Chapter 4. Skills for a digital society

Digitalisation transforms the way people live, bringing both opportunities and challenges. This chapter investigates social changes arising from the ubiquity of smartphones and Internet connections, the types of skills people need to make the most of these changes, and how education and training policies can best provide those skills. The "digital divide", which initially concerned gaps in Internet access, increasingly concerns the different ways people are able to use the Internet and the benefits they derive from their online activities. Skills appear to be an important factor behind these differences. A wide range of policies is needed to ensure that the use of technologies does not exacerbate inequalities between individuals or hinder well-being. Schools have a key role in teaching values and skills to combat cyberbullying and excessive use, while local communities can help older individuals to develop basic digital skills.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

The digital transformation affects many aspects of daily life. Information and communication technologies (ICTs) provide more than an infrastructure that can facilitate access to information and to private and public services. They influence the way people interact, communicate, learn, build trust in others, participate in the democratic process, and spend their time. E-commerce is shaping consumers' behaviour and time use, the retail industry and even how cities look. The time that people spend on their smartphones and the implications for their social life and well-being have now become crucial questions.

As parents, consumers and citizens, people need skills to access information and perform tasks that are done through the Internet while preserving their privacy and security. If people have the necessary skills, digitalisation offers considerable potential not only to disseminate knowledge, improve political engagement and increase efficiency of public services, but also to enable new forms of leisure.

If technology spreads more quickly throughout daily life than people's skills develop, however, some individuals may be left behind or may feel isolated. Older people are especially vulnerable to such risks. Differences in how individuals use digital devices and the Internet tend to exacerbate existing inequalities. To prevent digital divides from emerging or expanding, it is vital to understand better the minimum skills that people require.

The digital transformation can increase well-being but also creates new risks, such as over-consumption, unwilling exposure of personal information or cyberbullying. Exposure to such risks may harm children's performance at school and the development of their skills. The increasing digitalisation of many services, public (e.g. e-government, e-health) and private (e.g. e-banking), can lessen people's opportunities to interact with others, reducing their sense of participating in and belonging to communities and societies. How does technology change social interactions and affect the development of social and emotional skills? These are compelling questions in an increasingly digitalised society.

This chapter investigates the types of skills people need to make the most of the digital society. It considers how policies can ensure that individuals benefit from new online opportunities while avoiding the risks attached to them. The chapter first describes the emergence of a "digital society" and the rapid increase in the type of activities that can be performed on line. Then it discusses how the digital divide in access has progressively been replaced by a divide in the ways individuals use the Internet and the benefits they derive from their online activities.

The chapter performs new empirical analyses to investigate which cognitive skills shape digital divides in terms of use and outcomes. It discusses how participation in online activities can expose people to risks or increase their well-being, while looking at the specific role of skills in these relationships. Finally, it derives some policy implications.

Evidence is lacking on many aspects of how new technologies change the way people live, what benefits and risks digital societies bring, and how education and training policies need to be adapted to address these changes. This chapter investigates these keenly debated questions on the basis of the information and data that is available. To obtain a more comprehensive analysis, however, more information would be needed, including data on a broader range of skills, such as advanced digital skills and social and emotional skills. Moreover, this chapter discusses several issues where existing evidence is not yet conclusive, including the implications of digitalisation for well-being, the exposure of individuals to privacy risks, cyberbullying, and the relationship between technology use, mental health and social ties. While cognitive, social and emotional skills are likely to shape

how technology affects individuals' well-being, more research is needed to gauge the effect of technology on many societal dimensions.

The main findings of this chapter are:

- The Internet provides people who would otherwise be isolated with opportunities to communicate and obtain access to information. As broadband access has developed, however, a lack of skills has become an increasingly important reason why some people do not have Internet at home.
- As Internet use evolves, divides between individuals concern more and more the ways they use the Internet and the benefits they obtain. An increasing number of activities can be performed on line, some of which are complex, and people go on line at increasingly younger ages.
- The ways people use the Internet tend to reproduce existing inequalities. Low-performing students are less likely than top performers to look for information on line or read the news, for example, while more skilled individuals are more likely to follow online courses.
- Four profiles of Internet users emerge from the analysis presented in this chapter, based on data from some European countries: i) diversified and complex use; ii) diversified but simple use; iii) use for practical reasons; and iv) use for information and communication. Lacking basic literacy and numeracy skills is a barrier to performing activities online and belonging to any of these profiles. Lacking basic problem-solving skills in technology-rich environments is a barrier to performing diversified and complex activities.
- Having higher cognitive skills – either literacy, numeracy or problem-solving skills in technology-rich environments, or a mix of these – significantly augments the probability that people will move from using the Internet mostly for information and communication to a diversified and complex use, taking other determinants into account. However, skills do not appear to play a significant role in shifting Internet use from information and communication to other types of relatively simple uses.
- Having a good level of cognitive skills also increases the likelihood that individuals perform activities to protect their privacy and security when they go on line. Different sets of cognitive skills have different impacts on the type of actions individuals take to ensure their online security and privacy.
- The ubiquity of smartphones at an increasingly younger age may create new opportunities for children's cognitive stimulation but also bring new risks, such as cyberbullying and excessive use, which are often difficult to detect. Information on the impact of smartphones and tablets on mental health at various ages is still scarce. More highly skilled parents may be better prepared to guide children in their use of technology, especially as evidence shows that children tend to turn to parents when they encounter problems linked to online activities. To prevent the development and use of such technologies from exacerbating inequalities, educational institutions and teachers have an important role to play: they can both help detect such problems and teach values and knowledge that prevent risky behaviours. Policy makers could also consider a co-ordinated and comprehensive regulatory response to address the risks that children face on line.

- Little is known about the effects of technology use on mental health, the development of skills, and social interactions both with friends and strangers. Equally, individuals' capacity to make the most of digital technologies in their everyday lives is likely to be shaped by a range of skills that cannot be measured with existing methods, including the ability to navigate in an uncertain environment, conceptual understanding, the capacity to see the bigger picture and grasp what lies behind information, and the kinds of actions that can be taken online.
- Available data on cognitive skills suggest that countries differ significantly in how prepared their populations are for the digital transformation. Some, such as Israel, Korea and Slovenia have a high proportion of older adults lacking basic skills in literacy, numeracy and problem solving in technology-rich environments. In these countries, programmes need to target older adults and ensure social isolation does not increase with the development of new technologies. Local communities and associations can play a key role in developing people's digital skills and resilience.
- In some countries, such as the United Kingdom and the United States, the share of young people lacking basic skills is relatively high. In these countries, policies need to ensure education and training systems equip all young people with strong skills. Finally, in countries such as Chile and Greece, a large share of the whole population is lacking basic skills, requiring a comprehensive approach to boosting skills.

Participation in online activities

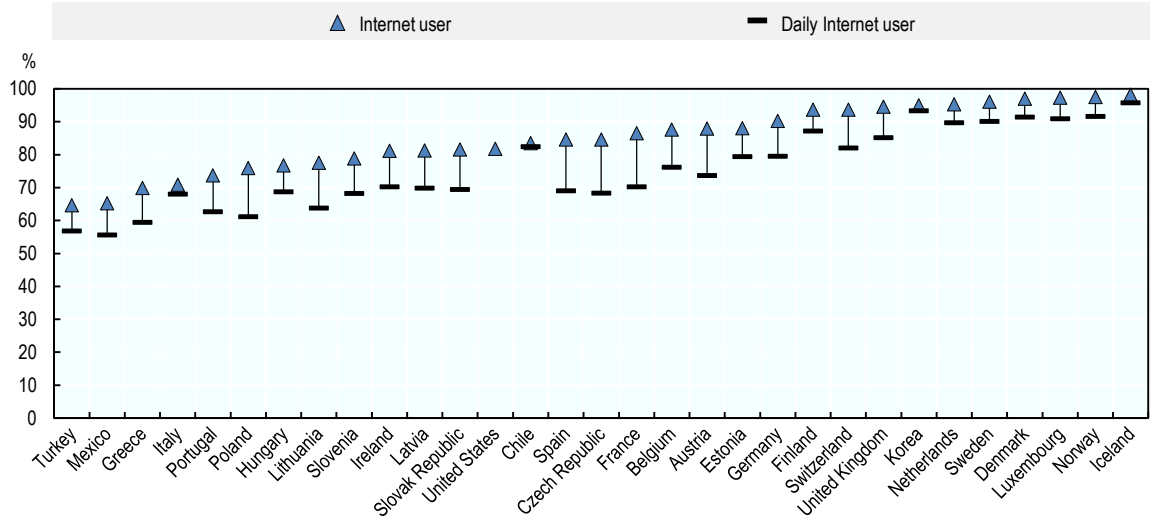
Across OECD countries, people go on line at increasingly younger ages. In 2015, two out of three students aged 15 in OECD countries with PISA data had accessed the Internet for the first time before they were 10; one out of five had done so before the age of 6 (OECD, 2017[1]). These numbers are likely to have further increased. Time spent by 15-year-olds on line increased between 2012 and 2015; on average across OECD countries students spent more than three hours on the Internet on a typical weekend day in 2015 (OECD, 2017[1]).

The pervasiveness of Internet use among 15-year-olds reflects ever higher use of the Internet and digital tools throughout society. In 2017, 76% of those aged 16-74 in OECD countries connected to the Internet on a daily basis and in several OECD countries, almost all individuals were daily Internet users (Figure 4.1). Disparities in Internet uptake across and within OECD countries remain, but Internet use has been rising steadily: in 2006, less than 60% of individuals went on line (OECD, 2017[2]), while more than 85% went on line in 2017.

ICTs have transformed daily lives. People go on line to look for jobs or accommodation, or to learn through online tutorials (Box 4.1). In recent years, the share of individuals going on line to become informed, use social networks, buy goods or interact with public authorities has steadily increased (Figure 4.2). As societies rapidly become digitalised, many emerging activities may not even be captured by data yet. Better access to the Internet and smartphones has enabled many individuals, including those who live in isolated areas or have low socio-economic status, to participate in many activities to which they might not otherwise have had access.

Figure 4.1. Internet users in OECD countries

Share of individuals aged 16-74, 2017



Note: Internet users are individuals who have used Internet in the last three months. Daily Internet users are individuals who have used Internet daily or almost daily in the last three months.
Source: OECD (2017[3]), *ICT Access and Usage by Households and Individuals Database*, http://oe.cd/hhind (accessed on 15 November 2018).

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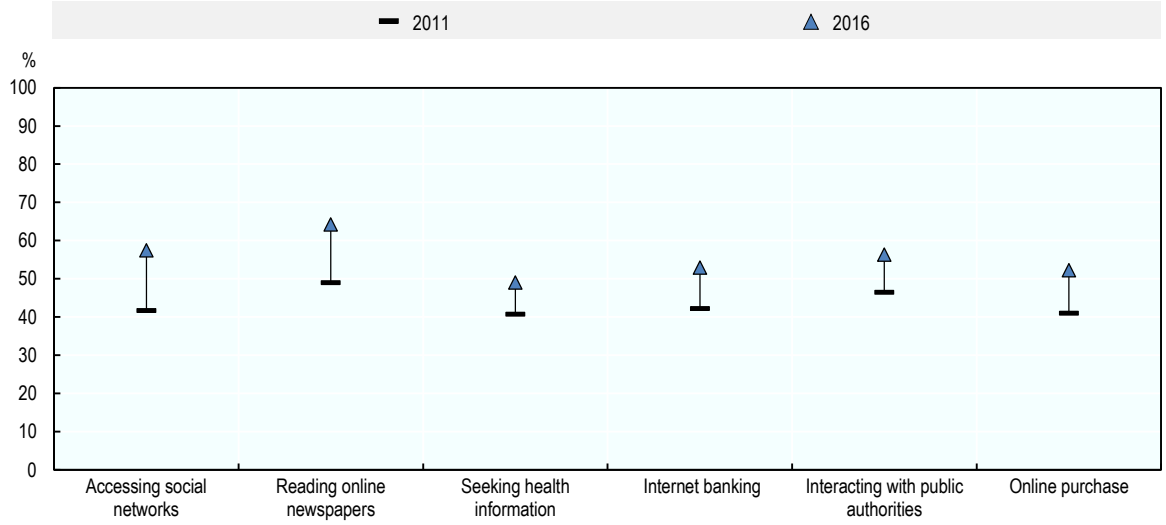
Figure 4.2. Participation in online activities in 2011 and 2016

Share of individuals aged 16-74



Note: Averages are computed over OECD countries with available data in both 2011 and 2016.
Source: OECD (2017[3]), *ICT Access and Usage by Households and Individuals Database*, http://oe.cd/hhind (accessed on 15 November 2018).

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Box 4.1. The emergence of new online activities

The Internet permeates every aspect of the economy and society: individuals connect not only with one another but also with businesses and public institutions, through multiple devices. As the uptake of activities such as sending e-mail or using social media reached a large majority of the population, other types of online activities have recently emerged and gained importance with the upskilling trend, new user needs and new business models.

E-health

E-health refers to the cost-effective and secure use of ICTs to support health and health-related fields. In 2017, across OECD countries, half of all individuals aged 16-74 accessed health information online – 58% of women and 46% of men, up from 40% of women and 32% of men in 2010. More and more people also use e-health services to make an appointment with a health practitioner. In 2016, 13% of Europeans used the Internet for this purpose, roughly a one-third increase since 2012 (OECD, 2019[4]). These behavioural changes are often related not only to increasing digital skills but also to the ageing of societies and the diversification of online service provision.

In addition, individuals are increasingly using mobile wireless technologies for public health, also referred as "m-health" (World Health Organization, 2017[5]). For example, the 2013 joint ITU-WHO initiative "Be He@lthy Be Mobile" harnesses the power and reach of mobile phones to educate people to make healthier lifestyle choices and hence prevent non-communicable diseases (heart disease, stroke, cancer, diabetes) by managing risk factors.

Platform-mediated services

Online platforms, such as Uber and Airbnb, facilitate interaction and (re-)intermediate transactions, partly or fully on line, by matching demand and supply of goods, services and information (OECD, 2016[6]). Platform service markets are often characterised according to aspects that may differentiate them from traditional markets, for example their potential to involve "collaboration", "sharing" or the delivery of services "on demand". Platform workers use an app or a website to connect customers with a diverse range of services, including ride hailing, coding and writing product descriptions.

