1.1 Pupils’ digital competence

The concept of digital competence as defined in the lifelong learning framework is elaborated in the European Digital Competence Framework for Citizens, also known as DigComp, to explain what it means to be digitally competent. Here digital competence is described in detail by dividing the knowledge, skills and attitudes that all citizens need in a digital society into five competence areas: information and data literacy; communication and collaboration; digital content creation; safety; and problem solving. This has become a common reference tool both at European and at national level.

In the following, we draw on ICILS to enquire about lower secondary school pupils’ level of digital competence. ICILS assesses the capacities of young people to use ICT by measuring the performance of grade eight pupils (13-14 years of age) performance in two domains of digital competence: computer and information literacy and computational thinking.

Box 2 – Croatian response to the COVID-19 crisis

Croatia began digital development of its schools only a few years ago, acquiring equipment and materials and training teachers. Preparations for the crisis started early (2 weeks before moving schools online): producing additional education content, adapting online platforms used for teacher training, and issuing clear instructions and guidelines for the organisation of distance learning. The existing school equipment was distributed to enable access for all pupils aged 11-18 when school moved online, and additional equipment was bought for students from low socio-economic backgrounds. Pupils aged 7-10 had lessons organised through public television and teachers communicated with their parents. A special web-site was set up by Agency for VET and Adult Education and dedicated for VET schools, where materials prepared by VET teachers, e-learning courses and other digital contents were shared. In cooperation with Chamber of Commerce companies have also sent their materials that are used for in-companies trainings of their staff.

Online classes for older pupils were complemented with shorter video lessons on public television. Experienced teachers helped less experienced ones. A website provided information on distance learning for teachers and pupils and various materials, and had a FAQs section where answers were posted weekly. The Minister communicated with pupils directly via her Facebook account.

The key for success was timely planning, clear guidance, good distribution of existing resources and huge commitment from teachers and government.

Source: European Commission (2020) Education and Training monitor, Volume II - Croatia

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Computer and information literacy, 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 work places and in society’\textsuperscript{13}, is the core focus of ICILS. This concept largely covers the first four competence areas identified in DigComp, but also includes aspects related to the fifth competence area, which is problem solving\textsuperscript{14}. Starting in 2018, participating countries also had the option for their pupils to complete an assessment of computational thinking: the ability to use the concepts of computer science to formulate and solve problems. Computational thinking incorporates aspects of the third and fifth competence areas identified in DigComp, digital content creation and problem solving.

In contrast to other international studies covering digital competence, where digital skills are approximated using less reliable instruments such as self-assessment questionnaires, ICILS directly measures pupils’ achievement through computer-based assessments. Two cycles have been completed, the first in 2013 and the second in 2018, and a third cycle is scheduled for 2023. Nine EU Member States participated in the first cycle, and seven in the second cycle\textsuperscript{15}. Denmark and Germany were the only Member States participating in both cycles, bringing total EU Member State participation to 14\textsuperscript{16}.

### 1.1.1 Comparing computer and information literacy between and within countries

Evidence from the two ICILS cycles shows substantial variation in the average pupil scores in computer and information literacy across the participating Member States (Figure 1 and Figure 2). In the 2018 cycle, the difference between the average scores of the top scoring Member State (Denmark), and the lowest scoring Member State with comparable results (Luxembourg), was 71 score points (Figure 2)\textsuperscript{17}. The corresponding difference in the 2013 cycle between the top scoring Member State (Czechia), and the lowest scoring Member State (Lithuania), was 59 score points (Figure 1). The difference in the variation between the highest and lowest average achievement scores between the two cycles – 12 score points – is small. In Germany, the only Member State with comparable results across cycles\textsuperscript{18}, the difference in average achievement score was not statistically significant, however.


\textsuperscript{15} ICILS 2013: Czechia, Denmark, Germany, Croatia, Lithuania, the Netherlands, Poland, Slovenia and Slovakia. ICILS 2018: Denmark, Germany, France, Italy, Luxembourg, Portugal and Finland.

\textsuperscript{16} Denmark did not meet the sample participation rate in 2013, and the 2013 results are thus not comparable to the 2018 results.

