying directional commands to control the drone's movements.

Figure F.5: CT release module, Farm drone tasks 2 – 3



Task three (Figure F.5) was a debugging task that introduced two new code blocks. One was an action function that made the drone drop one of three configurable materials (seeds/water/fertilizer) on the tile below the drone's current position. The other was a loop, referred to as "repeat do," that could be configured to repeat actions (or any code block) a specified number of times. Students were required to make the drone drop seeds on the four dirt tiles. However, the default algorithm presented to students was designed to make the drone move to the first dirt tile in front of it, and then drop seeds on that tile three times. Students were instructed to change the code blocks in the work space to fix the problem.

The loop increased the complexity of the task because the "move forward" action is repeated, the drone's position does not directly correspond to the number of movement code blocks, reducing the level of visual support compared to linear solutions that use separate action commands for each step.

In the latter approach, students can identify an error in the display (e.g., the drone dropping water on a non-crop tile) by counting the number of actions before the error occurred and then counting the same number of code blocks in sequence to pinpoint the step responsible for the error.

The key CT concepts and cognitive processes involved in task three of the Farm drone module were as follows:

- **Loops**: Utilizing repetition to efficiently perform the same action multiple times, specifically using the 'repeat do' block.
- **Sequencing**: Arranging commands in the correct order to achieve the desired outcome of moving and dropping seeds.
- **Conditional logic**: Applying conditions to control the flow of the program based on specific criteria (e.g., reaching a dirt tile).
- **Efficiency**: Creating an efficient solution using the fewest number of code blocks to complete the task.

Farm drone tasks 4 – 5

Task four (Figure F.6) was a code creation task that required students to create code that made the drone drop water on the four dirt tiles with seeds (the targets) without dropping water on any of the grass tiles using the "repeat do" code block.

The key CT concepts and cognitive processes involved in task four of the Farm drone module were as follows:

- **Loops**: Utilizing repetition to efficiently perform the same action multiple times, specifically using the 'repeat do' block.
- **Sequencing**: Arranging commands in the correct order to achieve the desired outcome of moving and dropping seeds.
- **Conditional logic**: Applying conditions to control the flow of the program based on specific criteria (e.g., reaching a dirt tile).
- **Optimization**: Optimizing a solution to use the fewest number of code blocks to complete the task correctly.

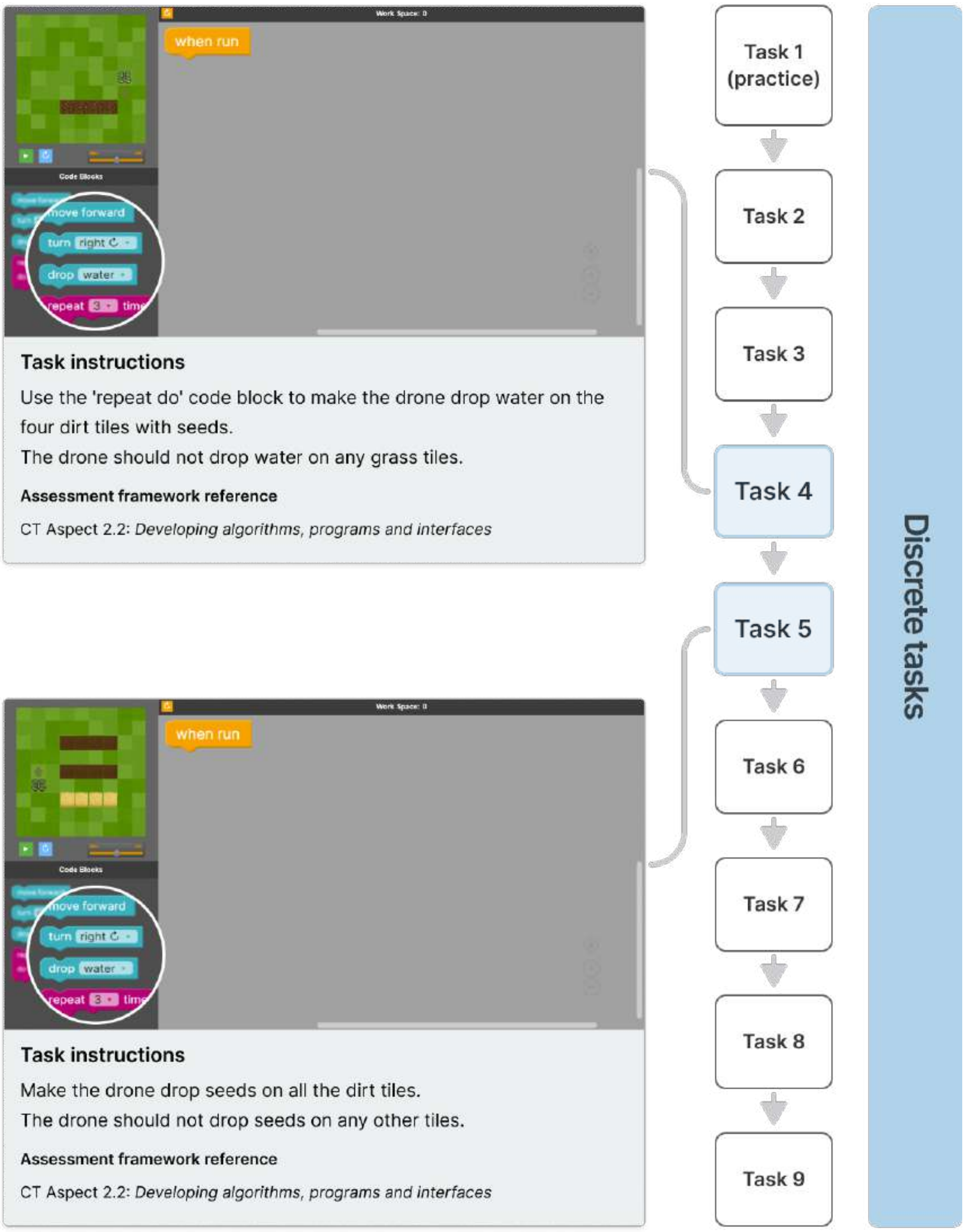
The objectives of task five (Figure F.6) required students to make the drone drop seeds onto the dirt tiles, without dropping seeds on any other tiles. Task five introduced an additional row of target tiles, increasing from four targets to eight targets. This change in the layout configuration of the targets emphasized the importance of using loops when completing the task using the fewest number of code blocks. Code solutions that did not use loops required at least 22 code blocks compared to 12 code blocks for solutions that did use loops.

The key CT concepts and cognitive processes involved in task five of the Farm drone module were as follows:

- **Loops**: Utilizing repetition to efficiently perform the same action multiple times, specifically using the 'repeat do' block.
- **Sequencing**: Arranging commands in the correct order to achieve the desired outcome of moving and dropping seeds.
- **Conditional logic**: Ensuring that seeds are only dropped on dirt tiles and not on any other type of tile, like grass.

- **Optimization**: Optimizing a solution to use the fewest number of code blocks to complete the task correctly.

Figure F.6: CT release module, Farm drone tasks 4 – 5



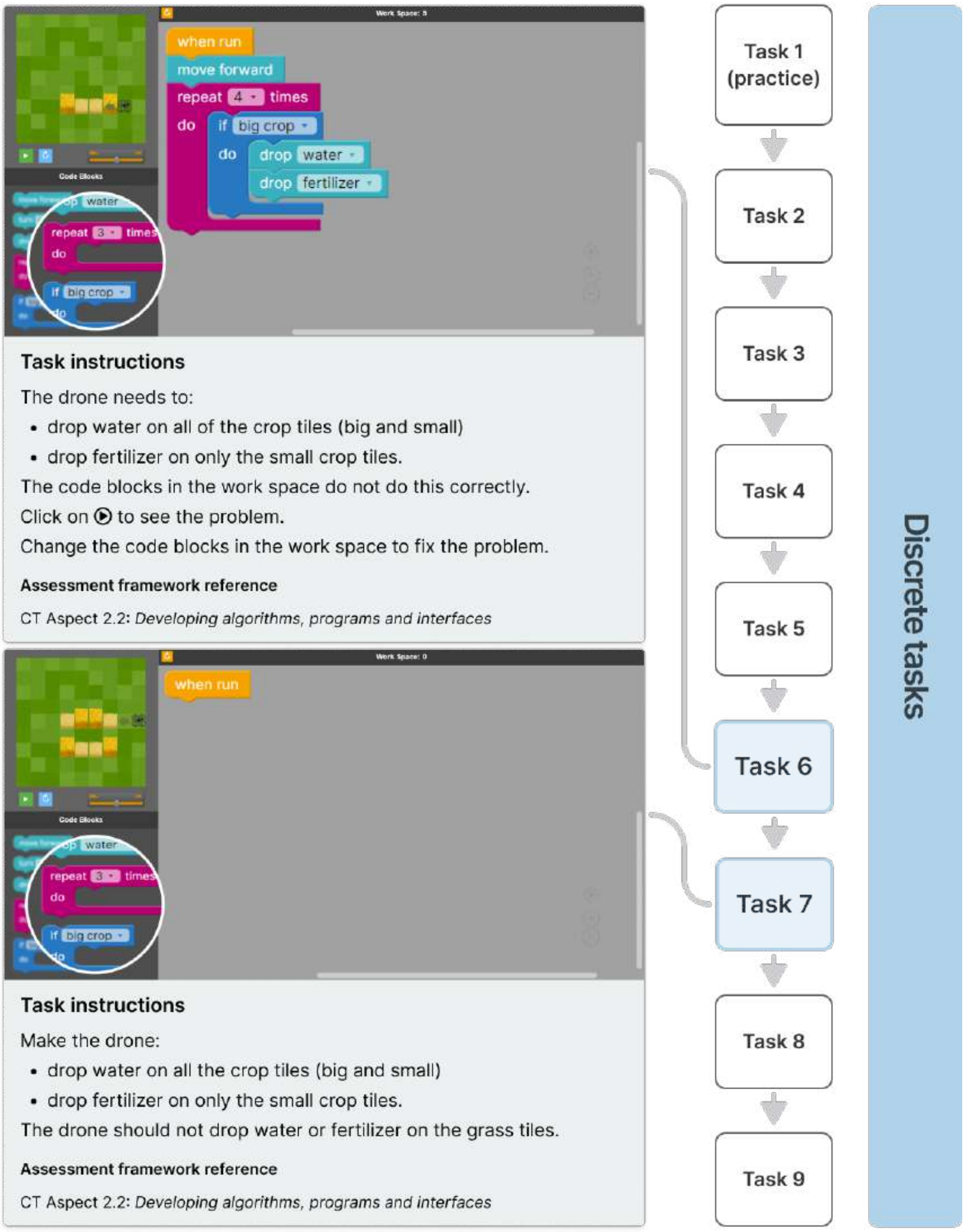
Farm drone tasks 6 – 7

Task six (Figure F.7) was a high-complexity debugging task. The objective was to make the drone drop water on the big and small crop tiles and fertilizer on only the small crop tiles. The work space was prepopulated with a five-statement algorithm with an if statement nested inside a repeat statement that students had to modify to complete the objective. In the logic of the existing algorithm, the decision to drop water and fertilizer was conditional on the size of the crop.

The key CT concepts and cognitive processes involved in task six of the Farm drone module were as follows:

- **Sequencing**: Arranging commands in the correct order to achieve the desired outcome of moving, watering, and fertilizing the crops.
- **Loops**: Utilizing repetition to efficiently perform the same action multiple times, specifically using the 'repeat do' block to navigate the tiles.
- **Conditional logic**: Using conditional statements to determine whether the drone should drop water or fertilizer based on the size of the crop tile.
- **Optimization**: Optimizing a solution to use the fewest number of code blocks to complete the task correctly.

Figure F.7: CT release module, Farm drone tasks 6 – 7



Task seven was a high-complexity code creation task. In addition to the objectives specified in task six, the number of targets was increased from four to eight across two rows. The most efficient solutions, using loops with nested conditionals, required 19 code blocks at most. Solutions that did not use loops needed 24 code blocks.

The key CT concepts and cognitive processes involved in task seven of the Farm drone module were as follows:

- **Sequencing**: Arranging commands in the correct order to move the drone and perform actions accurately on different tile types.
- **Loops**: Utilizing repetition to efficiently perform the same action across multiple tiles, minimizing the number of commands needed.
- **Conditional logic**: Using if-else statements to check the type of tile and determine whether to drop water, fertilizer, or nothing.
- **Optimization**: Optimizing the sequence of commands to use the fewest number of blocks while achieving the correct outcome.

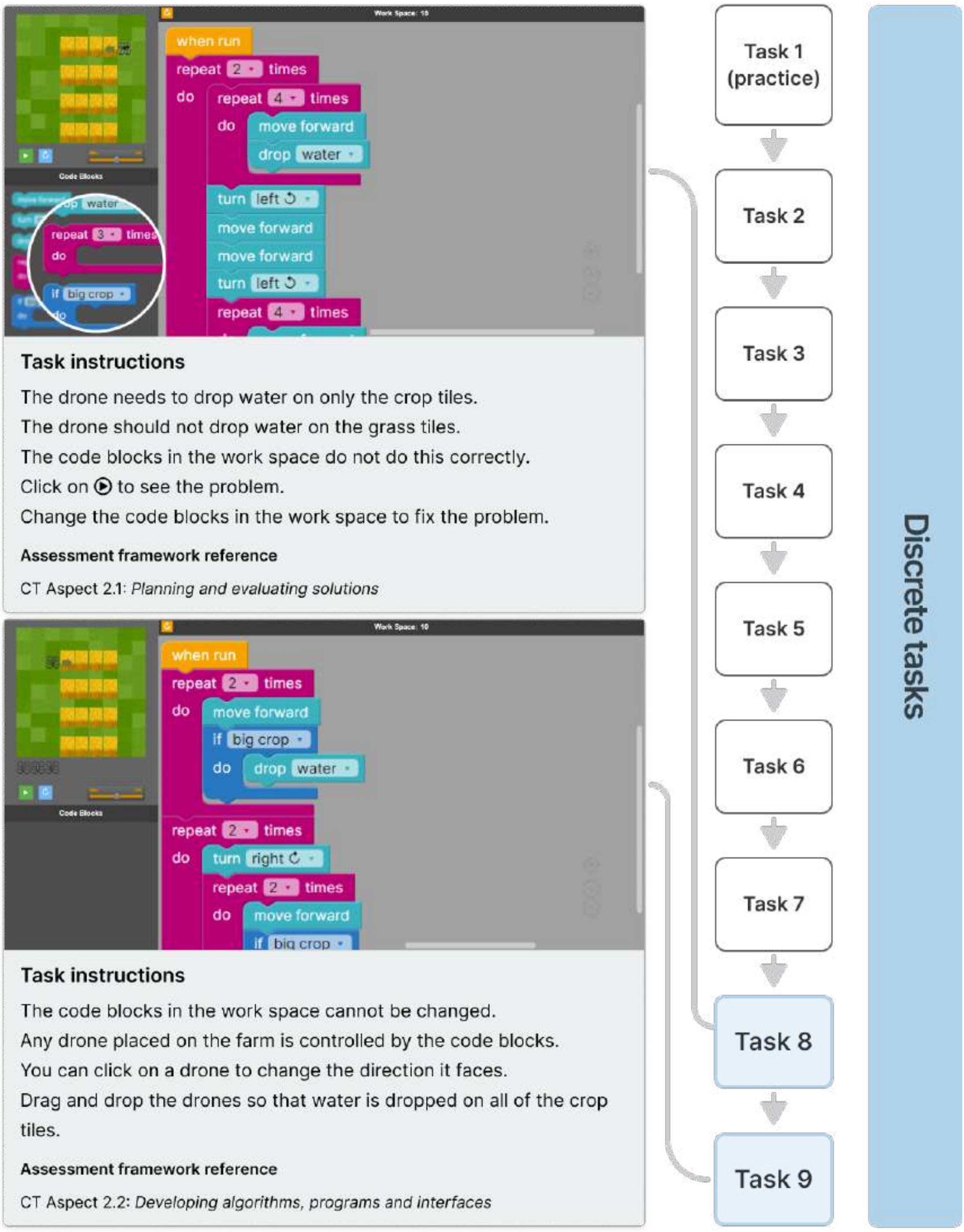
Farm drone tasks 8 – 9

Task eight was a debugging task that required students to make the drone drop water on only the nine crop tiles. This task introduced a "repeat do" code block nested inside another "repeat do" code block.

The key CT concepts and cognitive processes involved in task eight of the Farm drone module were as follows:

- **Sequencing**: Arranging commands in the correct order to move the drone and perform actions accurately on different tile types.
- **Loops**: Utilizing repetition to efficiently perform the same action across multiple tiles, minimizing the number of commands needed.
- **Conditional logic**: Using if-else statements to check the type of tile and determine whether to drop water or not.
- **Optimization**: Optimizing the sequence of commands to use the fewest number of blocks while achieving the correct outcome.

Figure F.8: CT release module, Farm drone tasks 8 – 9



Task nine did not involve debugging or constructing an algorithm. Instead, the algorithm in the work space controlled the actions of multiple drones that were dragged onto a tile in the farm drone display space. A drone in the display space could be moved by simply dragging it to another tile and its direction could be changed by left clicking it. Students were required to make the drones drop water on all crop tiles.

The key CT concepts and cognitive processes involved in task nine of the Farm drone module were as follows:

- **Decomposition**: Breaking down the overall task into smaller, manageable parts, such as moving the drone, checking tile types, and performing the appropriate action.
- **Algorithmic thinking**: Designing step-by-step instructions to accomplish a specific task, in this case, ensuring all crop tiles are watered.
- **Pattern recognition**: Identifying the patterns in tile arrangements and drone movements to optimize the placement and orientation of drones.
- **Conditional logic**: Using conditions to determine the actions of the drones based on the type of tile they encounter.

The task assessed the skills and knowledge related to parallel processing and thus reflects CT aspect 2.2: Developing algorithms, programs, and interfaces.

