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Managing tomorrow's digital skills - what conclusions can we draw from international comparative indicators?

Education 2030

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Simon Fau and Yasmeen Moreau

UNESCO Education Sector

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Executive summary

While digital technology plays an increasingly important role in our lives, and political systems are mobilizing to make the most of its leverage effect on innovation and economic growth, **56% of adults lack digital skills**, according to the Organization for Economic Cooperation and Development (OECD).

This report looks at the conditions impacting the development of digital skills of a population based on international indicators of the levels of skills amongst children and adults.

It is based on five international comparative surveys, the results of which reveal a sample group of twelve countries whose population have particularly high levels of digital skills. Building on these results, **this rapport seeks to answer two questions: what has enabled these States to rise to the top of the rankings in digital skills, and what can other countries to do catch up?**

Comparison between the different surveys confirms that the factors affecting the level of digital skills in children include:

- age of acculturation to information technology;
- nature and level of diversity of online activities;
- level of ICT use by teachers.

Adults' skills are more widely determined by socio-economic factors, especially the level of training, indicating a link between inequalities in training and performance in terms of digital skills. The report also shows a knock-on effect of digital skills, which can be positive or negative.

Analysis of the characteristics of the best-performing countries reveals that other factors indirectly influence the development of digital skills by laying the foundations for an enabling environment: the quality of infrastructure, the level of digitization of businesses and the wealth of digital content.

Consideration of public policies on education and the labour market in the countries in the sample group highlights good practices, such as monitoring the level of digital skills, integration of digital technology in the global education ecosystem (beyond ICT lessons), supporting educational reforms with proper teacher training and fighting against digital exclusion which often leads to social exclusion.

This report also shows that **to achieve the best conditions for the development of digital skills, public authorities must pursue efforts in two areas: policies that create a supportive framework, and sectoral policies for basic and further training.** To ensure that these policies are as relevant as possible, they must be the result of collaboration between government, educational and training institutions, and businesses.

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Introduction

Introduction

The significance of digital technology in both the personal and working environments, and therefore the digital skills needed to make the best use of it, have constantly grown in recent decades. There are increasing numbers of studies monitoring the level of those skills among both young people and adults. This study seeks to analyse the degree to which international comparisons in the area of digital skills provide useful guidance for the future management of policies in this area.

While the analysis of international indicators reveals key success factors for improving digital skills, consideration of the policies of the best-performing countries will also demonstrate the role of the state in the development of digital skills.

There are two parts to this study: (1) we analyse the results of an international benchmark of digital skills, focusing on the factors contributing to the level of skills in children and adults, and bringing to light the lessons we can take from it; and (2) we consider the nature of public policies to promote digital skills, on two levels: first, non-sectoral policies promoting the creation of an enabling environment for the development of digital skills; and second, sectoral policies focusing on education and on the labour market. This enables us to establish a set of best practices identified in the countries at the top of international rankings in digital skills.

From all these analyses, we reach conclusions on the conditions necessary for the development of digital skills, and formulate recommendations for public policies promoting digital skills.

Digital skills, an evolving notion

A great deal of work is being done on digital skills, to adapt not only to technological innovations but also to emerging societal challenges (such as "fake news" and artificial intelligence). In this context, there are various definitions of digital skills. In the English-language version of this report, the French terms numérique and digital are both translated as "digital". We have focused on defining digital skills in their broadest sense.

The notion of digital skills goes beyond merely knowing how to use ICT, which involves the use of computer and Internet technology to obtain, produce and share information. While this is a necessary condition for digital skills, they go farther in terms of the use which is made of ICT. What is important is to seek, process and evaluate information *critically*, to exploit it in solving complex problems and to use precise techniques to produce or access Internet content.

The definition of digital skills has become enhanced over the years. In their typology of digital skills, Jan Steayaert and Jos de Haan (2001) distinguish three levels:

- *Instrumental* skills, which denote the basic technical and operational know-how in relation to the use of computer equipment;
- *Structural or informational* skills, relating to a cognitive rather than technical dimension: seeking, selecting and processing online information, but also understanding, interpreting and evaluating it.
- *Strategic* skills, which concern the ability to use the information proactively to affect one's professional and/or personal environment.

Yoram Eshet-Alkalai, who defines digital literacy as a survival skill in the digital era, proposes a more precise typology of digital skills:[1]

Digital Literacy	
Photo-visual literacy	Understanding visual representations
Reproduction literacy	Creative re-use of information
Information literacy	Evaluation of information
Branching literacy	Ability to understand hypermedia
Socio-emotional literacy	Behaviour in cyber space

Thus, digital skills exist in a continuum, from basic functional skills to high-level specialized ones. The expression "digital skills" should be understood in a broad sense: it denotes a wide range of skills, some of which are not strictly skills but relate more to behaviour, expertise, know-how and life skills.[2] These forms of behaviour and skills are complementary and closely interconnected.

