Chapter 1. Overview – Skills-related policies to work, live and learn in a digital world

Digitalisation transforms economies and societies, triggering new policy challenges. Countries' preparedness to seize the benefits of digital transformation is largely dependent on the skills of their populations and the range of appropriate policies put in place, with skills-related policies as a cornerstone. This chapter proposes a scoreboard to capture countries' performance in terms of skills, digital exposure and skills-related policy effort. It assesses the extent to which countries have been, are and will be able to make the most of digitalisation through their population's skills. The chapter provides an overview of the publication. It investigates how policies, particularly those related to skills development and use, can shape the outcomes of digital transformation and ensure that the new technological wave leads to prosperity and better lives for all.

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.

Digitalisation changes many aspects of peoples' lives

Economies and societies are undergoing a *digital transformation*. Information and communication technologies (ICT), artificial intelligence (AI) and robotics are profoundly changing the way people work, interact with one another, communicate and live. Digital technologies have also enabled the rise of the "platform economy", which has introduced new ways to work, create value and socialise. These changes prompt new policy challenges.

These technologies can reduce some inequalities between individuals. Now people can supply their skills in a more flexible way by using online platforms, rather than a unique formal employer, blurring the frontiers between standard and non-standard forms of employment. Some people can work from anywhere by teleworking, hence benefiting from job creation regardless of the location of the firm. Anybody can access educational content on line at zero or very low cost, even content created by academics from top universities. They can easily communicate with their friends and families who are far from them, share ideas and make them easily available to many people simply by going on line. People from anywhere can buy products from everywhere.

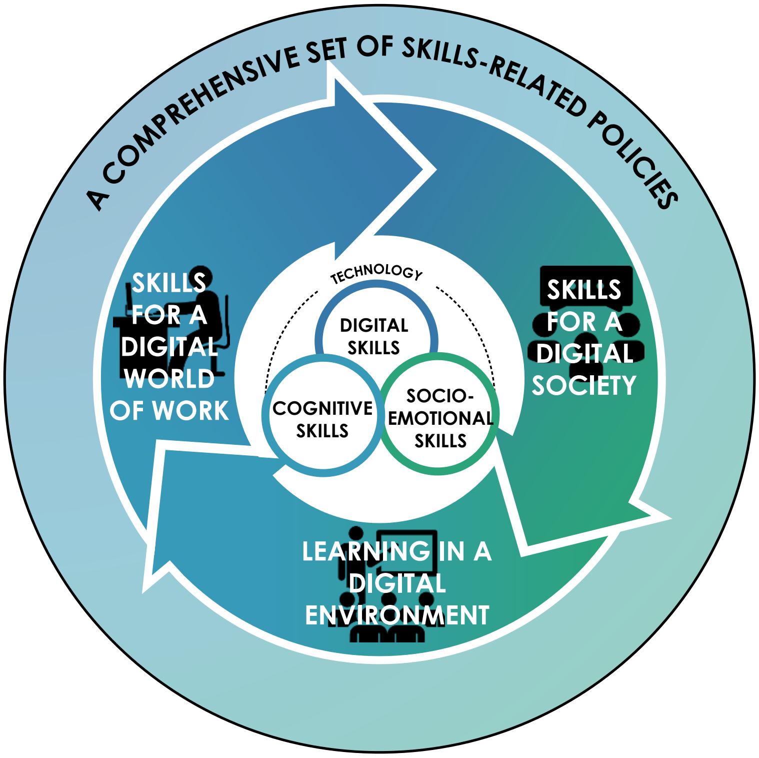
However, digital transformation can also lead to divergence:

- *Between workers*: those who are high-skilled and can easily adapt to a digitalised workplace, and those with low levels of skills who are most likely to bear the costs of digital transformation; those in rapidly growing firms that have adopted the most recent technology, who can learn from technology and develop highly demanded skills, and those in firms with old work practices. Divergence can also develop between workers in different sectors and occupations that are affected differently by technology. Those working through online platforms do not have the same rights and social protection as workers under standard contracts.
- *Between firms*, with a small share of them accounting for a large share of profits.
- *Between regions*, with some attracting high-tech firms, high-paid jobs, and a high-skilled population while others lag behind or stagnate, experiencing lay-offs and a shrinking population.
- *Between individuals*, with children spending an increasing amount of their time on line and older people feeling more isolated as many activities are now done on digital devices; with highly skilled adults performing many activities on line and low-skilled ones performing fewer or simpler tasks using the Internet.

While some argue that the current wave of technological change is broader and quicker than past ones, technological change has always been part of economies and societies. It has contributed to productivity growth, but skill-biased technological change has also increased inequalities, with highly skilled individuals benefiting the most. Many uncertainties remain about how the current technological transformation will affect workers, economies and societies. Rather than wait to see what those effects are, it is preferable to adopt a pro-active approach that builds resilience now.

The purpose of this publication is to understand how policies, particularly those that affect skills development and use, can shape the outcomes of digital transformation and ensure that the benefits are more equally shared among and within countries' populations (Figure 1.1).

Figure 1.1. Skills for a digital world



SKILLS FOR A DIGITAL WORLD OF WORK

- The nature of many jobs is changing due to technology.
- Low-skilled workers are most at risk of being in a highly automatable job.
- Quality workers' training can help workers in occupations at high risk of automation transition to a low risk occupation.

SKILLS FOR A DIGITAL SOCIETY

- Skills help bridge digital divides in terms of digital device access, use and outcomes.
- Higher cognitive skills enable individuals to do more diverse and complex activities on line and better protect their online privacy.
- A range of skills are necessary to navigate sources of information and understand the implications of harmful behaviours on line.

LEARNING IN A DIGITAL ENVIRONMENT

- In schools, technology can help develop skills for a digital future but its potential has not been realised yet.
- Open educational resources are important sources for lifelong skills development, though they have have mostly benefitted already skilled individuals.

A COMPREHENSIVE SET OF SKILLS-RELATED POLICIES

- Policies can foster lifelong learning and ensure everyone can adapt to changing work environments and societies.
- Policies can address the geographic dimension of digitalisation and ensure its benefits are more equally shared within countries.
- The policy effort can be better coordinated across areas and actors.

In several countries, inequalities have reached their highest level in 50 years. The average disposable income of the richest 10% of the population in OECD countries is now more than nine times that of the poorest 10% (OECD, 2016[1]). Perhaps more importantly, inequalities of opportunities are high in many countries. Children whose parents did not complete secondary school have significantly fewer chances of making it to university than their peers who have at least one parent who achieved tertiary-level education (OECD, 2016[2]). About a third of children of manual workers remain manual workers themselves (OECD, 2018[3]). In this context, the urgency for policies is to ensure that the new technological wave does not simply add to existing inequalities.

Investing in skills, education and training is needed to make the most of digital transformation

OECD member countries spent from 3% to 6% of their GDP on educational institutions in 2015 (OECD, 2018[4]). However, 1.5% to 19% of young tertiary-education graduates (depending on countries) have low literacy and numeracy skills as evidenced by the Survey of Adult Skills (PIAAC). Thirteen percent of 15- to 29-year-olds were not in employment, education or training (NEET) in 2017. This suggests there may be imbalances between the type of skills and knowledge developed during education and those demanded by employers, although labour market regulations and other aspects also play important roles (OECD, 2018[4]). Raising the number of years of education is not *per se* the solution. Enrolling a larger share of the population in tertiary education can be costly and may not necessarily lead to the right skills mix for all.