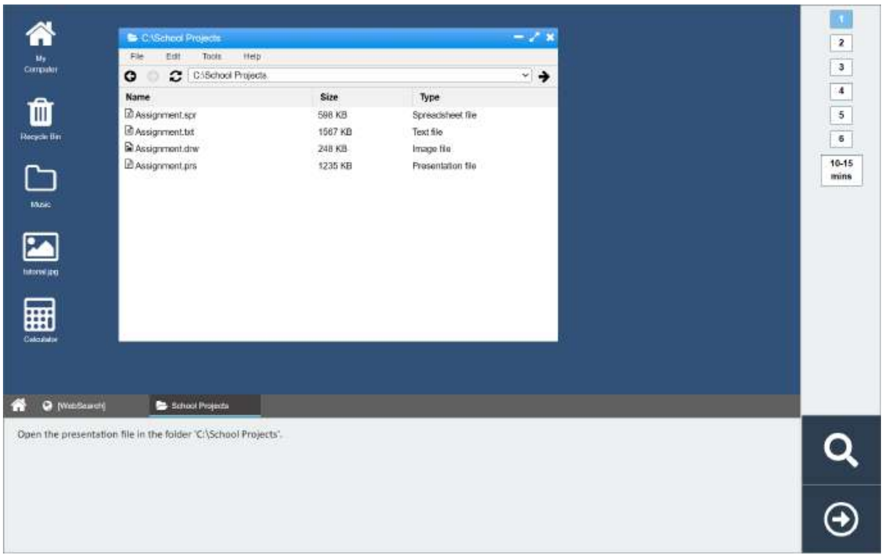
Appendix G:

CIL and CT release module screenshots

G.1 CIL modules

Figure G.1: Breathing module screenshots

(a) Breathing task 1



(b) Breathing task 2

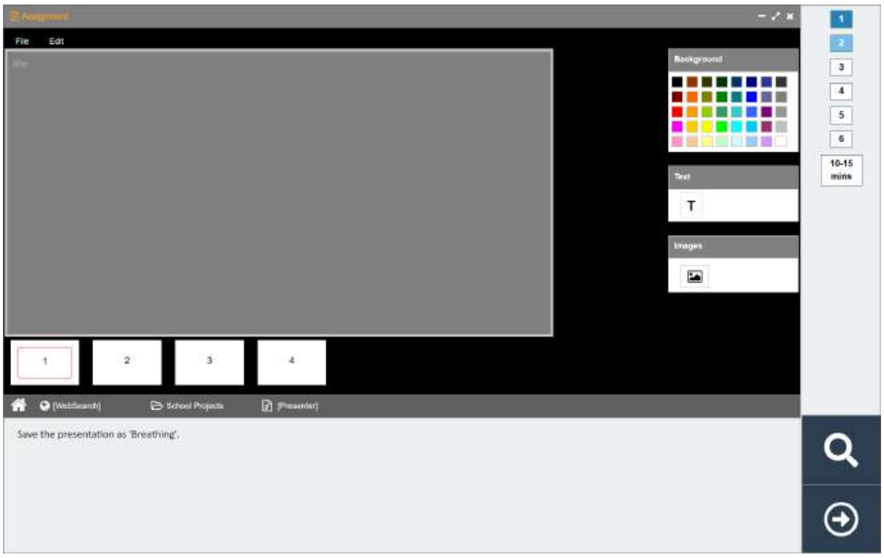
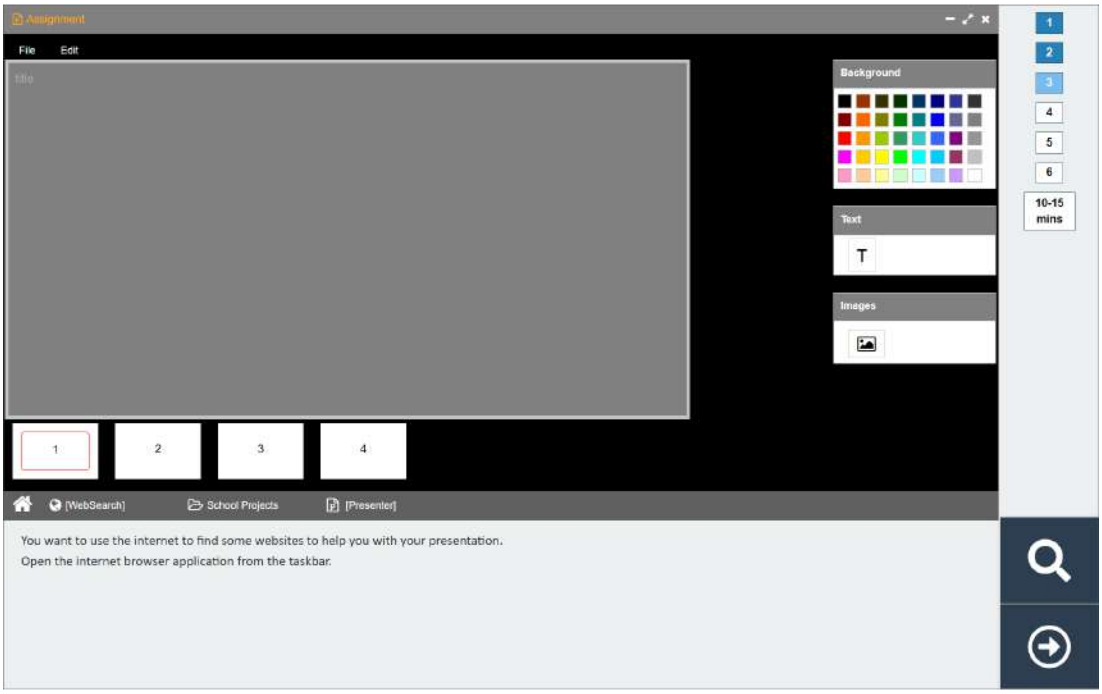


Figure G.1: Breathing module screenshots (cont'd)

(c) Breathing task 3



(d) Breathing task 4

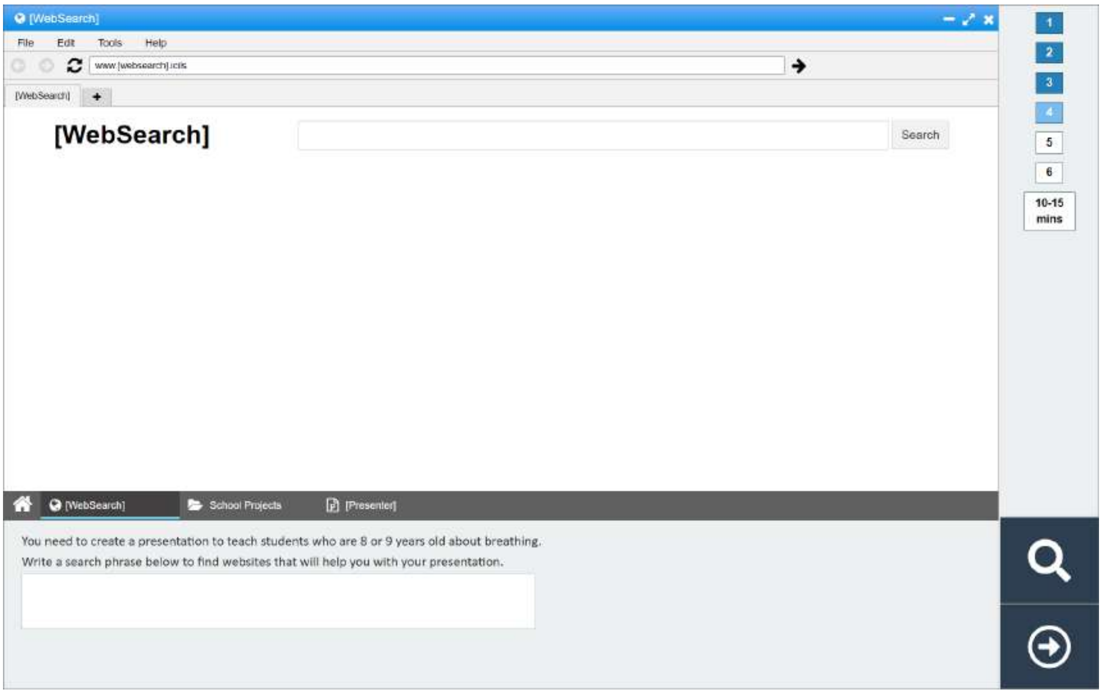
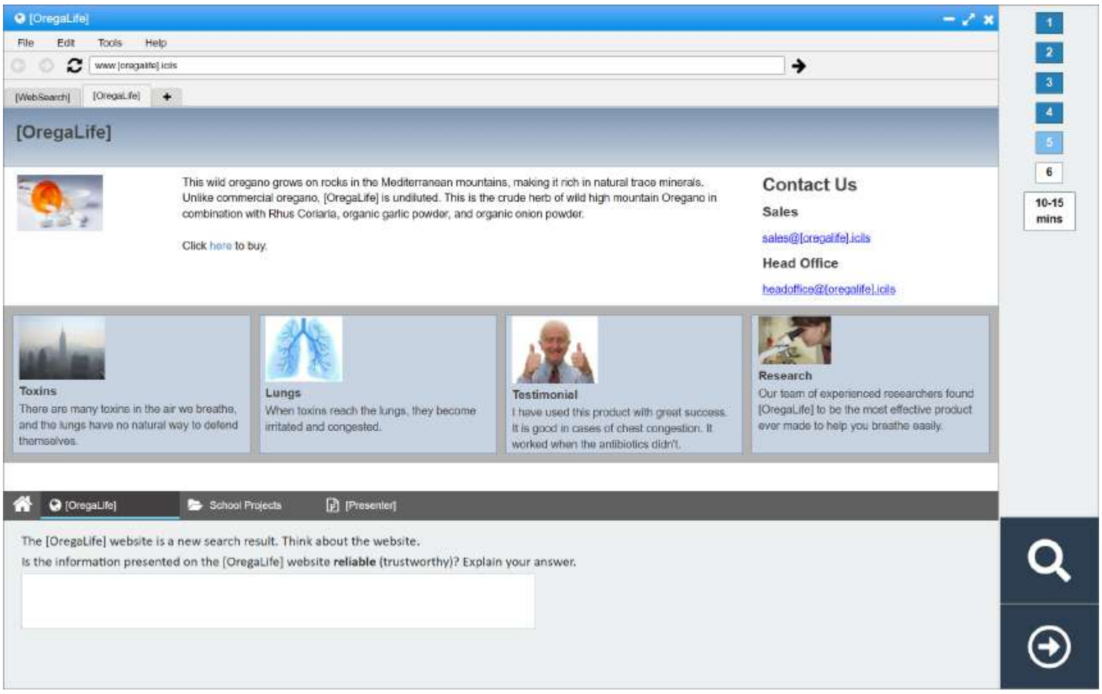


Figure G.1: Breathing module screenshots (cont'd)

(e) Breathing task 5



(f) Breathing task 6

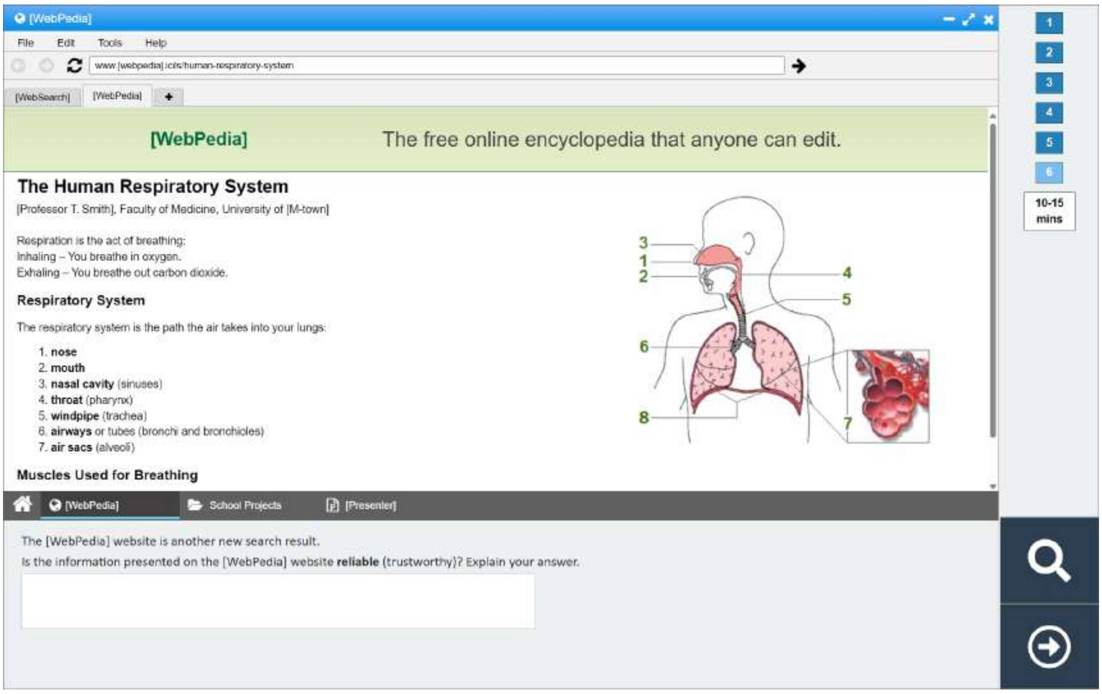


Figure G.1: Breathing module screenshots (cont'd)

(g) Breathing task 7 (large task)

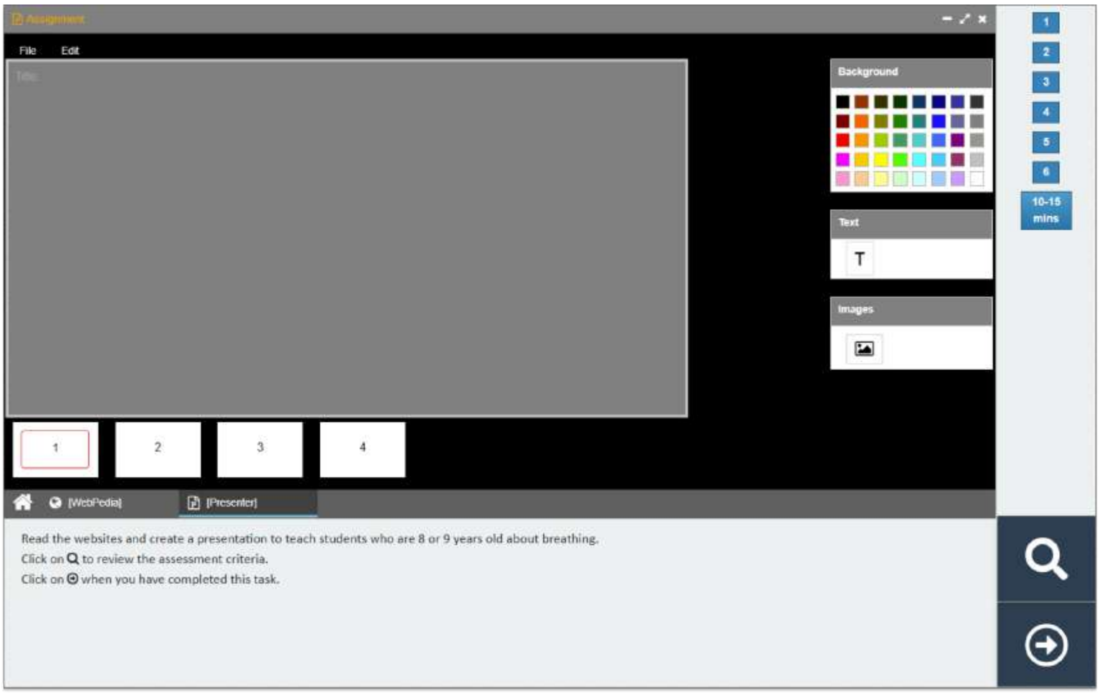
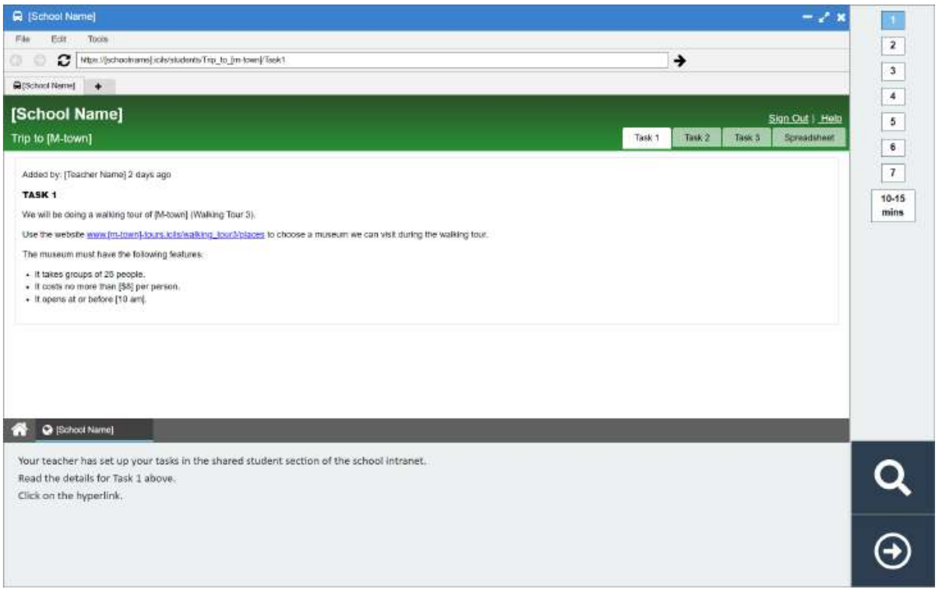