In 2018, 23% of surveyed individuals in the European Union used services offered via collaborative platforms (Flash Eurobarometer 467, 2018[7]). Among these people, over half have accessed services in the accommodation (57%) and transport (51%) sectors, but few have accessed professional services (9%) or collaborative finance (8%). Furthermore, only 6% of Europeans have offered services via collaborative platforms.

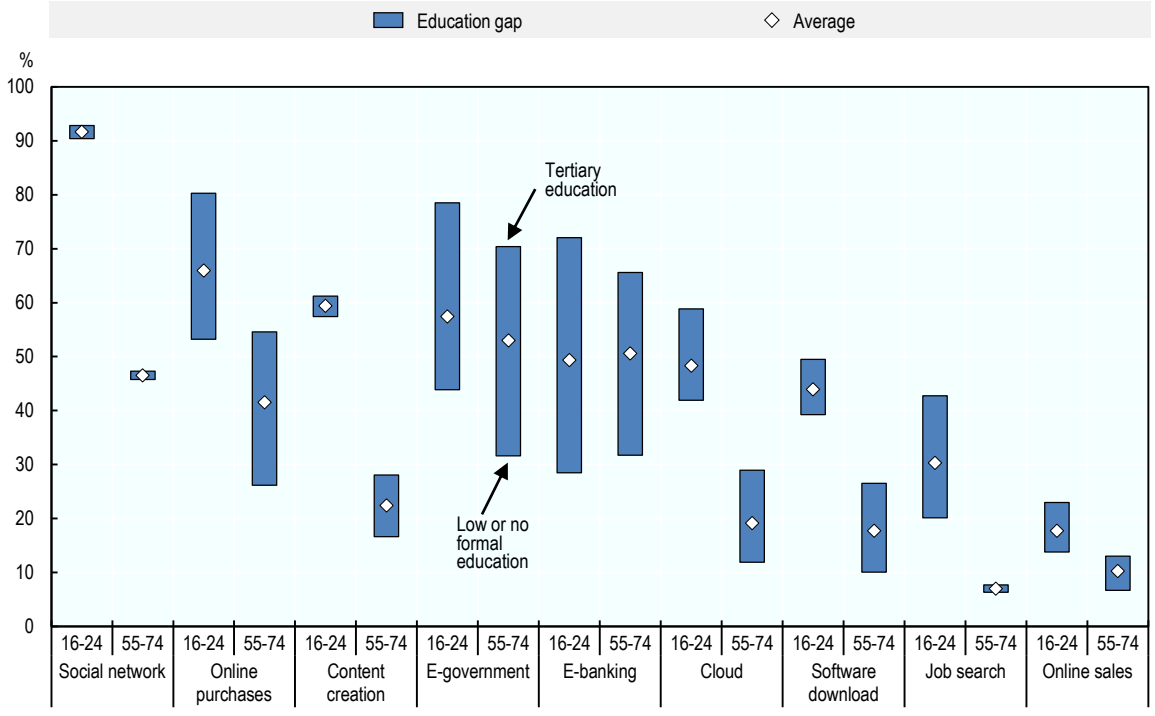
Sources: Campante, F., R. Durante and F. Sobbrio (2018[8]), "Politics 2.0: The multifaceted effect of broadband Internet on political participation", http://dx.doi.org/10.1093/jeea/jvx044; Falck, O., R. Gold and S. Heblich (2014[9]), "E-lections: Voting behavior and the Internet", http://dx.doi.org/10.1257/aer.104.7.2238; Flash Eurobarometer 467 (2018[7]), *The Use of the Collaborative Economy*, http://dx.doi.org/10.2873/312120; OECD (2019[10]), *How's Life in the Digital Age?: Opportunities and Risks of the Digital Transformation for People's Well-being*, OECD, Paris; OECD (2016[6]), *New Forms of Work in the Digital Economy*, https://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DSTI/ICCP/IIS(2015)13/FINAL&docLanguage=En (accessed on 16 January 2019); OECD (2019[4]), *Measuring the Digital Transformation: A Roadmap for the Future*, https://doi.org/10.1787/9789264311992-en; World Health Organization (2017[5]), *mHealth: Use of Appropriate Digital Technologies for Public Health*, http://dx.doi.org/10.1371/journal.pmed.1001362.

The Internet also provides people with a new arena in which to engage in civic and political debates, to exchange ideas and to voice frustration (OECD, 2019[4]). In 2017, 11% of people in the European Union expressed opinions on civic or political issues via websites (e.g. blogs and social media). Across the OECD countries, several governments use ICTs to engage citizens not only to facilitate voting but also throughout the regulatory process (OECD, 2019[10]). The most frequent purpose is to gather feedback from the public on draft regulations and plans to change existing regulations. In parallel, civil and political participation is also affected by the Internet as an alternative information channel to the traditional media. The Internet shapes voters' exposure to information and voter turnout under certain conditions (Falck, Gold and Heblich, 2014[9]; Campante, Durante and Sobbrio, 2018[8]).

Many activities that were previously conducted in person, such as paying taxes or consulting a medical practitioner, are being progressively digitalised. Digitalisation offers easier access to services and goods, but also raises challenges in terms of inclusion: all individuals are not equally likely to take part in many of these new activities, especially as levels of trust in online environments vary. Young people engage more in many of these new online activities, as do those with tertiary education (Figure 4.3).

Figure 4.3. Diffusion of selected online activities among Internet users, by age and educational attainment

Internet users performing each activity as a percentage of the respective group, 2017



Note: For a given activity: (i) data are computed on the basis of the same group of OECD countries for both age categories; (ii) for both age categories, data relate to the average of all individuals ("Average"), the average of all individuals with low or no formal education, and the average of all individuals with tertiary educational attainment. For all activities, the average for all individuals relates to a number of OECD countries ranging from 23 to 27, according to data availability for both age categories. Tertiary education refers to ISCED levels 5 or 6 and above. Low or no formal education refers to ISCED levels 0 to 2.
Source: OECD (2017[3]), *ICT Access and Usage by Households and Individuals Database*, http://oe.cd/hhind (accessed on 15 November 2018).

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Age and education shape online participation differently. Younger people have a higher uptake of social networks, online purchases and content creation, but participation in e-banking or e-government is more influenced by education levels. Irrespective of their age, people with tertiary education are almost two times more likely to engage in e-banking or e-government than lesser-educated people. The more digitally skilled individuals are, the higher their satisfaction and perceived quality of e-government (Ebbers, Jansen and van Deursen, 2016[11]). As many governments increasingly digitalise their administrative services, many people will not be able to make use of such services if they lack the necessary skills.

These initial figures suggest that digitalisation offers many new opportunities for daily life and participation in society. However, not all individuals are equally positioned to take advantage of them.

From a divide in access to a divide in uses

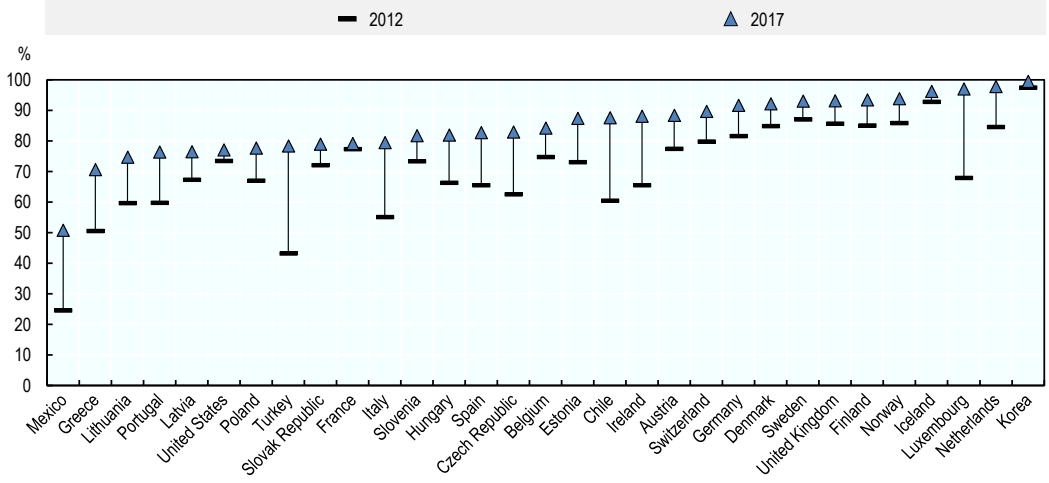
The digital divide has evolved from a divide in Internet access to a divide in how individuals use the Internet and the benefits they derive from their online activities. Skills play a key role in the emergence and evolution of digital divides.

Sources of the divide in access

The digital divide in terms of access has progressively narrowed across OECD countries. Access to broadband Internet connections has steadily increased in the past years, giving people better online experiences. In 2017, 85% of households across OECD countries with available data had access to broadband Internet, a 20% rise from 2012 (Figure 4.4). Cross-country digital divides persist nevertheless. Despite a large catch-up rate between 2012 and 2017, connectivity remains a problem in Mexico, where only one in two households has access to broadband Internet. In France, the Slovak Republic and the United States, access to broadband has stagnated in the past years and remains below the OECD overage.

Figure 4.4. Home access to broadband Internet in 2012 and 2017

Share of households with broadband Internet access at home



Source: OECD (2017[3]), *ICT Access and Usage by Households and Individuals Database*, http://oe.cd/hhind (accessed on 15 November 2018).

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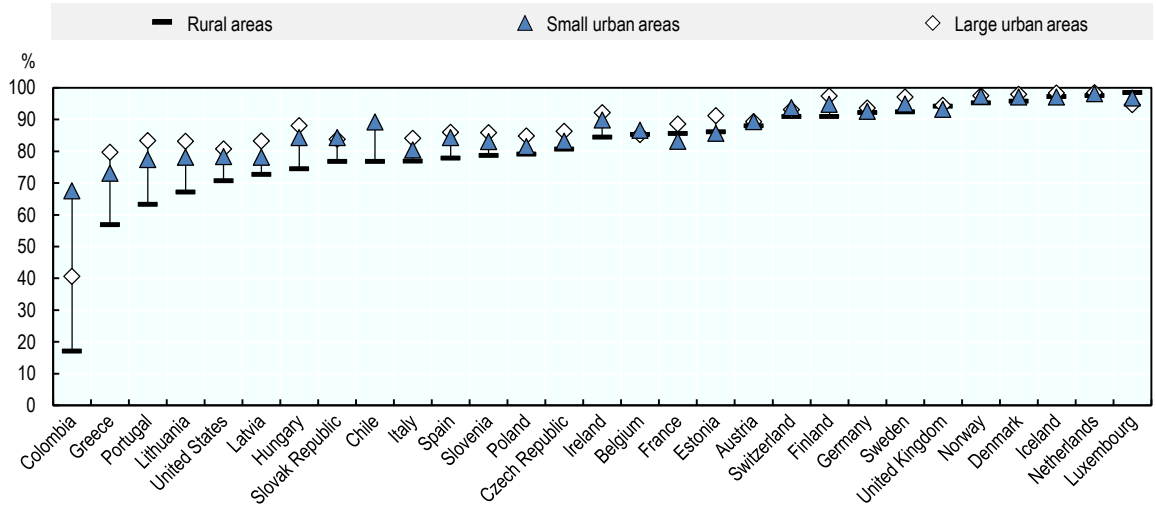
Divides in digital access run within countries as well as between countries. In many OECD countries, rural areas still lag behind urban areas in terms of Internet broadband access (Figure 4.5). In Chile, Greece, Lithuania and Portugal, the connectivity gap between households in rural areas and those in large urban areas exceeds 10 percentage points. Similar divides persist across regions (Chapter 6). Such digital exclusion patterns are likely to exacerbate other social and economic inequalities.

Figure 4.5. Internet broadband access in rural and urban households

Share of households with broadband Internet access at home in each category, 2017



Source: OECD (2017[3]), *ICT Access and Usage by Households and Individuals Database*, http://oe.cd/hhind (accessed on 15 November 2018).

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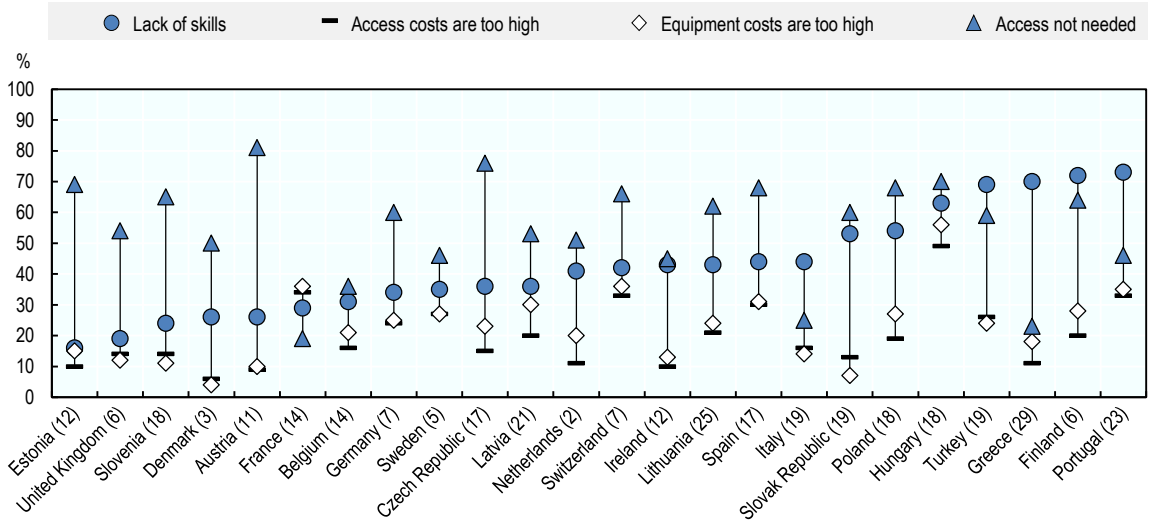
However, access to digital infrastructure is limited not just by unaffordable costs or insufficient infrastructure investments. Among OECD countries with available data, 43% of households give as a main reason for their lack of Internet access a lack of skills or knowledge, such as not knowing how to use a website or considering its use too complicated (Figure 4.6). In countries like Greece or Portugal, where more than one in five households are not connected to the Internet, more than 70% of households report such a lack of skills. When skills are not the most recurrent reason for lacking Internet access, most households report that they do not need access because content is not useful or not interesting. Such a rationale is likely to reflect an inability – because of inadequate skills – to make the most of the opportunities offered by the Internet.