The concept of digital skills continues to evolve, adapting to the constant development of new technologies. Thus, a person possessing digital skills at a given time is likely to lose his or her mastery as a result of that evolution. This dimension must be taken into account in grasping the subject of digital skills: those skills must be not only acquired but constantly

1. Eshet-Alkalai, Yoram. "Digital Literacy: a Conceptual Framework for Survival Skills in the Digital Era", Journal of Educational Multimedia and Hypermedia (2004) 13(1), pp. 93-106
2. Broadband Commission for Sustainable Development, Working group on Education: Digital Skills for Life and Work, September 2017.

adapted and updated. For example, the rapid development of artificial intelligence and the "Internet of Things" will give rise to new skills relating, not to the technical use of technology, but to people's awareness and understanding of technologies which, while they may not use them, will profoundly influence their everyday lives.

Five comparative studies to distinguish leading countries

Partial results, currently focused mostly on highly developed countries

There are comparative studies on levels of digital skills among children and adults, but they are still partial, focused on highly developed countries, and are not yet repeated often enough to provide definitive conclusions on success factors in the digital field.

This report will focus on the following five comparative studies:

Students, Computers and Learning – Making the Connection	OECD	2015	Evaluation of children's skills
ICILS 2013 IEA International Computer and Information Literacy Study	IEA	2013	Evaluation of children's skills
ePIRLS Online Reading 2016 Progress in International Reading Literacy Study (online extension)	IEA	2016	Evaluation of children's skills
OECD Skills Studies – Skills Matter – Further results from the Survey of Adult Skills	OECD	2015	Evaluation of adults' skills
Digital Economy and Society Index 2017 Digital Economy and Society Index	European Commission	2017	Evaluation of adults' skills

The sampling used, participating countries and indicators taken into account for each study are detailed in annex 1.

Analysis of data from these studies has encountered some methodological limitations:

- The countries considered in the various studies are not the same. For example, Singapore, which is in the lead in the ePIRLS and PISA studies, was not evaluated by ICILS. This makes it difficult to produce a relevant ranking of the best-performing countries in the area of digital skills for a population group as a whole.
- Studies (and therefore data) on adults are much less numerous than those on children.
- Evaluation criteria for digital skills are not the same from one study to another. For example, PISA uses online viewing as its main criterion, whereas ICILS focuses on the communication aspect of the technologies.
- The data collection year differs from one study to another, which can affect the results.

Nonetheless, these studies reveal factors for improving digital skills and identifying good practices on the basis of certain countries' experiences.

1. Analysis of study results: contributing factors of digital skills?

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Study results: the leading countries

The aforementioned five studies reveal a number of countries whose population (children or adults) have particularly high levels of digital skills. Selection of the three leading countries from each study reveals the following panel:

Digital skills of children		Digital skills of adults	
Singapore 	First PISA study First ePIRLS study	**Denmark** 	First DESI study
Czechia 	First ICILS STUDY	**New Zealand** 	First PIAAC study
Republic of Korea 	Second PISA study	**Norway** 	Second DESI study
Australia 	Second ICILS study	**Sweden** 	Second PIAAC study
Norway 	Second ePIRLS study Third ICILS study	**Luxembourg** 	Third DESI study
Hong Kong, China 	Third PISA study	**Finland** 	Third PIAAC study
Ireland 	Third ePIRLS study		

There are some repetitions: certain countries, such as Finland, Norway and Singapore, are among the leaders in more than one study. Singapore has the highest score in the PISA and ePIRLS studies and Finland is in second place in the DESI study and third in the PIAAC study. Norway is in second place in the ePIRLS study and third in the ICILS study.

When examining the leading countries, the factors chosen for evaluating digital skills in each study must be taken into consideration. Some studies, in fact, go beyond digital skills. Denmark, for example, which is in first place in the Digital Economy and Society Index, did not come first in all the indicators selected for the study (connectivity, human capital, Internet use, integration of digital technology into businesses and digitization of public services). If the focus is solely on dimensions relating strictly to digital skills, that is, Internet use and human capital,[3] Denmark is in first place for the former but not among the leaders for the latter. For the human capital indicator, it was Finland which showed the best results, followed by Luxembourg and the United Kingdom. In this report, we will take into account only the digital skills aspect of the studies, rather than the consolidated studies which also integrate other dimensions.

A distinction must also be made between countries topping the table for adults' skills and those achieving the best scores for those of children; the two do not necessarily go together. There are three models for the convergence or divergence of children's and adults' skills:

1. Countries ranking among the best for children's digital skills, but not for those of adults:

	Children	Adults
Czechia 	First ICILS study	18th DESI study 15th PIAAC study
Republic of Korea 	Second PISA study	18th PIAAC study

These two examples are interesting in that they reflect positive evolution in the development of digital skills from one generation to the next; this may be due to improvements in recent years in the quality of the education system and training programmes.

2. Countries ranking among the best for adults' digital skills, but not for those of children:

	Children	Adults
Denmark 	First DESI study	19th PISA study
Sweden 	Second PIAAC study	18th PISA study

These situations may be due to the integration of digital technology into public services and/or businesses upstream of its integration into education. In 2012, when the PISA and PIAAC studies were conducted, we may assume that for some years, adults had been accustomed to the everyday use of digital technology in the workplace, whereas it was a relatively new component for schoolchildren. This model may also reflect the availability of training opportunities which play a key role in the development of adults' digital skills.