\textsuperscript{17} Pupils in Italy were tested at the beginning of the school year, with an average age of 13.3, lower than the minimum requested of 13.5 and against the average age of the students tested of 14.4, and the results are consequently not comparable to those of the other Member States.

\textsuperscript{18} See note 16.
Digital competence, as measured by the computer and information literacy instrument in ICILS, is described across four levels of increased sophistication. The proficiency levels describe the nature and the complexity of the tasks pupils are able to solve. Pupils’ computer and information literacy proficiency becomes more sophisticated as they progress up the scale; a pupil located at a particular place on the scale will be able to undertake and successfully accomplish tasks up to that level of achievement.

Level 1: Pupils demonstrate a functional working knowledge of computers as tools and a basic understanding of the consequences of computers being accessed by multiple users.

Level 2: Pupils use computers to complete basic and explicit information gathering and management tasks.

Level 3: Pupils demonstrate the capacity to work independently when using computers as information gathering and management tools.

Level 4: Pupils select the most relevant information to use for communicative purposes. They evaluate usefulness of information based on criteria associated with need and evaluate the reliability of information based on its content and probable origin.

Figure 1 – Variation in computer and information literacy scores across and within countries, 2013

Source: IEA, ICILS 2013.

Note: Computer and information literacy achievement levels: below level 1 (below 407 scale points), level 1 (407-491 scale points), level 2 (492-576 scale points), level 3 (577-661 scale points), level 4 (above 661 scale points).

¹ Met guidelines for sampling participation rates only after replacement schools were included.

² Did not meet the sampling participation rate.

The average pupil scores are situated within the lower end of the level 2 proficiency interval of the computer and information literacy scale (492-576 score points) in all Member States, with the exception of Luxembourg and Italy \(^{20}\) (Figure 1 and Figure 2). At this level, pupils demonstrate basic use of computers as information resources, and are able to complete basic and explicit information-gathering and management tasks. This is where we find the highest percentage of pupil scores across Member States in both ICILS cycles, as shown in Figure 3.

Average scores across countries, however, do not provide a complete picture of the situation in the Member States. If we consider the percentiles of performance, we see that the within-country variation is greater than the variation in average scores (Figure 1 and Figure 2). Between countries, the difference between the highest average score and the lowest average score in countries with comparable results is 71 score points. In comparison, the variation between the highest 5% and lowest 5% (5\(^{\text{th}}\) and 95\(^{\text{th}}\) percentiles) of the pupil scores within countries is above 200 score points in all Member States.

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\(^{20}\) See note 17 for information on the comparability of the Italian results.
Box 4 – Improving pupils’ digital competences in the Netherlands

A digitalisation agenda for primary and secondary education was adopted in 2019 as part of the Dutch digitalisation strategy. The objectives are to foster innovation in education, improve teachers’ and pupils’ digital skills, ensure that IT infrastructure is secure and reliable and to raise awareness of the ethics of digitalisation. In addition, there are a number of other related programmes such as the national training programme ‘Digital Teacher’, which aims to improve the digital skills of primary teachers. The programme ‘Pass IT on!’ (Geef IT Door) allows secondary schools to invite IT professionals to give a guest lecture. The government-funded centre of expertise Mediawijzer.net provides links to over 1 000 media literacy organisations to organise public campaigns, conduct research, and offer educational services. Kennisnet, the public organisation for ICT in education, developed a step-by-step school guide to choosing digital learning resources and created a catalogue based on information from education publishers and providers to give schools a free, transparent and comprehensive overview of available digital learning resources.

Figure 3 presents the distribution of pupil scores for the different proficiency levels of the computer and information literacy scale for each Member State, giving a more nuanced picture than the average score for all countries. Regardless of overall ranking, the average score presented in Figure 1 and Figure 2 indicates that the pupil population in Member States range from pupils lacking very basic digital skills to pupils excelling in the use and application of digital tools and competence.

