Part 1

Teaching and learning in a digital age
1 Teaching and learning in a digital age

Key findings
The International Computer and Information Literacy Study (ICILS) points to competence gaps and large performance variations in computer and information literacy among pupils in the participating EU Member States.

The ICILS results dispel the myth that being born in a digital world automatically makes people digitally competent. Contrary to the common view of the young generation 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 while using digital devices.

Teachers need to be equipped with the necessary skills to take advantage of the potential of digital technologies to improve teaching and learning and to prepare their pupils for life in a digital society. Evidence from the OECD Teaching and Learning International Survey (TALIS) 2018 indicates that the use of information and communication technology (ICT) for teaching was rarely included in the education and training of lower secondary teachers in EU countries. On average in the Member States, fewer than half of teachers (49.1%) report that ICT was included in their formal education or training.

Information technologies have been shaping the way we learn, communicate, work and organise society. In the transformation into the digital age, digital competences are becoming crucial for the ability of individuals to function in society and their inclusion in the labour market. Investing in one’s digital skills throughout life is thus of utmost importance. This means that education and training systems need to introduce digital learning early on and promote it as part of lifelong, giving people the forward-looking knowledge, skills and competences they need to innovate and prosper in the world transformed by digital technology.

In 2019, 56% of individuals in the EU had at least basic digital skills, with 31% possessing above basic skills, according to the EU Digital Economy and Society Index (DESI)\(^2\). This continues the positive development seen since 2015, the first year with available data, when the percentages were 54% and 27%, respectively. The skills indicator varies widely across socio-demographic categories. For example, 80% of young individuals (aged 16-24) showed basic or higher digital skills against only 33% of those aged 55-74. 84% of those with high formal education showed basic or higher digital skills against 32% of individuals with no or low formal education. 66% of employed or self-employed and 87% of students had at least basic digital skills. In contrast, only 28% of the retired and other inactive categories and 44% of unemployed demonstrated such skills. The lack of basic digital skills poses serious risks of digital exclusion in a context of rapid digitisation\(^3\).

Ensuring that the EU makes the most of the potential of the digital age is a key priority\(^4\). The EU has identified digital competence one of eight key competences for lifelong learning, highlighting its importance for all stages of education, both formal and informal, and across all segments of the EU population. Within this framework, digital competence is defined as ‘the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for

\(^3\) To better prepare young people for the labour market, the Commission’s proposal for a Council Recommendation on a Bridge to Jobs – Reinforcing the Youth Guarantee recommends that, based on an assessment of gaps in digital skills, all young people who register in the Youth Guarantee are offered a dedicated preparatory training to enhance their digital skills.
participation in society. From an educational point of view, the challenge is twofold: developing digital competence and more extensive, effective and purposeful use of technology in teaching and learning.

The 2018 Communication from the Commission on the digital education action plan reflects this dual need of pedagogical use of technologies and development of digital competence through its two first priorities: 1) making better use of digital technology for teaching and learning and 2) developing relevant digital competence and skills for the digital transformation. This chapter uses these priorities as a point of departure to provide an insight into the current state of affairs of digital education in the Member States by looking at lower secondary school pupils’ digital competence and the pedagogical use of technology for teaching and learning in lower secondary school.

Box 1 – The COVID-19 crisis: school and campus closures, emergency measures, distance learning, loss of learning

The closure of schools and campus buildings lasting for 2-6 months as part of the international effort to contain the spread of COVID-19 has been unprecedented, and is estimated to have affected 74% of all enrolled learners in 186 countries. All EU Member States have put in place remote learning schemes as a temporary measure to replace physical presence at school. The full cost of school and campus closures and their long-term consequences are hard to predict and measure, and will perhaps only become visible in the next waves of international school performance surveys such as the OECD Programme for International Student Assessment (PISA), ICILS and the Progress in International Reading Literary Study (PIRLS). A set of risks and negative impacts of the closures is already emerging from various case studies, however. Physical school and campus closure and the adoption of distance and online education may negatively affect students’ learning in four main ways: less time spent in learning, stress symptoms, a change in the way learners interact, and lack of learning motivation. Nonetheless, distance and online education is fundamental to ensure the continuity of learning in situations where in-person classes are suspended.