3. Lastly, countries showing very good results for the digital skills of both children and adults. This is true of Norway:

	Children	Adults
Norway 	Second ePIRLS study Third ICILS study	Second DESI study

Young people's digital skills

Networks, equipment and usage: the earlier schoolchildren are acculturated, the better their digital skills

While access to digital tools is necessary in order to develop skills, the degree of schoolchildren's skills is influenced more by usage than by access. This is confirmed by the fact that the great majority of the countries covered by the studies have high levels of computer equipment in schools and households. Having the equipment, however, does not guarantee actual use. The PISA study shows that in the Netherlands, where there are 2.8 schoolchildren per

3. In this study, the two indicators taken into account in measuring digital skills are the human capital indicator (defined on the basis of the number of Internet users with at least basic skills, ICT specialists and those with diplomas in science, technology, engineering and mathematics – STEM) and the internet use indicator (defined as the nature and level of diversity of online activities).

computer, 94% of students stated that they use a computer at school, whereas in Ireland, for the same number of students per computer, only 63.5% use one at school.

Among those who actually use a computer (or tablet) at school, the impact varies depending on the reason for its use. The ePIRLS study shows that students using a computer at school every day to prepare reports or papers had higher levels of digital skills than others (549 points compared with 535). On the other hand, students spending the same amount of time on a computer at school, but for accessing online information, showed slightly lower digital skills scores than others. Thus, what counts is not the time spent on the computer but the use which is made of it.

The same is true of equipment in the home. The ICILS study shows that the numbers of computers and digital equipment present in the home has no incidence on students' levels of digital literacy if allowance is made for their socioeconomic backgrounds. However, digital skills are affected by experience (the number of years of computer use) and the ways in which the computer is used in the home.

Concerning experience, ICILS shows that one additional year of computer experience is associated on average with an increase of nine points in digital literacy, and this factor explains 6% of the variation in literacy levels. It is interesting to note that this factor is stronger for less developed countries: in Thailand and Turkey, the two lowest-income countries in the sample, the number of years of computer experience accounts for 10% or more in the variation in digital skills levels. This has major implications in terms of the teaching of digital skills: the earlier it begins, the greater the impact.

One additional year's experience of computing is associated with a nine-point increase in digital literacy.

- ICILS, 2016

The type and, above all, number of activities on a computer in the home can also influence students' digital skills levels. A study conducted by UNICEF and the London School of Economics[4] reveals a strong correlation between the number of online activities engaged in by a child and his or her digital skills level. A greater diversity of activities is associated with improved skills. Thus, encouraging children to diversify their range of online activities can help to improve their digital skills. More specifically, the study reveals a correlation between Internet safety skills and critical thinking about online information. This is interesting, since it places the issue of online safety at the heart of digital skills: since safety skills entail other skills, and a higher skills level is associated with a greater number of online activities, teaching children to behave cautiously online does not reduce their online opportunities but, on the contrary, increases it.

These observations show that it is not enough for a child to have access to a computer; other conditions are necessary to promote computer use which makes sense and thereby to improve their digital skills. This view is supported by the One Laptop Per Child project in Peru, which involved mass distribution of inexpensive portable computers to the country's schoolchildren. Comparison of a treatment group consisting of students who had received computers and a control group of students who had not benefited from the programme showed that the distribution of computers had had no impact on the children's academic results (measured by standardized mathematics and language tests). Nonetheless, a positive impact on the students' cognitive skills was observed. The treatment group achieved slightly better results than the control group in tests evaluating analytical skills, executive functions and short-term memory. Nonetheless, the project had no effect on the quality of teaching since it offered no tools for integrating the use of digital technology into education. The results of the programme evaluation match our conclusions; the use of technology in education is not a rapid, magical solution whereby educational problems and challenges can be resolved merely through the acquisition of technological equipment.[5] Investment in technological infrastructure does not automatically lead to improvements in educational, digital or cognitive skills. To produce the desired results, such investment must be accompanied by systemic integration of technology into teaching.

4. UNICEF Office of Research – Innocenti, London School of Economics and Political Science, Global Kids Online Research Synthesis 2015-2016, (2016).
5. IDB Education, "Evaluation of the 'Un Laptop por Niño' program in Peru: results and perspectives", Briefly Noted, n°13 (December 2011).

In terms of public policy, these observations reaffirm the need to focus not only on equipment and Internet access (which are, however, necessary conditions), but also on the use which is made of computers, and this from a very early age.

The level of digital skills is linked to the level of hard-copy skills

One of the key outcomes of the PISA study "Students, Computers and Learning: Making the Connection" is the existence of a link between comprehension of electronic texts and comprehension of printed texts. The results achieved by students in the digital evaluation mostly reflect their hard-copy reading levels: the countries which scored highest in terms of online reading all show good results in hard-copy evaluations. This implies that the consolidation of students' written-language skills (reading, comprehension and word processing) is a necessary condition for the development of their digital skills. A good policy for improving young people's digital skills must therefore include an element focusing on strengthening their abilities with printed texts.