Moreover, some skills may be best developed on the job. While there are no comparable data for adult learning and on-the-job training, some countries have or are implementing ambitious plans for adult training. However, high-skilled workers are, on average across OECD countries, almost three times more likely to participate in training than low-skilled ones.

Investing in skills, education and training is necessary to make the most of digital transformation. Many countries face challenging questions, however, about how this investment can become more efficient and inclusive and whether current investments are enough.

Countries are unequally prepared to seize the benefits of digital transformation

The extent to which countries have been, are and will be able to make the most of digitalisation through the skills of their population and the policies they put in place is summarised here in a scoreboard (Table 1.1). The scoreboard is structured around three main dimensions: 1) skills needed to benefit from digitalisation; 2) exposure to digitalisation; 3) skills-related policies to make the most of digital transformation.

The scoreboard shows that:

- No country achieves above-median outcomes in all the dimensions of the scoreboard, suggesting that all countries have room for improvement.
- A small group of countries, including Belgium, Denmark, Finland, the Netherlands, New Zealand, Norway, and Sweden, tends to fare very well in most dimensions. Their populations are, broadly speaking, well-equipped in terms of skills and supported by robust lifelong systems to benefit fully from digitalisation. These countries are also ahead in terms of the exposure to digitalisation of their economies and societies.

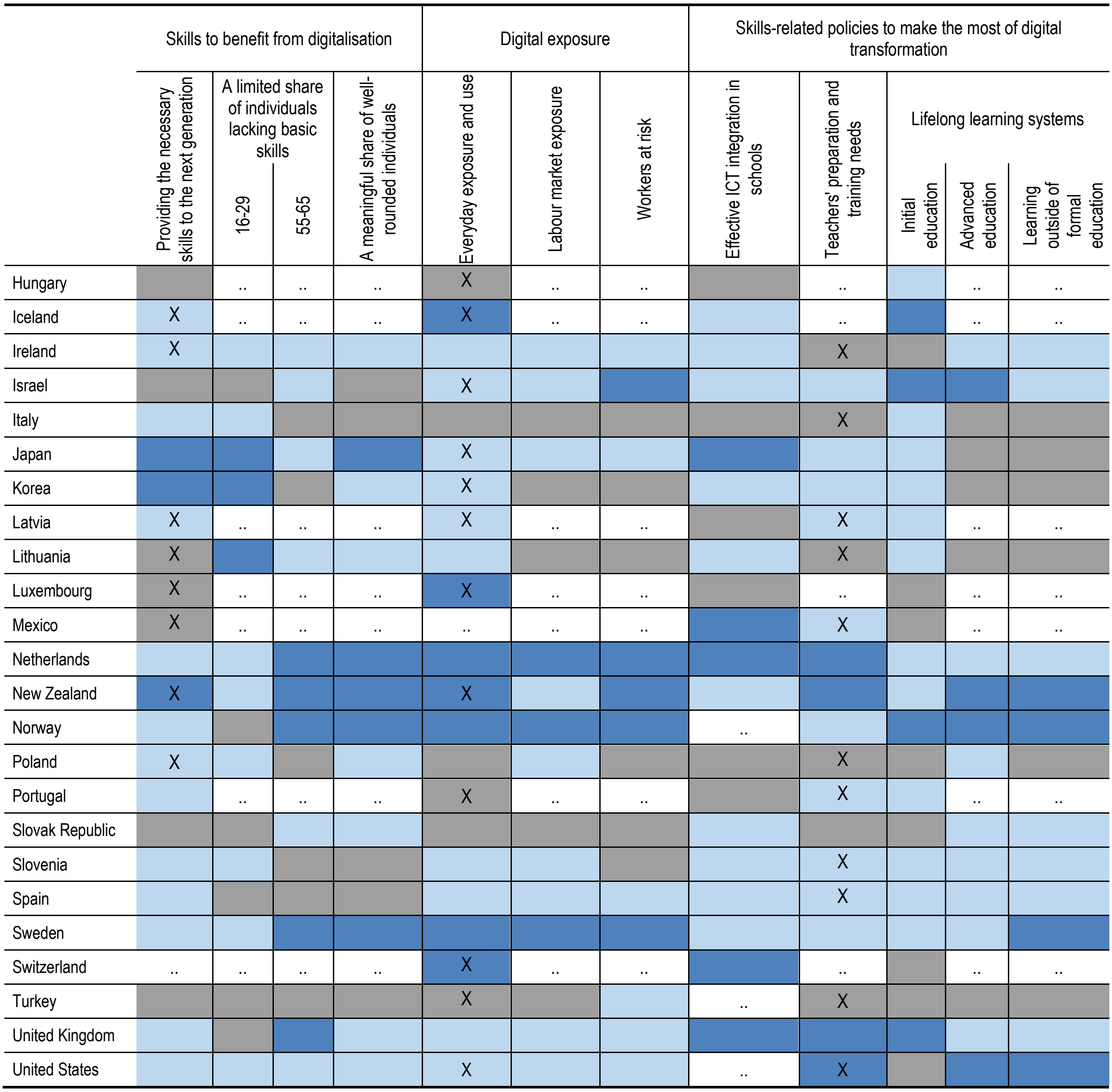
- Other countries such as Japan and Korea perform unequally depending on the dimension considered. Though they perform well on indicators closely linked with the skills acquired in formal education and those of the young generation's skills, they perform around average or poorly when it comes to labour market exposure and learning outside of formal education. These countries have potential to make the most of digital transformation but would have to adopt a range of policies to ensure older workers and adults are not left behind.
- Chile, Greece, Italy, Lithuania, the Slovak Republic and Turkey tend to perform poorly in many dimensions. Their populations often lack the necessary foundational skills to flourish in a digital world, both as individuals and workers. Moreover, their lifelong learning systems, both formal and non-formal, are not developed well enough to enable workers to upskill or reskill throughout their lifetimes, a crucial issue in a quickly changing world.

The scoreboard also shows that the skills of a country's population and its skills-related policies are strongly linked to its exposure to digitalisation, which in a way captures the adoption of technologies at work and at home. Almost all countries with low exposure to digitalisation (Chile, Greece, Italy, Lithuania, the Slovak Republic and Turkey) tend to perform relatively badly in the skills levels and skills policies dimensions.