Figure G.2: School trip module screenshots

(a) School trip task 1



(b) School trip task 2

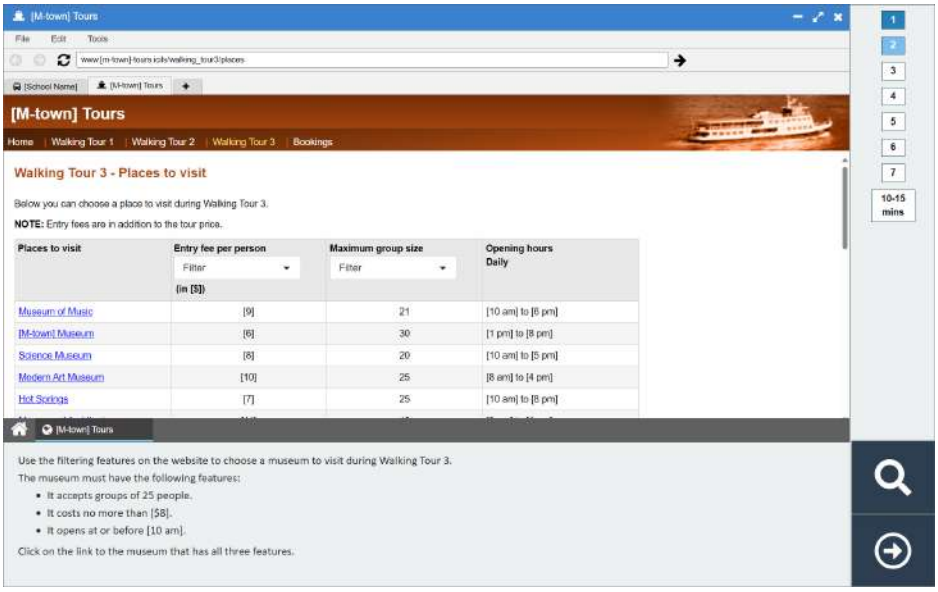
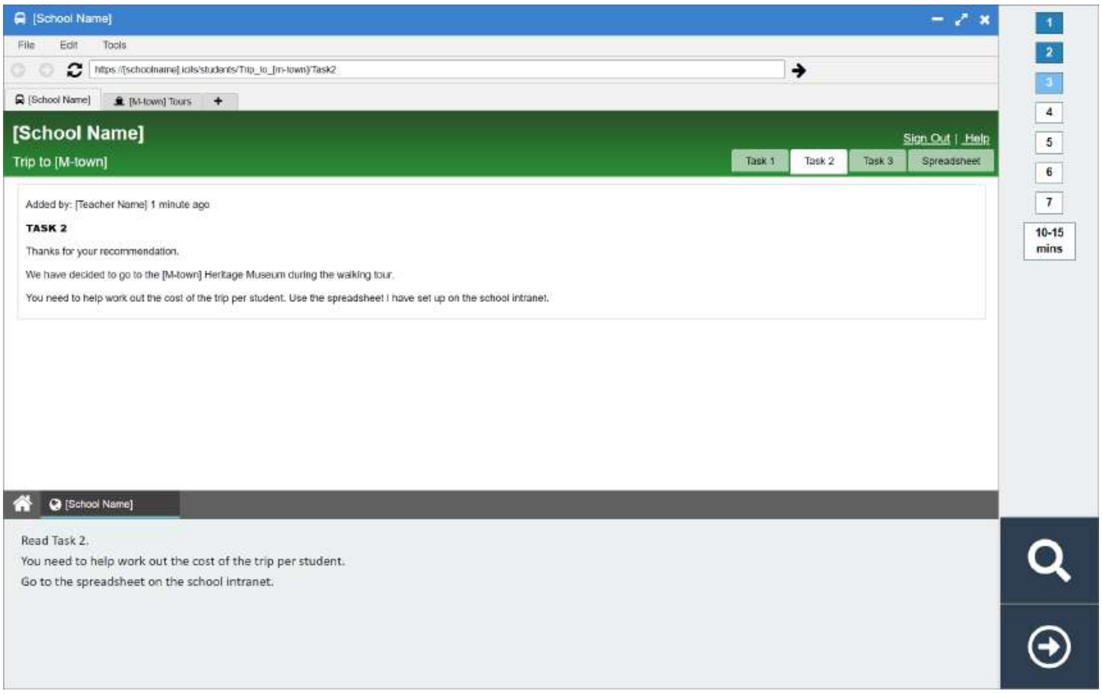


Figure G.2: School trip module screenshots (cont'd)

(c) School trip task 3



(d) School trip task 4

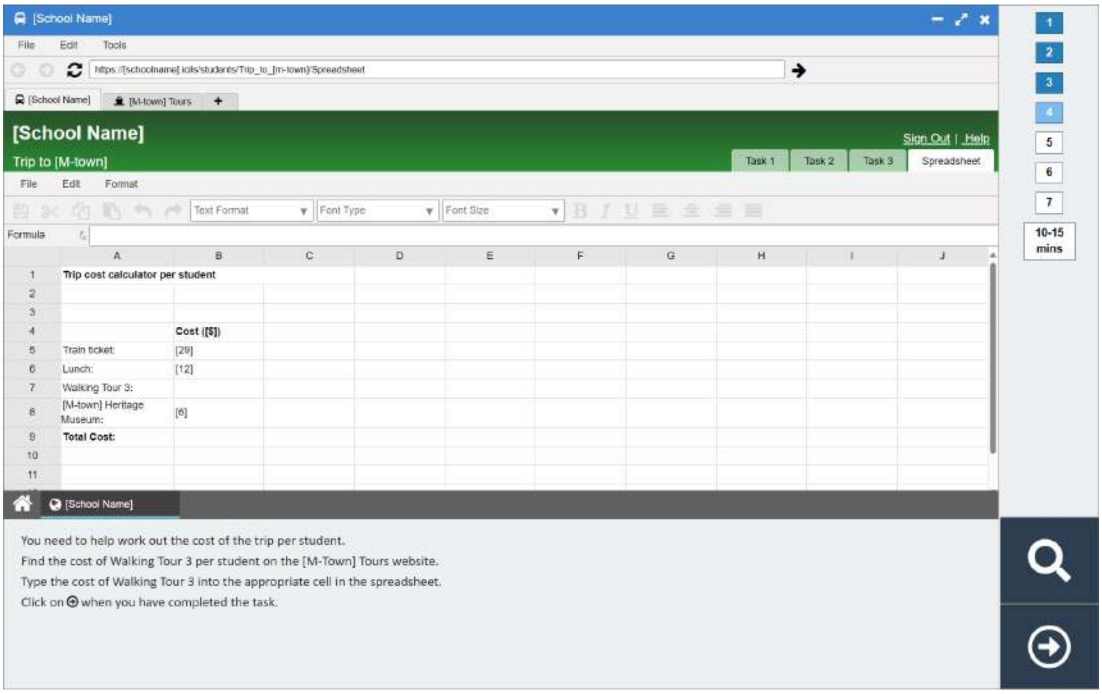
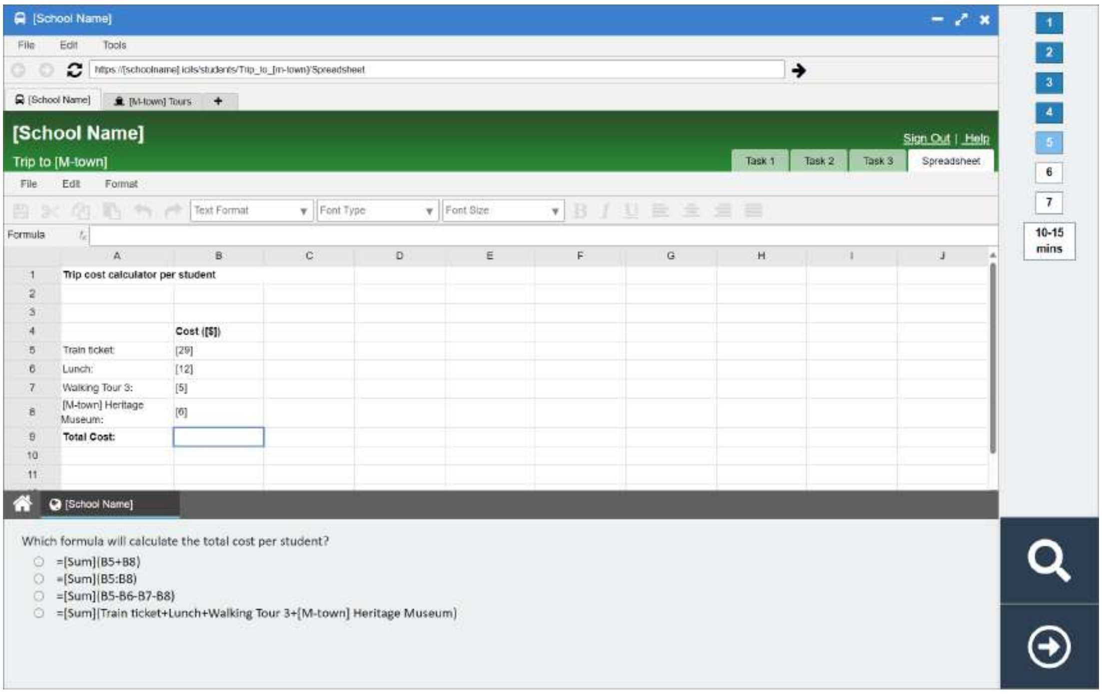


Figure G.2: School trip module screenshots (cont'd)

(e) School trip task 5



(f) School trip task 6

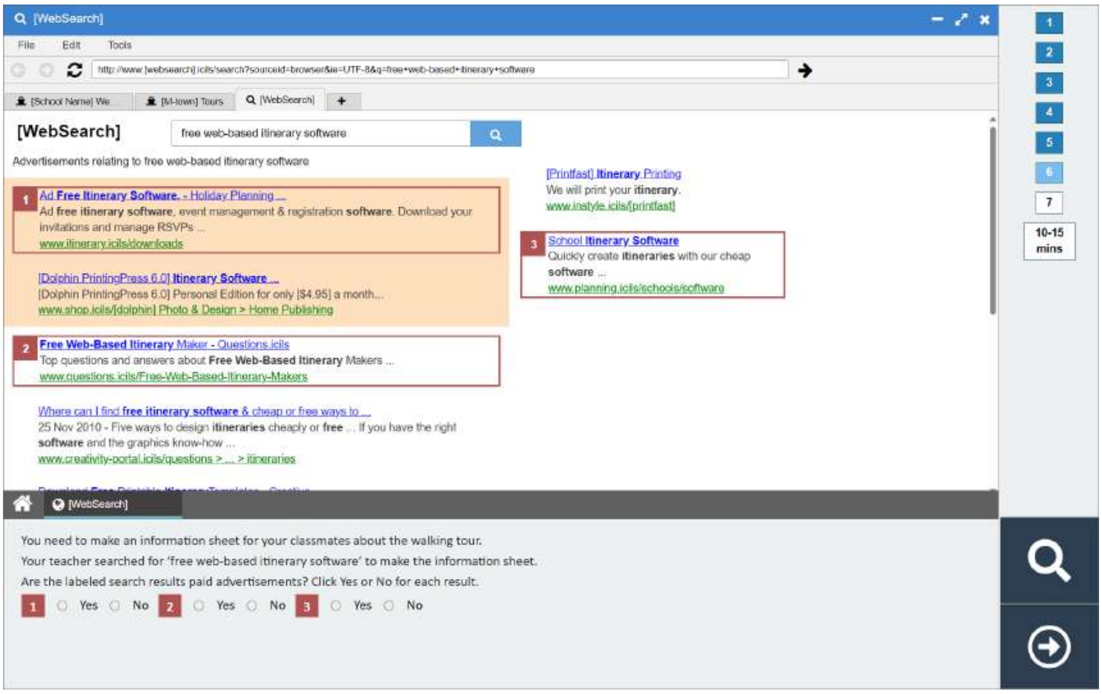
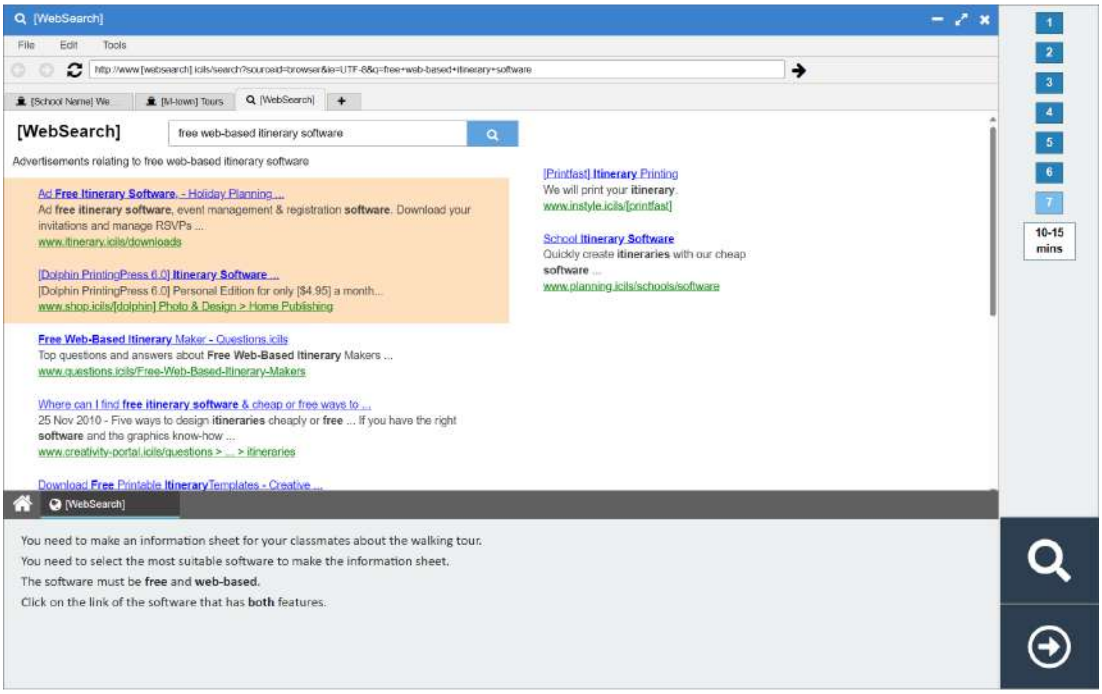
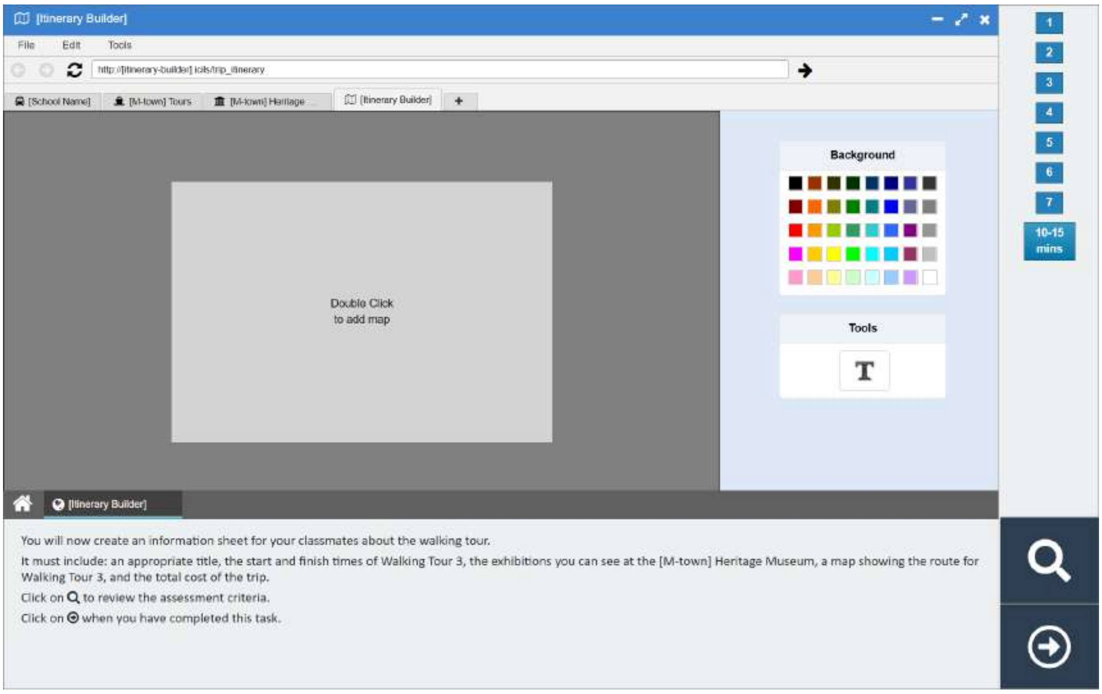


Figure G.2: School trip module screenshots (cont'd)

(g) School trip task 7



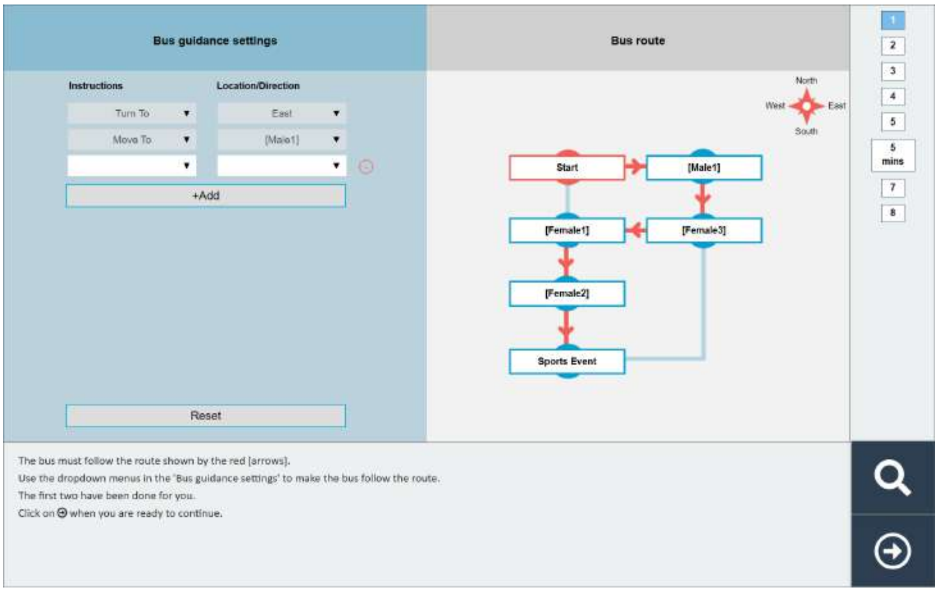
(h) School trip 8 (large task)