A ‘School Barometer’ survey conducted in late March and early April 2020 among Austrian and German pupils, parents and school staff, later extended to a few other EU countries indicates that a substantial proportion of students reported a worryingly low level of learning at home during the school lockdown (2 h or less per day). In contrast, just under a third of students reported a relatively high level of learning commitment (5 h or more per day). An analysis conducted to characterise these two student groups indicates that conscientious students – who self-regulate their planning for the day, get up early, have a regular schedule, do not feel like they are on holiday and do sports regularly – are more likely to be hard-working (in terms of the weekly hours spent on academic matters). Also, it seems that, when teachers regularly control students’ work, students are more engaged in learning at home.

Being confined at home may trigger unique psychosomatic stress reactions in pupils. Being constrained to social contacts only with members of the household and deprived of face-to-face contacts with their schoolmates and peers may lead to

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7 Huber G.H., Helm, C (2020). COVID-19 and schooling: evaluation, assessment and accountability in times of crises – reacting quickly to explore key issues for policy, practice and research with the school barometer.
feelings of loneliness, grief, depression, lack of concentration or insomnia, all of which may be detrimental to learning outcomes.

Sharing the classroom with other pupils is known for its positive indirect effects: mutual learning, healthy rivalry, social influence etc. Moreover, classroom interactions are vital for developing non-cognitive social skills, sense of identity, positive self-esteem, empathy, the calibration of social reactions and teamwork and the sense of belonging to a group.

Home confinement may also be detrimental to learning motivation. Taking this into account, several countries (e.g. Spain, Italy) have announced that pupils would not have to repeat the school year regardless of their performance while studying remotely, as a general rule. France has forbidden the use of student assessment results during the COVID-19 period in the formal evaluation of the brevet (lower secondary school exam) and of the baccalauréat (upper secondary school exam). Although this could be a fair decision, studies suggest that students may be more externally motivated to learn if they know their learning will be assessed.

Furthermore, distance learning may pose unprecedented challenges to parents who have to juggle their own remote work while helping their children studying at home.

The inequality dimension and the social gradient in both distance and online learning and in coping with lockdown is an important policy challenge. For children to successfully take part in distance and online learning, certain minimum technical requirements have to be satisfied, requirements that poorer households often cannot afford. Successful online learning presupposes that each child has a computer or a tablet at their disposal, combined with a fast internet connection. Moreover, each child needs a private and quiet room during the online sessions, but also for successful self-study and homework. Poorer families typically live in more crowded spaces and are able to offer their children much less comfortable conditions for distance and online learning and self-study.

The social gradient extends to children’s wellbeing. Poorer families typically have less space for children to play (no gardens for example, or no access to playgrounds). Food security might be yet another issue as poorer children may rely more on school meals. Children from poorer families are more likely to suffer isolation and boredom with less space available at home and fewer things to keep them creatively occupied at home, such as musical instruments or books.

On the other hand, this crisis has been an opportunity and a stress test for educational systems that might have a positive effect on accelerated digitalisation and modernisation of teaching. The educational systems could test which solutions have worked and which have not during the distance learning under lockdown.

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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’\(^\text{13}\), 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\(^\text{14}\). 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\(^\text{15}\). Denmark and Germany were the only Member States participating in both cycles, bringing total EU Member State participation to 14\(^\text{16}\).

### 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)\(^\text{17}\). 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\(^\text{18}\), the difference in average achievement score was not statistically significant, however.

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

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

\(^{17}\) 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.

\(^{18}\) See note 16.
**Box 3 – Computer and information literacy proficiency levels in ICILS**

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.