Table 1.1. Scoreboard on skills and digitalisation

■	Top 25%	□	Around median	▨	Bottom 25%
..	Missing data	X	Missing data for underlying indicator(s)		

	Skills to benefit from digitalisation				Digital exposure			Skills-related policies to make the most of digital transformation				
	Providing the necessary skills to the next generation	A limited share of individuals lacking basic skills		A meaningful share of well-rounded individuals	Everyday exposure and use	Labour market exposure	Workers at risk	Effective ICT integration in schools	Teachers' preparation and training needs	Lifelong learning systems		
		16-29	55-65							Initial education	Advanced education	Learning outside of formal education
Australia	■	□	□	□	■ X	□	..	■	■	□	■	□
Austria	□	□	□	□	□	□	□	□	□ X	□	□	□
Belgium	□	■	□	■	□	■	■	□	■	■	□	□
Canada	■	□	□	□	□ X	□	□	..	■	■ X	■	■
Chile	▨	▨	▨	▨	▨ X	▨	□	□	□	▨	□	□
Czech Republic	□	■	□	□	▨ X	■	▨	▨	□	□	□	□
Denmark	■	□	■	□	■ X	■	□	□	□	■	□	■
Estonia	■	■	□	□	□	□	□	□	▨	□	□	□
Finland	■	□	■	■	□	■	■	■	■	□	■	■
France	□	□	□	□	□	□	□	■	□ X	■	▨	□
Germany	□	■	□	□	□ X	□	□	□	□ X	■	▨	□
Greece	▨ X	□	□	▨	▨	▨	□	▨	▨ X	..	□	▨



	Skills to benefit from digitalisation				Digital exposure			Skills-related policies to make the most of digital transformation				
	Providing the necessary skills to the next generation	A limited share of individuals lacking basic skills		A meaningful share of well-rounded individuals	Everyday exposure and use	Labour market exposure	Workers at risk	Effective ICT integration in schools	Teachers' preparation and training needs	Lifelong learning systems		
		16-29	55-65							Initial education	Advanced education	Learning outside of formal education
Hungary	▨	..	..	..	▨ X	..	..	▨	..	▢	..	..
Iceland	▢ X	..	..	..	🟦 X	..	..	▢	..	🟦	..	..
Ireland	▢ X	▢	▢	▢	▢	▢	▢	▢	▨ X	▨	▢	▢
Israel	▨	▨	▢	▨	▢ X	▢	🟦	▢	▢	🟦	🟦	▢
Italy	▢	▢	▨	▨	▨	▨	▨	▨	▨ X	▢	▨	▨
Japan	🟦	🟦	▢	🟦	▢ X	▢	▢	🟦	▢	▢	▨	▨
Korea	🟦	🟦	▨	▢	▢ X	▨	▨	▢	▢	▢	▨	▨
Latvia	▢ X	..	..	..	▢ X	..	..	▨	▢ X	▢	..	..
Lithuania	▨ X	🟦	▢	▢	▢	▨	▨	▢	▨ X	▢	▨	▨
Luxembourg	▨ X	..	..	..	🟦 X	..	..	▨	..	▨	..	..
Mexico	▨ X	..	..	..	..	..	..	🟦	▢ X	▨	..	..
Netherlands	▢	▢	🟦	🟦	🟦	🟦	🟦	🟦	🟦	▢	▢	▢
New Zealand	🟦 X	▢	🟦	🟦	▢ X	▢	🟦	▢	🟦	▢	🟦	🟦
Norway	▢	▨	🟦	🟦	🟦	🟦	🟦	..	▢	🟦	🟦	🟦
Poland	▢ X	▢	▨	▢	▨	▢	▨	▨	▨ X	▨	▢	▨
Portugal	▢	..	..	..	▨ X	..	..	▨	▢ X	▢	..	..
Slovak Republic	▨	▨	▢	▢	▨	▨	▨	▢	▨	▨	▢	▢
Slovenia	▢	▢	▨	▨	▢	▢	▨	▢	▢ X	▢	▢	▢
Spain	▢	▨	▨	▨	▢	▢	▢	▢	▢ X	▢	▢	▢
Sweden	▢	▢	🟦	🟦	🟦	🟦	🟦	▢	▢	▢	▢	🟦
Switzerland	..	..	..	..	🟦 X	..	..	🟦	..	▨	..	..
Turkey	▨	▨	▨	▨	▨ X	▨	▢	..	▨ X	▨	▨	▨
United Kingdom	▢	▨	🟦	▢	▢	▢	▢	🟦	🟦	🟦	▢	▢
United States	▢	▢	▢	▢	▢ X	▢	▢	..	🟦 X	▨	🟦	🟦

Notes: The scoreboard shows for each sub-dimension countries that perform in the top 25%, bottom 25%, and those around the OECD median. A sharp threshold has been applied and therefore, some countries can be classified in one group (e.g. the bottom 25%) but be close to the other group (e.g. median). For all performance levels (top 25%, around median and bottom 25%), cells that display "X" indicate missing data for underlying indicator(s). Countries are ranked according to the sub-dimensions, which are aggregates of the indicators presented in Annex Table 1.A.1 (see Box 1.1 for details regarding the aggregation and the sub-dimensions of the indicators). For indicators based on the Survey of Adult Skills (PIAAC), data of Flanders is used for Belgium, and of England and Northern Ireland for the United Kingdom.
Sources: See Annex Table 1.A.1 for detailed sources of the underlying indicators.

Box 1.1. Scoreboard on skills and digitalisation

The scoreboard in Table 1.1 examines how countries have performed in recent years in terms of skills, digital exposure, and skills-related policies to make the most of digital transformation.

Main dimensions

Three overarching dimensions are considered, with sub-dimensions often based on a group of indicators. Many of them are taken from the analytical work presented in this edition of the OECD Skills Outlook (see Annex 1.A for the full list of indicators and their sources).

Skills to benefit from digitalisation: This dimension attempts to capture the extent to which individuals have acquired the foundational skills they need to take advantage of the benefits of digitalisation while facing its risks. As digital transformation requires individuals have a mix of skills, the three sub-dimensions evaluate proficiency in a range of skills for different age groups (15-year-olds, young adults and seniors) and different types of skills (literacy, numeracy, problem-solving skills and social skills). The focus is on people who lack baseline proficiency in a given skill, as these people will find it significantly harder to upskill or to acquire new skills. The three sub-dimensions analyse the extent to which:

- the young generation is proficient in a set of cognitive and social-emotional skills, including reading, science, mathematics, collaborative and creative problem solving (*Providing the necessary skills to the next generation*);
- younger and older generations lack basic cognitive skills, including ICT skills (*A limited share of individuals lacking basic skills*); and
- individuals have a well-rounded set of skills, combining high levels of literacy and numeracy skills (*A meaningful share of well-rounded individuals*).

Digital exposure: This dimension aims to describe how digitalisation has permeated people's everyday lives and work environments. Digital transformation has not penetrated all countries to same extent, suggesting that countries that are currently lagging behind will have to catch up soon. As such, the three sub-dimensions analyse the extent to which:

- people use digital technologies in their everyday life (*Everyday exposure and use);*
- workers' tasks may change because they become more non-routine or ICT intensive (*Labour market exposure*); and
- workers could encounter difficulties finding a new job if they were dismissed (*Workers at risk*).