G.2 CT modules

Figure G.3: Automated bus module screenshots

(a) Automated bus task 1



(b) Automated bus task 2

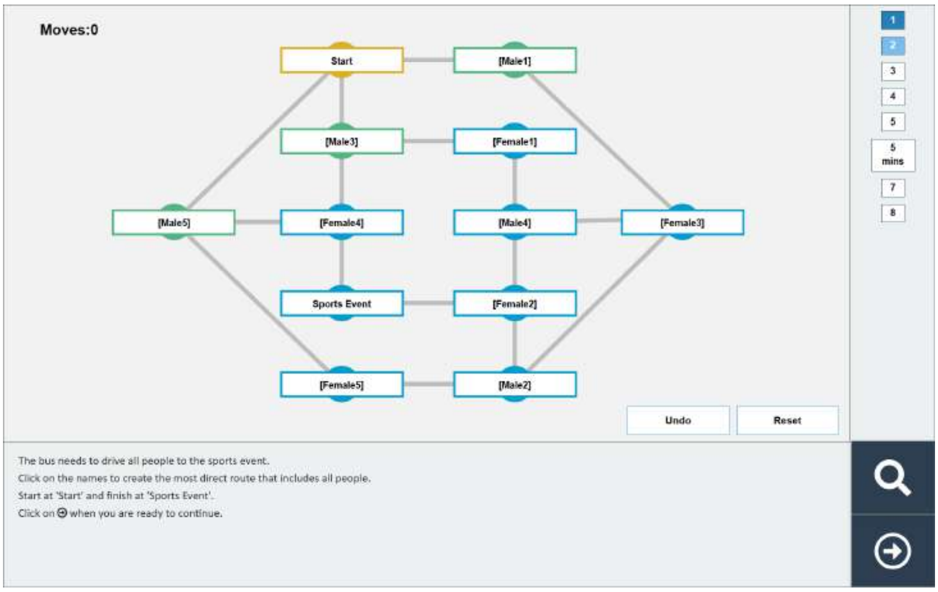
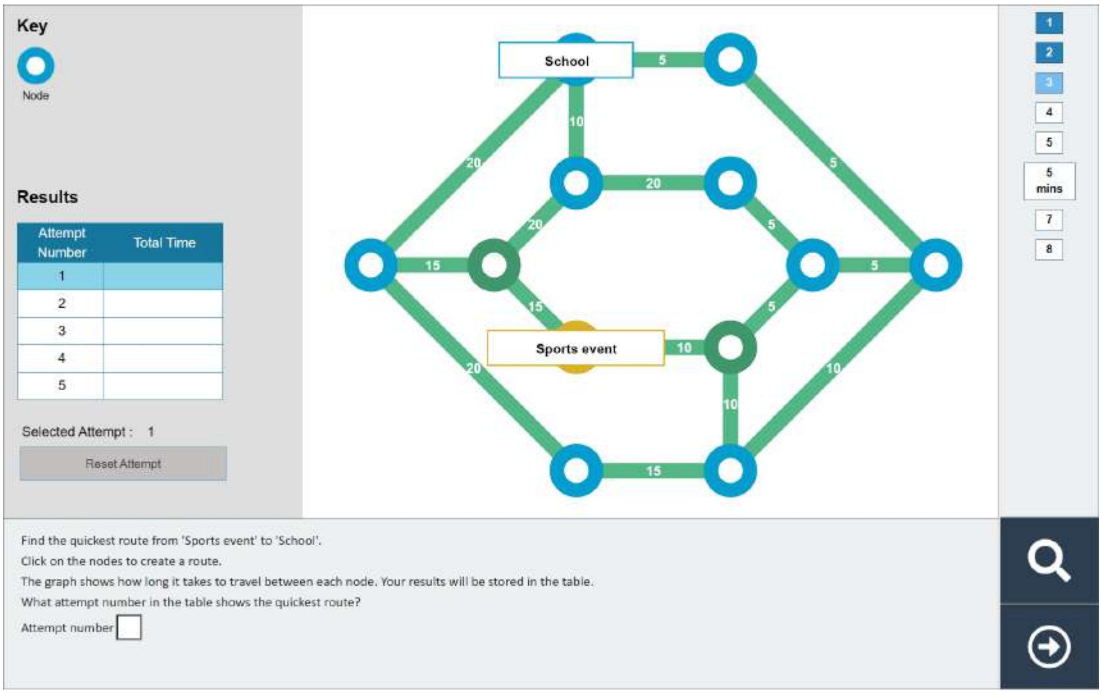


Figure G.3: Automated bus module screenshots (cont'd)

(c) Automated bus task 3



(d) Automated bus task 4

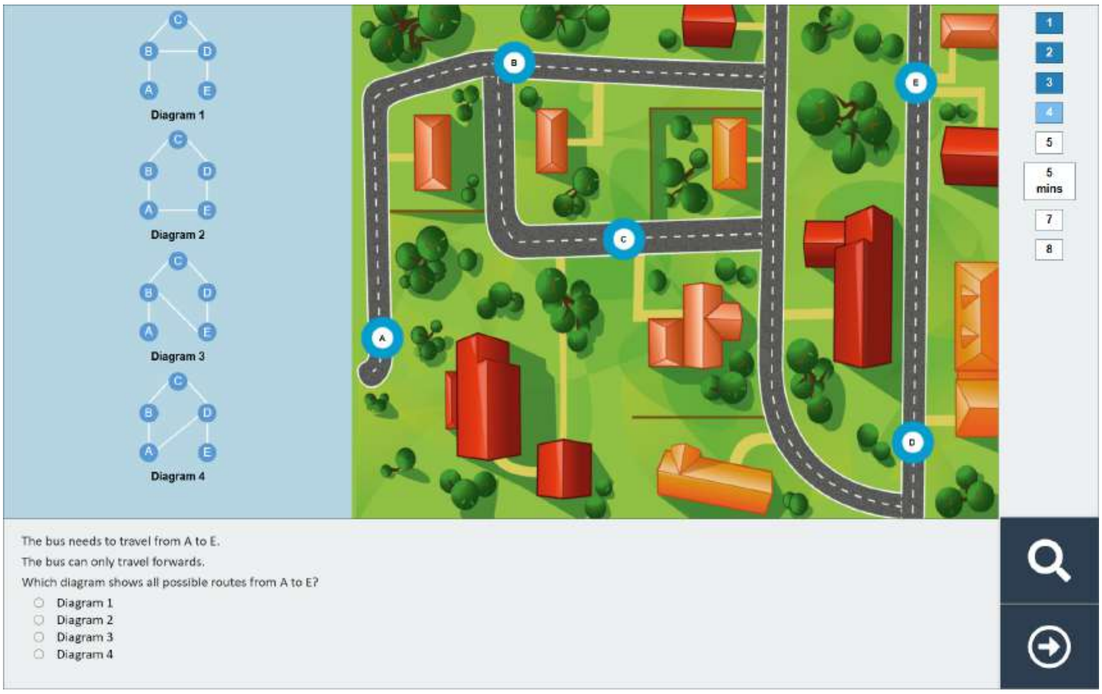
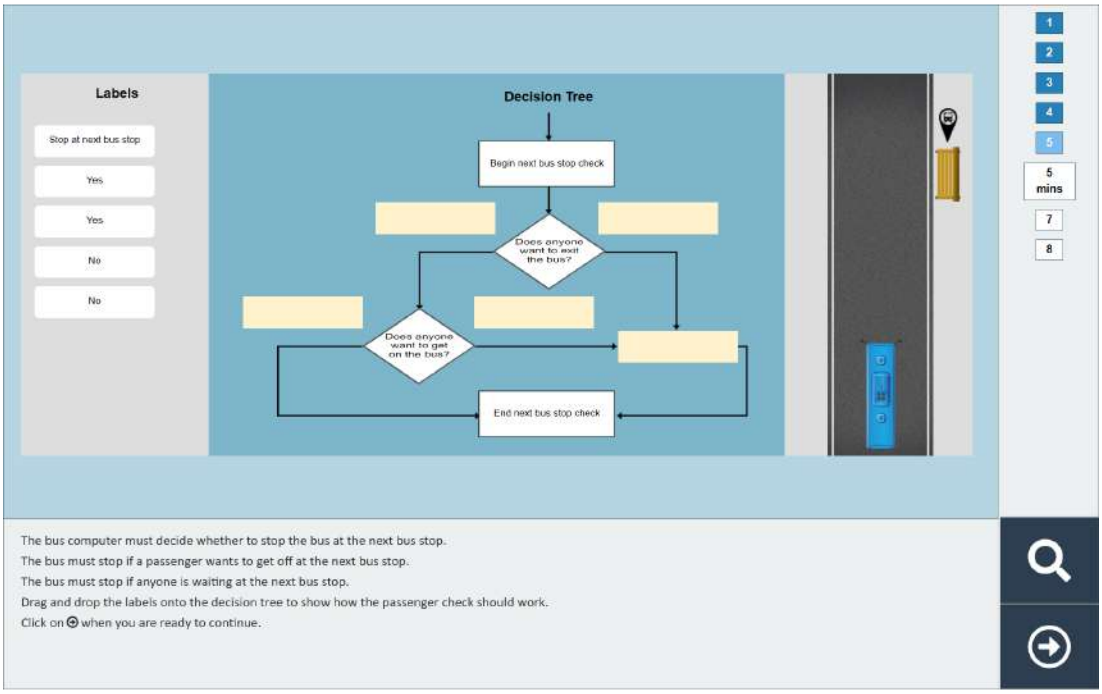


Figure G.3: Automated bus module screenshots (cont'd)

(e) Automated bus task 5



(f) Automated bus task 6 (simulation task)

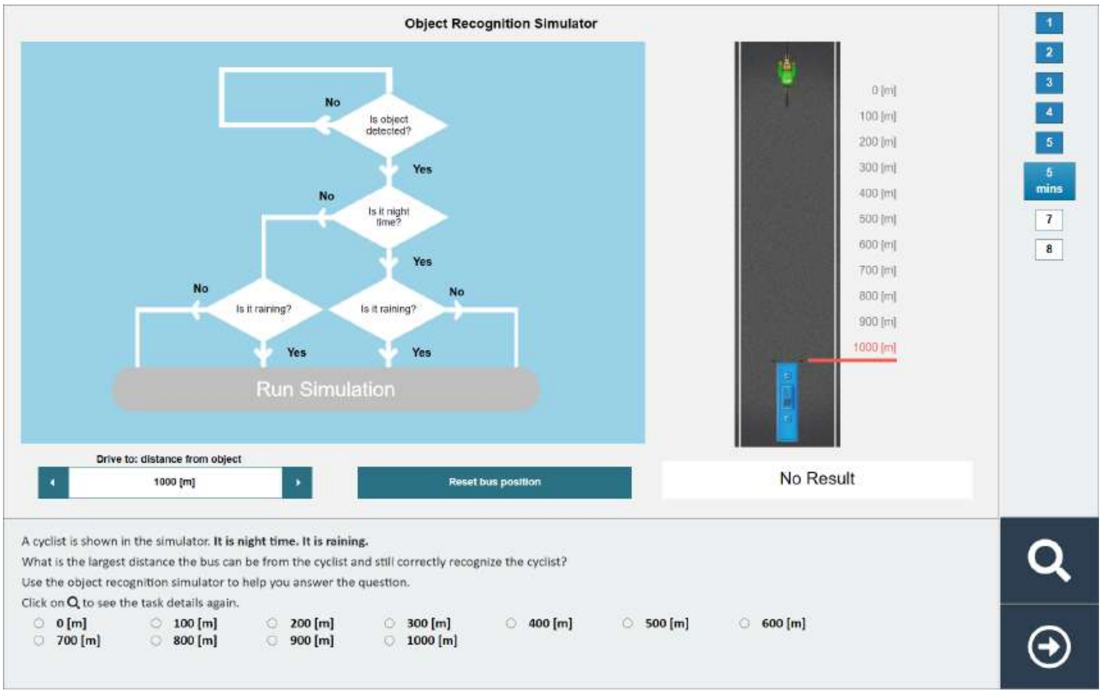
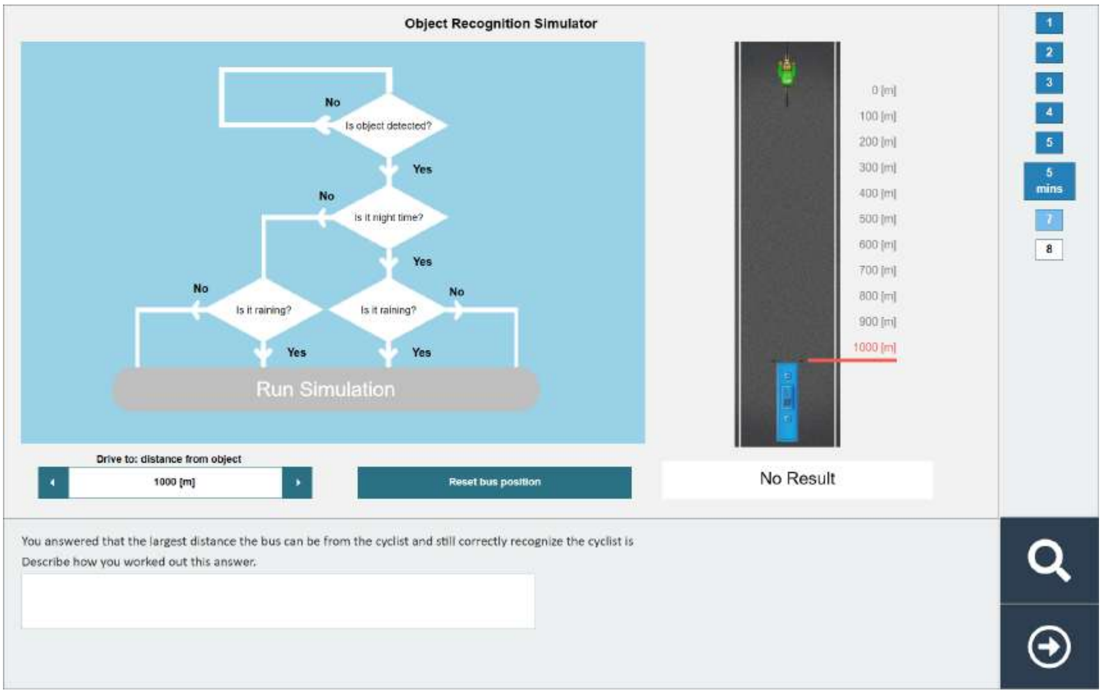


Figure G.3: Automated bus module screenshots (cont'd)

(g) Automated bus task 7



(h) Automated bus 8

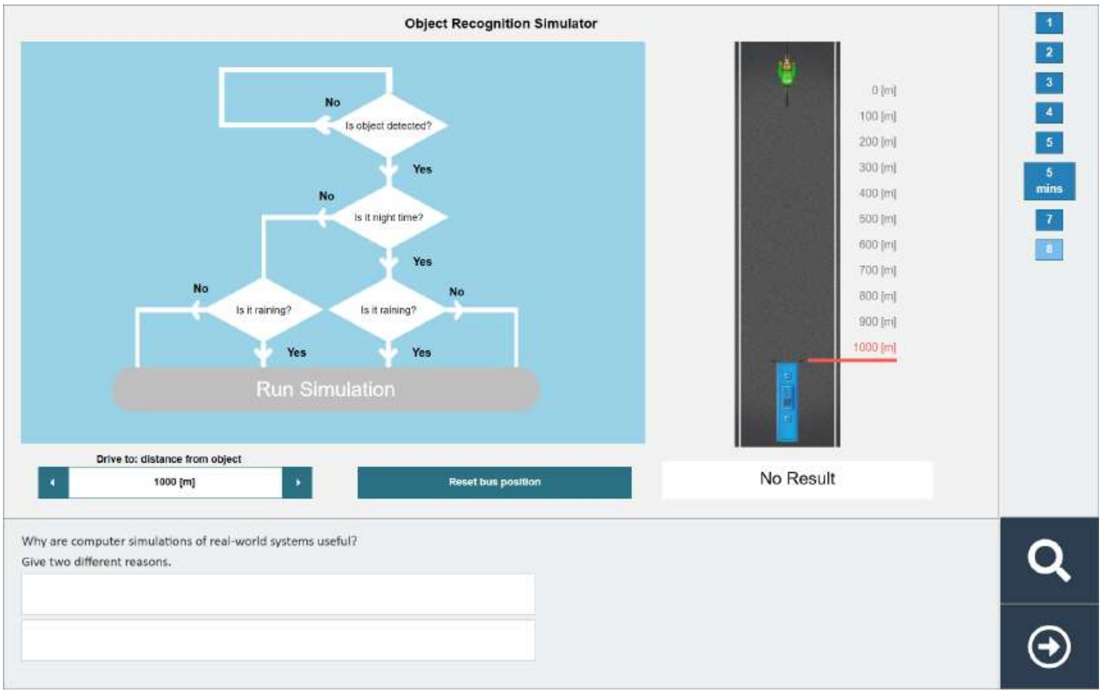
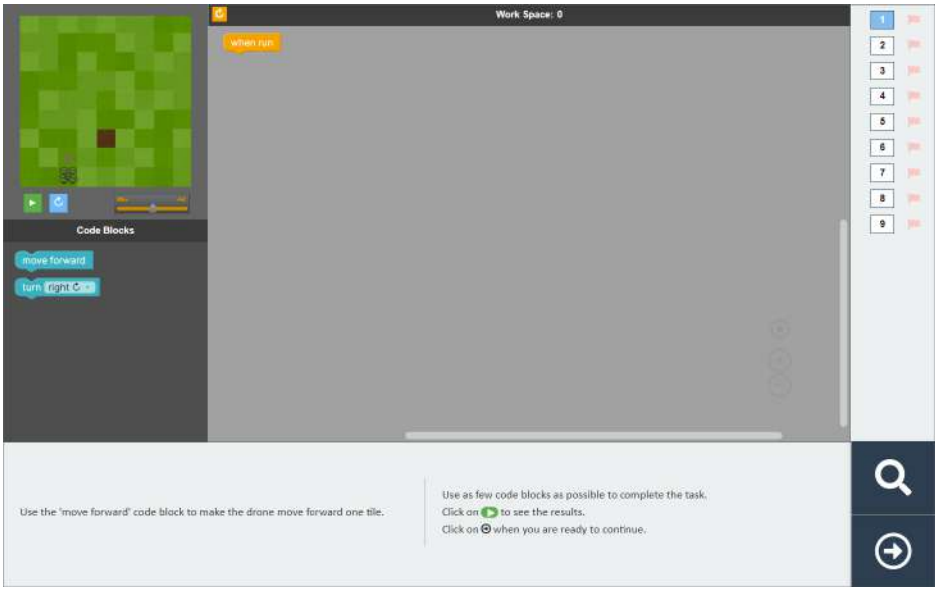