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**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 sample participation rate.

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Figure 2 – Variation in computer and information literacy scores across and within countries, 2018

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\(^\text{20}\) (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.

\(^{20}\) 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 Mediation.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%-99% 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)\(^21\).

### 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

![Underachievement in computer and information literacy, 2013 and 2018](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\(^22\). 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.

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

\(^{22}\) 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 States23.

1.1.4 Individual background factors influencing students’ digital competence

ICILS 2018 and ICILS 2013 reveal that digital competence is linked to socio-economic background24. 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 curriculum27.

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

![Average computational thinking score](chart.png)


Note: Computational thinking regions: lower region below (459 scale points), middle region (459-589 scale points), upper region (above 589 scale points).

† 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 national target population.

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.

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. 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.

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. 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. 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. 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 are currently reforming the curricula related to digital competence in primary and general secondary education. 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.
Figure 6 – Digital competence areas addressed in terms of learning outcomes in national curricula (ISCED 2), 2018/19


Note: The aggregate total includes Belgium, as Belgium covers all five competence areas. Belgium fr and Belgium de do not have learning outcomes/objectives related to digital competence. This is not reflected in the chart total as it counts each Member State once.

Box 7 – Teaching computer science at primary level in Lithuania

Lithuania is one of the few countries in the EU where fostering digital awareness is promoted from pre-primary level. The ongoing competence-based curriculum reform aims to enhance digital competences even at primary level, where they have not previously been addressed, update content and strengthen particular areas such as computer science which will be taught starting at primary level. In 2018 a European Social Fund study was launched to test whether Lithuanian primary schools could integrate informatics into their curriculum. About 100 primary schools were selected for this 4-year project which covers the development of digital content, algorithms and programming, data and information, problem solving, virtual communication and security. Teachers have been provided with training of about 120 hours. The purchase of ICT equipment such as tablets and board education games has also been announced. Public events have been organised in local municipalities to discuss the importance of informatics in primary schools and to share information with stakeholders. The purpose of this project is to provide recommendations for the integration of computer science at primary level.


1.2.2 Digital infrastructure

A key part of digital education is ensuring equity and quality of access and infrastructure. Shortage of resources affects schools in EU countries to varying degrees. The COVID-19 situation has highlighted that this goes beyond the domain of schools, however. Access by households to digital equipment and internet connection at home are key prerequisites for participation in distance learning. It follows that COVID-19 may have exacerbated education inequalities. In 2018, 3.9% of households in the EU-27 could not afford a computer. For households with income below 60% of median equalised income, the figure was 12.8% (13.4% in households with dependent children). In contrast, 2.1% of households with income above 60% of the median equalised income could not
afford a computer (1.7% of households with dependent children)\textsuperscript{37}. The percentage of persons who could not afford an internet connection is similar, with 4% of households in the EU in 2018\textsuperscript{38}.

Unequal distribution of access is also present when comparing EU natives to non-EU born persons. Figure 7 shows that the share of persons who could not afford a computer was higher amongst non-EU born persons than natives in all but one EU Member State in 2018. At the EU level, 9.7% of non-EU born persons could not afford a computer compared to 3.4% of EU natives. The difference is not as high when comparing natives to non-EU born persons who could not afford an internet connection, with 3.9% and 4.8% respectively\textsuperscript{39}.

**Figure 7 – Persons who cannot afford a computer, by group of country of birth, 2018 [%]**

![Graph showing the percentage of persons who cannot afford a computer by group of country of birth, 2018][1]

Source: Eurostat, EU-SILC survey. Special extraction.

Note: Sorted in descending order by share of non-EU born. Data not shown for BG, CZ, DK, HU, PL, RO and SK due to low n. Unreliable data for non-EU born for DE, IE, LT, LU, NL and FI.