Skills-related policies to make the most of digital transformation: This dimension tries to summarise how countries' skills-related policies will enable them to prepare their population for digital transformation. Teachers play a crucial role in preparing the next generation to acquire the right skills for a digital world and workers need to be able to upskill or reskill throughout their lifetime. Lifelong learning is pivotal in reaching this goal. Therefore, the three sub-dimensions evaluate:

- the gap in students' performance depending on the level of ICT use at school (*The effective integration of ICTs in schools*);
- teachers' skills and training needs in ICT (*Teachers' preparation and training needs*); and
- whether countries have lifelong learning systems that facilitate participation in learning activities from initial to advanced education, as well as in non-formal and informal learning (*Lifelong learning systems*).

Methodology

For each of the sub-dimensions of the scoreboard, a summary indicator is calculated and presented in Table 1.1. Each summary indicator aggregates the set of indicators presented in Annex 1.A. Before the aggregation, each indicator was normalised to obtain values between 0 and 1, with higher values reflecting better performance. The summary indicators for each sub-dimension are calculated as simple averages of the indicators they contain.

Countries are ranked according to the summary indicators. The scoreboard shows countries that perform in the bottom 25%, in the top 25% and those around the OECD median (in the remaining part of the distribution). A sharp threshold has been applied and therefore, some countries can be classified in one group (e.g. the bottom 25%) but remain close to the other group (e.g. median).

Most occupations are changing and workers need to adapt

The use of the Internet by most workers, the possibility of automating an increasing range of tasks and opportunities to supply skills through online platforms are different facets of digital transformation that affect what people do on the job, how and where they work. Almost all occupations are changing because of these transformations. To face these changes, most workers need to adjust their skills mix either through training or by learning on the job.

New technologies lead to both substitution and complementarity effects (Chapter 2). Technology replaces workers in the performance of some tasks that can be automated, such as routine tasks. Workers use technology, such as ICT tools, to perform their tasks differently and perhaps more efficiently. Both of these effects have implications on the mix of skills people need.

Workers need more than digital skills to adapt to these changes. The mix of skills is required to successfully navigate the transition to the digital world of work and thrive in it. Strong general cognitive skills are needed, such as literacy, numeracy and ICT skills, from basic to advanced ICT skills depending on the job. Analytical skills are required, alongside a range of complementary skills such as problem solving, creative and critical thinking, communication skills and a strong ability to continue learning. Working in growing occupations linked to new technologies requires advanced ICT skills such as coding.

Workers in different countries and in different occupations are exposed to digital technologies to a different extent (Figure 1.2). In the coming years, countries and occupations lagging behind in technology adoption may catch up progressively, which would lead to important changes for workers in those countries or occupations. Among countries covered by the Survey of Adult Skills (PIAAC), a group of countries (Denmark, the Netherlands and Sweden) is ahead in the digital transformation of the workplace, with most of their workers intensively using ICTs on the job and predominantly performing non-routine tasks. Other countries are lagging behind (Chile, Greece and Turkey). In the same vein, workers in some low-skilled occupations, such as services and sales workers or plant machine operators, or in elementary occupations, vary considerably in their exposure to digitalisation, suggesting the nature of these occupations might change as firms progressively adopt technologies.

New or growing occupations have appeared (e.g. artificial intelligence specialists, big data analysts), along with new ways to supply skills to the market. Online platforms lead to major changes in some sectors but also facilitate self-employment for a broader range of workers. People need to have the skills to benefit from these new work opportunities. So far, however, workflows on online platforms have been asymmetric, with the United States the major hiring country and Asia (South and Southeast Asia) a major provider of services. In many OECD countries, an important question is to ensure that if employers are looking for skills through online labour platforms, they are not doing so at the expense of investing in upskilling and training for their employees.

Education and training policies need to facilitate mobility across occupations

New technologies make some occupations less needed in the economy while creating others. Workers need to be mobile, or able to change occupation, to escape the risk of losing their jobs and benefit from new job opportunities. However, the skills requirements of declining occupations are likely to differ from those of growing occupations.

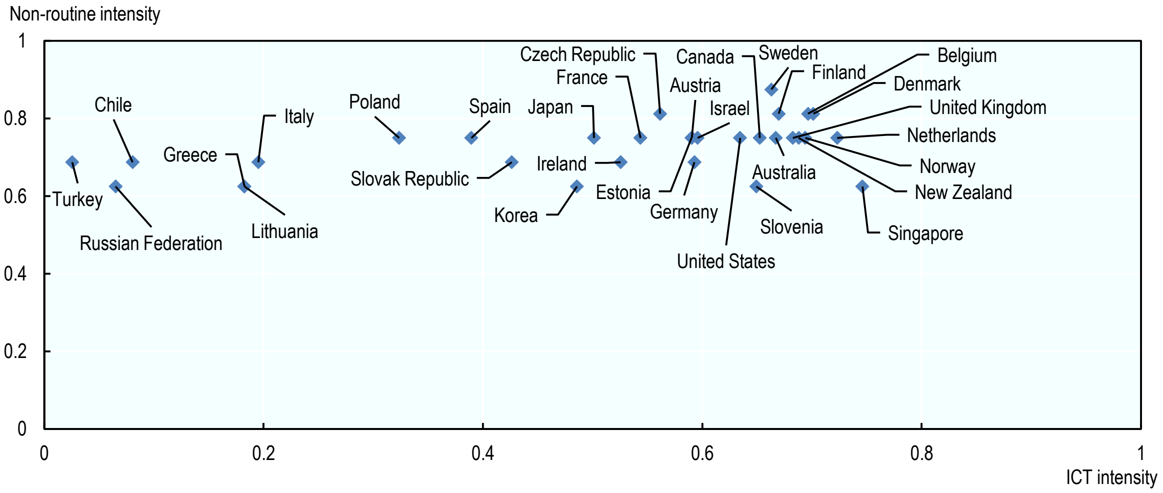
Education and training policies can aim to make it easier for workers to move from one occupation to another (Chapter 3). To limit the cost of the education and training effort, policies can facilitate transitions between occupations that are as similar as possible in terms of skills requirements.

Most occupations appear to be fairly close to some other occupations in terms of cognitive skills requirements, task content, and knowledge area, and therefore, most workers have *possible* transitions to other occupations with a relatively small training effort (approximately up to six months). However, workers may be unwilling to move to other occupations if moving entails large drops in wages and significant underuse or loss of skills. Such transitions would not be *acceptable* from individual and societal points of view. When requiring that transitions entail at worst moderate wage reductions and limited skills excesses, *acceptable* transitions can be identified for just over half of occupations with a small training effort.