Figure G.4: Farm drone module screenshots

(a) Farm drone task 1



(b) Farm drone task 2

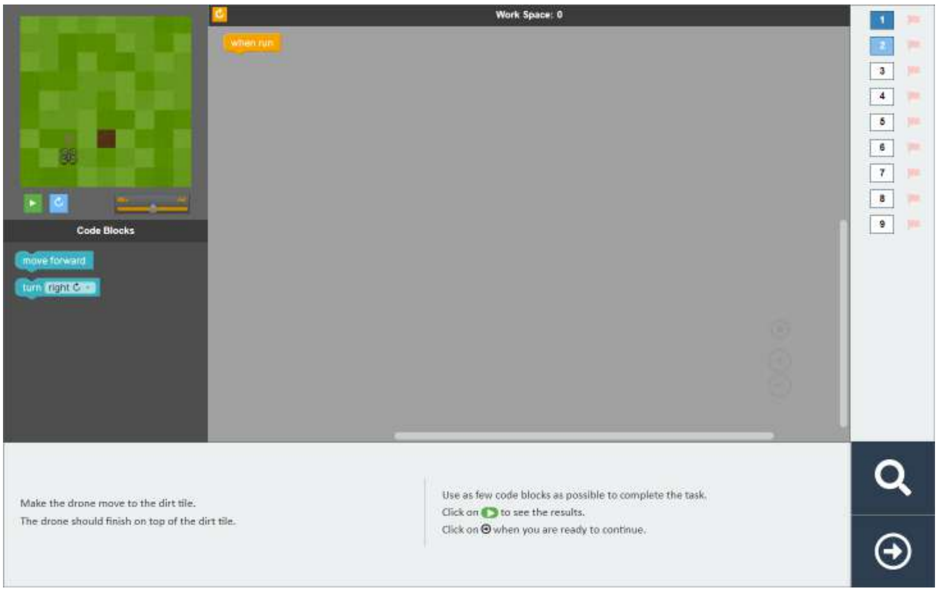
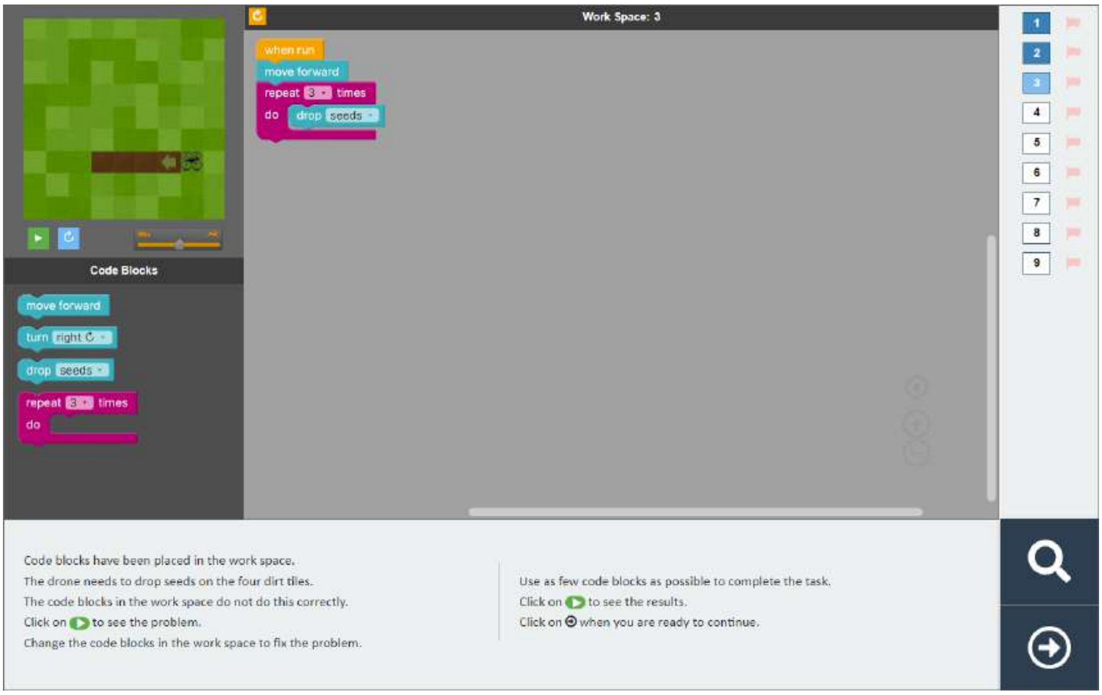


Figure G.4: Farm drone module screenshots (cont'd)

(c) Farm drone task 3



(d) Farm drone task 4

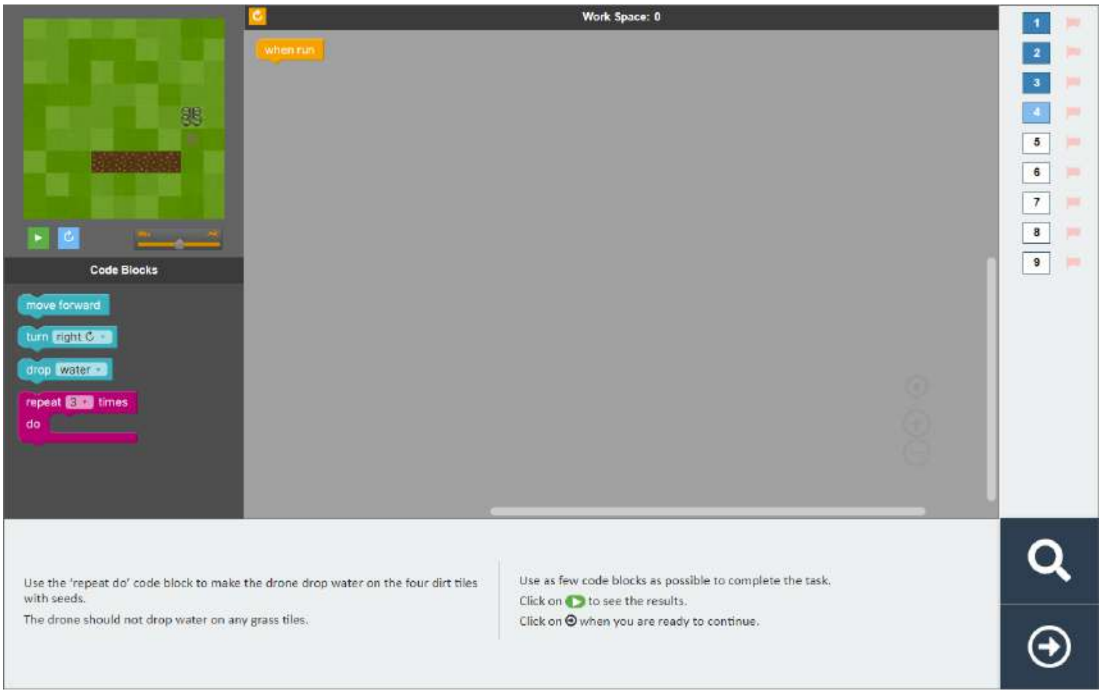
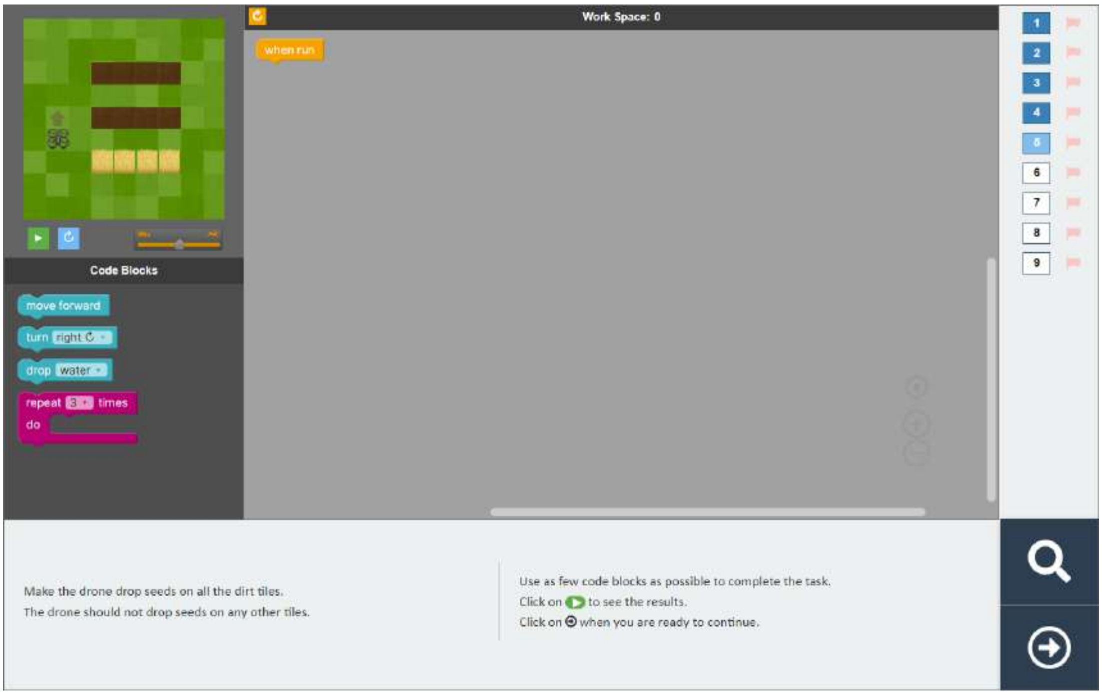


Figure G.4: Farm drone module screenshots (cont'd)

(e) Farm drone task 5



(f) Farm drone task 6

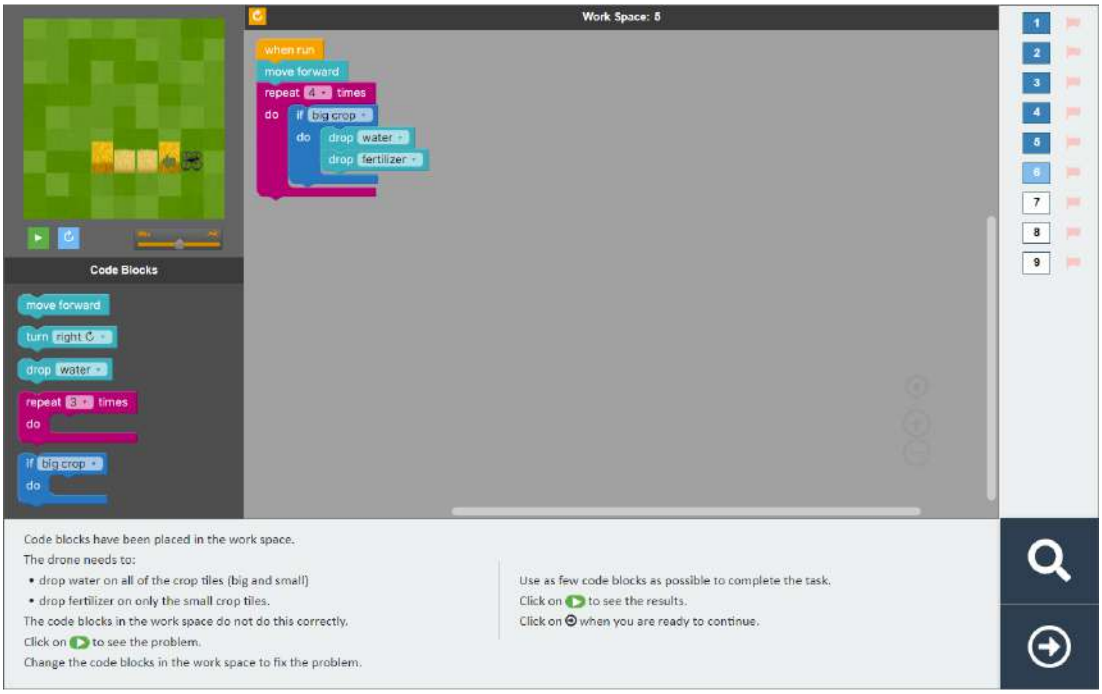
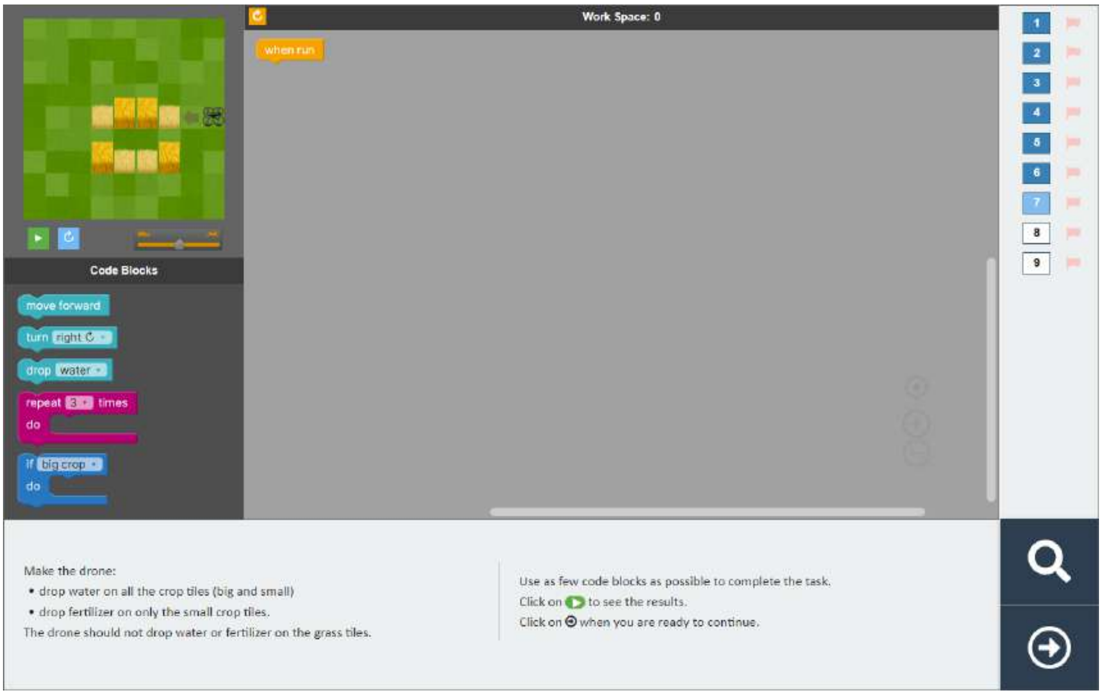


Figure G.4: Farm drone module screenshots (cont'd)

(g) Farm drone task 7



(h) Farm drone 8 (large task)

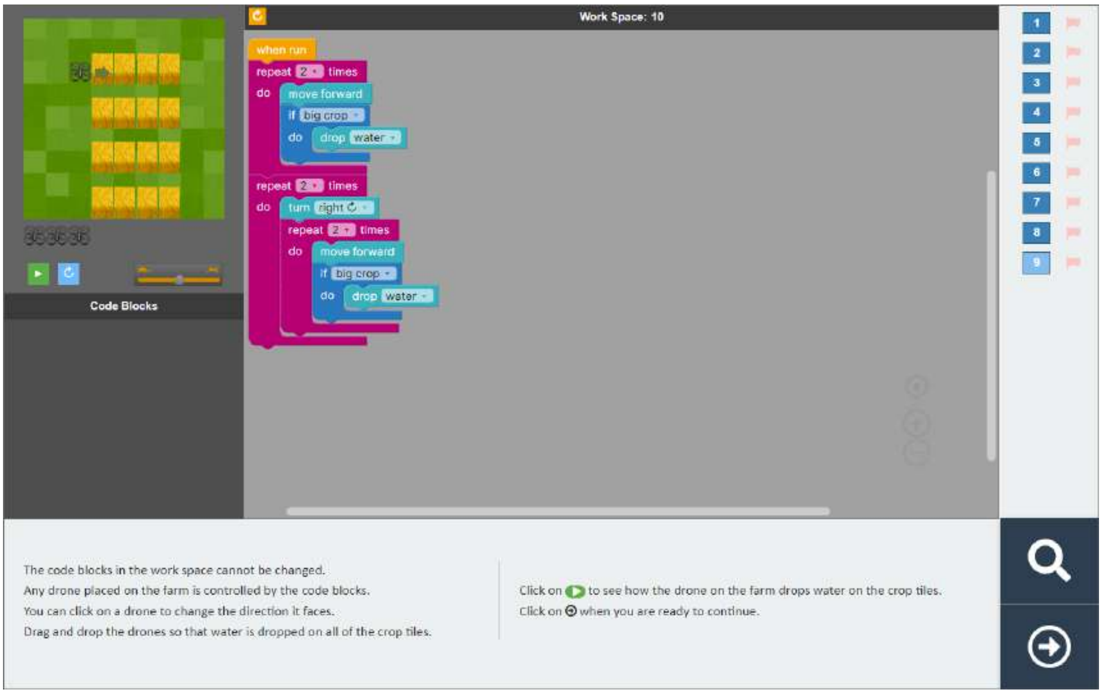
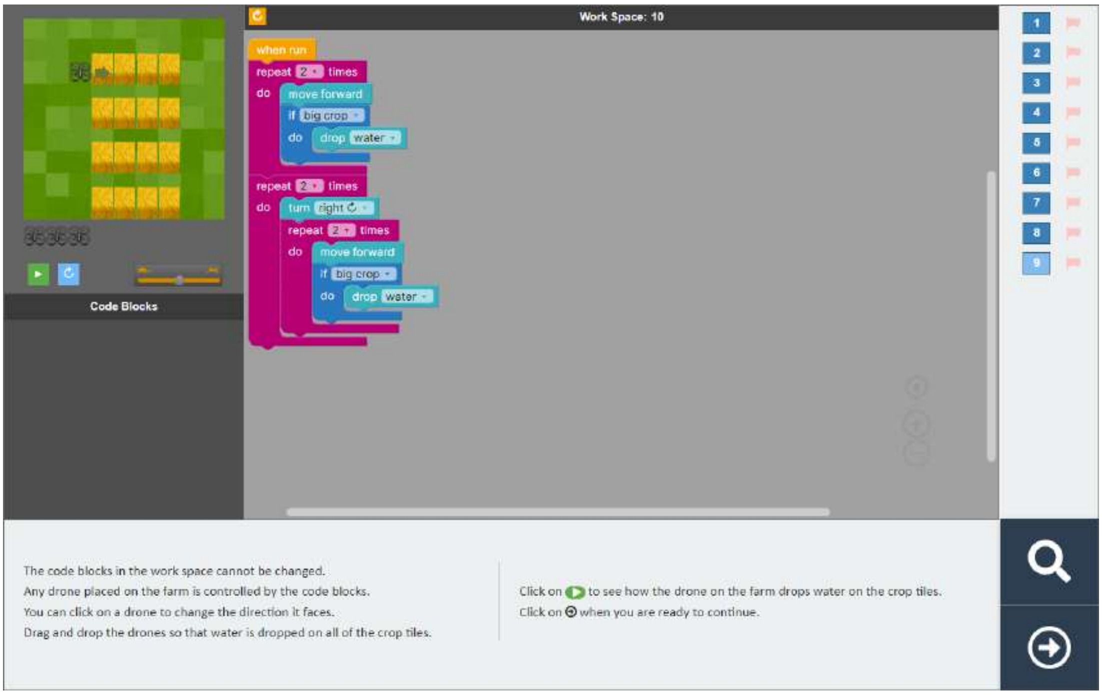


Figure G.4: Farm drone module screenshots (cont'd)

(i) Farm drone task 9



Appendix H:

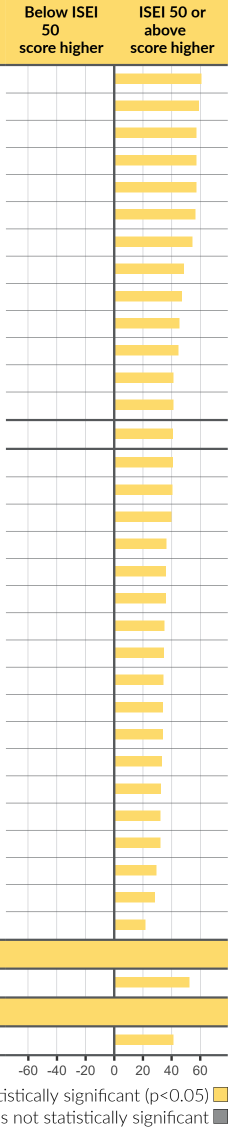
Relationship between CIL, CT, and student background additional tables