Figure 8 shows that insufficient internet access is identified as pertinent issue by lower secondary school principals in Italy (42.9%), Portugal (37.2%) and Romania (36.2%). This is also a concern in France, Hungary and Belgium for at least one principal in five. At the other end of the scale, we find Slovenia, Finland and Sweden, where fewer than 1 principal in 20 sees insufficient internet access as an obstacle to providing quality instruction.

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\textsuperscript{37} ‘Persons who cannot afford a computer’. Eurostat. EU-SILC survey, online data code: [ilc_mddu03].

\textsuperscript{38} ‘Persons who cannot afford an internet connection’. Eurostat, EU-SILC survey. Special extraction.

\textsuperscript{39} ‘Persons who cannot afford an internet connection’. Eurostat, EU-SILC survey. Special extraction.
Figure 8 – Percentage of school principals who report that the following shortages of resources hinder the school’s capacity to provide quality instruction ‘quite a bit’ or ‘a lot’.

Source: OECD, TALIS 2018 Database, Table I.3.63.

Note: Results based on responses of lower secondary principals.

1 Weighted EU average based on the 22 participating Member States in TALIS 2018.

2 Such as software, computers, tablets and smartboards.

In the EU Member States, shortage or inadequacy of digital technology for instruction (such as software, computers and smartboards) is perceived among principals as more of a hindrance to school capacity than insufficient internet access (Figure 8). In Portugal 55.4% of principals report a shortage, closely followed by Romania (49.8%) and Latvia (41.3%). There are only two Member States (Malta and Slovenia) where fewer than 1 principal in 10 reports a shortage of digital technology as an issue affecting instruction.

Box 8 – Consolidation of Latvia’s school network

Latvia is working on the consolidation of its large and inefficient school network. In 2019 the Education law was amended to give the government the power to set the minimum number of students per class in upper secondary schools. The Ministry of Education and Science has proposed four regional categories of schools, with different requirements for the minimum number of students per school (from 450 in larger towns to just 15 in border areas) and per class (from 25-5). The goal is a network of fewer but bigger upper secondary schools better able to provide quality education for students and better remuneration for teachers, narrowing educational gaps between urban and rural areas. Progress so far has been slow, but the administrative and territorial reform due to come into force in 2021, which reduces the number of municipalities from the current 119 to fewer than 40, could provide an opportunity to speed the process along.


The exceptions are EE, IT, and AT, where insufficient internet access is reported as a concern by a higher percentage of principals.
Teachers agree with principals; on average, 35.9% of lower secondary teachers in the EU identify investing in ICT to be of high importance (Figure 9). In Cyprus (66.3%) and Hungary (56.3%) more than 50% of teachers see this as a priority. This is contrasted by the Nordic countries Denmark (15.3%), Sweden (17.6%) and Finland (13%), which are the only countries where fewer than 20% of teachers consider investments in ICT to be a high priority. The relative importance of ICT equipment is further emphasised by the recent results from the ‘2nd Survey of Schools: ICT in Education’, in which equipment-related obstacles were perceived as the most important issue adversely affecting the use of digital technologies by teachers\(^{41}\).

**Figure 9 – Percentage of teachers who reported investing in ICT to be of ‘high importance’**

Source: OECD, TALIS 2018 Database, Table I.3.66.

Note: Results based on responses of lower secondary teachers. Respondents were not asked to prioritise. They were able to attribute ‘high importance’ to all spending priorities.

\(^{1}\) Weighted EU average based on 20 of 22 participating Member States in TALIS 2018 (data for BG and FR is not available).