Figure 3 – Distribution of computer and information literacy scores across achievement scale levels, 2013 and 2018


Note: Computer and information literacy achievement levels: below level 1 (below 407 scale points), level 1 (407-491 scale points), level 2 (492-576 scale points), level 3 (577-661 scale points), level 4 (above 661 scale points). Italy participated in ICILS 2018, but the results are not comparable with those of other Member States and have been excluded from the figure.

† Met guidelines for sampling participation rates only after replacement schools were included.
†† Nearly met guidelines for sampling participation rates after replacement schools were included.
¹ National defined population covers 90%-95% of the national target population.
² Did not meet the sample participation rate.

An interesting observation from the distribution of pupil scores presented in Figure 3 is the contrast between the proportions of students achieving the highest level (level 4) and those failing to reach the level 2 threshold. While only 0.2%–3.9% of pupils in all countries achieved scores above the level 4 threshold, the percentage of pupils scoring below the level 2 threshold ranged from 15.0%-62.7%. In all but two countries, Denmark (2018) and Czechia (2013), a higher proportion of pupils performed below the lowest level (level 1) than were at level 4.
The ICILS results help dispel the myth that being born in a digital world automatically makes a person digitally competent. Contrary to the common view of the young of today as a generation of ‘digital natives’, the ICILS results indicate that young people do not develop sophisticated digital skills just by growing up using digital devices. This is underlined by the high share of pupils with scores below the level 2 threshold on the computer and information literacy achievement scale, which exceeded 30% in 8 out of 13 Member States participating in ICILS (Figure 4)\textsuperscript{21}.

### 1.1.2 Underachievement in digital competence

Underachievement in digital competence can be defined as failing to reach level 2 of the computer and information literacy achievement scale. Below this threshold, a pupil lacks the basic digital competence required for participation in a digital society. Key factors differentiating level 1 achievement from the higher levels are 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.

**Figure 4 – Underachievement in computer and information literacy, 2013 and 2018**

![Figure 4](image)


Note: Underachievement is defined as performance below the level 2 threshold (492 score points) on the ICILS computer and information literacy scale. Italy participated in ICILS 2018, but the results are not comparable with those of other Member States and have been excluded from the figure.

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

†† Nearly met guidelines for sampling participation rates after replacement schools were included.

¹ National defined population covers 90% to 95% of the national target population.

² Did not meet the sample participation rate.

Figure 4 shows the share of underachieving pupils in the participating Member States. In the first ICILS cycle, the share of underachievers ranged from 15.0% in Czechia to 45.1% in Lithuania. The second cycle has a similar distribution, with the share of underachievers in countries with comparable results ranging from 16.2% in Denmark to 50.6% in Luxembourg. Of the two countries participating in both cycles, only the German results are comparable\textsuperscript{22}. The difference in the percentage of students achieving scores at level 2 or above in Germany did, not change significantly between 2013 and 2018, however.

\textsuperscript{21} Member States with comparable results. For the case of Italy, see note 17.

\textsuperscript{22} Denmark did not meet the sample participation rate in 2013.
Box 5 – 8-Point Plan for digital learning – Austria

From 2020/2021, a single gateway, the portal ‘Digital Schule’, should become the prime platform for applications and communication between students, teachers and parents. A reduction in the number of management systems in learning is planned. Uneven ICT skills among teachers became more apparent during the COVID-19 school closures. The plan aims to prepare all teachers well for blended and distance learning, which will include intensified continued professional training, already in summer 2020. Eduthek provided access to learning and teaching material during the crisis, and its content will now be more closely harmonised with curricula. A new good practice label should help teachers choose effective learning apps. By 2021/2022, a purchasing programme starting with school levels 5 and 6 will upgrade IT infrastructure so that all students have access to devices. Purchasing is based on local demand and is linked to compulsory digital and pedagogical plan for each school.


1.1.3 Gender differences in pupils’ digital competence

In both ICILS cycles, there is evidence of a gender gap in digital competence. Female pupils perform, on average, better than male pupils in the participating countries. The highest recorded gap is observed in Finland and Slovenia, where there was a score difference of 29 in the average scores for girls and boys. At the other end of the scale, we find Czechia and Portugal, where the difference was 11 score points. The differences in scores for girls and boys were statistically significant in all Member States.