A lack of skills has become a major factor behind the digital divide in access in many European countries (Figure 4.7). As the costs of connecting to the Internet at home have fallen, more and more households in countries such as Greece, Lithuania and Turkey are invoking their lack of skills to explain the absence of an Internet connection in their household. When compared with all other reasons reported by households to explain why they have no Internet connection (including access and equipment costs, privacy concerns, access elsewhere), lack of skills has experienced the most sizeable rise since 2010 on average across European countries (European Commission, 2018[12]).

Figure 4.6. Reasons for not having Internet access at home

Share of households without Internet at home reporting a given reason for not having Internet access, 2017



Note: The share of households without Internet access at home is reported in parentheses next to the country names. Several reasons can be reported by the same household.
Source: Eurostat (2017[13]), *European Community Survey on ICT Usage in Households and by Individuals*.

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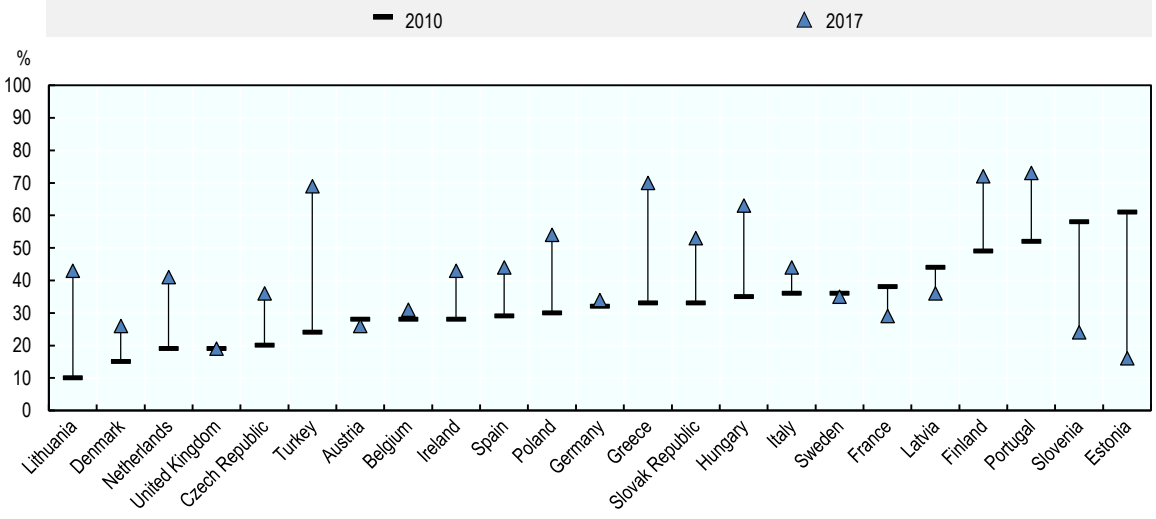
Figure 4.7. Households without Internet access because of lack of skills, in 2012 and 2017

Share of households reporting not having Internet access at home because of lack of skills among households with no Internet access at home



Source: Eurostat (2017[13]), *European Community Survey on ICT Usage in Households and by Individuals*.

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Divides in uses and benefits of Internet access

Access to the Internet and digital infrastructure is merely the first step for digital inclusion. Even when people have access to the Internet, there may still be differences in how they use the Internet and the benefits they obtain. Differences in access have declined over time, but differences in uses and the results of Internet use are becoming increasingly important (van Deursen and van Dijk, 2014[14]; van Deursen and Helsper, 2018[15]; Hargittai and Hsieh, 2013[16]).

Most of the factors that shape digital inequalities in access, such as gender, socio-economic background, labour force status, geography or skills (Fairlie, 2004[17]; Dewan and Riggins, 2005[18]), can equally shape digital inequalities in use (Robinson, Dimaggio and Hargittai, 2003[19]; Hargittai and Hsieh, 2013[16]; Demoussis and Giannakopoulos, 2006[20]). The share of low-educated individuals with no Internet access has decreased in the last decade, but some studies find that low-educated individuals use the Internet more for recreational than for instructional activities in comparison with the highly educated (van Deursen and van Dijk, 2014[14]). In a similar vein, disadvantaged students play online games, chat or participate in social networks as much as advantaged students, but they are less likely to read news or get practical information from the Internet (Figure 4.8). Overall, data from PISA (2015) show that in OECD countries, socio-economic and demographic characteristics shape the ways 15-year-olds use ICTs in their leisure time.

Differences in people's digital activities may not matter if they have no effect on other outcomes. There is significant evidence, however, that most digital uses reproduce and even amplify non-digital inequalities (van Deursen et al., 2017[21]). If low-skilled people use the Internet more for chatting and entertainment whereas highly skilled people look for jobs, follow courses or make health appointments on line, the use of Internet coupled with the lack of skills risks amplifying existing inequalities. Thanks to their Internet use, the highly skilled obtain more opportunities to expand their knowledge, find better jobs more easily or secure faster access to healthcare. Having the needed skills and level of education can protect against the risk of a digital divide and can also avoid exacerbating other divides.

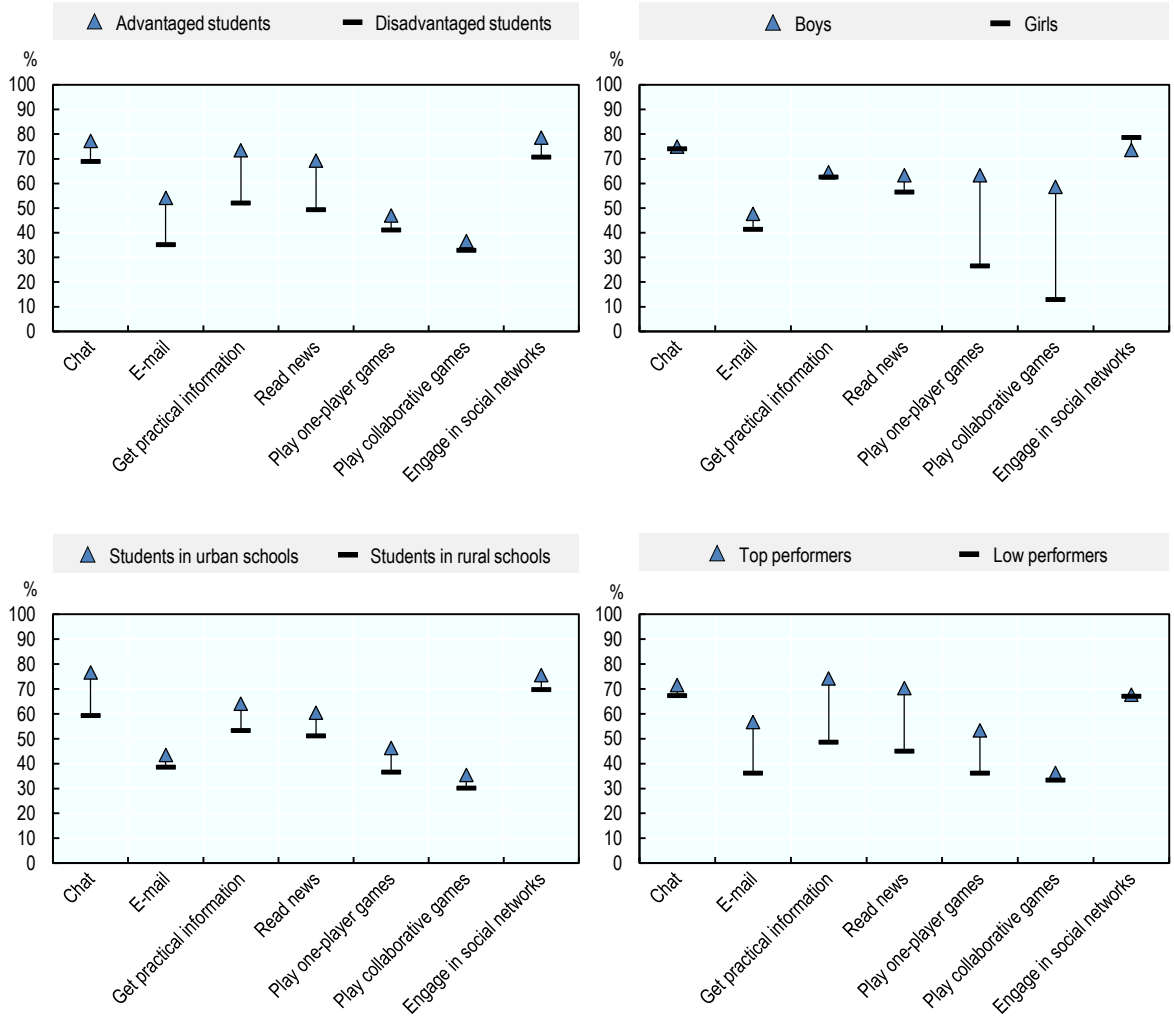
Which cognitive skills to bridge digital divides in use?

People with more skills can make better use of the Internet and online activities. To design policies that bridge the digital divide, it is necessary to understand what types of skills help people to get the most out of the Internet, and how important those skills are vis-a-vis other determinants.

To investigate the relationship between skills and participation in online activities, and how skills can help close digital divides, data from two surveys was related through statistical matching (Box 4.2). The European Community Survey on ICT Usage in Households and by Individuals (CSIS) is carried out annually by Eurostat, the statistical office of the European Union. It gathers detailed data on a range of activities performed online, such as reading and sending emails, looking for information, buying goods and services, participating in social networks, and learning online. The Survey of Adult Skills, a product of the OECD Programme for the International Assessment of Adult Competencies (PIAAC), includes information on cognitive skills (literacy, numeracy, problem solving in technology-rich environments) measured through assessment tests.

Figure 4.8. Uses of digital devices outside of school, by students' characteristics

Share of students reporting to make a given use of digital devices outside of school at least once per week



Note: Shares are computed on average over all OECD countries participating in the PISA ICT questionnaire. Activities are unfolded on line. Students are considered to be socio-economically disadvantaged if their values on the PISA ESCS index are among the bottom 25% within their country or economy. Students in rural schools are students whose school is located in "a village, hamlet or rural area with fewer than 3 000 people" while students in urban schools are students whose school located in a city of over 100 000 people. Students who are low performers are students who score at less than Level 2 in the reading, mathematics and science assessments. The level 2 is considered to be the baseline level of proficiency reading, mathematics and science. Students who are top performers are students who are proficient at Level 5 or 6 in reading, mathematics and science.
Source: OECD calculations based on OECD (2015[22]), *PISA database 2015*, http://www.oecd.org/pisa/data/2015database/.

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The robustness of analyses performed on a matched database inevitably depends on the quality of the statistical matching between the two datasets, which in turn is largely determined by the information available in the two datasets and the similarity of this information. The two datasets used for this analysis share a fair number of variables on ICT

usage but a limited number of individual characteristics. Limited information on educational level and occupation in the CSIS dataset may have lowered the quality of the match. For these reasons, the analysis presented in this section should be considered as exploratory and results should be taken with caution.

Identifying profiles of Internet users

As most people perform several activities online, the analysis applies a clustering method to identify profiles of Internet users (Box 4.3). Those profiles take into account the number and the distribution of activities performed. Four clusters or profiles of Internet users emerge.

These four profiles of Internet users first differ in the average number of activities performed (Figure 4.9). People belonging to profile 1 perform most of the activities (8 activities on average among the 11 considered in the analysis) while those belonging to profile 4 perform the smallest number (slightly less than two on average). Hence, profile 1 reflects a diversified use of the Internet while profile 4 captures a much narrower use. Profiles 2 and 3 fall in between. People in profile 2 also display a relatively diversified use of the Internet, with more than four activities on average, while those in profile 3 show a less diversified use. Some activities emerge as being rarely performed and therefore draw a line between profiles. This is the case of learning, e-finance and, to a lesser extent, creative activities that can be considered more complex.

More specifically, the following Internet user profiles can be identified:

- *Diversified and complex use*, corresponding to profile 1. People in this profile perform on average the largest number and greatest variety of activities. They carry out the biggest share of online tasks linked to e-finance, learning and creativity, activities that are performed by the smallest range of individuals and that can also be considered more complex.
- *Diversified and simple use*, corresponding to profile 2. Individuals in this profile perform a range of activities, like those in profile 1, but fewer linked to finance, creativity and learning. Their main activities online revolve around communication, social networks, access to information and entertainment.
- *Use for practical reasons*, corresponding to profile 3. People in this profile use the Internet in diverse ways, albeit less so than individuals in profiles 1 and 2. They use Internet mostly for communication, looking for information, e-health and e-banking.
- *Use for communication and information*, corresponding to profile 4. Individuals in this profile make the most specialised use of internet, mainly using communication tools and accessing the Internet to obtain information. These latter two activities combined make up for 70% of all activities performed on line by individuals in this user profile.

Socio-demographic characteristics appear to be related to the type of Internet uses (Figure 4.10). People whose online activity is "diverse and complex" are the most educated in the sample, a majority of them employed and of prime age. Among them, 39% are tertiary educated and 41% have completed upper-secondary education. Employed people are over-represented in this profile – they constitute 70% of all individuals with a "diverse and complex use". Three out of four individuals in this Internet user profile are aged 25 to 55, showing that young people (aged 16 to 24) and those aged 55 to 64 are less likely to make diverse and complex use of Internet.

Box 4.2. Statistical matching of the Survey of Adult Skills (PIAAC) and the European Community Survey on ICT Usage in Households and by Individuals (CSIS)

For this report, statistical matching was performed to generate a unique dataset that includes both information on cognitive skills measured through assessment tests (from the Survey of Adult Skills, PIAAC) and indicators of ICT usage by individuals (from the European Community Survey on ICT Usage in Households and by Individuals).

Statistical matching integrates two (or more) datasets drawn from the same population (D'Orazio, Di Zio and Scanu, 2006[23]) to explore the relationship between variables of interest that could not be jointly observed. If dataset A contains Y and dataset B contains Z, and both datasets contain a set of common variables X, statistical matching allows a unique dataset to be created that contains X, Y and Z (Rubin, 1986[24]). In this case, Y and Z are the variables of interest and X are control variables.

Matching methods that only rely on the common X variables to integrate the two (or more) datasets are based on the assumption that only the common variables explain the association between Y and Z (D'Orazio, 2017[25]). If this conditional independence assumption does not hold, the joint dataset will result in incorrect inferences. External auxiliary information can be used to ensure that results derived from statistical matching are reliable (D'Orazio, Di Zio and Scanu, 2006[23]; Leulescu and Agafitei, 2013[26]).