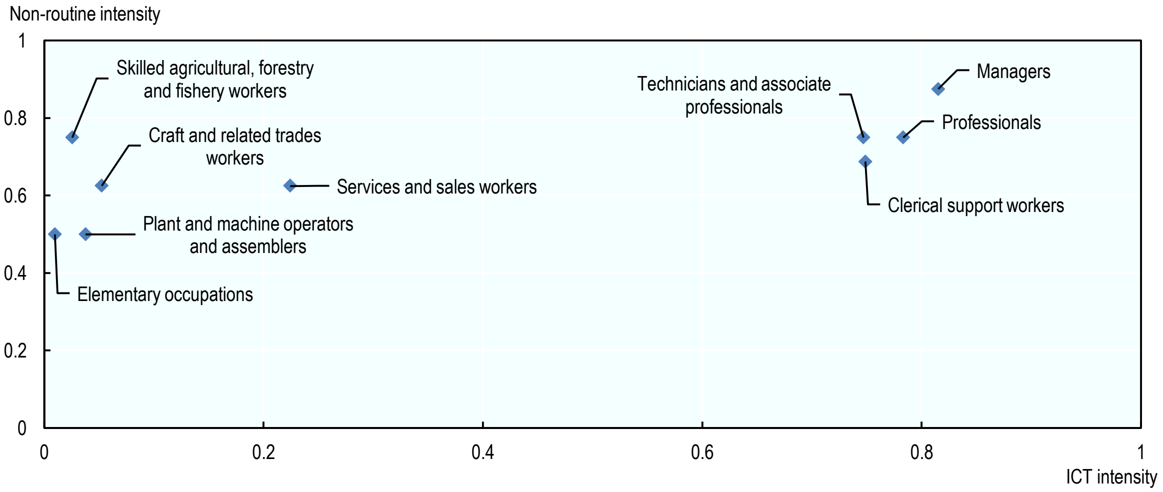
For a group of occupations, a large share of the tasks may be automatable, rendering these occupations more likely to disappear (Frey and Osborne, 2017[5]; Nedelkoska and Quintini, 2018[6]). Workers in these occupations may need to change occupation to remain in employment. To do so, they would need to adapt their skills set and perhaps acquire new skills – general and specific – and knowledge areas. While assessments of the risk of automation and of the number of jobs that may disappear remain debated, policies can target workers in those occupations to increase their mobility.

Figure 1.2. Countries’ and occupations’ exposure to digitalisation

Median non-routine intensity and ICT intensity of workers, by country



Median non-routine intensity and ICT intensity of workers, by occupation



Notes: The top panel plots countries’ median non-routine and ICT intensities across all workers, while the bottom panel plots one-digit occupations’ median non-routine and ICT intensities across all workers of that group of occupations in all countries. For example, the median non-routine intensity across all workers in Turkey is 0.7, meaning that 50% of all workers in Turkey are in jobs with a non-routine intensity above 0.7 and 50% are in jobs with a non-routine intensity below 0.7. The non-routine intensity of jobs indicator is computed following the methodology proposed by Marcolin, Miroudot and Squicciarini (2016[7]) and builds on items that capture the extent to which one’s job is codifiable and sequentiable. It is close to 0 when the job is routine-intensive and to 1 when the job is not routine-intensive. The ICT intensity of jobs indicator was developed in work by Grundke et al. (2017[8]) and describes tasks associated with ICT use, from reading and writing emails to using word-processing or spreadsheet software, or a programming language. It is close to 0 when the job is not ICT-intensive and to 1 when the job is ICT-intensive. More details on the construction of the non-routine and ICT intensity indicators can be found in Chapter 2 (Box 2.3).

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.

StatLink http://dx.doi.org/10.1787/888933973076

For a proportion of occupations at high risk of automation, a relatively small training effort may be sufficient to enable *acceptable* transitions towards occupations at medium lower risk of automation. Around 10 out of 127 occupations are identified as being in a particularly critical situation, as they are at high risk of automation and an average worker in these occupations would need substantive training (of more than approximately one year) to be able to move to occupations at lower risk of automation. The share of employment in these critical occupations varies between countries and ranges from 2% to 6% if all workers in these occupations are considered to be at high risk and from 0.3% and 1.5% when only some of them are at high risk.

The required education and training effort is substantial but difficult to assess precisely

An important question for countries is to get an idea of the cost of the upskilling or (re)training required to ensure that workers at risk of losing their jobs because of automation can find a new job. Trying to assess this cost is a difficult exercise that requires making several strong assumptions given available data. These assumptions can affect the size of the estimated cost. For these reasons, the analyses should be seen as aiming to foster reflection on several issues while indicating directions for policies, rather than giving precise estimates.

Chapter 3 provides estimates of the country-level minimum cost of helping workers at high risk of automation move to an occupation with a low or medium risk of automation with minimum upskilling or (re)training efforts, moderate wage reductions and limited skills excesses. These estimates range from less than 0.5% (lower bound) or 1% (upper bound) of one year's GDP in Norway, to more than 2% (lower bound) or 10% (upper bound) of one year's GDP in Chile. Assuming only a share of these workers are at risk gives the lower bound estimate while assuming all workers are at risk gives the upper bound estimate. Differences between countries reflect several factors, including differences in the shares of employment in jobs at high risk of automation, the costs of education and training policies, the indirect costs of training of foregone wages, and the occupational and skills distributions of the population.

These estimates mostly relate to the cost of training individuals to endow them with the cognitive skills needed in the occupation of destination. Different occupations, however, require workers to acquire several job-specific skills. Although available data present a series of caveats, an extra cost component needed to enable workers gain some job-specific skills required to move to different occupations can be added to the estimates. The training duration captured in these specific data is short, hence the extra cost component amounts to 0.06% to 0.3% of GDP, on average across the considered countries.

Estimated cost ratios may appear to be high partly because they compare costs of training that are likely to occur over several years with yearly GDP. Furthermore, workers and employers may decide to spread training over several years to reconcile (part-time) work and training. Lastly, policies should not target all workers currently employed in a high risk of automation at the same time and within one year, as technology spreads and is adopted at different paces in different countries, industries and companies.

Compared with other public expenditure, however, these estimates may appear low. This is because they only encompass the cost of education and training needed for workers who are considered the most at risk to lose their jobs and therefore may need to change occupation. However, as most occupations may change because of the development of new technologies, the education and training effort necessary to address this broader challenge is larger.

Training programmes need to be well targeted and designed

Workers in occupations at high risk of automation are particularly in need of upskilling or (re)training as they are more exposed than other workers to the risk of losing their jobs. More generally, low-skilled workers face a large skills gap that needs to be filled to adjust to changing occupations. However, workers in occupations at high risk of automation and low-skilled workers are less likely to participate in on-the-job training than other workers (Nedelkoska and Quintini, 2018[6]).

Overcoming the barriers to learning in adulthood is critical to deal with fast-changing skills demand. Countries can do this by creating flexible and shorter types of learning opportunities, improving the labour market relevance of adult learning and better recognising prior learning. It is also vital to provide a range of financial and social support to address specific barriers to learning faced by low-skilled and disadvantaged adults. In addition, countries can use targeted information and guidance to help workers move to occupations with similar skills requirements but lower risk of automation and raise awareness of the returns to skills (Chapter 3).

The specific type of training required to help workers in occupations at high risk of automation move to occupations with lower risk includes, in addition to training in general cognitive skills (literacy and numeracy), training predominantly in non-cognitive skills, such as management, communications and self-organisation. Such workers also require some training in ICT (Chapter 3). Most workers receive very short training mostly on job-specific skills that are unlikely to facilitate occupation transitions. Education and training providers, employers and labour unions can better co-ordinate their actions to provide training options that match workers' needs for career progressions and transitions.

Flexible options to combine work and learning are needed

Estimates of the effort each country needs to make to help workers move away from occupations at high risk of automation assume that people do not work when they participate in training, which leads to a large indirect cost coming from foregone wages. To reduce the cost of the training effort and ensure countries can sustain these costs, policies should encourage working and learning at the same time through flexible education and training programmes and informal learning.