While comprehension of printed texts is necessary for the development of digital skills and must not be neglected, it is not sufficient. Comprehension of electronic text requires a skill which is specific to digital technology, the ability to navigate the Web. The example of Shanghai illustrates the necessity of this skill: its students achieved the panel's top scores in comprehension of printed text (570), they lost 40 points for the comprehension of electronic text. This gap shows that some of the students, despite a high score in online reading which reflects excellent levels in traditional reading, had difficulty in navigating a digital environment. On the other hand, the Internet navigation abilities of students in the Republic of Korea and Singapore gave them significantly better results online than students in other countries having similar skills in reading printed text. Students' familiarity with the digital environment and learning of Web navigation are therefore essential for the development of digital skills. These elements must be taken into consideration by decision-makers in designing public policies to improve young people's digital skills.

The role of teachers in the school environment is central

Another type of factor which emerges from the various studies concerns the relationship that teachers and schools have with ICT. The ICILS study shows that the use of ICT by teachers is positively correlated with students' digital skills levels. The integration of ICT into teaching is higher among teachers who have confidence in their own command of digital technology and who work in schools where the use of that technology is encouraged. Another important factor is the provision by schools of resources for technology (equipment, funds).

This shows that, if schools wish to promote the best possible development of their students' digital skills, they must invest in ICT training for teachers and support the integration of ICT into curricula, creating a collaborative environment and planning teaching programmes.

The conclusions of the TALIS study by the European Commission[6] (2013) show that teachers' demands and needs in the field of ICT are not sufficiently addressed by existing policies. Although the role of ICT in education is widely recognized, digital skills remain one of the two main areas in which teachers report having a critical need of professional development.

Tackling the development of teachers' digital skills is all the more important because continuing training is required to ensure that teachers always possess the necessary skills for the integration of ICT in their work. The "Opening up education" initiative launched in 2013 by the European Commission aims to remove barriers (lack of skills, of infrastructure or of resources) which prevent schools from imparting to their students the digital skills which will be required in 90% of jobs by 2020. One of the goals of this initiative was to create more opportunities to innovate for organizations, teachers and students, calling for significant development of teachers' digital skills and of their use of ICT in the classroom.

Digital skills in adults

The higher the level of adults' education, the better their digital skills

In all the countries surveyed, there is a close correlation between adults' levels of education and their skills in digital technology. The PIAAC study reveals an average difference of 61 points between the estimated computer literacy of an adult aged between 25 and 65 having a diploma from higher education and that of an adult in the same age range whose educational level is below secondary school. It is also confirmed in relation to the link between problem-

6. European Commission, The Teaching and Learning International Survey: main findings from the survey and implications for education and training policies in Europe, 2013.

solving skills in technology-intensive environments and the level of education. In the panel of countries evaluated, the proportion of individuals having no computer experience among those who had benefited from higher education was strictly below 15% whereas, for adults with educational levels below upper-secondary school, it could be as high as nearly 80% (this was the case in the Republic of Korea). This raises the question of whether countries where digital skills are highest are also those having the least educational inequality.

As for a possible correlation between digital skills and income, although a link has been observed between high salaries and better digital skills, this is not relevant. Levels of digital skills account for only a small proportion of income variation compared with other factors such as age, work experience or educational level. Levels of digital skills are therefore only one aspect among many in human capital, whose various components affect workers' productivity and incomes.

On the other hand, workers who use their data processing skills more intensively in the workplace tend to have higher incomes, even after controlling for educational level, mastery of the skills and type of employment. The real link with incomes is therefore with the intensity of skills use and not the fact of having those skills. This observation supports the corresponding one for children's skills. It is, however, difficult in this context to determine whether the level of use of digital skills is a cause or a consequence of high incomes.

An interesting observation from the PIAAC study is that, in applying for a job, the importance of digital skills in relation to qualifications becomes higher with age. When a recruiter is dealing with a young adult with little work experience, he or she will be more likely to rely on the applicant's educational level rather than his or her real skills (which will be more difficult to evaluate). On the other hand, for older adults with more work experience, real skills (including digital skills) will play a greater part in the hiring decision than qualifications. This implies that policies on continuing education in ICT must not neglect middle-aged or older adults.

A knock-on effect of digital skills?

The PIAAC report also reveals a strong correlation between adults' numeracy and literacy levels and their problem-solving skills in technology-intensive environments. This reflects a knock-on effect inherent to digital skills: adults with poor skills in literacy and/or numeracy will find it more difficult to acquire basic computing skills and, in the same way, adults having computer skills but low literacy and/or numeracy levels will have difficulty in performing many of the data processing tasks associated with digital skills. It can be deduced from this that countries whose populations show high illiteracy rates will also have weak digital skills levels. In countries where literacy and numeracy levels are relatively low, it implies that policies to improve adults' digital skills should focus no less on developing literacy and numeracy skills than on improving access to ICT (OECD, 2015).