The method of Rubin (1986[24]) relaxes the conditional independence assumption, by taking into account a non-zero partial correlation between Y and Z given a set of control variables X. The statistical matching between PIAAC and CSIS was thus performed in three phases:

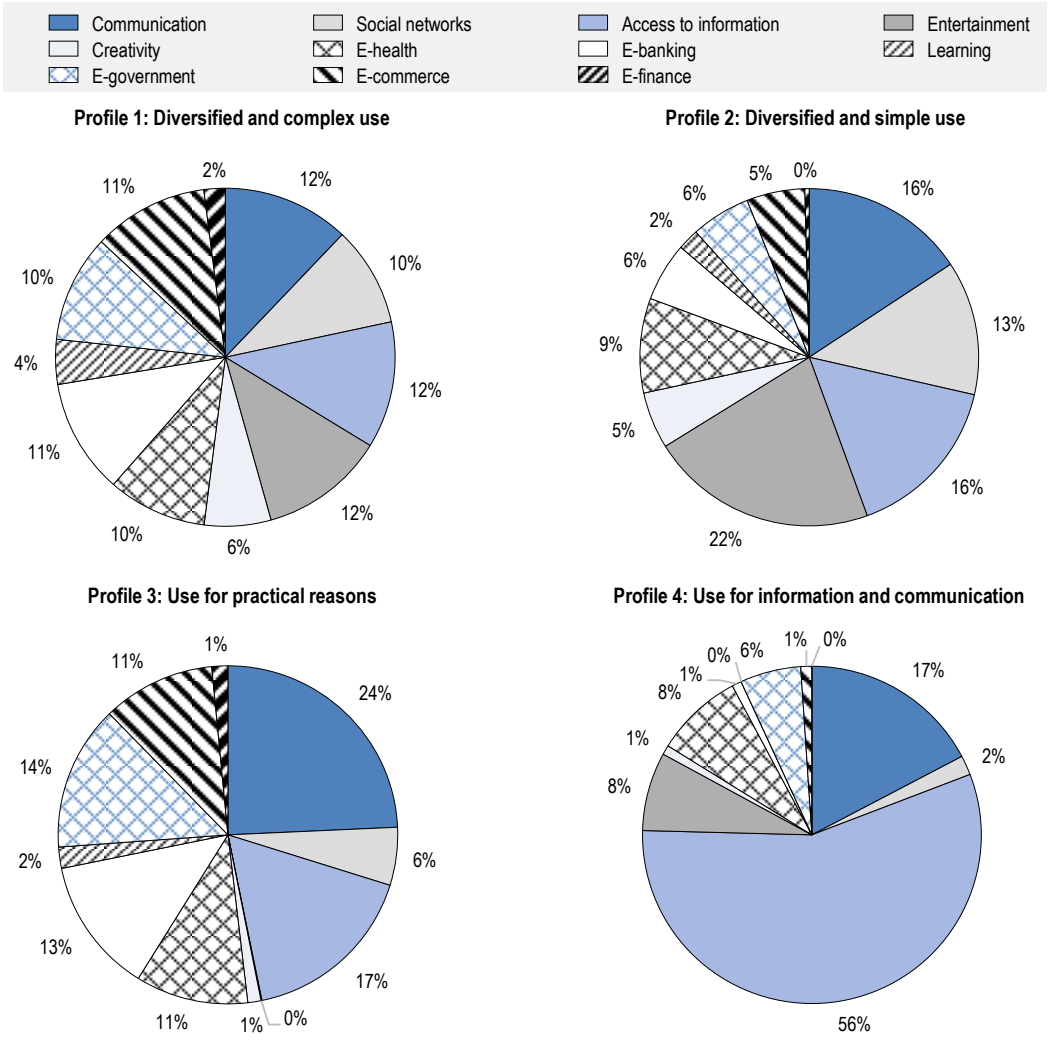
1. The method of Rubin (1986[24]), as implemented by Alpman (2016[27]) was applied to impute the variables on ICT usage for which the value of partial correlation with skills can be derived from auxiliary information available in the Survey of Adult Skills (PIAAC).
2. Missing values of the other variables were imputed with values from a "similar" responding unit (i.e. a random hot deck method), based on the common PIAAC-CSIS variables and on the variables matched through the method of Rubin (1986[24]).
3. Quality checks are performed for both matches (method of Rubin (1986[24]) and random hot deck).

The matching was performed by country, for seven countries (Czech Republic, Finland, France, Ireland, Italy, Lithuania and Spain) out of the 19 that are covered by both the PIAAC and CSIS databases. Data for the Survey of Adult Skills (PIAAC) refers to 2012 (Czech Republic, Finland, France, Ireland, Italy and Spain) and 2015 (Lithuania). CSIS data refers to 2016 in order to capture the most recent and diversified set of ICT-related uses. The skills set of the population is unlikely to have substantially evolved between 2012 and 2016, so the difference in the reference period of the two surveys is not considered as problematic for the subsequent analysis.

Sources: Alpman, A. (2016[27]), "Implementing Rubin's alternative multiple-imputation method for statistical matching in Stata", www.stata-journal.com/article.html?article=st0452 (accessed 2 October 2018); D'Orazio , M., M. Di Zio and M. Scanu (2006[23]), *Statistical Matching: Theory and Practice*, www.wiley.com/en-us/Statistical+Matching%3A+Theory+and+Practice-p-9780470023532 (accessed 3 October 2018); D'Orazio, M. (2017[25]), "Statistical matching and imputation of survey data with StatMatch", www.essnet-portal.eu/di/data-integration (accessed 4 October 2018); Leulescu, A. and M. Agafitei (2013[26]), *Statistical Matching: A Model-based Approach for Data Integration*, http://dx.doi.org/10.2785/44822; Rubin, D. (1986[24]), "Statistical matching using file concatenation with adjusted weights and multiple imputations", http://dx.doi.org/10.2307/1391390.

Figure 4.9. Profiles of online users

Share of each online activity among the activities performed by each profile of users



Note: The analysis was performed on the matched PIAAC-CSIS file including seven countries (Czech Republic, Finland, France, Ireland, Italy, Lithuania and Spain). The identification of profiles is explained in Box 4.3. In the Survey of Adult Skills (PIAAC): Lithuania- year of reference 2015; all other countries- year of reference 2012.

Sources: OECD calculations based on OECD (2012[28]) and OECD (2015[29]), *Survey of Adult Skills (PIAAC)*, www.oecd.org/skills/piaac/publicdataandanalysis; Eurostat (2016[30]), *European Community Survey on ICT Usage in Households and by Individuals*.

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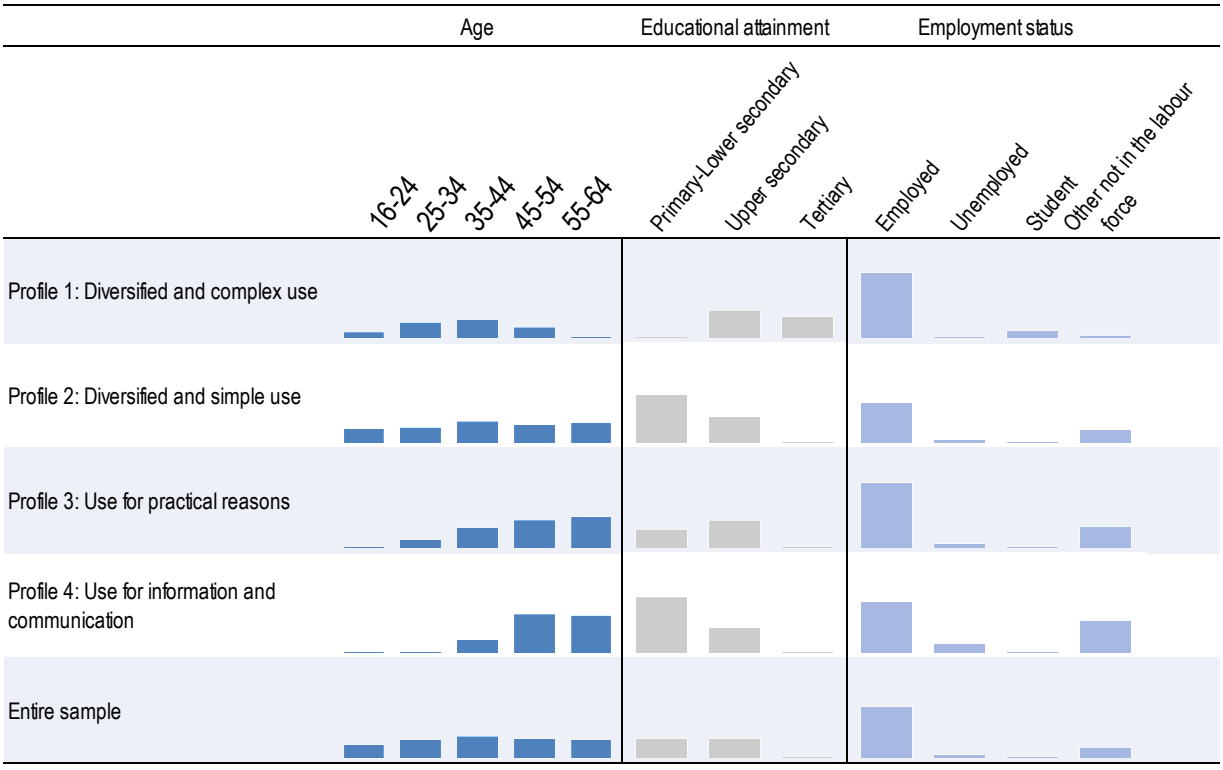
At the opposite end stands Profile 4, "Use for information and communication", which gathers a majority of those with primary or lower secondary education, aged over 45, either employed or out of the labour force. People in this profile perform few activities and few types of activities. Older individuals are also highly represented in Profile 3, "Use for practical reasons". This profile gathers not only simple uses such as access to information or communication, but also e-health or e-commerce, which explains the more balanced distribution of educational attainment among users in this profile. Finally, those with diverse but simple uses of Internet (Profile 2) are more likely to be primary-secondary educated and one in four of them is out of the labour force.

These first descriptive statistics offer some hints about where digital inequalities in the use of the Internet may originate. Age, educational attainment and employment status seem to shape both the number and the types of activities that people carry out on line.

Figure 4.10. Profiles of online users and socio-demographic characteristics

Share of individuals in each age/educational attainment/employment status category, by online user profile



Note: The bars display the share of individuals in each socio-demographic category. The maximum value of each share is 100%. The analysis was performed on the matched PIAAC-CSIS file including seven countries (Czech Republic, Finland, France, Ireland, Italy, Lithuania and Spain). The identification of profiles is explained in Box 4.3. In the Survey of Adult Skills (PIAAC): Lithuania- year of reference 2015; all other countries- year of reference 2012.

Sources: OECD calculations based on OECD (2012[28]) and OECD (2015[29]), *Survey of Adult Skills (PIAAC)*, www.oecd.org/skills/piaac/publicdataandanalysis; Eurostat (2016[30]), *European Community Survey on ICT Usage in Households and by Individuals*.

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Box 4.3. Identifying profiles of activities performed online through a clustering analysis

The European Community Survey on ICT Usage in Households and by Individuals (CSIS) provides information on what people do on line that can be grouped into 11 major activities: communication, social networks, access to information, entertainment, creativity, learning, e-health, e-banking, e-finance, e-government, and e-commerce.

Each of these 11 activities is defined as a binary variable that takes the value of 1 if individuals perform at least one of the underlying uses associated with that activity (e.g. listening to music on line and watching Internet-streamed TV are both associated with online entertainment). Underlying variables related to Internet use are grouped into types of activities based on a normative approach and on the structure of the CSIS (2016) questionnaire. Twenty-six underlying variables are used for this analysis.

To identify profiles of online users, a clustering procedure was used: individuals were grouped according to the similarity of their online activities.

A *k*-means clustering algorithm (Hartigan, 1975[31]) was used on the matched PIAAC-CSIS file of the seven countries considered in the analysis (Czech Republic, Finland, France, Ireland, Italy, Lithuania and Spain). The initial *k* number of groups was determined by the user. The algorithm departed from a random split of all observations into *k* clusters, then reassigned individuals seeking to minimise within-cluster variance (OECD/JRC-European Commission, 2008[32]).

To detect the clustering with the optimal number of groups, the algorithm was run several times with different values of *k.* The different results were compared using a scree plot (Makles, 2012[33]), showing the change in within-cluster sum of squares as the *k* number of clusters varies. On this basis, four different profiles of online users were chosen for the analysis.

Based on the 11 major online activities defined above, the clustering algorithm measured similarities between individuals using the following clustering variables:

- The share of each activity in the total number of activities performed by an individual online. For example, if one individual performs e-banking, communication, e-government and e-health, then the share of each activity for this individual will be ¼.
- The total number of activities performed by an individual online. In the sample example as above, the total number is 4.

This method allows profiles of online users to be created that account for both the number and types of activities they perform.[1]

Sources: Hartigan, J. (1975[31]), *Clustering Algorithms*, https://people.inf.elte.hu/fekete/algoritmusok_msc/klaszterezes/John%20A.%20Hartigan-Clustering%20Algorithms-John%20Wiley%20&%20Sons%20(1975).pdf (accessed 25 October 2018); Makles, A. (2012[33]), "Stata tip 110: How to get the optimal k-means cluster solution", www.stata-press.com/data/r12/physed (accessed 25 October 2018); OECD/JRC-European Commission (2008[32]), *Handbook on Constructing Composite Indicators: Methodology and User Guide*, www.oecd.org/fr/els/soc/handbookonconstructingcompositeindicatorsmethodologyanduserguide.htm (accessed 25 October 2018).

Skills and Internet profiles

The analysis investigated whether belonging to a given Internet profile is linked to one skill in particular or to a mix of skills. In a first step, as for characteristics listed in the previous section, some descriptive statistics are given on the skills of individuals within each profile.

Around 40% of people with a "diversified and complex use" of the Internet also have a well-rounded literacy and numeracy skills set (Figure 4.11). The share of highly skilled individuals is substantially lower in the other profiles. Among those who use the Internet mainly for information and communication, less than 10% have a well-rounded set of skills.

The share of those lacking basic skills is more evenly distributed across the different profiles. Few people going on line seem to lack both basic literacy and numeracy skills. However, looking at skills separately provides a different picture, especially when numeracy skills are considered. More than 9% of people in Profiles 2, 3 and 4 lack basic numeracy skills, suggesting that a lack of basic numeracy skills is not a barrier to participation in Internet activities, while lacking both literacy and numeracy does seem to be a barrier.