### 1.2.3 Teachers and digital competence

Competence of educators refers to their ability to understand and use digital technology, and their capacity to use digital technology for teaching and learning. Teachers need to be equipped with the necessary competence to take advantage of the potential of digital technologies to enhancing teaching and learning and prepare pupils for life in a digital society. This means that teachers must be digitally prepared when they join the profession, and that they can further develop and reinforce their specific digital competence throughout their career. The European Commission released the Digital Competence framework for Educators (DigCompEdu) in 2017, defining and describing 22 competences along 6 areas to help with addressing these competences for educators.\(^{42}\) A self-reflection tool for educators is also under development.\(^{43}\)

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\(^{43}\) See website
Six EU Member States have developed a specific framework referring to teacher-specific digital competence (Spain, Croatia, Lithuania and Austria) or standards (Estonia and Ireland). In a further 15 countries, digital competence are included in a general teacher competence framework. The remaining countries either do not acknowledge digital competence in their teacher competence frameworks (Czechia, Portugal and Sweden) or have no teacher competence framework at all (Greece, Cyprus, Malta and Finland).

Evidence from TALIS 2018 indicates that the use of ICT for teaching was rarely included in the education and training of lower secondary teachers in EU countries. On average in the EU, fewer than half of all teachers (49.1%) report that ICT was included in their formal education or training. If we only consider teachers who have recently completed their formal education or training, the situation changes. Figure 10 compares all TALIS responses to the responses of teachers who completed their formal education in the 5 years prior to the TALIS survey. For all countries with available data by year of completion, a higher percentage of recently educated teachers received training in the use of ICT for teaching.

**Figure 10 – Percentage of teachers for whom use of ICT for teaching was included in their formal education, by year of completion**

![Bar chart showing percentage of teachers for whom use of ICT for teaching was included in their formal education, by year of completion.](chart.png)

Source: OECD, TALIS 2018 Database, Table I.4.13.

Note: Results based on responses of lower secondary teachers. Data is not available by year of completion for BG, IT, NL and SE.

Teachers’ sense of preparedness for the use of ICT for teaching is related to the year of completion of their formal education or training. A higher percentage of teachers who completed their formal education or training in the 5 years prior to the TALIS survey felt well or very well prepared to use ICT for teaching, compared to the survey total (Figure 11). Conversely, teachers’ confidence in supporting pupil learning through the use of digital technology does not appear to be affected by experience, with statistically significant differences between novice teachers (≤ 5 years’ experience) and more experienced teachers in only two countries (Czechia and the Netherlands).

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44 BE (BE fr and BE nl), BG, DK, DE, ES, FR, IT, LV, LU, HU, NL, PL, RO, SI, SK.
46 OECD, *TALIS 2018*, Table I.2.20.
Figure 11 – Percentage of teachers who felt ‘well prepared’ or ‘very well prepared’ for the use of ICT for teaching, by year of completion

ICT skills for teaching is an area where teachers say they need more training, surpassed only by ‘teaching students with special needs’. When asked about their level of need of training in ICT skills, an average of 18% of teachers in the EU reported a ‘high level of need’ (Figure 12). The need is the highest in Croatia (26.2%), where about one in four teachers report a high need of continuous professional development (CPD) in ICT skills for teaching. In Slovenia in comparison, less than one in ten teachers report a high need for training in ICT skills.

Figure 12 – Percentage of teachers reporting a high level of need of professional development in ICT skills for teaching

Source: OECD, TALIS 2018 Database, Table I.5.21.
Note: Results based on responses of lower secondary teachers.

¹ Weighted EU average based on the 22 Member States in TALIS 2018.
An interesting observation from the TALIS data is that the percentage of teachers reporting a high need of professional development in ICT skills for teaching has decreased over time. In 10 out of the 12 Member States with available data, there were statistically significant reductions in the reported need of professional development in ICT skills for teaching between TALIS 2008 and TALIS 2018.

### 1.2.4 Use of digital tools for teaching

Effective and systematic use of digital tools for teaching and learning in schools is still a challenge in many Member States. To help schools with their digital capacity building, the European Commission has developed SELFIE, a free, online, multi-lingual self-reflection tool. It includes questionnaires for school leaders, teachers and students and creates a report, a snapshot of where the school stands in the area of digital technologies, enabling to plan actions and monitor progress. SELFIE is one of the 11 priority actions of the 2018 Digital Education Action Plan (DEAP). More than 660,000 school leaders, teachers and students from 7200 schools in 57 countries in EU, SEET and other countries have already used the tool. A new version was released in August 2020, addressing new items stemming from the COVID-19 shift to digital and online learning. SELFIE combines obligatory items with optional ones and open ones to be inserted by the schools themselves.