Policies aiming to send workers back to formal education and training institutions can be costly unless those institutions provide flexible programmes for workers. On-the-job training programmes may be less costly and may teach job-specific skills better. On-the-job training tends to be very fragmented in most countries, however, and in many cases little is known about its quality. Programmes in formal education and training institutions might still be a preferred option when workers have to develop a range of skills including general cognitive ones. Overall, the approach needs to be tailored to workers' specific needs and build on the strengths of countries' education and training providers and programmes.

Workers are more likely to maintain their skills in workplaces more exposed to digitalisation (Chapter 2). Digital environments help workers retain problem-solving skills in technology-rich environments while non-digital environments may lead to skill obsolescence. As digital transformation affects sectors and firms differently, it may exacerbate the skills gaps and inequalities between workers in sectors and firms (mainly large firms) at the forefront of technology adoption and those in sectors and firms lagging behind. Policies can remove some of the barriers to technology adoption by firms and sectors lagging behind – for example, by improving broadband access – to ensure all workers develop the necessary skills.

The potential of open education can be exploited further

Over the last decade, open educational resources have grown significantly. A broad range of digital learning resources are offered on line freely and openly to teachers, educators, students and independent learners, (Chapter 5). Massive open online courses (MOOCs) have greatly contributed to this boost.

Open education and MOOCs offer important new sources of knowledge and skills development throughout life. The increasing take-up of MOOCs on a broad range of topics – including not only computer science but also the development of social and emotional skills – suggests that a section of the population is well aware of the need to adjust skills throughout life. As in standard adult education and training, however, adults who are already highly educated and highly skilled are more likely to participate.

In theory, open education and MOOCs offer flexible and easily accessible ways to develop skills that firms could use for on-the-job training, but this potential is not being realised at the moment, despite initiatives in this area. This is partly because their content does not match fully with employers' needs and their quality is uneven. Evidence suggests they are mostly used by those who combine work and formal education and to a lesser extent by those who are only employed.

Governments can work with education and training providers, employers, job-search agencies and MOOC platforms to broaden participation in open education, expand the use of these courses on the job, and define standards and good practices to better signal their quality and certify acquired skills. More data are needed to better understand how people may learn through MOOCs, even if they follow only a fraction of the content and do not complete the entire course.

New technologies also transform everyday life and societies

The ubiquity of smartphones and Internet connections affects many aspects of daily life in ways that are still difficult to apprehend fully (Chapter 4). These changes lead to both opportunities and challenges. Using smartphones, tablets or computers, people can do a range of activities easily from anywhere. New technologies offer great potential for spreading knowledge, improving political engagement and increasing efficiency of public services, as well as enabling new forms of leisure.

However, the development of online activities and the fact that younger and younger children are spending an increasing amount of time on line raise three major challenges:

- Internet use tends to reproduce existing inequalities. Low-performing students are less likely than top performers to use their devices to look for information on line or read the news, for example, and more skilled individuals are more likely to follow online courses.
- Children and adolescents are exposed to new risks that may affect their skills development and their educational outcomes. The quality of parent-child interactions suffers when parents use their smartphones during these exchanges, for example. The time children spend on homework can be interrupted by use of smartphones and children can be targeted by cyberbullying and other forms of cyber harassment.
- Some individuals are left behind or feel more isolated, either because they do not participate in online activities or because online activities have replaced opportunities for social interaction, reducing people's sense of belonging to a community. Older people are particularly exposed to these risks.

Skills are important sources of divides in terms of digital devices access, uses and outcomes

As broadband access has developed, lacking skills has become an increasingly important reason for not accessing the Internet. In addition, as a growing number of activities can be performed on line and some of these activities are complex, divides between individuals concern more and more the type of uses they make of the Internet and the outcomes they get from them. People need not participate in all these activities but do need to be able to benefit from them, ensuring that Internet usage does not exacerbate inequalities.

Cognitive skills have an impact on people's participation in online activities. Four profiles of Internet users emerge from the analysis in Chapter 4 (which is 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 on line 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. For those who participate in online activities, higher cognitive skills – whether literacy, numeracy or problem-solving skills in technology-rich environments, or a mix of them – significantly augment the probability of moving from a use mostly for information and communication to a diversified and complex use, taking other determinants into account.

Having a good level of cognitive skills also increases the likelihood that people take measures to protect their privacy and security when they go on line. People with a well-rounded set of cognitive skills, including problem-solving skills in technology-rich environments, are more able to protect themselves on line and thus reduce their exposure to digital risks. More skilled parents and children may also be better prepared to combat risks such as cyberbullying or excessive use.

However, the range of skills and values necessary to navigate among many sources of information, fully understand the implications of harmful behaviours, and adapt to new technological development goes beyond cognitive skills. Social and emotional skills, and skills that combine both cognitive and social aspects, are also likely to play an important role. Further data are needed to uncover the differential effect of some social and emotional skills and values, and more advanced digital skills, on people's capacities to make informed use of technology in their everyday lives and protect themselves from risks.

Initial education can become more forward-looking

Initial education needs to prepare young people for tomorrow's world. It should help all youth develop skills for the 21st century, adapt to changes on the labour market, have a career progression or change occupations, and become informed and responsible citizens. Leaving initial education without the necessary skills has become increasingly penalising.

New technologies change skills requirements but can also enhance learning opportunities and help develop skills for the future. The use of technology in the classroom can help develop digital skills and the complementary skills people need. In addition, digital tools can favour personalised instruction, allowing students to progress at their own pace and teachers to spend more time with learners who lag behind. Technology can enable new ways of teaching that may prevent school failure (Chapter 5).

Student assessments rarely measure computer competencies, so there is little evidence on whether technology use in schools improves students' digital skills, although a few studies find it does (Bulman and Fairlie, 2016[9])

Which digital skills should schools aim to develop? As technologies evolve rapidly, people should acquire general digital skills rather than specialised ones that risk soon becoming obsolete. Computational thinking, or the ability to frame problems in ways that computers can help solve them, is increasingly put forward as an important skill for a growing number of jobs and a way to develop wider skills, such as creativity or critical thinking. In addition, students should be able to interpret the information provided by digital tools in specific contexts, adapt to increasing numbers and types of tools while protecting their data and privacy and understanding the implications of invading others' privacy.

Technology use in schools offers multiple benefits but its potential has not been realised yet

Access to ICT infrastructure in schools is extensive in most OECD countries, where socio-economically disadvantaged students have levels of access similar to those of advantaged ones. However, student use of computers, laptops or tablets available in schools is not widespread and the share of students using these tools has decreased in many countries.

In schools, mere access to and use of computers are not enough to enhance student performance in general topics. The effect of technology on student outcomes depends on how technology is integrated in the classroom and associated with teaching practices. When levels of digital device use at school are very high, student performance is lower in mathematics, reading, science, and even collaborative problem solving. This is because extensive use of new technologies at school may replace other more efficient educational practices or may simply distract students.