2. Analysis of study results: contributing factors of digital skills?

2. Public policies to promote digital skills

Understanding how certain countries have succeeded in taking the lead in digital skills requires examination of public digitization policies implemented in those countries. It is however difficult to estimate the duration between the launching of a public policy and the moment when it bears fruit, and therefore to measure its effective impact on digital skills. It is more useful to examine the good practices which have promoted the development of those skills from a longer-term perspective.

Two types of policies require analysis. First, non-sectoral policies promoting the creation of an enabling environment for the development of digital skills; and second, sectoral policies focusing on education (for children's skills) and on the labour market (for those of adults).

Non-sectoral policies: "activating" factors lead to the creation of a favourable environment for digital skills

Determining the characteristics of the best-performing countries in the area of digital skills

Country	Ranking of digital skills, children	Ranking of digital skills, adults	Per capita GDP (US$, 2015)	Population density	Urbanization rate	Internet users (2014)	Fixed-line broadband subscribers (2014)
Denmark		1st DESI study (average), 1st DESI for "internet use"	51423	136 per km²	87%	95.99%	41.38%
Singapore	1st ePIRLS study 1st PISA study		53224	8274 per km²	100%	82%	27.79%
New Zealand		1st PIAAC study	36964	18 per km²	85%	85.50%	30.45%
Czechia	1st ICILS study		17330	138 per km²	74%	79.71%	27.64%
Finland		1st DESI for "human capital" 3rd PIAAC study	42159	18 per km²	84%	92.38%	32.30%
Rep. of Korea	2nd PISA study		27513	526 per km²	81%	84.33%	38.78%
Hong Kong, China	3rd PISA study		42328	7075 per km²	100%	72.8% (2012)	31.70%
Australia	2nd ICILS study		51642	3 per km²	89%	84.56%	25.76%
Norway	2nd ePIRLS study 3rd ICILS study	2nd DESI (average)	76266	15 per km²	79%	96.30%	38.14%
Sweden		2nd DESI for "Internet use" 2nd PIAAC study	48966	24 per km²	85%	92.52%	34.19%
Luxembourg		2nd DESI for "human capital" 3rd DESI for "Internet use"	103187	228 per km²	86%	94.67%	33.28%
Ireland	3rd ePIRLS study		48940	70 per km²	64%	79.69%	26.91%

Sources:

- Per capita GDP: actualitix.com, IMF data
- HDI: actualitix.com
- Internet users, fixed broadband subscribers: actualitix.com, World Bank data
- Population density, urbanization rate: http://www.worldometers.info/world-population/population-by-country/
- School enrolment rate, adult education levels, public spending on education: https://data.oecd.org/fr (except for Singapore: actualitix.com, World Bank data)

High-speed mobile subscribers per 100 inhabitants (2016)	Proportion of households having Internet access at home (2016)	Absorption of new technology by businesses (on a scale from 1 to 6, average for 2016-2017)	School enrolment rate, age 15-19 (2015)	Public spending on education (% of GDP, 2014)	Level of training of adults (% of adults aged 25-64 with higher-education diplomas, 2016)	HDI
123.6	94.00%	5.7	86.90%	4.70%	38.17%	0.92
148.4	91.10%	5.6	n/a	2.94% (2013)	n/a	0.91
124.4	85.70%	5.5	81.80%	3.81%	36.30%	0.91
80.4	76.10%	5.1	90.70%	2.40%	22.97%	0.87
152.3	84.60%	5.9	86.80%	3.90%	43.60%	0.88
109.7	99.20%	5.3	86.40%	3.60%	46.86%	0.9
105.5	79.50%	5.2	n/a	n/a	n/a	0.92
130.8	88.40%	5.3	92.10%	3.21%	43.74%	0.94
111.4	97.10%	5.8	86.60%	4.50%	43.02%	0.94
123.4	92.00%	6	86.30%	3.70%	41.14%	0.91
132.7	97.00%	5.7	76.00%	3.00%	42.9%	0.89
100.80		5.3	97.20%	3.50%	42.80% (2015)	0.92

- Households with Internet access at home, high-speed mobile subscriptions per 100 persons: https://www.itu.int/net4/itu-d/icteye/CountryProfile.aspx
- Corporate absorption of new technology: Global Competitiveness Index 2017-2018 (World Economic Forum)
- Hong Kong, China sources: http://www.bmcetrade.co.ma/fr/observer-les-pays/hong-kong/approcher-consommateur, https://www.itu.int/net4/itu-d/icteye/CountryProfile.aspx

A number of trends can be detected. Examination of the 12 most advanced countries in terms of digital skills shows that they all have a high Human Development Index (HDI) and high urbanization rates (aside from Ireland, whose urban population makes up only 64% of the total).

It can also be noted that:

- They are all countries with high connectivity and rates of Internet access: the number of high-speed mobile subscriptions per 100 inhabitants exceeds 100 in all the countries except for Czechia (80.4)
- The proportion of households with Internet access in the home is at least 85% throughout.