1.1.4 Individual background factors influencing students’ digital competence

ICILS 2018 and ICILS 2013 reveal that digital competence is linked to socio-economic background. Characteristics reflecting higher socioeconomic status, as measured, for example, by parents’ educational attainment, their occupational status and the number of books at home, are positively linked to pupil achievement. The consistent and statistically significant relationship between socio-economic status and pupil achievement across the Member States offers evidence of a digital divide, in which pupils from lower socioeconomic backgrounds on average perform more poorly in computer and information literacy than their peers from more privileged backgrounds.

Box 6 – Remote School – tackling digital exclusion in Poland

To prevent digital exclusion in education during the COVID-19 crisis, on 1 April Poland launched the ‘Remote School’ initiative, followed by ‘Remote School+’ in mid-May. Around EUR 81 million (PLN 366 million) was allocated to local governments to buy over 100,000 laptops for primary and secondary school students and teachers under the ERDF Operational Programme ‘Digital Poland’ (2014-2020). Closing educational institutions for many weeks forced new standards of conducting lessons remotely. Many children, however, were left without access to the internet or equipment on which they could continue their studies. The funds are primarily targeted at students with disadvantaged backgrounds, and disadvantaged families with a minimum of three children. The funds can also be used to purchase appropriate software, internet connections and insurance. Once schools are re-opened, the equipment will be placed in schools and made available to all students. Thanks to the Remote School initiatives, numerous Polish municipalities were able to distribute laptops, tablets or mobile

23 IEA, ICILS 2018. Table 3.7 and IEA, ICILS 2013, Table 4.1.
24 IEA, ICILS 2018. Table 3.8 and Table 3.9, and IEA, ICILS 2013, Tables 4.3-4.7.
internet to children who did not have them, to allow them to attend the classes online. By mid-June, 4,738 of 5,267 eligible local authorities had applied for funds.

Additionally, the delivery of equipment and Wi-Fi infrastructure to schools has been speeded up under the ERDF project the ‘Polish Educational Network’ (Ogólnopolska Sieć Edukacyjna) (2017-2020), which aims to create an internet network connecting all Polish schools by the end of 2020. Schools will be centrally provided with internet access, security services and free educational content for teachers and students. The capital costs estimated at EUR 76.2 million will come from the ERDF. The Ministry of National Education has modernised the Integrated Educational Platform (www.epodreczniki.pl), currently used by schools for distance learning. The platform has two functions:

1. a repository of proven and valuable teaching materials;
2. tools for use in remote learning and learning.

The platform currently offers over 6,000 pieces of educational material, intended for all stages of education, both general and vocational. Almost all teaching material includes open-ended questions or interactive exercises.

All content posted on the platform is free. The materials are available through a web browser and do not require installation or additional software. Users can search for material by keywords or by the content of the core curriculum. Users can save the content as favourites or share it with other users.

Source: Ministry of Digitalisation’s website (Remote School; Remote School+): on remote schools and on digitalisation.

Migrant status and language spoken at home are other factors identified in ICILS as being associated with pupil achievement. Pupils from non-migrant families score on average higher compared to pupils from migrant families. With the exception of Czechia and Poland in ICILS 2013, and Portugal in ICILS 2018, the difference is statistically significant in all participating Member States. The outcome is similar when comparing pupil performance between pupils speaking the same language as the test language at home, and pupils speaking a different language than the test language at home. With the exception of the three countries above, where the difference was not statistically significant, speaking the test language at home was positively associated with pupil achievement.

1.1.5 Comparing computational thinking between and within countries

Computational thinking and related concepts such as coding and programming have received increasing attention in the education field in the past decade. The concept of computational thinking is related to, yet different from, computer and information literacy. While computer and information literacy is primarily concerned with the ability to collect and manage information and to produce and exchange information, computational thinking encompasses an ‘individual’s ability to recognise aspects of real-world problems, which are appropriate for computational formulation and to evaluate and develop algorithmic solutions to those problems so that the solution could be operationalised with a computer’. The two domains can be regarded as complementary aspects of a broader notion of digital competence as described in the DigComp framework.