Most countries can revisit the way technology is integrated into the curriculum and pedagogical practices. Rather than focusing on specific digital tools or software, a consistent approach is needed at all levels of education that aims to develop digital skills and the complementary skills required to work and live with new technologies,. Decisions to adopt given technologies in schools, for instance, could be better informed by consulting more with teachers to make sure the type of technology fits with their needs, plans and ability to use it.

The teaching profession is a cornerstone of a forward-looking education system

Teachers' ability to use appropriate and innovative pedagogical tools plays an important role in their students' development of the skills they need for the future. Making use of innovative pedagogical tools can also help re-engage students who tend to fail when traditional teaching methods are used or who need more time to learn. Teachers' digital competencies are instrumental for their own students' capacity to make the most out of new technologies. The better teachers' problem-solving skills in technology-rich environments, for example, the better their students' performance in computer problem-solving and computer mathematics (Chapter 5). Problem-solving skills in technology-rich environments do not measure teachers' ability to teach with ICT, but give information on their capacity to use ICT tools and applications to assess, process, evaluate and analyse information in a goal-oriented way.

There is a need to provide high-quality training to teachers on how best to integrate technology in their pedagogical practices. Teachers are less likely than other tertiary-educated graduates to perform well in problem solving in technology-rich environments. In addition, many teachers report needing professional development in ICT skills for teaching. Providing high-quality training for teachers, both initial and continuous, is an important step to ensure education systems adapt to new needs. It can also attract highly skilled and motivated candidates to teaching, which in many countries is not attractive to students.

Lifelong learning for all should become a reality

The rapid pace of change at work and in society brought about by digitalisation requires flexible learning systems. These need to be both lifelong – accessible to all at any age – and life-wide, promoting and recognising learning acquired outside of formal education systems. The term "lifelong learning system" covers the whole range of policies and institutions providing adults with a range of options to continue learning and preparing young people to adapt to changing skills requirements.

Inequalities in learning opportunities tend to start in early childhood education and are reinforced in schools and in higher education. They often continue at later stages of life and in the labour market. For instance, low-skilled workers are more likely to have jobs exposed to the risk of automation and less likely to participate in training. Addressing these inequalities in learning opportunities requires a comprehensive approach. In addition to policies to reduce failures in schools, efforts need to be put on improving the quality of vocational education and training and providing pathways to further education including general programmes. Providing tertiary funding and grants, as well as relevant information on the returns to higher education, can help remove barriers faced by students from disadvantaged backgrounds.

A comprehensive approach is also needed to raise the participation of low-skilled workers in training. Relevant measures include flexible types of learning opportunities, a range of financial and social support for training, and targeted information and guidance to raise awareness of the returns of training. In particular, open education and MOOCs offer new sources of knowledge and skills development throughout life. At this stage, however, they seem to reinforce rather than reduce inequalities in participation in adult learning.

Policies also need to raise the quality of education and training opportunities throughout life. For initial education, this means adapting the school curriculum to changing skills requirements and training the teaching profession to face these changes. For adult education and training, it is vital to ensure that programmes respond to labour market needs at the country and local levels, to set standards for non-formal education and training, and to assess it better.

Better recognition and signalling of skills acquired throughout life would help employers recruit the right person and provide individuals with incentives to continue learning. Online certification of a broad range of skills has developed. Governments can build on this trend to adapt systems of recognition and certification of skills to changing needs.

A range of policies, with skills-related policies being an important element, can address the geographical dimension of digitalisation

Technological improvements and globalisation have led to marked changes in regional and urban performances in advanced economies. In particular, the decline in manufacturing employment and the adoption of digital technologies since the 1980s has contributed to a strong geographical polarisation as jobs are destroyed in some places, while new jobs are created in others. Areas initially well-supplied with high-skilled workers have predominantly benefited from these changes, as high-skilled individuals attracted technology-intensive firms and high-paying jobs, which in turn further attract high-skilled workers. Other areas are left behind, unable to benefit from these developments. The accumulation of disadvantages in some regions has created strong feelings of discontent and injustice among their populations.

As skills beget skills in the digital age, it is important that all areas are able to provide high-quality education at all levels. Effective early childhood education is crucial to narrow skills gaps that emerge at an early age between children of different socio-economic backgrounds but also of different geographical locations. Disparities between regions in students' performance in secondary education also need to be addressed. Across OECD countries, 15-year-old students in city schools score 30 points higher in science than students in rural areas, the equivalent of roughly one academic year. Policies should also tackle disparities in educational aspirations between young people who live more or less near universities, by limiting information gaps, providing distance-based financial aid, and supporting efficient role model and mentoring initiatives.

Higher education institutions can play a significant role in regional convergence. They can increase the demand for and supply of high-skilled individuals through entrepreneurial ventures necessitating proximity to frontier research. They also enable skilled individuals to be more mobile geographically, reducing income gaps and unused productive capacity in declining areas. However, higher education institutions are very unequally distributed within countries.

Labour mobility between geographical areas can lessen the differences in regional performance brought about by digitalisation. Yet, it has been in decline in some OECD countries. Moving from low-income to high-income areas increases labour supply in the high-income area, putting downward pressure on wages. In the medium run, this decreases income gaps between the two areas. Mobile individuals may also have shorter unemployment spells, as they can take advantage of opportunities in areas that are more dynamic. Moreover, they may find a better match for their skill set, which would improve productivity and potentially yield positive local spill-overs. Geographical mobility can be facilitated by removing inefficient land use regulations, moderating the tax bias towards home ownership, revisiting and possibly harmonising local social transfers, and providing financial assistance to unemployed workers to reduce migration costs.

Investments in digital infrastructure are also essential for participation in the digital economy and the adoption of advanced technologies. These can enable areas with no or slow connectivity to enjoy some of the benefits of digitalisation.

The policy effort needs to be co-ordinated

New technologies offer many “do-it-yourself” options: people can learn, work, find out about their health and do many other activities with a click of the mouse or a tap of the screen. However, this publication shows that if most of the responsibility is left to individuals and firms, the benefits of digital transformation may be shared very unequally. Ensuring people can benefit from new technologies at home and at work and are not left behind requires a comprehensive, co-ordinated policy effort. The package of co-ordinated policies needs simultaneously to promote digitalisation where it increases productivity and well-being and cushion its negative impacts. Skills and education policies are of paramount importance to this package.

A first range of challenges concerns labour markets. All interested parties need to consider how to implement a range of policies that can accompany labour market restructuring through effective training and adequate social protection. It is also crucial to discuss how the cost of these policies can be shared between stakeholders to ensure that inequalities do not increase (OECD, 2019[10]). The policy package should also include measures that can facilitate occupational and geographical mobility (e.g. housing policies, occupational licencing) and can shape the incentives to train and benefit from new opportunities (e.g. tax policies, unemployment insurance). In parallel, research and innovation policies can unlock the potential of digital technologies for economic and social well-being, while regional and local development policies can help spread the benefits of digitisation.