This reveals a correlation between the penetration of technology into citizens' lives and strong digital skills levels. Infrastructure therefore appears to be one "activating" factor in high digital skills.

They are also economies whose populations are more highly qualified than the average. In all the countries, except for Czechia, the proportion of adults with higher-education diplomas is above the OECD average (35%). The rate of school enrolment for young people aged 15-19 is also high in all the countries, with Luxembourg recording the lowest rate at 76% (which is still above average).

Another significant factor is the use of digital technology in businesses. In all the countries, the rate of corporate absorption of new technologies is above average. It can be concluded that working in highly-digitized environments has a positive impact on digital skills levels.

It would be interesting to complement the comparison with indicators of inequalities (such as the Gini index[7], education gaps, disparities in the rate of home Internet access between blue- and white-collar workers) to try to confirm or invalidate the hypothesis whereby the most advanced countries in terms of digital skills are also those where inequalities in education are the lowest.

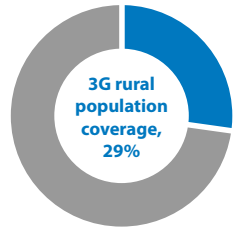
Other characteristics, such as per capita GDP or population density, show no particular trends in relation to digital skills. Among the leading countries, per capita GDP ranges from US$ 17, 330 in Czechia to US$ 103,187 in Luxembourg; population density varies from three inhabitants per square kilometre in Australia to 8,274 per square kilometre in Singapore. This underlines the importance of sectoral and non-sectoral public policies.

Infrastructure is a driver of digital skills development

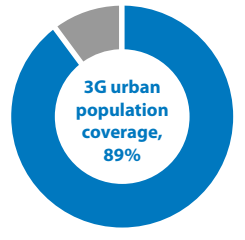
Technological infrastructure (telecommunications networks and physical infrastructure) is a key driver for the development of digital skills. The cost of Internet access and connection quality and speed can promote or prevent improvements in digital skills.

The ICT Development Index of the International Telecommunication Union (ITU), a United Nations specialized agency specializing in ICT, provides an international ranking of ICT infrastructure and access.[8] This is based on five criteria: landline telephone subscriptions per 100 inhabitants, mobile telephone subscriptions per 100 inhabitants, international Internet bandwidth per inhabitant,[9] proportion of households possessing a computer and proportion of households having Internet access. The 15 countries at the top of the ranking include six of those which were selected as having the best performance in digital skills: Luxembourg (at the top of the table), Hong Kong, China; Republic of Korea; Singapore; Sweden; and Denmark. Czechia (in first place in the ICILS study) could only achieve 55th place, with a score that was still high (7.14/10). Regarding these results, it is more relevant to consider countries' scores rather than their positions in the ranking. It is noteworthy that developed countries and those performing well in digital skills all achieved scores exceeding 7/10 in this ranking, emphasizing the importance of high-quality technological infrastructure, a necessary prerequisite for the development of strong digital skills.

2015*



World rural population 3.4 billion



World urban population 4 billion

It is between the developed and developing countries that the impact on digital skills levels of disparities in access is the most significant. The ITU study, in 2016, showed practically 100 active high-speed mobile subscriptions per 100

7. The Gini index measures levels of inequality (salaries, income, standard of living) in a given country. It varies between 0 (situation of perfect equality) and 1 (extreme inequality).

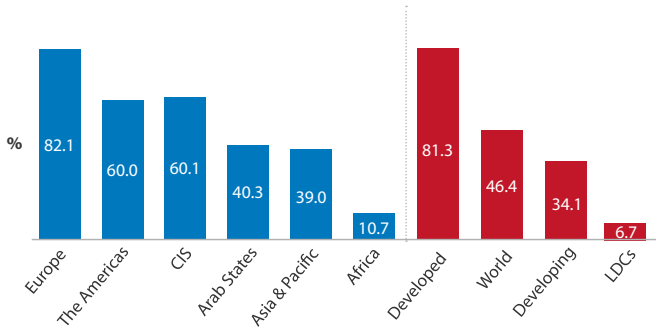
8. International Telecommunication Union, Measuring the Information Society Report, 2017.

9. The international Internet bandwidth per inhabitant is obtained by dividing the bandwidth (in bits per second) by the total population.

inhabitants in the developed countries, as against 40 per 100 in the developing countries. The cost of infrastructure needed for the use of ICT is also mentioned as one of the factors obstructing Internet use (and therefore the development of digital skills). In fact, these disparities in access and cost reflect the social inequalities which weigh heavily on digital skills.

These inequalities can also affect countries which perform well in digital technology, which are faced with major disparities between urban and rural areas. The ITU study, en 2015, showed that 89% of urban populations were covered by 3G wireless technology, compared with only 29% of rural populations, across all the countries.[10]

Percentage of households with internet access



Digitization of businesses is an engine for strengthening digital skills

One natural consequence of technological innovation is the search for new skills. The digitization of businesses can therefore be a driver of the development of digital skills. The growing use of new technologies in businesses leads to demand for digital skill and therefore encourages their development. This trend can be seen both in businesses, through growing awareness of the need to update employees' skills, and in education systems (primary, secondary and higher education), in efforts to bring their teaching closer to labour-market requirements by developing students' digital skills.