Using a more restricted sample of individuals for whom data on problem solving in technology-rich environments are available, the skills mix of individuals can be defined as including literacy, numeracy and problem-solving skills in technology-rich environments. Individuals with a well-rounded skills set are over-represented in the "diversified and complex use" profile, though fewer individuals are proficient in all three skills (34%) than those who are proficient in literacy and numeracy only (40%). In general, many more people seem to lack problem-solving skills in technology-rich environments. Even among those whose use of the Internet is "diversified and complex", almost one in five lacks basic skills when it comes to solving problems in a digital environment.

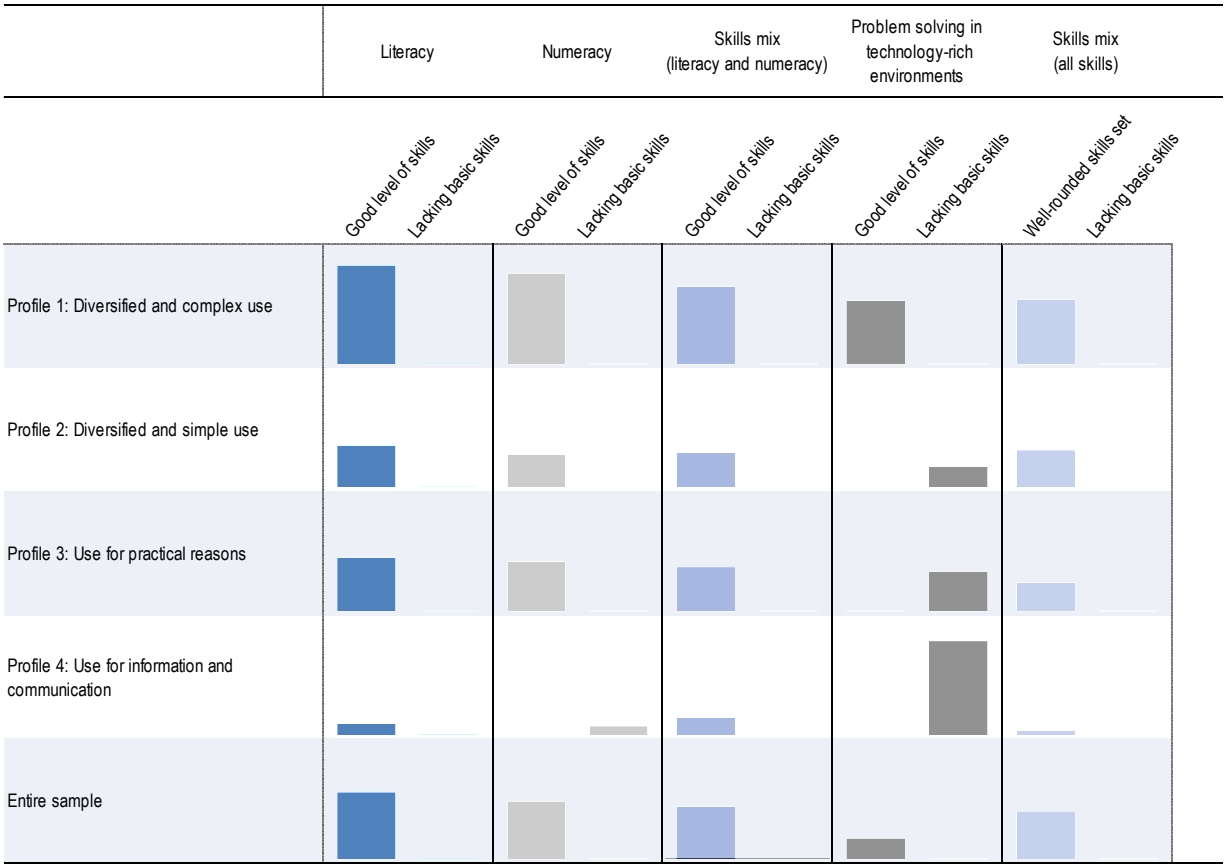
These results suggest that lacking problem-solving skills in technology-rich environment might not be a barrier to participation in online activities, while lacking a mix of skills may be a strong barrier. The problem-solving skills assessed in the OECD Survey of Adult Skills (PIAAC) are not digital skills per se, but basic computer literacy skills (i.e. the capacity to use ICT tools and applications) (OECD, 2016[34]). As such, the assessment cannot capture how prepared an individual is to react to junk email, for instance, or illegal requests for personal information on line. Further data would be needed to uncover any advantage that more advanced digital skills confer compared with the other types of skills used in the analysis.

Having a good level of cognitive skills seems to enable more diverse and complex Internet uses. These descriptive statistics on the skills levels of various Internet user profiles are confirmed by an analysis that accounts for other sources of inequalities and differences in Internet use. Figure 4.10 showed that age, educational attainment and employment status seem to determine the number and types of activities that people carry out on line. Results in Figure 4.12 account for these socio-demographic characteristics, as well as for gender and country effects. People with a good level of skills are more likely to make diverse and complex uses of the Internet, rather than simply go on line for information and communication.

While the analysis shows that one needs an overall good level of skills to move to a more complex and diverse use of Internet, it does not uncover any effect of skills on the likelihood of belonging to the other Internet user profiles ("diversified and simple use" or "use for practical reasons"). This is because other digital divides have a higher influence on the likelihood that individuals belong to one of the two other Internet user profiles.

Figure 4.11. Skills of Internet users by profile

Share of individuals in each skill level category, by online user profile



Note: The bars display the share of individuals in each socio-demographic category. The maximum value of each share is 60%. For literacy and numeracy: individuals lacking basic skills score at most *Level 1* (inclusive); individuals with a good level of skills score at least *Level 3*. For skills mix (literacy and numeracy): individuals lacking basic skills score at most *Level 1* (inclusive) in literacy and numeracy; individuals with a good level of skills score at least *Level 3* in literacy and numeracy. For problem solving in technology-rich environments: individuals lacking basic skills score at most *Below Level 1* (inclusive) in problem solving (including failing ICT core and having no computer experience); individuals with a good level of skills score at least *Level 2* (inclusive) in problem solving. For the skills mix (all skills): individuals lacking basic skills score at most *Level 1* (inclusive) in literacy and numeracy and at most *Below Level 1* (inclusive) in problem solving (including failing ICT core and having no computer experience); individuals with a well-rounded skill set score at least *Level 3* (inclusive) in literacy and numeracy and at least *Level 2* (inclusive) in problem solving.
The analysis was performed on the matched PIAAC-CSIS file including seven countries (Czech Republic, Finland, France, Ireland, Italy, Lithuania and Spain). The identification of profiles is explained in Box 4.3. The sample for the analysis on the effect of good problem-solving skills includes individuals from the Czech Republic, Finland, Ireland and Lithuania. France, Italy and Spain did not participate in the problem-solving skills in technology-rich environments assessment.
In the Survey of Adult Skills (PIAAC): Lithuania- year of reference 2015; all other countries- year of reference 2012.
Sources: OECD calculations based on OECD (2012[28]) and OECD (2015[29]), *Survey of Adult Skills (PIAAC)*, www.oecd.org/skills/piaac/publicdataandanalysis; Eurostat (2016[30]), *European Community Survey on ICT Usage in Households and by Individuals*.

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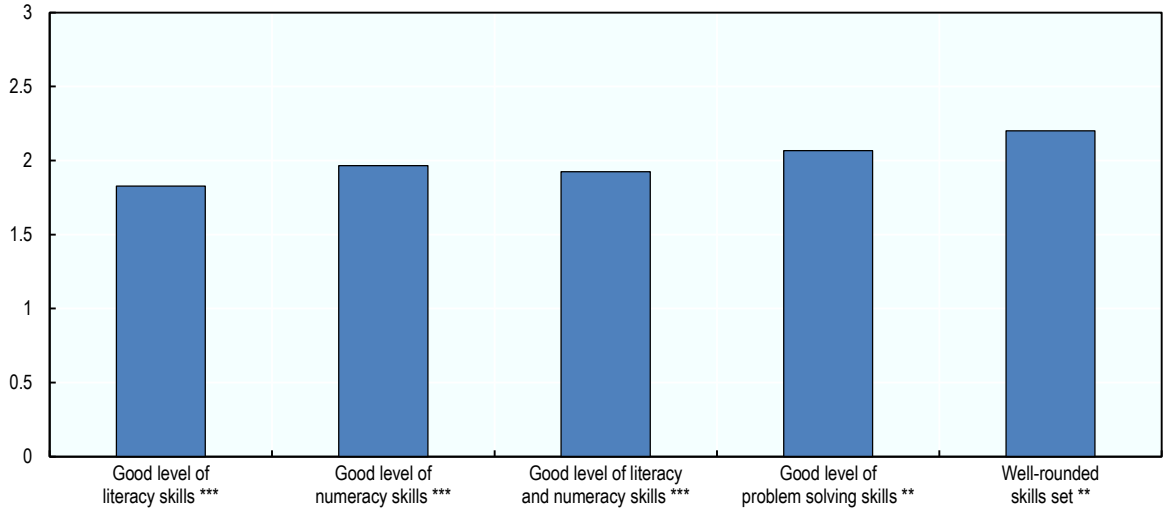
Skills are a prerequisite for fully taking advantage of all the opportunities offered by the digital society. Analyses based on PISA (2015) provided a similar picture: students' performance in paper-based and digital tests are highly correlated and once divides in access are accounted for, differences in the use of digital devices between socio-economic groups are largely due to differences in cognitive skills (OECD, 2015[35]).

Not everyone needs to carry out complex and diverse Internet tasks, but people should be able to do so if wanted, so they need to be empowered with good cognitive skills. Just as the use of emails or social networks appeared innovative and advanced a decade ago, the use of e-finance or the creation of websites are likely to become common practice in a few years – and many other new Internet or technology uses will emerge. The type of skills mix people need to make the most of these new activities could be further refined with detailed data on digital skills as well as on social and emotional skills.

Figure 4.12. Effects of skills on the likelihood to perform diverse and complex Internet uses

Relative risk ratios (comparison profile – "Diversified and complex use", reference profile – "Use for information and communication")



*** - significant at the 1% level.
** - significant at the 5% level.
Note: Each bar displays the relative risk ratio obtained from a multinomial logit regression in which the dependent variable is the profile of Internet user to which each individual belongs and the independent variable of interest is a dummy equal to 1 if the individual has a given level of skills. Skills levels are defined in the note on Figure 4.11. Other independent variables included in the estimation include: age categories, educational attainment level, employment status, gender, and country dummies. The sample for the analysis on the effect of good problem-solving skills and that of having a well-rounded skills set includes individuals from the Czech Republic, Finland, Ireland and Lithuania. France, Italy and Spain did not participate in the problem-solving skills in technology-rich environments assessment. Relative risk ratios are obtained by an exponential transformation of the estimated coefficients from the multinomial logit. Significance levels have been obtained from the estimated coefficients of the multinomial logit.
In the Survey of Adult Skills (PIAAC): Lithuania- year of reference 2015; all other countries- year of reference 2012.
Sources: OECD calculations based on OECD (2012[28]) and OECD (2015[29]), *Survey of Adult Skills (PIAAC)*, www.oecd.org/skills/piaac/publicdataandanalysis; Eurostat (2016[30]), *European Community Survey on ICT Usage in Households and by Individuals*.

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Well-being and risks and in a digital society

Better-skilled individuals are likely to benefit more from the opportunities offered by new technologies and hence experience higher life satisfaction. Having the appropriate level of skills is also crucial to protect oneself and others – including children – against the risks that come with life in a digital society.

Safety and privacy issues

As people spend more time on line, they are increasingly exposed to a variety of risks. A majority of individuals surveyed in European countries considered the Internet to be unsafe and more than two-thirds reported having found some type of illegal content on line (Flash Eurobarometer 469, 2018[36]). In the United States, more than 60% of users reported that a data breach had affected their personal information or sensitive online accounts (Olmstead and Smith, 2017[37]).

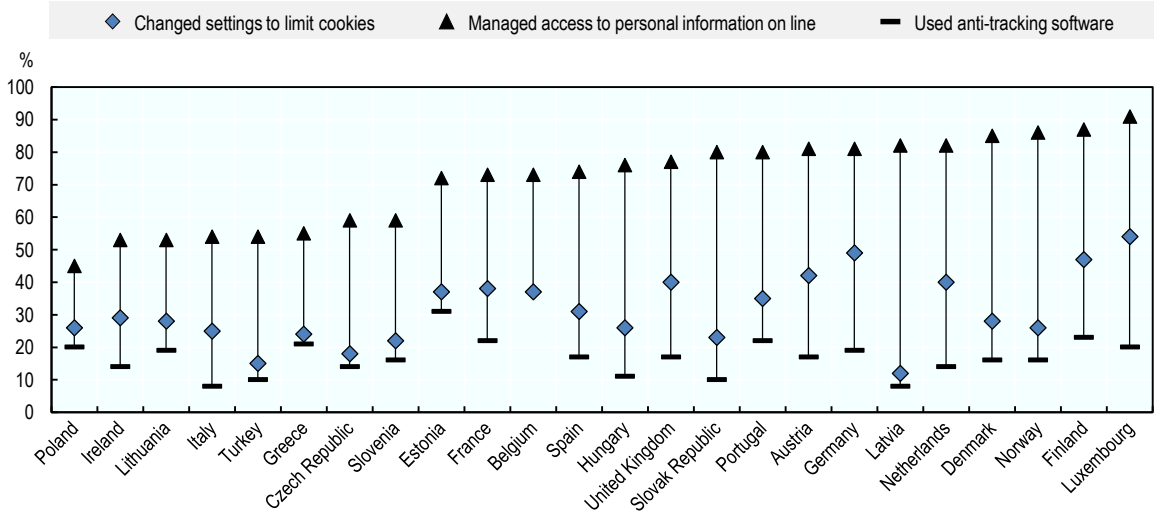
People can do many things to protect their safety on line, from limiting the number of cookies put on their computer to asking websites to delete personal information held about them. Many users know of the threats they face while surfing the Internet, but not all of those conscious of these threats take action to protect themselves. In 2016, in OECD countries with available data, 32% of surveyed individuals were aware that cookies can be used to trace movements of people on the Internet but had never changed the browser settings to prevent or limit them (Eurostat, 2016[30]). There is a large cross-country variation in the share of individuals performing activities related to their security and privacy on line (Figure 4.13). In Poland, Ireland and Lithuania, more than one-third of individuals take no action to manage their personal information on line, in stark contrast with individuals from Luxembourg, Finland or Norway. At the same time, countries with high shares of individuals acting to manage their information on the Internet do not necessarily display similarly high shares of individuals taking steps to avoid their activities being tracked.