Policies also need to address the impact of new technologies on everyday life and societies more broadly. The emergence of new risks that were not envisaged 15 years ago requires a comprehensive and flexible policy approach. Cyberbullying is often difficult to detect and evidence is still scarce on how excessive exposure to smartphones and tablets affects mental health at various ages. The proliferation of fake news and information manipulation affects the political landscape and how citizens vote. Harmful new practices will certainly emerge in the coming years. Children are particularly exposed to some of these risks. Education institutions and teachers have an important role to play in detecting these problems and in teaching students the values and knowledge they need to avoid these behaviours and make informed choices in a complex world. If the responsibility lies solely on parents, inequalities between children will tend to be exacerbated. Local governments can continue to collaborate with communities and social and cultural institutions to better inform all citizens of the benefits and risks of new technologies.

The policy effort required to make the most of digital transformation is substantial and needs to be efficient and cost-effective. Several countries have put in place strategies to co-ordinate policy concerning the digital transformation. However, few of these digital strategies seem to have the necessary level of government engagement, breadth of policy coverage and concreteness of policy responses. There is no single model of how to design such a policy package and countries need to build on the strengths of their respective institutions.

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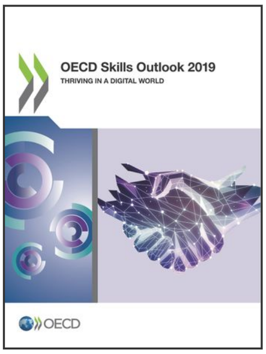
Annex 1.A. Scoreboard Indicators

Annex Table 1.A.1. List of indicators considered in the scoreboard on Skills and digitalisation

Category	ID	Indicator	Source
1. Skills to benefit from digitalisation			
Providing the necessary skills to the next generation	1.1	Percentage of students scoring below Level 1 (inclusive) in collaborative problem solving, 2015	OECD (2017[11]), *PISA 2015 Results (Volume V): Collaborative Problem Solving*, Table V.3.1, http://dx.doi.org/10.1787/9789264285521-en
	1.2	Percentage of students scoring below Level 1 (inclusive) in creative problem solving, 2012	OECD (2014[12]), "Student performance in problem solving", in *PISA 2012 Results: Creative Problem Solving (Volume V): Students' Skills in Tackling Real-Life Problems*, Table V.2.1, http://dx.doi.org/10.1787/9789264208070-en
	1.3	Percentage of students scoring strictly below Level 2 in PISA (reading, mathematics, science), 2015	OECD calculations based on OECD (2015[13]), *PISA database 2015*, http://www.oecd.org/pisa/data/2015database/
A limited share of individuals lacking basic skills	1.4	Percentage of 16-29 scoring below Level 1 (inclusive) in literacy and numeracy and having no computer experience or having failed ICT core, 2012, 2015	OECD calculations based on OECD (2012[14]) and OECD (2015[15]), *Survey of Adult Skills (PIAAC)*, www.oecd.org/skills/piaac/publicdataandanalysis
	1.5	Percentage of 55-65 scoring below Level 1 (inclusive) in literacy and numeracy and having no computer experience or having failed ICT core, 2012, 2015	OECD calculations based on OECD (2012[14]) and OECD (2015[15]), *Survey of Adult Skills (PIAAC)*, www.oecd.org/skills/piaac/publicdataandanalysis
A meaningful share of well-rounded individuals	1.6	Percentage of 16-65 scoring at least Level 3 (inclusive) in literacy and numeracy, 2012, 2015	OECD calculations based on OECD (2012[14]) and OECD (2015[15]), *Survey of Adult Skills (PIAAC)*, www.oecd.org/skills/piaac/publicdataandanalysis
2. Digital exposure			
Everyday exposure and use	2.1	Percentage of 16-65 with no computer experience or who failed ICT core test, 2012, 2015	OECD calculations based on OECD (2012[14]) and OECD (2015[15]), *Survey of Adult Skills (PIAAC)*, www.oecd.org/skills/piaac/publicdataandanalysis
	2.2	Share of households without Internet due to "lack of skills", 2017	Eurostat (2017[16]), *European Community Survey on ICT Usage in Households and by Individuals*, [isoc_pibi_rni]
	2.3	Share of individuals making a diversified and complex use of Internet, 2016	OECD calculations based on Eurostat (2016[17]), *European Community Survey on ICT Usage in Households and by Individuals*, Chapter 4, Figure 4.16
Labour market exposure	2.4	Median non-routine intensity across all workers	OECD calculations based on OECD (2012[14]) and OECD (2015[15]), *Survey of Adult Skills (PIAAC)*, www.oecd.org/skills/piaac/publicdataandanalysis,, Chapter 2, Figure 2.17
	2.5	Median intensity of ICT use across all workers	OECD calculations based on OECD Survey of Adult Skills (PIAAC) OECD (2012[14]) and OECD (2015[15]), *Survey of Adult Skills (PIAAC)*, www.oecd.org/skills/piaac/publicdataandanalysis, Chapter 2, Figure 2.17
Workers at risk	2.6	Percentage of employment in occupations at high risk of automation requiring at least moderate training needs to transition to occupations at low or medium risk of automation (lower bound)	OECD calculations based on OECD (2012[14]) and OECD (2015[15]), *Survey of Adult Skills (PIAAC)*, www.oecd.org/skills/piaac/publicdataandanalysis, Chapter 3, Figure 3.13
	2.7	Percentage of workers at "high" risk of automation	Nedelkoska, L. and G. Quintini (2018[6]), “Automation, skills use and training”, http://dx.doi.org/10.1787/2e2f4eea-en

Category	ID	Indicator	Source
		3. Skills-related policies to make the most of digital transformation	
Effective ICT integration in schools	3.1	Gap in scores in science between students in the third quartile of ICT use and those in the bottom quartile	OECD calculations based on OECD (2015[13]), *PISA database 2015*, http://www.oecd.org/pisa/data/2015database/, Chapter 5, Figure 5.8
Teachers' preparation and training needs	3.2	Percentage of teachers scoring at least Level 2 (inclusive) in problem solving in technology-rich environments	OECD calculations based on OECD (2012[14]) and OECD (2015[15]), *Survey of Adult Skills (PIAAC)*, www.oecd.org/skills/piaac/publicdataandanalysis, Chapter 5, Figure 5.12
	3.3	Percentage of teachers reporting needing further training in ICT	OECD calculations based on OECD (2014[12]), *TALIS database 2013*, http://www.oecd.org/education/school/talis-2013-results.htm, Chapter 5, Figure 5.18
Lifelong learning systems	3.4	Enrolment rates at the age of 3 (early childhood education and pre-primary education) and at age 5-14, 2015	OECD (2017[18]), *Education at a Glance 2017*, Indicators C1 and C2, https://doi.org/10.1787/19991487
	3.5	Share of adults 35 years and older enrolled in at least post-secondary non-tertiary, (PIAAC)	OECD calculations based on OECD (2012[14]) and OECD (2015[15]), *Survey of Adult Skills (PIAAC)*, www.oecd.org/skills/piaac/publicdataandanalysis
	3.6	Percentage of adults participating in non-formal and informal learning over the past 12 months (PIAAC)	OECD calculations based on OECD (2012[14]) and OECD (2015[15]), *Survey of Adult Skills (PIAAC)*, www.oecd.org/skills/piaac/publicdataandanalysis



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