H.1 Achievement differences by socioeconomic status

SES differences in CIL

Table H.1: CIL achievement by parental occupation

Country	Below ISEI 50		ISEI 50 or above		Difference CIL score averages
	Percentage	Average score	Percentage	Average score	ISEI 50 or above - Below ISEI 50
[3] Bosnia and Herzegovina	67 (1.5)	426 (4.4)	33 (1.5)	487 (5.4)	**61** (7.0)
Luxembourg	50 (0.9)	472 (2.3)	50 (0.9)	531 (2.2)	**59** (2.6)
[†12] Romania	56 (2.5)	409 (5.6)	44 (2.5)	466 (5.3)	**57** (7.4)
Hungary	53 (1.5)	481 (4.7)	47 (1.5)	539 (2.5)	**57** (4.7)
[†] Uruguay	67 (1.5)	435 (3.6)	33 (1.5)	492 (4.6)	**57** (5.2)
Malta	43 (1.1)	457 (3.6)	57 (1.1)	513 (2.7)	**57** (3.9)
Cyprus	45 (1.1)	436 (3.0)	55 (1.1)	491 (3.2)	**55** (4.0)
Germany	56 (1.2)	491 (4.4)	44 (1.2)	540 (2.7)	**49** (4.6)
[1] Kosovo	65 (1.6)	351 (3.8)	35 (1.6)	398 (5.7)	**47** (5.6)
Slovak Republic	58 (1.5)	486 (3.3)	42 (1.5)	532 (3.1)	**46** (4.3)
[1] Serbia	57 (1.6)	430 (4.1)	43 (1.6)	475 (3.4)	**45** (3.9)
Greece	58 (1.2)	448 (3.4)	42 (1.2)	489 (3.6)	**41** (3.5)
[1] Portugal	51 (1.4)	493 (3.5)	49 (1.4)	534 (2.7)	**41** (3.6)
ICILS 2023 average	52 (0.2)	464 (0.7)	48 (0.2)	505 (0.6)	**41** (0.7)
Azerbaijan	53 (1.5)	323 (5.1)	47 (1.5)	364 (6.2)	**41** (6.1)
[1] Sweden	39 (1.4)	488 (3.5)	61 (1.4)	528 (2.8)	**41** (3.4)
[†] Belgium (Flemish)	55 (1.7)	502 (5.5)	45 (1.7)	541 (3.4)	**40** (5.3)
[1] Austria	59 (1.2)	494 (2.8)	41 (1.2)	531 (2.6)	**36** (2.8)
Chinese Taipei	51 (1.1)	501 (3.0)	49 (1.1)	538 (3.0)	**36** (3.1)
[†1] Denmark	35 (1.4)	500 (3.0)	65 (1.4)	536 (2.6)	**36** (3.3)
France	52 (1.2)	486 (3.1)	48 (1.2)	521 (2.5)	**35** (3.1)
[1] Croatia	58 (1.6)	479 (5.2)	42 (1.6)	514 (3.5)	**35** (5.7)
[1] Latvia	58 (1.7)	505 (4.0)	42 (1.7)	539 (3.2)	**34** (4.3)
Finland	49 (1.2)	499 (3.2)	51 (1.2)	533 (2.8)	**34** (3.0)
Oman	40 (0.9)	375 (2.8)	60 (0.9)	409 (3.5)	**34** (3.6)
[1] Czech Republic	57 (1.0)	514 (2.4)	43 (1.0)	547 (1.6)	**33** (2.3)
[1] Spain	52 (1.1)	484 (2.2)	48 (1.1)	517 (2.0)	**33** (2.5)
[1] Norway (Grade 9)	41 (1.1)	492 (3.2)	59 (1.1)	524 (2.5)	**32** (3.2)
[1] Kazakhstan	48 (1.3)	393 (3.3)	52 (1.3)	425 (3.8)	**32** (3.9)
Italy	60 (1.3)	482 (2.6)	40 (1.3)	511 (2.9)	**30** (3.3)
[1] Slovenia	42 (1.1)	472 (2.6)	58 (1.1)	500 (2.6)	**28** (3.0)
[†] Korea, Republic of	47 (1.4)	538 (2.7)	53 (1.4)	559 (2.9)	**22** (3.2)
Benchmarking participant					
[1] North Rhine-W. (Germany)	58 (1.5)	474 (4.4)	42 (1.5)	526 (3.8)	**52** (4.9)
Country not meeting sample participation requirements					
[‡] United States	49 (1.9)	477 (7.3)	51 (1.9)	519 (7.4)	**41** (8.4)



Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant differences (p<0.05) between subgroups are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Countries are ranked in descending order of the CIL score difference between groups.

[†] Met guidelines for sampling participation rates only after replacement schools were included.

[‡] Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

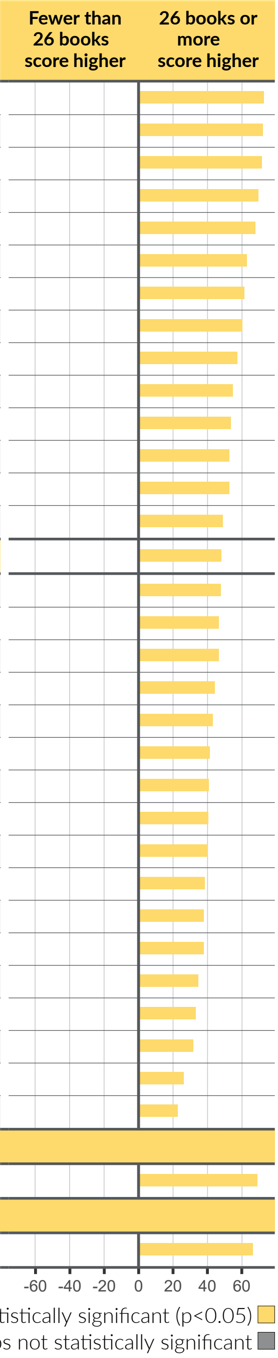
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

[2] Country surveyed target grade in the first half of the school year.

[3] National defined population covers 61% of the national target population.

Table H.2: CIL achievement by number of books at home

Country	Fewer than 26 books		26 books or more		Difference CIL score averages
	Percentage	Average score	Percentage	Average score	26 books or more - Fewer than 26 books
Hungary	31 (1.6)	456 (6.8)	69 (1.6)	529 (2.4)	**73** (6.5)
Luxembourg	31 (0.8)	446 (2.9)	69 (0.8)	518 (2.1)	**72** (3.2)
†[1,2] Romania	46 (2.1)	384 (5.8)	54 (2.1)	455 (4.8)	**72** (6.3)
Germany	31 (1.2)	459 (6.1)	69 (1.2)	529 (2.8)	**69** (5.3)
Malta	32 (1.0)	432 (4.3)	68 (1.0)	500 (2.7)	**68** (4.9)
Slovak Republic	38 (1.3)	460 (4.0)	62 (1.3)	523 (2.5)	**63** (4.0)
[1] Kosovo	58 (1.6)	330 (3.8)	42 (1.6)	392 (5.1)	**61** (5.0)
† Uruguay	69 (1.4)	431 (3.7)	31 (1.4)	491 (4.8)	**60** (5.7)
[1] Austria	29 (1.3)	466 (3.8)	71 (1.3)	523 (2.4)	**57** (3.9)
[1] Serbia	35 (1.3)	409 (4.9)	65 (1.3)	464 (3.5)	**55** (4.7)
Cyprus	33 (0.9)	427 (3.7)	67 (0.9)	481 (3.0)	**54** (4.6)
[1] Portugal	44 (1.5)	481 (3.9)	56 (1.5)	534 (2.4)	**53** (3.7)
[1] Sweden	32 (1.2)	471 (4.0)	68 (1.2)	524 (2.8)	**53** (4.1)
[1] Czech Republic	26 (1.1)	489 (4.1)	74 (1.1)	538 (1.6)	**49** (4.0)
ICILS 2023 average	39 (0.2)	448 (0.8)	61 (0.2)	496 (0.6)	**48** (0.8)
France	37 (1.4)	469 (3.7)	63 (1.4)	516 (2.3)	**48** (3.2)
[1] Spain	36 (0.9)	466 (2.3)	64 (0.9)	513 (2.2)	**47** (2.7)
Finland	30 (1.0)	478 (4.7)	70 (1.0)	525 (2.8)	**47** (4.1)
Greece	34 (1.0)	432 (4.5)	66 (1.0)	476 (3.0)	**44** (3.3)
Azerbaijan	59 (1.4)	305 (5.6)	41 (1.4)	348 (6.2)	**43** (6.7)
Chinese Taipei	42 (1.0)	492 (3.4)	58 (1.0)	534 (3.0)	**41** (3.1)
† Belgium (Flemish)	38 (1.6)	487 (6.4)	62 (1.6)	528 (3.7)	**41** (5.6)
[3] Bosnia and Herzegovina	56 (1.4)	423 (4.2)	44 (1.4)	464 (5.2)	**41** (5.6)
Italy	34 (1.4)	465 (3.6)	66 (1.4)	505 (2.6)	**40** (3.9)
[1] Norway (Grade 9)	27 (0.7)	478 (4.2)	73 (0.7)	517 (2.5)	**38** (3.8)
[1] Slovenia	30 (0.9)	458 (3.1)	70 (0.9)	496 (2.4)	**38** (3.4)
†[1] Denmark	31 (1.3)	494 (4.0)	69 (1.3)	532 (2.6)	**38** (3.9)
[1] Croatia	46 (1.4)	470 (5.2)	54 (1.4)	505 (4.0)	**35** (5.3)
† Korea, Republic of	20 (0.9)	516 (4.1)	80 (0.9)	549 (2.4)	**33** (4.1)
[1] Latvia	38 (1.5)	491 (5.0)	62 (1.5)	522 (3.5)	**32** (4.9)
[1] Kazakhstan	68 (1.2)	399 (3.1)	32 (1.2)	425 (4.4)	**26** (4.3)
Oman	56 (0.8)	372 (3.1)	44 (0.8)	395 (3.4)	**23** (3.0)
Benchmarking participant					
[1] North Rhine-W. (Germany)	33 (1.4)	443 (6.4)	67 (1.4)	512 (3.4)	**69** (5.5)
Country not meeting sample participation requirements					
‡ United States	43 (1.9)	450 (7.5)	57 (1.9)	516 (6.3)	**66** (7.6)



Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant differences (p<0.05) between subgroups are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Countries are ranked in descending order of the CIL score difference between groups.

† Met guidelines for sampling participation rates only after replacement schools were included.

‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

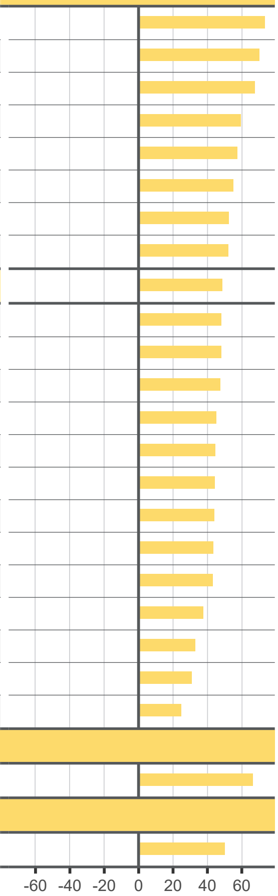
[2] Country surveyed target grade in the first half of the school year.

[3] National defined population covers 61% of the national target population.

SES differences in CT

Table H.3: CT achievement by parental occupation

Country	Below ISEI 50		ISEI 50 or above		Difference CT score averages		
	Percentage	Average score	Percentage	Average score	ISEI 50 or above - Below ISEI 50	Below ISEI 50 score higher	ISEI 50 or above score higher
Luxembourg	50 (0.9)	446 (2.9)	50 (0.9)	519 (3.4)	**73** (4.0)		
Germany	56 (1.2)	460 (4.4)	44 (1.2)	530 (4.7)	**70** (6.1)		
Malta	43 (1.1)	415 (4.6)	57 (1.1)	482 (3.5)	**67** (5.4)		
[1] Sweden	39 (1.4)	459 (5.8)	61 (1.4)	518 (4.8)	**59** (5.5)		
Slovak Republic	58 (1.5)	482 (3.6)	42 (1.5)	540 (4.3)	**57** (4.8)		
† Uruguay	67 (1.5)	408 (4.4)	33 (1.5)	463 (6.6)	**55** (7.2)		
[1] Austria	59 (1.2)	460 (4.0)	41 (1.2)	512 (4.9)	**52** (4.7)		
†[1] Denmark	35 (1.4)	474 (4.7)	65 (1.4)	526 (3.5)	**52** (4.7)		
ICILS 2023 average	52 (0.3)	467 (1.0)	48 (0.3)	516 (1.0)	**49** (1.1)		
[1] Norway (Grade 9)	41 (1.1)	466 (4.6)	59 (1.1)	514 (3.6)	**48** (4.9)		
[1] Portugal	51 (1.4)	465 (4.2)	49 (1.4)	512 (4.5)	**48** (5.2)		
† Belgium (Flemish)	55 (1.7)	498 (7.3)	45 (1.7)	546 (5.5)	**47** (6.5)		
[1] Czech Republic	57 (1.0)	510 (3.2)	43 (1.0)	555 (2.9)	**45** (3.5)		
Finland	49 (1.2)	489 (5.0)	51 (1.2)	533 (4.7)	**44** (4.3)		
[1] Latvia	58 (1.7)	490 (4.9)	42 (1.7)	534 (6.8)	**44** (6.3)		
Chinese Taipei	51 (1.1)	531 (4.2)	49 (1.1)	575 (4.1)	**44** (4.2)		
[1] Croatia	58 (1.6)	417 (5.2)	42 (1.6)	460 (5.4)	**43** (6.7)		
France	52 (1.2)	485 (4.3)	48 (1.2)	528 (4.0)	**43** (4.4)		
[1] Serbia	57 (1.6)	414 (5.2)	43 (1.6)	451 (5.9)	**38** (5.8)		
Italy	60 (1.3)	472 (3.2)	40 (1.3)	505 (3.9)	**33** (4.6)		
[1] Slovenia	42 (1.1)	436 (3.9)	58 (1.1)	466 (3.4)	**31** (4.1)		
† Korea, Republic of	47 (1.4)	534 (4.2)	53 (1.4)	559 (4.1)	**25** (5.0)		
Benchmarking participant							
[1] North Rhine-W. (Germany)	58 (1.5)	444 (4.8)	42 (1.5)	510 (4.7)	**66** (6.3)		
Country not meeting sample participation requirements							
‡ United States	49 (1.9)	450 (7.2)	51 (1.9)	500 (10.3)	**50** (9.8)		

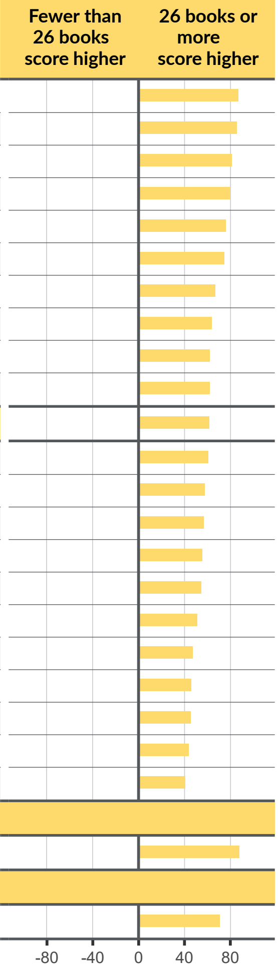


Difference between groups statistically significant (p<0.05)
Difference between groups not statistically significant

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant differences (p<0.05) between subgroups are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements. Countries are ranked in descending order of the CT score difference between groups.
† Met guidelines for sampling participation rates only after replacement schools were included.
‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

Table H.4: CT achievement by number of books at home

Country	Fewer than 26 books		26 books or more		Difference CT score averages
	Percentage	Average score	Percentage	Average score	26 books or more - Fewer than 26 books
Germany	31 (1.2)	424 (5.9)	69 (1.2)	511 (4.1)	**87** (6.2)
Luxembourg	31 (0.8)	418 (3.4)	69 (0.8)	504 (2.8)	**85** (3.6)
Slovak Republic	38 (1.3)	448 (4.8)	62 (1.3)	529 (3.9)	**81** (5.4)
[1] Sweden	32 (1.2)	434 (6.0)	68 (1.2)	514 (4.6)	**80** (5.8)
Malta	32 (1.0)	390 (6.0)	68 (1.0)	466 (3.6)	**76** (7.2)
[1] Austria	29 (1.3)	424 (5.2)	71 (1.3)	499 (4.0)	**75** (5.4)
Finland	30 (1.0)	459 (6.6)	70 (1.0)	526 (4.3)	**67** (5.0)
[1] Czech Republic	26 (1.1)	479 (5.0)	74 (1.1)	543 (2.5)	**64** (5.1)
[1] Norway (Grade 9)	27 (0.7)	443 (5.5)	73 (0.7)	505 (3.5)	**62** (5.4)
[†] Uruguay	69 (1.4)	403 (4.3)	31 (1.4)	465 (6.4)	**62** (6.9)
ICILS 2023 average	35 (0.3)	445 (1.2)	65 (0.3)	506 (0.9)	**62** (1.2)
France	37 (1.4)	462 (4.6)	63 (1.4)	523 (3.8)	**61** (4.4)
[†1] Denmark	31 (1.3)	465 (5.1)	69 (1.3)	522 (3.6)	**57** (5.3)
[1] Serbia	35 (1.3)	387 (6.2)	65 (1.3)	444 (5.1)	**57** (5.9)
[1] Portugal	44 (1.5)	454 (5.2)	56 (1.5)	510 (4.1)	**55** (5.8)
[†] Belgium (Flemish)	38 (1.6)	477 (8.4)	62 (1.6)	532 (5.5)	**54** (7.1)
[1] Slovenia	30 (0.9)	414 (4.2)	70 (0.9)	465 (3.5)	**51** (4.6)
[†] Korea, Republic of	20 (0.9)	501 (5.4)	80 (0.9)	549 (3.2)	**47** (5.6)
[1] Croatia	46 (1.4)	405 (5.9)	54 (1.4)	451 (4.9)	**46** (6.6)
Chinese Taipei	42 (1.0)	523 (4.7)	58 (1.0)	568 (3.7)	**45** (3.9)
Italy	34 (1.4)	454 (3.7)	66 (1.4)	498 (3.4)	**44** (4.5)
[1] Latvia	38 (1.5)	471 (6.1)	62 (1.5)	512 (5.9)	**41** (6.4)
Benchmarking participant					
[1] North Rhine-W. (Germany)	33 (1.4)	405 (6.4)	67 (1.4)	493 (3.7)	**88** (6.0)
Country not meeting sample participation requirements					
[‡] United States	43 (1.9)	423 (7.1)	57 (1.9)	494 (8.8)	**71** (8.8)



Difference between groups statistically significant (p<0.05)
Difference between groups not statistically significant

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant differences (p<0.05) between subgroups are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements. Countries are ranked in descending order of the CT score difference between groups.