These figures suggest that not all online privacy- and security-related actions that individuals can take are equally accessible to all of them. Placing the responsibility of adopting such privacy measures on individuals implicitly assumes that the latter have the necessary skills to do so. Restricting an app's access to the user's geographical location may require just a smartphone click. But checking whether used websites are secure or installing anti-tracking software demands more advanced knowledge and fine understanding of potential threats. Highly skilled individuals are much more likely not only to be aware of such threats but also to take the appropriate steps to ensure safe online navigation.

Analysis based on statistically matched CSIS-PIAAC data shows that having a good level of skills increases the likelihood that individuals take action to protect their privacy and security when they go on line (Figure 4.14). Different sets of skills have different impacts on the type of actions individuals take to ensure their online security and privacy. Managing access to personal information online requires a good level of literacy skills, while using anti-tracking software is more demanding in terms of problem-solving skills in technology-rich environments. Individuals with good literacy, numeracy and problem-solving skills are also more likely to change their website settings to limit cookies. Estimates that account for people's age, education level and country of origin illustrate that individuals endowed with a well-rounded set of skills are more able to protect themselves on line and thus reduce their exposure to a variety of digital risks.

Figure 4.13. Online security and privacy activities

Share of individuals who performed a given activity among those who used Internet within the last year



Note: Individuals who changed settings to limit cookies are individuals who declared changing the settings in their Internet browser to prevent or limit the number of cookies put on their computer. Individuals who managed access to personal information on line are individuals who declared performing any of the following activities: read privacy policy statements before providing personal information, restricted access to their geographical location, limited access to their profile or content on social networking sites, refused to allow the use of personal information for advertising purposes, checked that the website where they needed to provide personal information was secure (e.g. https sites, safety logo or certificate), asked websites or search engines to access the information they hold about them to update or delete it.
Source: OECD calculations based on Eurostat (2016[30]), *European Community Survey on ICT Usage in Households and by Individuals*.

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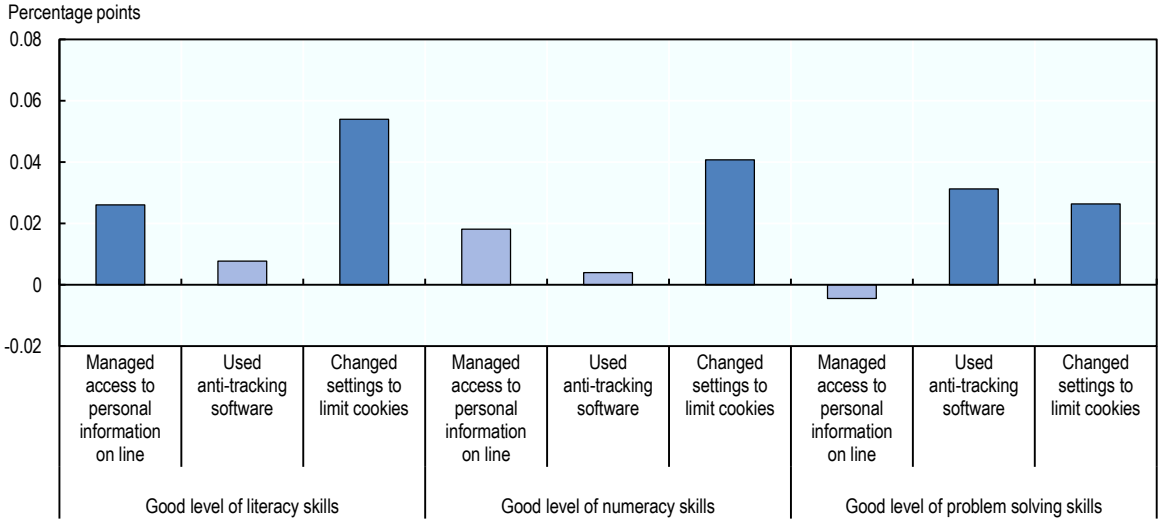
Threats to personal information are not the only risk individuals face online or through new technologies more generally. The spread of "fake news" – online misinformation or disinformation – raises the question of how well individuals, whether children or adults, can critically assess the type of information they encounter on line. In a recent Eurobarometer poll (Flash Eurobarometer 464, 2018[38]), more than one-third of respondents reported encountering "fake news" on a daily basis and another third at least once a week. New technologies facilitate the diffusion of such intentionally misleading or false information, which poses substantial threats not only for trust, political participation and democratic institutions, but also for health or any other outcome for which individuals make decisions based on information found online.

Cyberbullying and other forms of online harassment

The digital environment is also often used to reproduce and amplify harmful behaviour that already exists outside the digital sphere. Cyber-stalking, online harassment and cyberbullying are only a few examples of such behaviours. The Internet provides bullying perpetrators with anonymity and accessibility, reducing fear of punishment and allowing them to be aggressive with the victim at any point in time (Hooft Graafland, 2018[39]). Cyberbullying occurs in many ways, from spreading of false rumours, offensive name-calling and exclusion from online groups, to cyberstalking and even physical threats (Hooft Graafland, 2018[39]; Pew Research Center, 2018[40]).

Figure 4.14. The relationship between skills and online security and privacy activities

Effect of having a given level of skills on performing a given online protection activity



Note: Each bar displays estimated effects of having a given level of skills on the likelihood that an individual performs one of the given activities related to online protection. Other independent variables included in the estimation are: age categories, educational attainment level, employment status, gender, and country dummies. The different activities were defined in the note of Figure 4.13 and are included as dummies in the regression: each dummy is equal to 1 if the individual performed the given activity. Individuals with a good level of literacy (numeracy) skills score at least *Level 3* (inclusive) in literacy (numeracy). Individuals with a good level of problem-solving skills score at least *Level 2* (inclusive) in problem solving. The analysis is performed on the matched PIAAC-CSIS file including seven countries (Czech Republic, Finland, France, Ireland, Italy, Lithuania and Spain). The sample for the analysis on the effect of good problem-solving skills includes individuals from the Czech Republic, Finland, Ireland and Lithuania. France, Italy and Spain did not participate in the problem-solving skills in technology-rich environments assessment.
In the Survey of Adult Skills (PIAAC): Lithuania- year of reference 2015; all other countries- year of reference 2012.
Statistically significant coefficients are displayed in the darker shade.
Sources: OECD calculations based on OECD (2012[28]) and OECD (2015[29]), *Survey of Adult Skills (PIAAC)*, www.oecd.org/skills/piaac/publicdataandanalysis and Eurostat (2016[30]), *European Community Survey on ICT Usage in Households and by Individuals*.

StatLink https://doi.org/10.1787/888933974026

As with information on other forms of harassment, data on cyberbullying are sensitive to gather. Evidence from the Health Behaviour in School-aged Children survey indicated that on average 9% of children aged 15 in OECD countries with available data had been cyberbullied by messages at least once (OECD, 2019[10]). More recent data from a survey on 750 teenagers in the United States show that 59% had experienced cyberbullying and 63% saw online harassment as a major problem (Pew Research Center, 2018[40]). These contrasting figures suggest that the prevalence of cyberbullying is still hard to measure, even if cyberbullying has been shown to reduce victims' life satisfaction and harm their mental health (Ybarra and Mitchell, 2004[41]; OECD, 2017[1]; Hooft Graafland, 2018[39]).

Fighting cyberbullying often requires a co-ordinated response from parents, schools, social media and tech companies, as well as lawmakers. Surveyed teenagers in the United States seemed to especially value parents' efforts to counter online harassment (Pew Research Center, 2018[40]). Teachers, social media sites and even law enforcement were perceived

much less favourably. Parents appear to be crucial in tackling cyberbullying. As children start using the Internet at an ever younger age, the scope increases for parents to educate children to use technology and support them when they face risks (Hooft Graafland, 2018[39]).

Parents' digital skills and awareness affect in turn the types of opportunities and threats their children experience online. Digitally skilled parents are more likely to have an enabling approach to Internet use, encouraging their children to explore and learn things on line, sharing online activities with their children, but also explaining why some websites may be inappropriate (Livingstone et al., 2017[42]). While such a strategy may also expose children to more risks, it also enables children to develop resilience and be better prepared to grapple with new risks when they face them. Policies that seek to minimise digital inequalities as well as the risks faced by children and adults online should also aim to boost parents' and children's digital skills, and use levers for skills development.

Mental health and social relationships

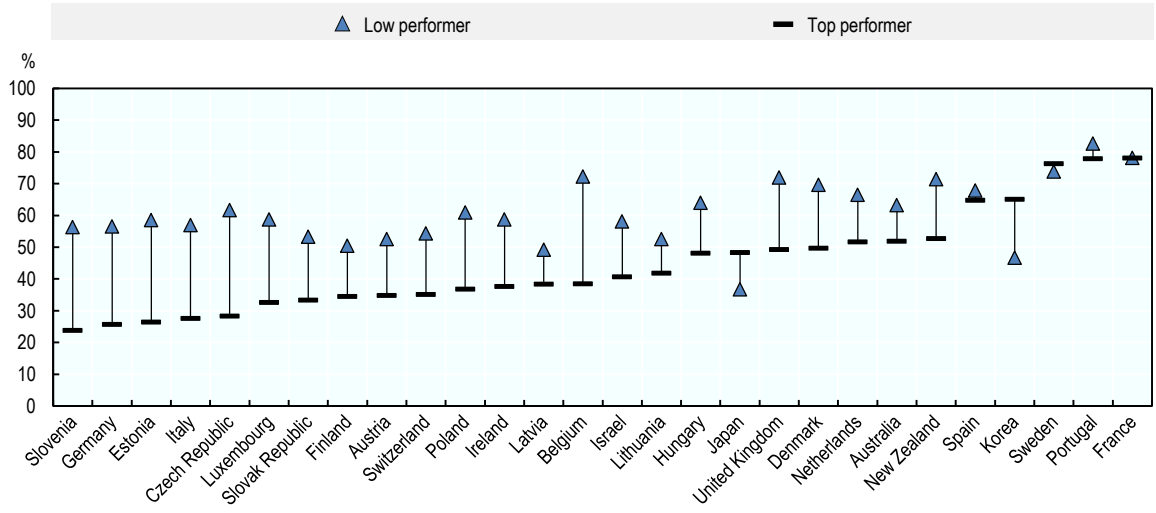
The increasing use of new technologies and devices has triggered fears that they may harm well-being in other ways, including users' mental health and social relationships. Extreme screen-time may reduce sleep quality, increasing the risk of depression and anxiety (Hooft Graafland, 2018[39]). Constant connectivity, especially when it is work-related, may lead to higher levels of stress and emotional exhaustion (Belkin, Becker and Conroy, 2016[43]). The use of new technologies is often associated with multitasking, whereby individuals access several streams of information or media content at the same time. Individuals who multitask using digital devices are more likely to get distracted easily, to have lower efficiency and to experience higher levels of social anxiety (Ophir, Nass and Wagner, 2009[44]; OECD, 2012[45]; Becker, Alzahabi and Hopwood, 2013[46]).

Evidence that the Internet and digital technologies impair mental health has nevertheless proven challenging to establish (Box 4.4). Moderate use of digital technologies mostly seems to have beneficial effects on mental well-being, with no or excessive use having small negative consequences. In OECD countries participating in PISA, extreme Internet users – students who use the Internet more than six hours a day – displayed lower life satisfaction, higher risk of disengagement from school and higher levels of perceived loneliness at school (OECD, 2017[1]). Extreme Internet users also scored less in all PISA subjects, even after taking into account differences in socio-economic background.

Highly skilled individuals are likely to be more informed about the risks associated with extreme uses of technology, and to pay more attention to how much time they spend in front of the computer and how they use devices. Data from PISA suggest that top-performing students are less likely to feel bad without an Internet connection. On average across OECD countries with available data, 45% of students with top performance in reading, mathematics and science reported feeling bad in the absence of an Internet connection, in contrast to 62% among low performers (Figure 4.15).

Figure 4.15. Feeling bad without Internet connection, by students' performance

Percentage of students who reported to agree or strongly agree to feel bad without Internet connection



Note: Students who are low performers are students who score at less than Level 2 in the reading, mathematics and science assessments. Level 2 is considered to be the baseline level of proficiency in reading, mathematics and science. Students who are top performers are students who are proficient at Level 5 or 6 in reading, mathematics and science. Shares for countries with less than 100 observations available for top or low performer categories are not reported in the figure.
Source: OECD calculations based on OECD (2015[22]), *PISA database 2015*, http://www.oecd.org/pisa/data/2015database/.

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Box 4.4. Digital technologies and mental well-being

On average across OECD countries, 91% of 15-year-olds have access to an Internet-enabled smartphone at home, and 55% to a tablet (OECD, 2017[1]). There is growing worry that digital technologies are having a detrimental impact on people's social interactions and mental well-being, especially for young children and adolescents.

The most robust studies suggest the relationship between Internet/social media use and mental well-being is U-shaped for children and adolescents, with no and excessive use being associated with small negative consequences (Kardefelt-Winther, 2017[47]; Przybylski and Weinstein, 2017[48]). The positive and negative outcomes depend largely on the type of activity and content to which children are exposed. More analysis is needed to establish causality and to obtain a more detailed understanding of the effects of different media contents and uses (Odgers, 2018[49]).

One of the most comprehensive studies to date examined 120 000 15-year-olds in England in 2017 (Przybylski and Weinstein, 2017[48]). Its results suggested no relationship between mental well-being and moderate computer and smartphone use, and very small negative correlations for people who had very low and very high levels of engagement (e.g. over two hours of smartphone use per day). However, these negative impacts were negligible

relative to other factors that influence child well-being, such as eating breakfast regularly or getting regular sleep. Another study of 6 000 US children aged 12 to 18 found a small relationship between excessive TV and video game screen time (over six hours per day) and feelings of depression (Ferguson, 2017[50]).

One study attempted to identify the causal impact of social media on 10- to 15-year-olds' mental well-being by exploiting variations in broadband speeds and mobile phone signal strength within the United Kingdom (Mcdool et al., 2016[51]). An increase in time spent on social networks was found to lower children's feeling of satisfaction with all aspects of their lives, with the exception of their friendships. The effect was stronger for girls than for boys. Another experimental study found that passive Facebook use (e.g. simply scrolling through one's newsfeed, viewing others' posts without interacting) induced feelings of envy and lowered participants' affective well-being ("How do you feel right now?") (Verduyn et al., 2015[52]).