One of the items of SELFIE is on project work enabled by digital tools. TALIS 2018 reveals that the extent to which teachers let pupils use ICT for projects or class work varies across the EU countries (Figure 13). On average in the EU, 46.9% of teachers report that they frequently or always let their pupils use ICT for projects or class work. Teachers in Denmark (90.4%) are most likely to let their pupils use ICT, while teachers in Belgium (28.9%) are least likely to let their pupils use ICT.

**Figure 13 – Percentage of teachers who reported that they ‘frequently’ or ‘always’ let pupils in the target class use ICT for projects or class work in their class**

Source: OECD, TALIS 2018 Database, Table I.2.1.

Note: Results based on responses of lower secondary teachers. These data are reported by teachers and refer to a randomly chosen class they currently teach from their weekly timetable.

¹ Weighted EU average based on the 22 Member States in TALIS 2018.

A T (-8.3 pps), BG (-4.3 pps), DK (-8.9 pps), EE (-8.7 pps), ES (-11.2 pps), IT (-9.2 pps), LT (-12.5 pps), MT (-8.9 pps), PT (-12.2 pps) and SI (-16.6 pps) and experienced a statistically significant reduction in the percentage of teachers reporting a high need for professional development in ICT skills for teaching from TALIS 2008 to TALIS 2018. This was also the case for BE fr (-5.4 pps). In HU (-2.5 pps) and SK (+1.8 pps) the differences were not statistically significant.

See SELFIE.
The percentage of teachers who report they ‘frequently’ or ‘always’ let their pupils use ICT for projects or class work has increased over time. Figure 14 shows the difference between the responses from TALIS 2013 and TALIS 2018. In the majority of the Member States where data is available, there has been a statistically significant increase. The biggest increases are present in Finland (+32.5 pps), Romania (+30.2 pps) and Sweden (+29.6 pps). In Czechia and Slovakia, the change was not statistically significant.

**Figure 14 – Percentage of teachers who reported that they ‘frequently’ or ‘always’ let pupils use ICT for projects or class work in their class, change from 2013 to 2018**

![Graph showing percentage change from 2013 to 2018 for various countries](image)

Source: OECD, TALIS 2018 Database, Table I.2.4.

Note: Results based on responses of lower secondary teachers. These data are reported by teachers and refer to a randomly chosen class they currently teach from their weekly timetable.

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**Box 9 – Integrating traditional textbooks with self-produced digital educational content in Italy**

*Avanguardie Educative* (Educational Avant-Garde) is a network of Italian schools set up by INDIRE, Italy’s national institute for research in education, with the objective of rethinking the Italian school model, still strongly classroom-lecture-activity-based and constrained by rigid organisation of the timetable. Among the innovative ideas promoted by *Avanguardie Educative* is CDD/Libri di testo (where CDD stands for *Contenuti Didattici Digitali*, Digital Didactic Content). The idea is to go beyond the traditional printed textbook associated with lecture-centred schooling by involving students in making the content of their books. The project’s starting point is that the textbook should be a ‘canvas’ that guides class activity, filled with content connected to the particular context of the school. The aim is to overcome the concept of studying as just rote learning: creating digital content implies cooperation among the whole class, critical use of different tools and resources in the analysis of various language forms, and the development of social skills. For teachers, it can be a way to produce content adapted to different learning needs, motivate students through their active involvement and to link content to the local area.

Source: [http://innovazione.indire.it/avanguardieeducative/cdd](http://innovazione.indire.it/avanguardieeducative/cdd)