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25 In ICILS a student is defined as coming from a ‘migrant family’ (the term ‘immigrant’ is used in ICILS) if both parents were born abroad (regardless of where the student was born), and as a ‘non-migrant family’ if when at least one parent was born in the country where the survey was conducted.

The assessment of computational thinking was an optional module introduced into ICILS 2018. Six of the seven Member States participating in this cycle opted to take part in this module (Figure 5). Aspects of computational thinking, such as creating algorithms or creating visual presentations of data, are emphasised differently in the national curriculum of the participating Member States. However, all countries, including Luxembourg from September 2020 have at least some aspects of computational thinking in the national curriculum.²⁷

**Figure 5 – Variation in computational thinking scores across and within countries, 2018**

Achievement on the computational thinking scale is measured across three distinct regions rather than different levels as used for the computer and information literacy scale: a lower region (below 459 scale points), a middle region (459-589 scale points) and an upper region (above 589 scale points).²⁸ Pupils were given a set of tasks to assess their achievement on the computational thinking scale. An example of a task is a farm drone simulator where pupils were required to use a visual coding environment to make a drone perform a series of actions, such as dropping water on specific areas but not others. Score points were awarded according to the completion of objectives and the effectiveness of the solution.

Figure 5 gives an overview of the variation in computational thinking across and within Member States. Average scores range from 460 points in Luxembourg to 527 points in Denmark, and are situated within the middle region of the scale. Variation within countries is larger than the variation between countries, similar to the assessment of computer and information literacy. Variation within countries is not clearly associated with high or low achievement compared to other countries, however.

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²⁷ IEA, ICILS 2018, Table 2.5.
On average, in all countries there is a strong positive and statistically significant correlation between pupils’ scores in computer and information literacy and scores in computational thinking
29. The same individual background factors influence pupils’ scores in both domains. Socio-economic status is positively associated with pupils’ computational thinking achievement, while migrant background and speaking a different language than the test language at home adversely affects scores
30.

Gender differences in computational thinking do not reflect the results seen in the computer and information literacy domain. There were statistically significant differences between female and male pupils in only two Member States, Finland and Portugal
31. Interestingly, the differences pointed to opposite directions in the two countries. In Finland, girls scored on average 13 points higher than boys, while boys in Portugal scored on average 16 points higher than girls. Although the difference between girls and boys was not statistically significant in the remaining countries, the average score for male pupils appears to be higher. The exception is Denmark, where there is no notable difference in average scores between the genders.

1.2 Pedagogical use of digital technology

Making better use of digital technology for teaching and learning is essential to reap the benefits of technological innovation and improve education. Pedagogical use of digital technologies depends on the availability, accessibility and quality of ICT resources
32. At the same time, empirical evidence suggests that improvements in infrastructure alone do not systematically lead to the integration and pedagogical use of digital technology in schools across Europe
33. If digital technology is to benefit pupils and educators, the right environment and support is needed.

Outcomes of the use of digital technologies in education depend on a variety of conditions, both individual and systemic. The digital competence level of lower secondary school pupils was addressed in the previous section. This section expands the scope and addresses the structural and pedagogical conditions that support digital education at lower secondary level, such as curricula and learning outcomes, resource availability, teachers’ digital competence and use of digital tools for teaching.

1.2.1 School curricula and learning outcomes

Digital technologies change rapidly, which requires the school curriculum to keep pace so as not to become outdated too quickly. Data from the Eurydice network shows that 17 Member States or regions within Member States
34 are currently reforming the curricula related to digital competence in primary and general secondary education
35. At lower secondary level, nearly all Member States have explicitly included learning outcomes related to all five areas of digital competence identified in the DigComp framework (Figure 6). Only two Member States (and the French Community and German-speaking Community of Belgium) have no explicit learning outcomes related to digital competence.

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30 IEA, ICILS 2018, Table 4.3 and Table 4.4.
31 IEA, ICILS 2018, Table 4.2.
34 BE (fr and nl), BG, CZ, DE, IE, EL, FR, HR, CY, LV, LT, NL, AT, PL, PT, RO.
36 Current reforms are addressing these issues.