Digital communication can improve the well-being and social interactions of elderly adults. Loneliness in old age is an epidemic in many countries. Recent qualitative studies suggest digital technologies, and in particular tablets with communication apps (e.g. Skype, Facetime and Facebook) could help improve seniors' well-being. One study consisting of semi-structured interviews with 21 older adults in an independent living community in the United States found that using tablets made them feel more connected to their families, friends and to the world more generally (Tsai et al., 2015[53]). In another qualitative study, 19 residents of a retirement community were provided with tablets and bi-weekly training (Delello and McWhorter, 2017[54]). Participants found the tablets allowed them to stay connected with their families as well as with friends within and outside the community, with 22% using videoconferencing weekly.

Sources: Delello, J. and R. McWhorter (2017[54]), "Reducing the digital divide: Connecting older adults to iPad technology", http://dx.doi.org/10.1177/0733464815589985; Ferguson, C.J. (2017[50]), "Everything in moderation: Moderate use of screens unassociated with child behavior problems", http://dx.doi.org/10.1007/s11126-016-9486-3; Kardefelt-Winther, D. (2017[47]), "How does the time children spend using technology impact their mental well-being, social relationships and physical activity?", www.unicef-irc.org/publications/pdf/Children-digital-technology-wellbeing.pdf; Mcdool, E. et al. (2016[51]), "Social media use and children's wellbeing", http://ftp.iza.org/dp10412.pdf; Przybylski, A. and N. Weinstein (2017[48]), "A large-scale test of the Goldilocks Hypothesis", http://dx.doi.org/10.1177/0956797616678438; OECD (2017[1]), *PISA 2015 Results (Volume III): Students' Well-Being*, https://dx.doi.org/10.1787/9789264273856-en; Tsai, H. et al. (2015[53]), "Getting grandma online: Are tablets the answer for increasing digital inclusion for older adults in the U.S.?", http://dx.doi.org/10.1080/03601277.2015.1048165; Verduyn, P. et al. (2015[52]), "Passive Facebook usage undermines affective well-being: Experimental and longitudinal evidence", http://dx.doi.org/10.1037/xge0000057.

As new technologies permeate every aspect of society, they change the types of interactions people have not only with their own social networks but also with people they do not know.

Participation in online activities and social networks may complement people's existing offline interactions and thus strengthen their social relations. While evidence on a causal impact of technology use on personal social connections may not yet be conclusive, many studies suggest that the use of digital technologies most likely stimulates existing social relationships (Box 4.5). On the other hand, the increasing digitalisation of societies may be reducing people's face-to-face interactions with strangers and their sense of community.

Box 4.5. Technology use and social relationships

Interactions with friends

There are four main hypotheses regarding how the use of digital technologies may affect offline social interactions (Lee, 2009[55]). (i) The *displacement hypothesis* postulates that online social ties substitute for offline interactions. (ii) The *increase hypothesis* claims that the Internet complements face-to-face relationships. (iii) The *rich-get-richer hypothesis* suggests that people with stronger offline social networks and social skills benefit more from digital technologies in terms of social capital. (iv) The *social compensation hypothesis* proposes that socially anxious and isolated people benefit more from digital technologies, as they are able to communicate more easily online. Some recent studies, summarised below, support the *increase hypothesis*.

The most recent empirical evidence, overall, suggests digital technologies are used by children and adults to develop and maintain social interactions (Kardefelt-Winther, 2017[47]; Yau and Reich, 2018[56]; Odgers, 2018[49]). Current digital technologies facilitate the maintenance of existing relationships, through communication tools (e.g. WhatsApp, Messenger, WeChat) and social networking sites (e.g. Facebook, Instagram, Snapchat). The causal evidence is scarce, however, and most studies evaluate time spent using digital technologies rather than the activities children undertake and the content they interact with, which are likely to play an important role.

A recent randomised control trial in California freely provided computers to low-income students aged 11 to 16 who did not previously have a computer at home (Fairlie and Kalil, 2017[57]). Comparing these children's social participation outcomes with those of children in the control group, who also did not have a computer before the experiment, they found "a significant and positive treatment impact on the number of friends children report communicating with and the amount of time children report actually hanging out with their friends (in person)." Moreover, treated students with no prior participation in social networking or texting experienced greater social connection gains.

Another study exploited a quasi-experiment in eastern Germany stemming from a misguided technological choice by the state-owned telecommunication provider in the 1990s, which hampered the provision of broadband Internet for numerous households (Bauernschuster, Falck and Woessmann, 2014[58]). Exploiting this mistaken technological choice to identify the effect of Internet adoption, they found no evidence that having broadband Internet at home had a negative impact on offline social connections such as going to the movies, concerts, visiting neighbours, friends, and volunteering activities. Their results for children aged 7 to 16 also show no evidence that broadband Internet access crowds out social activities in or out of school, but rather indicates that it may support participation in social group activities outside school.

Interactions with strangers

Smartphones and online services may be eroding a sense of belonging and community by eliminating opportunities for short casual interactions with strangers. Such interactions are important for trust building and facilitating the ease of social interactions. For example, while people trying to find their way in a city used to ask around for help and directions, they now look up their location on their smartphone's map app. Short encounters would take place while commuting or in queues. Now, many people in such situations stare at their screens to check their social media or watch TV shows. These developments are too

recent for a definitive assessment of their likely societal implications, but they should be examined carefully.

Using US data from the World Values Survey, a recent study found that using one's mobile phone more frequently to obtain information was associated with trusting strangers less (Kushlev and Proulx, 2016[59]). The relationship remained after taking into account a number of individuals' characteristics (e.g. income, education, employment status, age). Moreover, obtaining information from other media sources such as TV, radio, and even online but through a laptop computer was not similarly associated with lower trust in strangers. Another study randomly assigned 92 predominantly young adults to look for a building either with or without a phone (Kushlev, Proulx and Dunn, 2017[60]). They found that very few participants in the phone group talked to people to obtain directions and, on average, they felt less socially connected.

Sources: Bauernschuster, S., O. Falck and L. Woessmann (2014[58]), "Surfing alone? The internet and social capital: Evidence from an unforeseeable technological mistake", http://dx.doi.org/10.1016/j.jpubeco.2014.05.007; Fairlie, R. and A. Kalil (2017[57]), "The effects of computers on children's social development and school participation: Evidence from a randomized control experiment", http://dx.doi.org/10.1016/j.econedurev.2017.01.001; Kardefelt-Winther, D. (2017[47]), "How does the time children spend using technology impact their mental well-being, social relationships and physical activity?", www.unicef-irc.org/publications/pdf/Children-digital-technology-wellbeing.pdf; Kushlev, K. and J. Proulx (2016[59]), "The social costs of ubiquitous information: Consuming information on mobile phones is associated with lower trust", http://dx.doi.org/10.1371/journal.pone.0162130; Kushlev, K., J. Proulx and E. Dunn (2017[60]), "Digitally connected, socially disconnected: The effects of relying on technology rather than other people", http://dx.doi.org/10.1016/J.CHB.2017.07.001; Lee, S. (2009[55]), "Online communication and adolescent social ties: Who benefits more from Internet use?", http://dx.doi.org/10.1111/j.1083-6101.2009.01451.x; Odgers, C. (2018[49]), "Smartphones are bad for some teens, not all", http://dx.doi.org/10.1038/d41586-018-02109-8; Yau, J. and S. Reich (2018[56]), "Are the qualities of adolescents' offline friendships present in digital interactions?", http://dx.doi.org/10.1007/s40894-017-0059-y

Being connected and skills development

Technology itself may affect the development of skills. People rely increasingly on the Internet, smartphones or computers for even the simplest tasks. For many, looking for directions has become a task for a smartphone rather than requiring thinking or interaction with surrounding people. Evidence is emerging that technology use affects memory and cognitive development. When people are confronted with difficult questions, they are primed to rely on computers. When they expect to be able to access information online, they are less likely to be able to recall that information (Sparrow, Liu and Wegner, 2011[61]). People appear to be outsourcing not only their memory or information storage to digital devices, but also their thinking (Barr et al., 2015[62]).

Technology may also affect the development of social and emotional skills, but there is still too little evidence to draw conclusions about this link (Box 4.6). Social and emotional skills are increasingly valued in a digital world, but the acquisition of such skills is likely to be hindered if people interact more frequently with computers and technology lowers the quality of social interactions.

Box 4.6. Digital technologies and the development of socio-emotional skills

Friendships and face-to-face interactions with peers are vital for the development of life-long social skills, so there are concerns that children's social skills might be impaired if such interactions are replaced by the use of digital technologies (George and Odgers, 2015[63]). Evidence suggests that such technologies tend to stimulate relationships (Box 4.4), but little is known about the extent to which technology use by children might affect their development of social and emotional skills. So far, the limited number of causal studies do not find any effect of computer use at home on children's socio-emotional skills.

Many children in advanced economies use a smartphone with an Internet connexion and are active on multiple social media platforms (George and Odgers, 2015[63]). These have been found to affect the quality of face-to-face interactions, with possible implications for the development of social and emotional skills, but more research is needed to understand the links. One study of 100 pairs found that 10-minute conversations were rated as significantly inferior, with lower levels of empathy, when one participant placed a mobile device on the table or held it in his or her hand, compared with conversations without the presence of a mobile device (Misra et al., 2016[64]).

Increasing psychological evidence suggests parental use of mobile devices adversely affects child-parent interactions. In the United States, 51% of US adolescents (13 to 17 years old) said their parents were "often" (14%) or "sometimes" (34%) distracted by their cell phone when they were trying to have a conversation in person" (Pew Research Center, 2018[65]). Parents who use their smartphones during parent-child play are usually less sensitive and responsive to their children, verbally and non-verbally, and children are more likely to engage in risky behaviours (Kildare and Middlemiss, 2017[66]). More longitudinal studies are needed to assess robustly how these changes in parent-child interactions affect children's long-term socio-emotional skills development, whether the context in which the interaction takes place (e.g. during meals, playtime, vacation) or the type of mobile phone activity undertaken by the parent makes a difference.

A review of 27 studies of parental mobile device use during parent-child interactions found that device use may compromise the development of a secure attachment relationship and child development, (Kildare and Middlemiss, 2017, p. 580[66]). One study of 225 interactions during meals between low-income mothers and their children (around 6 years old) found that mobile use by mothers was associated with 20% fewer verbal and 39% fewer non-verbal interactions and 28% fewer encouragements, compared with no mobile use (Radesky et al., 2015[67]). Mothers' characteristics such as age, ethnicity, education and parenting style were not related to mobile use. Repeated lack of engagement with children may affect their non-cognitive development, as they have fewer opportunities to pick up social cues.

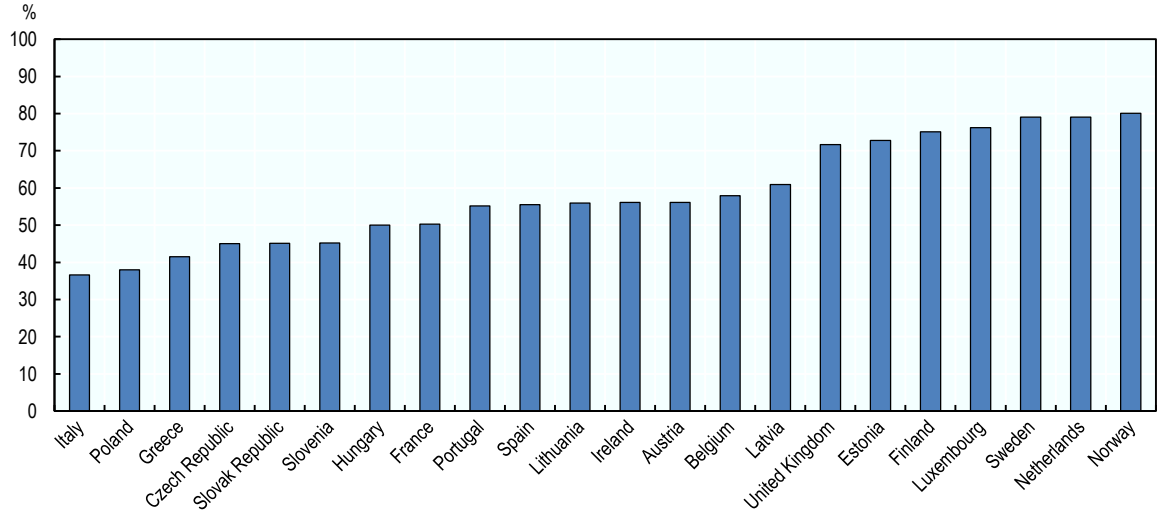
Sources: Fiorini, M. (2010[68]), "The effect of home computer use on children's cognitive and non-cognitive skills", http://dx.doi.org/10.1016/J.ECONEDUREV.2009.06.006; George, M. and C. Odgers (2015[63]), "Seven fears and the science of how mobile technologies may be influencing adolescents in the digital age", http://dx.doi.org/10.1177/1745691615596788; Kildare, C. and W. Middlemiss (2017[66]), "Impact of parents mobile device use on parent-child interaction: A literature review", http://dx.doi.org/10.1016/J.CHB.2017.06.003; Malamud, O. and C. Pop-Eleches (2011[69]), "Home computer use and the development of human capital", http://dx.doi.org/10.1093/qje/qjr008; Misra, S. et al. (2016[64]), "The iPhone effect: The quality of in-person social interactions in the presence of mobile devices", http://dx.doi.org/10.1177/0013916514539755; Pew Research Center (2018[65]), *How Teens and Parents Navigate Screen Time and Device Distractions*, www.pewinternet.org/2018/08/22/how-teens-and-parents-navigate-screen-time-and-device-distractions/; Radesky et al. (2015[67]), "Maternal mobile device use during a structured parent-child interaction task", http://dx.doi.org/10.1016/j.acap.2014.10.001.

Skills-related policies for a digital society

The digitalisation of economies requires people to be well-rounded, or relatively proficient in many cognitive, social and emotional skills, so they can adapt to their changing environments. The ability to learn new things, whether they be tasks or know-how, is also becoming increasingly important in a digital world. Digitalisation increases the variety of tasks executed on the job or activities performed in everyday life, and the use of cognitive skills. Across OECD countries with available data, there is significant variation in the share of individuals using the Internet in diverse and complex ways (Figure 4.16). In the Netherlands, Norway and Sweden, more than 80% of those aged 16 to 64 perform many and complex activities online, including e-finance or the creation of websites and blogs. In contrast, less than half of individuals in Greece, Italy and Poland engage in such activities. These figures suggest that even where Internet access is universal, there are large disparities in the extent to which people from different countries take advantage of all the opportunities brought about by digitalisation. If technological change continues to expand the number and complexity of activities that individuals are required to perform in their everyday life using digital tools, people in some countries are more likely to be left behind.