The digitization of businesses generally gives rise to internal employee training programmes. These aim to maintain their employability by giving them generic skills enabling them to use ICT in their daily work. That internal skills growth goes along with the recruitment of new staff with more specialized digital skills such as programming, Web development and network management.

These specific skills, directly linked to the emergence of new professions in the ICT sector, are the subject of specialized courses in higher education systems. The creation or evolution of those courses, which provide large-scale training in digital skills, is strongly linked to the digitization of businesses, which creates demand and values those new skills.

Corporate digitization also changes working methods, requiring employees to develop additional ICT-related skills (such as communication, flexibility and adaptability), a set of knowledge and behaviour which is an aspect of digital skills.

The Global Competitiveness Index 2017-2018 created by the World Economic Forum, with its ranking of economies by the rate of penetration of digital skills in businesses, confirms the clear link between corporate digitization and digital skills levels. It has been observed that the best-performing countries in digital skills are all above 5.2/6 on the scale of absorption of new technology by businesses (6 being the maximum score).

These findings put pressure on initial training and continuing training sectoral policies tailored to the needs arising from the digitization of businesses.

The wealth of digital content leads to improvements in digital skills

The wealth of online content is also an engine for the development of digital skills. There are various levels to that wealth:

- Linguistic wealth: the lack of content available in the local language is a brake to the development of digital skills. The World Bank estimates that over half of online content is in English, a language understood by only 21% of the world population.[11] On the other hand, the availability of content in the local language promotes Internet use by a greater number of people, and therefore opportunities for skills improvement.

- Content relating to local everyday life: many studies have concluded that digital ecosystems which produce content relating to local everyday life (public transport, events, etc.) are essential for the development of digital skills.[12] They do indeed increase the usefulness of the Internet as perceived by users, encouraging increased usage.

10. International Telecommunication Union (ITU), 2015 ICT Facts & Figures.

11. GSM Association, *Embracing the Digital Revolution: Policies for Building the Digital Economy*, 2017

12. *Ibid.*

- Diversity of activities available online: as stated above, there is a positive correlation between the number of online activities engaged in by a child and his or her digital skills level.[13]

The availability of rich content is both an engine and a result of improved digital skills. It sets off a virtuous circle where the wealth of content promotes the development of skills, which in turn lead to improvements in content, and so on.

There are three relevant engines of non-sectoral policies:

- infrastructure,
- corporate digitization, and
- the nature of online content.

▸ A better-equipped and -connected society, a more digitized economy and richer content are a better preparation for digital skills.

Education policies to strengthen children's digital skills

Comprehensive Master Plans supported by strong political will

In relation to sectoral policies in the field of education in the various countries concerned, it has been observed initially that they all have "Master Plans" for digitization in education. This has resulted from political will and they have mobilized such plans for the digitization of education. These are the fruits of strong political will and involve mobilizing considerable resources.

These strategies respond to the double goal of increasing the effectiveness of teaching methods and improving students' digital skills. Among the countries topping the table for digital skills, Singapore and the Republic of Korea are particularly noteworthy for their education policies.

The Republic of Korea has undertaken a real movement for digitizing education through the SMART Education initiative,[14] conducted by its Government since 2009. It is based on recognition of the close link between progress in education and the development of technology, requiring the integration of the latter into the education system. The initiative involves freeing education from its physical constraints, whether those of the classroom or those of textbooks. The idea is to use digital teaching materials (such as online courses, digital textbooks and cloud storage of educational content) to offer teaching which will be better adapted, more resource-rich and more interactive. The country's Government has invested massively in support of this initiative and the various associated projects. This is part of the country's overall growth strategy since the late 1990s, based on digitization, to enable it to become an economic power.

Singapore has a similar vision, considering that school must play a major role in the learning of digital skills, with a view to training future workers for the new digital professions. This policy is reflected in ICT Master Plans for Education, renewed every five years; the first of them was for 1997-2002. These major plans comprise several strands: equipping schools with the necessary infrastructure, training teachers in the use of ICT and its integration into teaching methods and including the learning of digital skills at all levels of education. The objective is to rebalance curricula between, on the one hand, acquiring factual knowledge and, on the other, learning to use digital tools to seek, reuse and interpret information, solve problems and communicate ideas effectively. Adapting the tools and contents of learning in time with technological change should enable students to acquire the necessary skills to exercise new professions in the digital world. In particular, Singapore encourages schools to experiment new teaching methods through emerging technologies (such as 3D virtual learning environments) to promote greater diversity and improved levels in the uses of digital technology.

13. UNICEF Office of Research – Innocenti, London School of Economics and Political Science, op. cit.

14. SMART is an acronym for Self-direct, Motivated, Adaptive, Resources, Technology Embedded (the five characteristics that the Government aims to give to its education system).

Master Plans for the development of digital skills

Two important points:

3) Master Plans relate to the various factors described above: technological infrastructure in schools (a necessary prerequisite), ICT training for teachers (an essential area in which gaps have been identified) and integration of digital technology into curricula, not only through specific courses, but also within other subjects.