† Met guidelines for sampling participation rates only after replacement schools were included.

‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

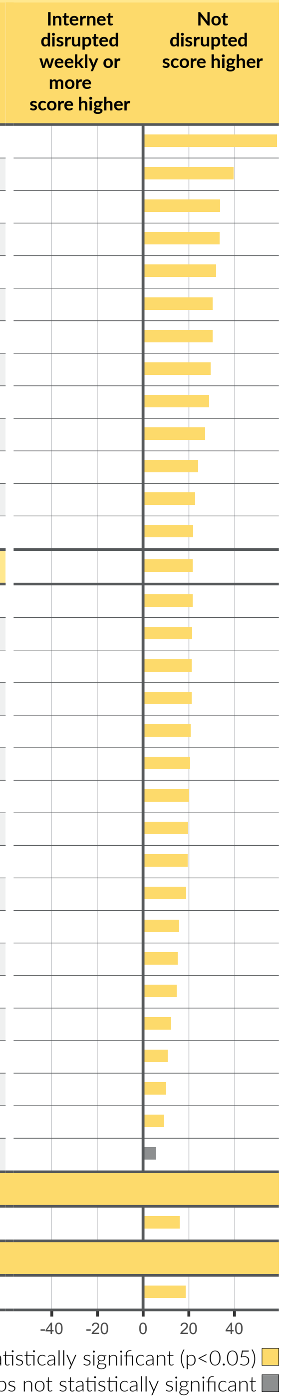
1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

H.2 Achievement differences by students' access to ICT resources

Home ICT access differences in CIL

Table H.5: CIL achievement by the quality of internet connection

Country	Internet disrupted weekly or more: Percentage	Internet disrupted weekly or more: Average score	Not disrupted: Percentage	Not disrupted: Average score	Difference CIL score averages: Not disrupted - Internet disrupted weekly or more
[†12] Romania	47 (1.3)	396 (6.1)	53 (1.3)	454 (4.0)	**58** (5.4)
[†] Uruguay	44 (0.9)	433 (4.1)	56 (0.9)	473 (3.8)	**39** (4.1)
[†1] Denmark	27 (1.0)	497 (3.6)	73 (1.0)	531 (2.5)	**34** (3.6)
France	38 (1.1)	480 (3.9)	62 (1.1)	514 (2.3)	**33** (3.7)
[1] Kosovo	79 (0.9)	356 (3.8)	21 (0.9)	388 (6.6)	**32** (5.4)
Azerbaijan	69 (1.1)	326 (5.4)	31 (1.1)	356 (5.4)	**30** (5.1)
Luxembourg	37 (1.0)	479 (2.9)	63 (1.0)	509 (2.2)	**30** (3.2)
Oman	77 (0.7)	381 (2.8)	23 (0.7)	410 (4.5)	**30** (4.1)
Slovak Republic	38 (1.1)	484 (3.6)	62 (1.1)	513 (3.0)	**29** (3.9)
[1] Sweden	20 (0.9)	488 (4.9)	80 (0.9)	515 (2.8)	**27** (4.5)
[3] Bosnia and Herzegovina	55 (1.6)	433 (5.4)	45 (1.6)	457 (4.2)	**24** (6.3)
[1] Croatia	46 (1.3)	479 (4.8)	54 (1.3)	502 (3.8)	**23** (4.6)
Malta	43 (1.1)	471 (3.7)	57 (1.1)	493 (3.6)	**22** (5.2)
ICILS 2023 average	40 (0.2)	468 (0.8)	60 (0.2)	490 (0.6)	**22** (0.8)
[1] Spain	36 (0.8)	484 (2.9)	64 (0.8)	505 (2.0)	**22** (3.0)
Hungary	34 (1.0)	494 (5.4)	66 (1.0)	515 (3.1)	**21** (4.6)
Finland	22 (0.8)	495 (4.6)	78 (0.8)	516 (3.1)	**21** (3.6)
Germany	37 (0.8)	495 (5.4)	63 (0.8)	516 (3.1)	**21** (4.8)
[1] Portugal	30 (1.0)	498 (4.3)	70 (1.0)	518 (2.7)	**21** (3.6)
[1] Serbia	47 (1.1)	439 (3.9)	53 (1.1)	459 (3.9)	**21** (3.7)
Cyprus	32 (0.9)	453 (4.0)	68 (0.9)	473 (2.9)	**20** (4.1)
[1] Norway (Grade 9)	21 (0.8)	496 (4.7)	79 (0.8)	516 (2.4)	**20** (4.9)
[†] Belgium (Flemish)	32 (1.0)	500 (6.4)	68 (1.0)	520 (3.8)	**19** (5.1)
[1] Kazakhstan	67 (1.0)	404 (3.2)	33 (1.0)	423 (3.8)	**19** (3.5)
[1] Czech Republic	43 (0.7)	517 (2.7)	57 (0.7)	533 (1.8)	**16** (2.0)
Italy	33 (0.8)	482 (3.1)	67 (0.8)	497 (2.4)	**15** (2.6)
[1] Slovenia	33 (0.8)	477 (3.6)	67 (0.8)	492 (2.4)	**15** (3.8)
[1] Latvia	44 (1.1)	505 (4.7)	56 (1.1)	517 (3.3)	**12** (4.1)
Greece	51 (1.0)	458 (3.8)	49 (1.0)	469 (3.5)	**11** (3.9)
[1] Austria	40 (0.9)	502 (3.2)	60 (0.9)	512 (2.6)	**10** (3.1)
Chinese Taipei	20 (0.7)	510 (5.1)	80 (0.7)	519 (2.8)	**9** (4.3)
[†] Korea, Republic of	17 (0.5)	538 (4.1)	83 (0.5)	544 (2.4)	6 (3.5)
Benchmarking participant					
[1] North Rhine-W. (Germany)	33 (1.1)	480 (7.1)	67 (1.1)	496 (3.3)	**16** (6.2)
Country not meeting sample participation requirements					
[‡] United States	43 (1.4)	479 (8.2)	57 (1.4)	498 (6.3)	**19** (6.8)



Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant differences (p<0.05) between subgroups are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Internet quality is based on how frequently the internet at home connection disconnects or become so slow it difficults studying (the highest frequency is kept). Countries are ranked in descending order of the CIL score difference between groups.

[†] Met guidelines for sampling participation rates only after replacement schools were included.

[‡] Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

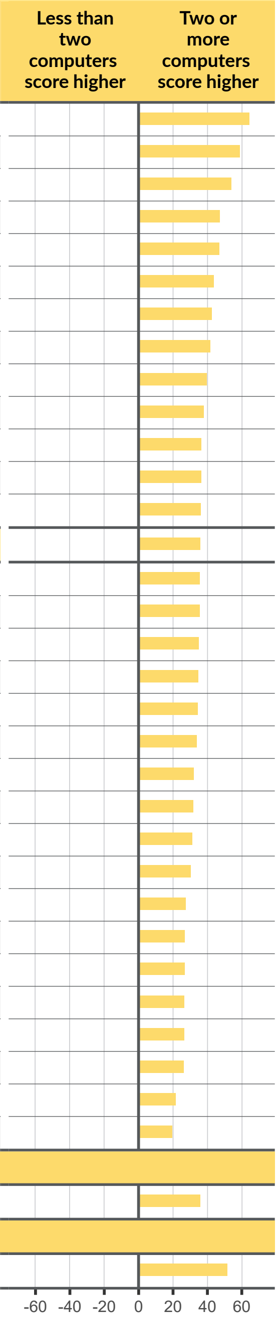
[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

[2] Country surveyed target grade in the first half of the school year.

[3] National defined population covers 61% of the national target population.

Table H.6: CIL achievement by number of computers at home

Country	Less than two computers: Percentage	Less than two computers: Average score	Two or more computers: Percentage	Two or more computers: Average score	Difference CIL score averages: Two or more computers - Less than two computers
† Belgium (Flemish)	10 (0.9)	454 (12.0)	90 (0.9)	519 (3.8)	**64** (11.1)
Hungary	31 (1.3)	466 (7.6)	69 (1.3)	525 (2.6)	**59** (7.5)
Malta	21 (1.0)	438 (5.4)	79 (1.0)	492 (2.7)	**54** (5.7)
Slovak Republic	32 (1.1)	469 (3.7)	68 (1.1)	516 (2.9)	**47** (4.4)
†12 Romania	49 (2.0)	401 (5.7)	51 (2.0)	448 (4.9)	**47** (5.9)
Luxembourg	22 (0.7)	462 (3.3)	78 (0.7)	506 (2.0)	**44** (3.6)
Cyprus	29 (0.9)	434 (4.3)	71 (0.9)	477 (3.1)	**43** (5.2)
1 Austria	23 (1.1)	475 (4.5)	77 (1.1)	517 (2.5)	**42** (4.7)
Germany	29 (0.8)	480 (6.2)	71 (0.8)	519 (3.2)	**40** (5.5)
1 Sweden	12 (0.7)	475 (5.7)	88 (0.7)	513 (2.9)	**38** (5.9)
1 Portugal	23 (0.9)	483 (4.3)	77 (0.9)	520 (2.7)	**37** (3.6)
1 Czech Republic	18 (0.7)	496 (4.4)	82 (0.7)	533 (1.7)	**36** (4.0)
† Uruguay	48 (1.3)	435 (3.9)	52 (1.3)	471 (4.6)	**36** (5.3)
ICILS 2023 average	32 (0.2)	455 (0.9)	68 (0.2)	490 (0.6)	**36** (0.9)
Chinese Taipei	36 (0.9)	494 (3.3)	64 (0.9)	529 (3.1)	**36** (3.2)
1 Kazakhstan	69 (1.0)	397 (3.0)	31 (1.0)	433 (4.5)	**35** (4.0)
†1 Denmark	8 (0.6)	489 (5.6)	92 (0.6)	524 (2.4)	**35** (5.1)
1 Norway (Grade 9)	13 (0.7)	477 (5.5)	87 (0.7)	512 (2.5)	**35** (5.4)
Azerbaijan	80 (1.1)	318 (5.4)	20 (1.1)	352 (7.9)	**34** (8.2)
Finland	24 (0.7)	485 (4.5)	76 (0.7)	519 (3.0)	**34** (3.3)
1 Spain	32 (1.0)	476 (2.4)	68 (1.0)	508 (2.0)	**32** (2.5)
Italy	45 (1.3)	475 (3.3)	55 (1.3)	507 (2.6)	**32** (3.6)
Oman	46 (0.9)	366 (3.2)	54 (0.9)	397 (3.5)	**31** (3.7)
1 Latvia	25 (1.1)	488 (4.8)	75 (1.1)	518 (3.6)	**30** (4.3)
3 Bosnia and Herzegovina	49 (1.2)	430 (5.6)	51 (1.2)	457 (4.4)	**27** (6.9)
1 Kosovo	52 (1.5)	345 (4.2)	48 (1.5)	372 (5.6)	**27** (5.6)
1 Croatia	34 (1.0)	473 (5.2)	66 (1.0)	500 (3.2)	**27** (4.1)
1 Slovenia	18 (0.8)	464 (4.6)	82 (0.8)	490 (2.3)	**27** (4.6)
1 Serbia	40 (1.4)	430 (4.4)	60 (1.4)	457 (3.8)	**26** (3.9)
Greece	37 (1.1)	447 (3.8)	63 (1.1)	473 (3.4)	**26** (3.5)
† Korea, Republic of	31 (1.0)	527 (3.4)	69 (1.0)	549 (2.6)	**22** (3.4)
France	29 (0.9)	485 (4.0)	71 (0.9)	505 (2.6)	**19** (3.4)
Benchmarking participant					
1 North Rhine-W. (Germany)	32 (1.1)	468 (9.0)	68 (1.1)	503 (3.4)	**36** (8.8)
Country not meeting sample participation requirements					
‡ United States	27 (1.4)	450 (8.4)	73 (1.4)	502 (6.8)	**51** (8.4)



Difference between groups statistically significant (p<0.05)
Difference between groups not statistically significant

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant differences (p<0.05) between subgroups are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Countries are ranked in descending order of the CIL score difference between groups.

† Met guidelines for sampling participation rates only after replacement schools were included.

‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

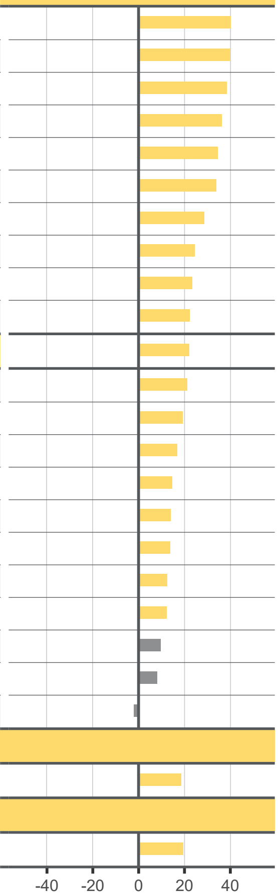
2 Country surveyed target grade in the first half of the school year.

3 National defined population covers 61% of the national target population.

Home ICT access differences in CT

Table H.7: CT achievement by the quality of internet connection

Country	Internet disrupted weekly or more		Not disrupted		Difference CT score averages		
	Percentage	Average score	Percentage	Average score	Not disrupted - Internet disrupted weekly or more	Internet disrupted weekly or more score higher	Not disrupted score higher
France	38 (1.1)	478 (5.1)	62 (1.1)	518 (3.7)	**40** (4.6)		
†[1] Denmark	27 (1.0)	477 (5.4)	73 (1.0)	517 (3.2)	**40** (5.1)		
Slovak Republic	38 (1.1)	478 (5.0)	62 (1.1)	517 (4.1)	**38** (5.5)		
† Uruguay	44 (0.9)	408 (4.5)	56 (0.9)	444 (4.7)	**36** (4.5)		
[1] Croatia	46 (1.3)	414 (5.3)	54 (1.3)	448 (4.6)	**35** (5.2)		
[1] Sweden	20 (0.9)	464 (7.3)	80 (0.9)	497 (4.7)	**34** (6.2)		
Luxembourg	37 (1.0)	462 (4.2)	63 (1.0)	491 (2.9)	**29** (5.0)		
Germany	37 (0.8)	469 (5.5)	63 (0.8)	494 (4.1)	**24** (5.3)		
[1] Serbia	47 (1.1)	417 (5.3)	53 (1.1)	441 (5.5)	**23** (4.6)		
[1] Norway (Grade 9)	21 (0.8)	478 (6.7)	79 (0.8)	500 (3.5)	**22** (6.8)		
ICILS 2023 average	34 (0.2)	473 (1.2)	66 (0.2)	495 (0.9)	**22** (1.1)		
Finland	22 (0.8)	490 (6.4)	78 (0.8)	511 (4.8)	**21** (4.8)		
† Belgium (Flemish)	32 (1.0)	500 (7.6)	68 (1.0)	519 (6.1)	**19** (6.0)		
[1] Czech Republic	43 (0.7)	518 (3.5)	57 (0.7)	535 (2.7)	**17** (2.6)		
Malta	43 (1.1)	439 (4.2)	57 (1.1)	453 (4.8)	**15** (6.5)		
[1] Latvia	44 (1.1)	490 (6.3)	56 (1.1)	504 (5.4)	**14** (5.6)		
[1] Austria	40 (0.9)	471 (4.5)	60 (0.9)	484 (4.5)	**14** (4.7)		
[1] Slovenia	33 (0.8)	443 (4.7)	67 (0.8)	456 (3.3)	**12** (4.7)		
[1] Portugal	30 (1.0)	478 (4.9)	70 (1.0)	490 (4.1)	**12** (4.1)		
Chinese Taipei	20 (0.7)	543 (6.5)	80 (0.7)	553 (3.6)	10 (5.5)		
Italy	33 (0.8)	478 (3.9)	67 (0.8)	486 (3.2)	8 (4.2)		
† Korea, Republic of	17 (0.5)	542 (5.8)	83 (0.5)	540 (3.2)	-2 (5.4)		
Benchmarking participant							
[1] North Rhine-W. (Germany)	33 (1.1)	452 (6.8)	67 (1.1)	471 (4.0)	**19** (6.3)		
Country not meeting sample participation requirements							
‡ United States	43 (1.4)	454 (9.0)	57 (1.4)	474 (7.9)	**19** (7.0)		



Difference between groups statistically significant (p<0.05)
Difference between groups not statistically significant

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant differences (p<0.05) between subgroups are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements. Internet quality is based on how frequently the internet at home connection disconnects or become so slow it difficults studying (the highest frequency is kept). Countries are ranked in descending order of the CT score difference between groups.

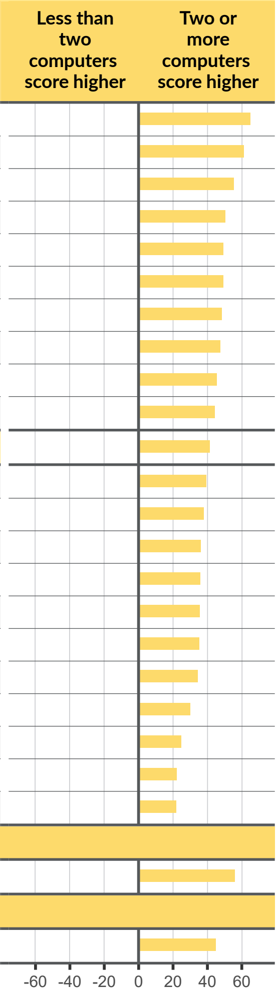
† Met guidelines for sampling participation rates only after replacement schools were included.

‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

[1] National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

Table H.8: CT achievement by number of computers at home

Country	Less than two computers		Two or more computers		Difference CT score averages
	Percentage	Average score	Percentage	Average score	Two or more computers - Less than two computers
† Belgium (Flemish)	10 (0.9)	452 (13.8)	90 (0.9)	517 (5.9)	**65** (12.8)
Slovak Republic	32 (1.1)	459 (4.8)	68 (1.1)	520 (4.1)	**61** (6.0)
Malta	21 (1.0)	401 (6.5)	79 (1.0)	456 (3.4)	**55** (6.8)
1 Austria	23 (1.1)	439 (6.4)	77 (1.1)	489 (4.0)	**50** (6.7)
1 Sweden	12 (0.7)	447 (8.1)	88 (0.7)	497 (4.7)	**49** (8.2)
1 Norway (Grade 9)	13 (0.7)	447 (8.2)	87 (0.7)	497 (3.3)	**49** (8.2)
Germany	29 (0.8)	452 (6.0)	71 (0.8)	500 (4.2)	**48** (5.8)
1 Czech Republic	18 (0.7)	488 (5.6)	82 (0.7)	536 (2.6)	**47** (5.2)
Luxembourg	22 (0.7)	443 (4.3)	78 (0.7)	488 (2.7)	**45** (4.8)
Chinese Taipei	36 (0.9)	521 (5.0)	64 (0.9)	566 (3.8)	**44** (4.7)
ICILS 2023 average	26 (0.2)	455 (1.4)	74 (0.2)	496 (0.9)	**41** (1.4)
1 Portugal	23 (0.9)	456 (5.8)	77 (0.9)	495 (3.7)	**39** (4.7)
1 Latvia	25 (1.1)	468 (6.2)	75 (1.1)	506 (5.7)	**38** (6.4)
† Uruguay	48 (1.3)	408 (4.7)	52 (1.3)	444 (5.5)	**36** (6.1)
1 Croatia	34 (1.0)	408 (6.1)	66 (1.0)	444 (4.3)	**36** (5.5)
Finland	24 (0.7)	479 (6.4)	76 (0.7)	514 (4.8)	**36** (4.9)
Italy	45 (1.3)	465 (3.3)	55 (1.3)	500 (3.6)	**35** (4.3)
†1 Denmark	8 (0.6)	474 (8.2)	92 (0.6)	508 (3.3)	**34** (7.3)
1 Slovenia	18 (0.8)	426 (5.7)	82 (0.8)	456 (3.1)	**30** (5.0)
† Korea, Republic of	31 (1.0)	522 (5.3)	69 (1.0)	547 (3.5)	**25** (5.6)
1 Serbia	40 (1.4)	413 (5.4)	60 (1.4)	435 (5.5)	**22** (5.1)
France	29 (0.9)	485 (5.3)	71 (0.9)	507 (3.8)	**22** (4.4)
Benchmarking participant					
1 North Rhine-W. (Germany)	32 (1.1)	429 (7.8)	68 (1.1)	485 (3.5)	**56** (7.7)
Country not meeting sample participation requirements					
‡ United States	27 (1.4)	432 (8.4)	73 (1.4)	476 (8.1)	**45** (8.0)



Difference between groups statistically significant (p<0.05)
Difference between groups not statistically significant

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. Statistically significant differences (p<0.05) between subgroups are shown in **Bold**. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements. Countries are ranked in descending order of the CT score difference between groups.

† Met guidelines for sampling participation rates only after replacement schools were included.

‡ Did not meet guideline for sampling participation rate, but achieved at least 50% overall sampling participation rate.

1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

Appendix I:

Generative AI addendum additional tables

Table I.1: School principals' use of ChatGPT or similar tools

Country		For work-related purposes				For non-work-related- purposes		
		Never	Less than weekly	Weekly or more		Never	Less than weekly	Weekly or more
Chinese Taipei		23 (3.7)	61 (4.2)	16 (3.2)	r	25 (3.8)	55 (4.1)	19 (3.6)
Cyprus		61 (2.4)	23 (2.4)	17 (1.4)	r	61 (2.4)	28 (2.4)	11 (0.5)
[†1] Denmark	s	66 (5.4)	33 (5.2)	1 (1.3)	s	59 (5.4)	38 (5.1)	2 (1.6)
Greece	s	60 (5.2)	34 (5.1)	5 (2.1)	s	59 (5.5)	35 (5.5)	6 (2.7)
[†] Korea, Republic of		31 (4.0)	53 (4.0)	16 (3.1)		24 (3.7)	55 (4.0)	22 (3.7)
[1] Norway (Grade 9)	x	39 (7.2)	56 (7.5)	5 (3.3)	x	41 (6.6)	56 (6.7)	3 (2.3)
[†12] Romania		59 (5.7)	23 (4.8)	17 (3.8)		60 (5.7)	21 (4.8)	19 (4.1)
Slovak Republic		64 (4.1)	28 (3.6)	8 (2.2)		64 (4.0)	29 (3.8)	7 (2.0)
[1] Slovenia		41 (4.3)	51 (4.3)	8 (2.2)		40 (4.1)	50 (4.2)	9 (2.4)
[1] Sweden	s	53 (5.0)	43 (5.0)	5 (2.4)	s	50 (5.1)	45 (5.1)	5 (2.6)
[†] Uruguay	r	61 (5.9)	23 (5.7)	15 (4.8)	r	66 (6.0)	24 (5.7)	9 (3.7)
ICILS 2023 average		50 (1.5)	41 (1.5)	9 (0.9)		49 (1.5)	42 (1.5)	9 (0.9)

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Percentages are representative of students' population, based on the school principal's response.

† Met guidelines for sampling participation rates only after replacement schools were included.

1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

2 Country surveyed target grade in the first half of the school year.

r indicates data are available for at least 70% but less than 85% of the students.

s indicates data are available for at least 50% but less than 70% of the students.

x indicates data are available for at least 40% but less than 50% of the students. Interpret with caution.

Table I.2: School principal reports on explicit policies regarding the use of ChatGPT or similar tools in school relating to the work of teachers

Country		Explicit policies relating to the work of teachers			
		No, and we are not planning to develop any policies	**No, but we are planning to develop some policies in the future**	**No, but we are currently developing some policies**	**Yes**
Chinese Taipei		33 (3.8)	55 (4.4)	9 (2.3)	3 (1.6)
Cyprus		31 (1.3)	51 (2.4)	13 (0.9)	5 (1.8)
†1 Denmark	s	64 (5.5)	35 (5.6)	0 (0.0)	1 (1.2)
Greece	s	53 (5.8)	42 (5.8)	5 (1.9)	0 (0.0)
† Korea, Republic of		36 (4.1)	57 (4.4)	5 (1.6)	2 (1.4)
1 Norway (Grade 9)	x	29 (7.1)	50 (7.4)	19 (5.7)	2 (1.9)
†12 Romania		39 (5.3)	53 (5.3)	6 (2.3)	2 (1.0)
Slovak Republic		41 (3.9)	48 (3.7)	11 (2.5)	1 (0.7)
1 Slovenia		27 (3.1)	70 (3.2)	2 (1.2)	1 (0.6)
1 Sweden	s	49 (5.3)	38 (5.3)	8 (3.1)	6 (2.5)
† Uruguay	r	56 (6.2)	40 (6.5)	2 (1.5)	3 (2.4)
ICILS 2023 average		42 (1.5)	49 (1.6)	7 (0.8)	2 (0.5)

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Percentages are representative of students' population, based on the school principal's response.
† Met guidelines for sampling participation rates only after replacement schools were included.
1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
2 Country surveyed target grade in the first half of the school year.
r indicates data are available for at least 70% but less than 85% of the students.
s indicates data are available for at least 50% but less than 70% of the students.
x indicates data are available for at least 40% but less than 50% of the students. Interpret with caution.

Table I.3: School principal reports on explicit policies regarding the use of ChatGPT or similar tools in school relating to the work of students

Country		Explicit policies relating to the work of students			
		No, and we are not planning to develop any policies	No, but we are planning to develop some policies in the future	No, but we are currently developing some policies	Yes
Chinese Taipei		21 (3.5)	63 (4.5)	13 (2.9)	3 (1.6)
Cyprus	r	29 (1.3)	57 (2.4)	9 (1.4)	6 (2.2)
†1 Denmark	s	35 (5.5)	60 (5.6)	0 (0.0)	6 (2.5)
Greece	s	51 (5.8)	42 (5.6)	6 (1.7)	1 (0.1)
† Korea, Republic of		34 (4.0)	58 (4.3)	6 (1.8)	2 (1.4)
1 Norway (Grade 9)	x	15 (5.1)	58 (7.1)	15 (5.1)	12 (4.7)
†12 Romania		37 (5.0)	55 (4.9)	6 (2.3)	2 (1.1)
Slovak Republic		39 (4.2)	48 (4.2)	12 (2.6)	1 (1.1)
1 Slovenia		15 (2.6)	80 (3.0)	4 (1.6)	1 (0.6)
1 Sweden	s	24 (4.1)	56 (5.5)	10 (3.4)	11 (3.0)
† Uruguay	r	46 (6.0)	42 (5.8)	2 (2.0)	10 (3.4)
ICILS 2023 average		31 (1.4)	56 (1.6)	7 (0.8)	5 (0.8)

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Percentages are representative of students' population, based on the school principal's response.
† Met guidelines for sampling participation rates only after replacement schools were included.
1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
2 Country surveyed target grade in the first half of the school year.
r indicates data are available for at least 70% but less than 85% of the students.
s indicates data are available for at least 50% but less than 70% of the students.
x indicates data are available for at least 40% but less than 50% of the students. Interpret with caution.

Table I.4: School principal reports on explicit recommendations regarding the use of ChatGPT or similar tools in school relating to the work of teachers

Country		Explicit recommendations relating to the work of teachers			
		No, and we are not planning to develop any recommendations	No, but we are planning to develop some recommendations	No, but we are currently developing some recommendations	Yes
Chinese Taipei		19 (3.7)	56 (3.7)	18 (3.3)	7 (2.2)
Cyprus		30 (0.9)	52 (2.2)	11 (1.4)	6 (2.5)
†1 Denmark	s	40 (5.4)	50 (5.6)	5 (2.7)	5 (2.3)
Greece	s	47 (5.7)	49 (5.7)	3 (1.2)	2 (1.3)
† Korea, Republic of		35 (4.1)	56 (4.3)	4 (1.8)	5 (1.6)
1 Norway (Grade 9)	x	30 (7.3)	52 (7.8)	7 (3.5)	12 (4.6)
†12 Romania		36 (5.4)	57 (5.5)	5 (1.8)	3 (1.6)
Slovak Republic		37 (3.6)	50 (3.6)	13 (2.7)	0 (0.0)
1 Slovenia		23 (2.7)	71 (3.0)	4 (1.6)	2 (1.0)
1 Sweden	s	26 (4.3)	51 (5.3)	13 (4.0)	10 (3.4)
† Uruguay	s	44 (5.6)	41 (5.8)	12 (3.7)	4 (2.8)
ICILS 2023 average		33 (1.5)	53 (1.6)	9 (0.9)	5 (0.8)

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Percentages are representative of students' population, based on the school principal's response.

† Met guidelines for sampling participation rates only after replacement schools were included.

1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.

2 Country surveyed target grade in the first half of the school year.

s indicates data are available for at least 50% but less than 70% of the students.

x indicates data are available for at least 40% but less than 50% of the students. Interpret with caution.

Table I.5: School principal reports on explicit recommendations regarding the use of ChatGPT or similar tools in school relating to the work of students

Country		Explicit recommendations relating to the work of students			
		No, and we are not planning to develop any recommendations	No, but we are planning to develop some recommendations	No, but we are currently developing some recommendations	Yes
Chinese Taipei		14 (3.2)	62 (3.8)	17 (3.3)	7 (2.2)
Cyprus	r	31 (1.0)	51 (2.3)	11 (1.9)	6 (2.8)
†1 Denmark	s	19 (4.1)	63 (5.3)	8 (3.2)	10 (3.4)
Greece	s	45 (5.6)	46 (5.5)	6 (1.6)	3 (1.4)
† Korea, Republic of		31 (3.7)	58 (3.9)	5 (1.7)	6 (1.8)
1 Norway (Grade 9)	x	12 (4.8)	58 (7.6)	9 (3.9)	22 (6.3)
†12 Romania		36 (5.2)	56 (5.3)	5 (1.8)	3 (1.7)
Slovak Republic		37 (4.0)	49 (4.0)	14 (2.7)	1 (0.7)
1 Slovenia		16 (2.7)	79 (3.2)	4 (1.6)	1 (0.8)
1 Sweden	s	18 (3.5)	54 (5.3)	15 (4.2)	13 (3.4)
† Uruguay	s	37 (5.4)	39 (5.5)	16 (4.7)	9 (3.4)
ICILS 2023 average		26 (1.3)	56 (1.5)	10 (1.0)	8 (1.0)

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. ICILS 2023 average is based on all non-benchmarking participants that met sampling participation requirements except Romania. Percentages are representative of students' population, based on the school principal's response.
† Met guidelines for sampling participation rates only after replacement schools were included.
1 National defined population covers 90% to 95% of the national target population. See Appendix A for further information.
2 Country surveyed target grade in the first half of the school year.
r indicates data are available for at least 70% but less than 85% of the students.
s indicates data are available for at least 50% but less than 70% of the students.
x indicates data are available for at least 40% but less than 50% of the students. Interpret with caution.

Appendix J:

CIL and CT scores in the Netherlands

Table J.1: Netherlands's correct percent in CIL and CT example items

Country	Percentage scoring one or more score points	Percentage scoring two or more score points	Percentage scoring three points
CIL			
Netherlands - Level 1, Example Item A	77 (2.8)		
Netherlands - Level 2, Example Item B	50 (2.4)		
Netherlands - Level 3, Example Item C	37 (3.0)		
Netherlands - Level 3, Example Item D	30 (4.9)	4 (1.4)	
Netherlands - Level 4, Example Item E	14 (2.4)		
Netherlands - Level 4, Example Item F	30 (4.9)	4 (1.4)	
CT			
Netherlands - Level 1, Example Item A	69 (3.7)	50 (3.9)	
Netherlands - Level 2, Example Item B	69 (3.7)	50 (3.9)	
Netherlands - Level 2, Example Item C	40 (4.7)	20 (3.1)	3 (0.9)
Netherlands - Level 3, Example Item D	40 (4.7)	20 (3.1)	3 (0.9)
Netherlands - Level 3, Example Item E	39 (3.2)	11 (2.5)	
Netherlands - Level 4, Example Item F	33 (4.6)	19 (3.2)	11 (2.4)

Notes: Standard error appear in parentheses ().

Table J.2: Netherlands's average and distribution for CIL and CT

Country	Average scale score	Standard deviation	Percentile 10	Percentile 25	Percentile 75	Percentile 90
CIL						
Netherlands	460 (10.1)	115 (4.9)	301 (10.8)	376 (11.0)	549 (15.2)	605 (12.6)
CT						
Netherlands	440 (12.8)	136 (6.7)	260 (23.8)	348 (16.8)	534 (16.2)	620 (18.1)

Notes: Standard error appear in parentheses ().

Table J.3: Percentage of students at each CIL and CT proficiency level in the Netherlands

Country	Percentage of students achieving at each CIL / CT level				
	Below Level 1	Level 1	Level 2	Level 3	Level 4
CIL					
Netherlands	33 (3.2)	24 (2.4)	25 (1.8)	16 (3.3)	2 (0.7)
CT					
Netherlands	21 (2.9)	28 (2.6)	29 (2.2)	16 (2.2)	5 (1.6)

Notes: Standard error appear in parentheses ().

Table J.4: Correlation between CIL and CT and average CT performance for students at each CIL proficiency level in the Netherlands

Country	Correlation CIL-CT	Average CT by CIL Level				
		Below Level 1	Level 1	Level 2	Level 3	Level 4
Netherlands	0.74 (0.04)	329 (17.8)	423 (11.3)	499 (9.4)	579 (12.3)	666 (27.9)

Notes: Standard error appear in parentheses (). Because of rounding some results may appear inconsistent. The correlation between CIL and CT is statistically significant (p < 0.01).

Table J.5: CIL and CT achievement by gender in the Netherlands

Country	Male		Female	
	Percentage	Average score	Percentage	Average score
CIL				
Netherlands	52 (2.2)	446 (11.0)	48 (2.2)	475 (10.2)
CT				
Netherlands	52 (2.2)	447 (13.8)	48 (2.2)	435 (13.1)

Notes: Standard error appear in parentheses ().

Table J.6: CIL and CT achievement by immigration background in the Netherlands

Country	Immigrant background		Non-immigrant background	
	Percentage	Average score	Percentage	Average score
CIL				
Netherlands	17 (2.7)	425 (18.3)	83 (2.7)	479 (9.8)
CT				
Netherlands	17 (2.7)	389 (23.5)	83 (2.7)	458 (12.5)

Notes: Standard error appear in parentheses ().

Table J.7: CIL and CT achievement by language at home in the Netherlands

Country	Other language		Language of test	
	Percentage	Average score	Percentage	Average score
CIL				
Netherlands	19 (2.5)	427 (16.0)	81 (2.5)	475 (10.4)
CT				
Netherlands	19 (2.5)	388 (22.0)	81 (2.5)	452 (13.3)

Notes: Standard error appear in parentheses ().

Table J.8: CIL and CT achievement by parental education in the Netherlands

Country	Below Bachelor-level		Bachelor-level or above	
	Percentage	Average score	Percentage	Average score
CIL				
Netherlands	56 (2.9)	448 (10.1)	44 (2.9)	506 (14.4)
CT				
Netherlands	56 (2.9)	417 (11.2)	44 (2.9)	486 (17.9)

Notes: Standard error appear in parentheses ().

Table J.9: CIL and CT achievement by access to computers to do schoolwork in the Netherlands

Country	Not always accessible		Always accessible	
	Percentage	Average score	Percentage	Average score
CIL				
Netherlands	30 (2.0)	440 (15.8)	70 (2.0)	484 (10.4)
CT				
Netherlands	30 (2.0)	416 (18.4)	70 (2.0)	457 (13.9)

Notes: Standard error appear in parentheses ().

Appendix K:

Organizations and individuals involved in ICILS 2023

International study center

The international study center is located at the International Association for the Evaluation of Educational Achievement (IEA). Center staff at IEA are responsible for designing and implementing the study in close cooperation with the National Research Coordinators (NRCs) in ICILS 2023 participating countries.

IEA is also responsible for coordinating and implementing ICILS. IEA Amsterdam, the Netherlands, is responsible for membership, translation verification, quality control monitoring, and publication. IEA Hamburg, Germany is mainly responsible for field operations, sampling procedures, and data-processing, scaling, analysis, and reporting.

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RM Assessment

RM Assessment was responsible for developing the software systems underpinning the computer-based student assessment instruments for ICILS 2023. This work included development of the test and questionnaire items, the assessment delivery system, and the web-based translation, scoring, and data-management modules.

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ICILS sampling referee

Marc Joncas was the sampling referee for the study. He has provided invaluable advice on all sampling-related aspects of the study.

National research coordinators

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 were responsible for the implementation of ICILS in the participating countries.

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This book presents the first results from the third cycle of the IEA International Computer and Information Literacy Study (ICILS 2023). This study investigated how young people are prepared for life in a world where the capacity to use computers and digital information responsibly, safely, and effectively is essential. The study reports on data collected from 34 countries across Europe, the Americas, and Asia. This first volume in the ICILS 2023 International Report Series focuses on Grade 8 students' achievement in the two areas tested in the study: i) their capacity to use digital technologies to collect and manage digital information and to produce and exchange information with others; and ii) in a subset of 22 participating countries, students' ability to plan and execute computer-based algorithmic solutions to real-world problems. This book also presents information about the school-based and out-of-school contexts in which students are learning these skills, and how aspects of these contexts are associated with student achievement.

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