Figure 4.16. Individuals with a diversified and complex use of Internet

Share of individuals, by country



Note: The identification of the individuals with a diversified and complex use of Internet is based on a clustering methodology similar to that explained in Box 4.3, but applied to the entire sample of OECD countries with available data in the European Community Survey on ICT Usage in Households and by Individuals (2016).
Source: OECD calculations based on Eurostat (2016[30]), *European Community Survey on ICT Usage in Households and by Individuals*.

StatLink https://doi.org/10.1787/888933974064

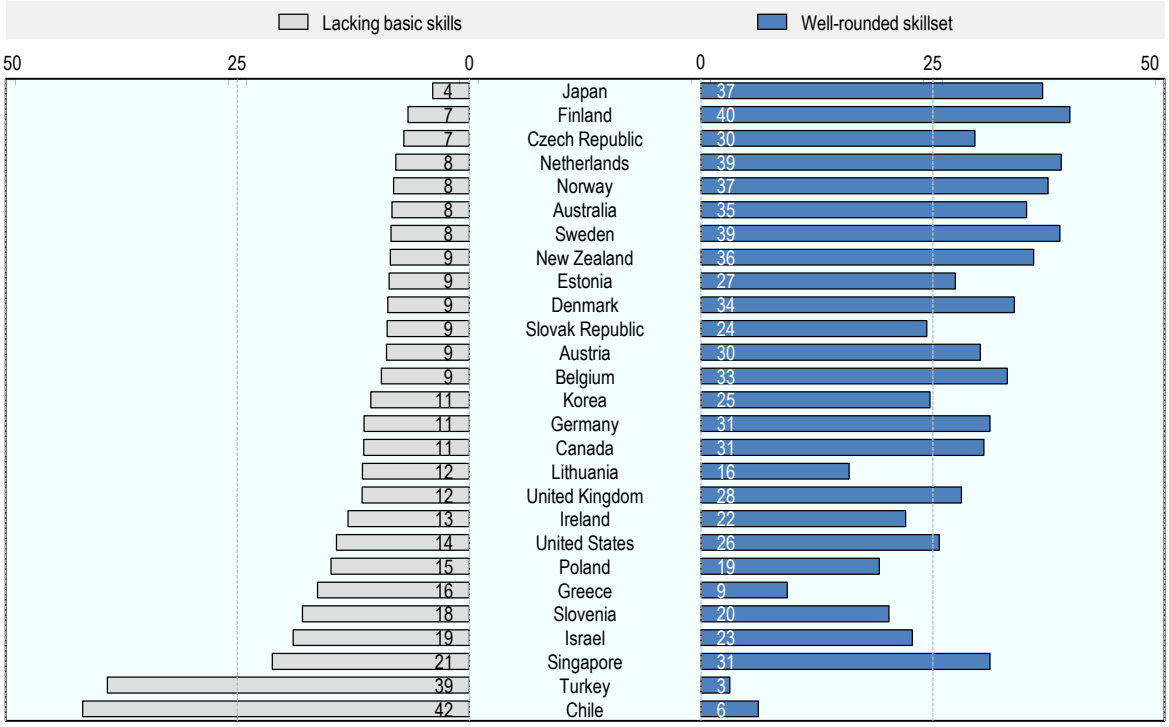
Countries with high proportions of well-rounded individuals and few adults lacking basic skills are likely to be better prepared for technological change than countries where a large share of the population lacks basic skills.

The Survey of Adult Skills (PIAAC) gives an indication of the mix of cognitive skills of countries' populations but does not cover other important types of skills discussed in this

chapter, such as social and emotional skills. Finland, the Netherlands, Norway and Sweden, where many people use the Internet in complex and diverse ways, are also among the OECD countries with the highest shares of individuals with well-rounded cognitive skills (Figure 4.17). Countries' population skill mix, which encompasses literacy, numeracy and problem-solving skills in technology-rich environments, varies substantially. As might be expected, countries that perform well in each separate skill, such as Finland, Japan, the Netherlands and Sweden, also tend to have a high proportion of their population with high proficiency in all three skills. These individuals are more likely to be able to adapt if digitalisation affects their job content or everyday activities, since they already have the well-rounded skill mix that is required for learning new working techniques, methods, or technologies.

Figure 4.17. Skills mix of countries' populations

Share of 16-65 year-olds lacking basic skills or having a well-rounded skill set, by country (%)



Note: Individuals lacking basic skills score at most *Level 1* (inclusive) in literacy and numeracy and at most *Below Level 1* (inclusive) in problem solving (including failing ICT core and having no computer experience). Individuals with a well-rounded skill set score at least *Level 3* (inclusive) in literacy and numeracy and at least *Level 2* (inclusive) in problem solving. Chile, Greece, Israel, Lithuania, New Zealand, Singapore, Slovenia and Turkey: Year of reference 2015. All other countries: Year of reference 2012. Data for Belgium refer only to Flanders and data for the United Kingdom refer to England and Northern Ireland jointly.

Sources: OECD calculations based on OECD (2012[28]) and OECD (2015[29]), *Survey of Adult Skills (PIAAC)*, www.oecd.org/skills/piaac/publicdataandanalysis.

StatLink https://doi.org/10.1787/888933974083

Countries with well-rounded populations also tend to have small proportions of adults who lack the required combination of basic cognitive skills including ICT skills and hence are likely to struggle to adapt to the changes of digitalisation. In Singapore and Israel, the proportion of adults lacking these basic skills reaches close to one in five. In Chile and Turkey, the share is twice as high.

People lacking basic cognitive skills are most at risk of not being able to adapt in a digital environment and should thus be a particular focus of policy. The aggregate share of low-skilled adults hides important variations among subgroups. Youth (16-24) are less likely to lack basic skills than prime-age people (25-54) and older people (55-65), with only a minority of young people lacking basic skills (Figure 4.18). In particular, on average, only around 7% of youth have low proficiency in all three skills (literacy, numeracy and problem solving with computers), while 23% of older people do. Prime-age adults fare closer to youth with, on average, 12% lacking basic skills.

There are significant variations between countries, with some having a much more prepared prime-age workforce, such as the Czech Republic, Finland and Japan, while others, notably Chile and Turkey, have significant shares of unprepared adults, pointing to different policy priorities for different countries. In countries with a high share of people lacking basic skills and young people not performing much better than prime-age ones (e.g. Greece and to some extent the United Kingdom), the focus needs to be put on improving the quality and inclusiveness of initial education. In countries where there is a much larger share of older individuals lacking basic skills than of young people (e.g. Korea and Slovenia), the priority needs to be put on policies to ensure that older individuals are not left behind by the digital transformation.

Preparing individuals for a digital society needs to begin early, in families and schools where parents and teachers equip children not only with the necessary cognitive skills but also with digital resilience – the ability to manage the risks and opportunities of going on line (Hooft Graafland, 2018[39]; Hatlevik and Hatlevik, 2018[70]). Parents' involvement in their children's digital education is increasingly important, as many children first access digital devices at home. When parents lack the skills required to help children manage their online activity, others need to step in to build children's digital resilience and avoid further exacerbating digital inequalities.

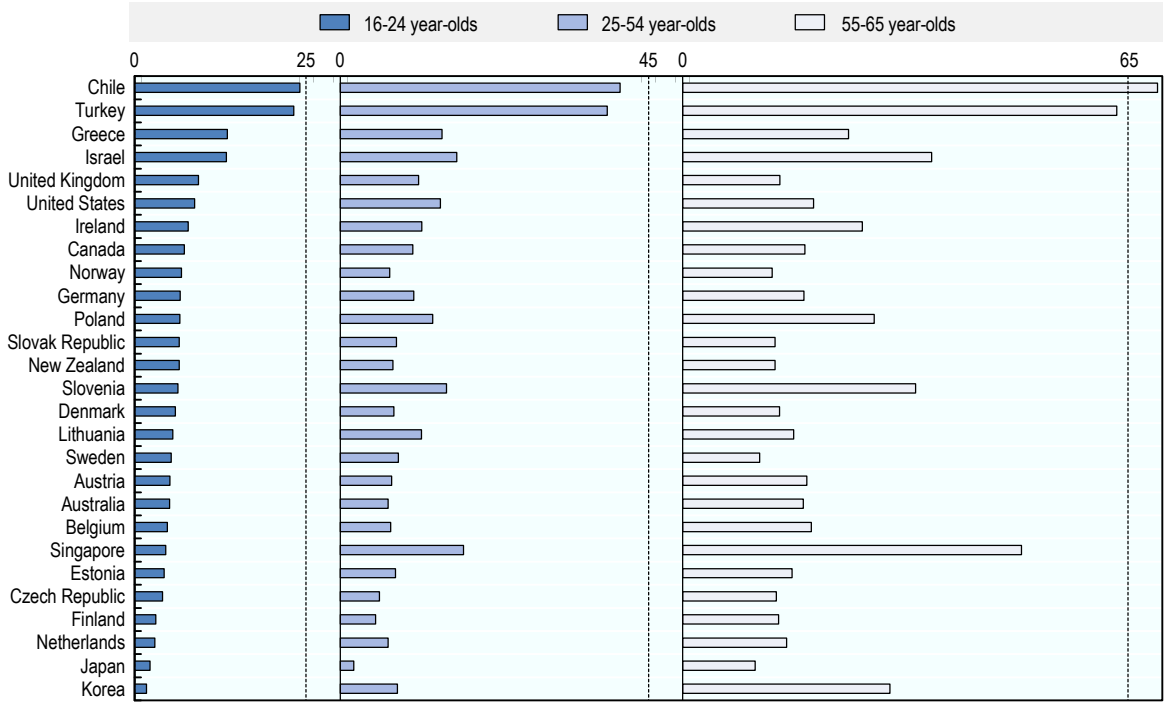
Teachers and schools are natural candidates to support the development of digital skills and digital resilience. To ensure education systems are able to adapt to new requirements, professional development programmes need to prepare teachers and school to educate students on online safety and privacy, understand the implications of some online behaviours and identify various forms of online harassment that build up in schools. Integrating online safety or digital citizenship responsibilities in the curriculum can also be considered, although more evaluations are needed to establish the effectiveness of such interventions (Hooft Graafland, 2018[39]). Beyond education systems, policy makers could also consider a co-ordinated regulatory response to child protection and better measuring and monitoring of existing policies (OECD, 2018[71]).

Local communities and associations can also help people develop their digital skills and resilience. In Denmark, local libraries offer digitalisation courses (European Commission, 2018[72]). In the United Kingdom, the Future Digital Inclusion programme, funded by the government and run by a charity, has provided support and training to more than 200 000 individuals in basic digital skills (Department of Digital, Culture, Media and Sport, 2017[73]). In a similar vein, the NHS Widening Digital Participation programme, delivered by a charity through networks of local online centres, has trained people to use digital health

resources and tools to tackle health inequalities and digital exclusion (Tinder Foundation, 2016[74]). Such initiatives also emphasise the need for programmes and tools that accompany low-skilled individuals or the elderly when public services become digitised.

Figure 4.18. Share of individuals lacking basic skills by age groups

Share of youth (16-24), prime age adults (25-54) and older people (55-65) lacking basic skills, by country (%)



Note: Individuals lacking basic skills score at most *Level 1* (inclusive) in literacy and numeracy and at most *Below Level 1* (inclusive) in problem solving (including failing ICT core and having no computer experience). Chile, Greece, Israel, Lithuania, New Zealand, Singapore, Slovenia and Turkey: Year of reference 2015. All other countries: Year of reference 2012. Data for Belgium refer only to Flanders and data for the United Kingdom refer to England and Northern Ireland jointly.

Sources: OECD calculations based on OECD (2012[28]) and OECD (2015[29]), *Survey of Adult Skills (PIAAC)*, www.oecd.org/skills/piaac/publicdataandanalysis.

StatLink https://doi.org/10.1787/888933974102

For all age groups, developing lifelong learning needs to be at the core of the policy answer to the digital transformation (Chapter 6). Digitalisation in itself brings many new learning opportunities in schools, at work and in everyday life.

A high-quality education system, from early childhood education to tertiary education and vocational education and training, can help develop the mix of skills people need to work and live in a digital world, including cognitive and digital skills, social and emotional skills, and a strong readiness to learn. There is a growing consensus about the importance of transversal skills or "21st century skills" such as thinking critically and creatively, solving problems, making informed decisions while using technology, and behaving collaboratively, as evidenced by the analysis in the previous chapters. At the same time, developing these skills cannot come at the expense of content knowledge, as working in a digital environment requires a deep grasp of substance. To achieve these aims, education and training systems have to move to a multidisciplinary approach to knowledge that imparts a range of skills and values, so that people can complete complex thinking and problem solving tasks.

Summary

This chapter aims to better understand the types of skills people need to benefit from new technologies in their everyday life. To do this, it combines information on cognitive skills, from the Survey of Adult Skills, with information on participation in online activities, from the Community Survey on ICT usage in households and by individuals. More data will be needed, however, to obtain a comprehensive view of the whole range of skills that can affect online behaviour, including high-level digital skills and social and emotional skills, and the role for policies.

The analysis proposed in the chapter shows the importance of literacy and numeracy skills as well as problem-solving skills in technology-rich environments to perform diversified and complex activities on line. While not everybody needs to perform these activities, people need to have the relevant skills to be able to choose how they participate in online activities.

Countries differ significantly in how well their populations' skills prepare them for digitalisation. An important question for the design of policies is to assess whether the skills gap between generations tend to decrease or not when a range of skills is considered, including digital ones.

People are not equally equipped to benefit from online opportunities. A range of policies is needed to ensure that the development of new technologies does not lead to inequalities of opportunities between children or between workers, or social isolation for older people. Policies should acknowledge the role of schools and the teaching profession in combatting exposure to risks, and the need for co-operation between local government and communities to bridge gaps in the skills people need to make use of online activities. Policies targeting skills, value and knowledge development need to be accompanied by policies that help people ensure the security and safety of their online activities.

Note

[1] The clustering algorithm is also run on the original variables of the online activities, defined as binary variable that equal 1 if the individual performs a given activity. The algorithm yields similar results to those computed using activity shares and the total number of activities.

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