4) These strategies are supported by strong political will and are part of a wider process of massive investment in digital technology.

The effectiveness of these two public policy elements is reflected by the remarkable results achieved in the Republic of Korea and Singapore in terms of schoolchildren's digital skills.

Policies for developing digital skills go beyond learning to use digital tools

There is a third, complementary element: the idea of not restricting the learning of digital skills to the mastery of digital tools.

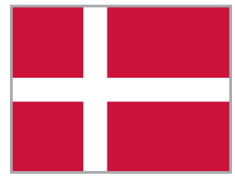
Czechia has made the development of algorithms and logical thinking one of the main goals of its Strategy of Digital Education 2020, adopted in 2014. The country is part of the group of countries where schoolchildren reported making the least use of ICT at school. This confirms that the acquisition of skills takes place beyond the use of computers and the learning of operational skills. The integration of structural and strategic skills (as defined in the Introduction) into educational strategies is therefore a key point to be borne in mind.

The learning of specialized digital skills such as programming or robotics is of increasing significance. In September, the United Kingdom introduced programming lessons into school curricula as early as the first year of compulsory education. This reform was born of a broader consideration of digital skills: given the constant evolution of software and programmes, it is no longer enough to know how to use a computer; it is necessary to understand its internal functioning. Students must be provided with a solid foundation so that they can constantly adapt to evolving tools. The coding programme comprises three phases in accordance with the students' levels:

- Phase 1 (age 5-6): learning the notion of algorithms, creation and debugging of very simple programmes and use of computers to create, organize, store, manipulate and recover digital content.
- Phase 2 (age 7-11): creation and debugging of more complex programmes with specific objectives, familiarization with the notions of variables and sequence, selection and repetition in programmes, development of logical thinking.
- Phase 3 (age 11-14): use of at least two programming languages to create programmes, learning of Boolean logic, work with binary numbers and learning the links between computer hardware and software.[15]

This curricular reform is complemented by programming training for teachers, funded by the Department of Education and operated, among others, by the British Computer Society.

Use of ICT in student evaluation places digital skills at the heart of the school system



The example of Denmark reflects another type of practice which develops digital skills: the use of ICT in student evaluation methods. Since 2007, students have Internet access when taking certain examinations (including some tests included in high-school graduation examinations). This reform reflects a certain vision of digital skills and learning: what is being evaluated is not students' ability to learn content by heart, but rather to process that content and evaluate it critically. This form of evaluation enables schools to address new challenges relating to digital technology, such as the issue of plagiarism and its consequences.

Improving public policy through the monitoring of digital skills

Norway devotes considerable efforts to the evaluation and monitoring of its students' digital

15. Stuart Dredge, "Coding at school: a parent's guide to England's new computing curriculum", The Guardian, September 2014. URL: https://www.theguardian.com/technology/2014/sep/04/coding-school-computing-children-programming

skills, through the work of the Norwegian Centre for ICT in Education. Through the ICT Monitor longitudinal study, the system takes stock of the digital skills of students at various levels (the seventh and ninth years of compulsory education, then at the end of secondary education). It covers use of and attitudes towards ICT and the development of pedagogical strategies integrating new technology and their results. The Centre also administers a national digital skills evaluation test for all students in the eighth year of compulsory education. Through this type of digital skills monitoring, students' strengths and weaknesses are correctly identified, in order to improve public policy on the basis of real needs.

Teacher training policies are an engine for development of digital skills

Lastly, teacher training policies are a vital dimension in education policy for the development of digital skills. ICT training for teachers who do not themselves necessarily possess the requisite digital skills ensures that they are able to pass on those skills to children.

In this regard, Hong Kong, China, has developed an ICT training framework for teachers. It aims to increase career development opportunities for teachers in the digital field. On the one hand, this improves their pedagogical integration of ICT and, on the other, promote the creation of communities of practice among teachers to disseminate new skills and pedagogical methods. The training framework has four dimensions corresponding to the range of skills the teachers will need to adapt their methods to a changing environment (digital culture, globalization, emergence of a knowledge-based society):

- Technical skills in ICT,
- Pedagogical integration,
- Management and supervision of digital technology,
- Sociocultural awareness

In light of the constant evolution of needs in the area of digital skills, the training framework covers both teachers' initial training and their continuing training, adapting to the specific requirements of preschool, primary and secondary education.

Policies to improve and upgrade digital skills among adults

Adult digital skills: a crucial factor in economic competitiveness

The labour market is increasingly affected by the use of digital technologies. Digital skills form part of the "ICE Triangle"[16] and promote innovation, competitiveness and employability.

In the European Union, 93% of workplaces have office computers and 94% have high-speed Internet access. Digital technology is used in all types of work, and 80% of businesses require their employees to possess at least basic digital skills (90% of businesses require this of their executives and 98% require it of their managerial staff).[17] Digital skills have been identified as the fourth key skill in the European framework for education and lifelong learning.[18]

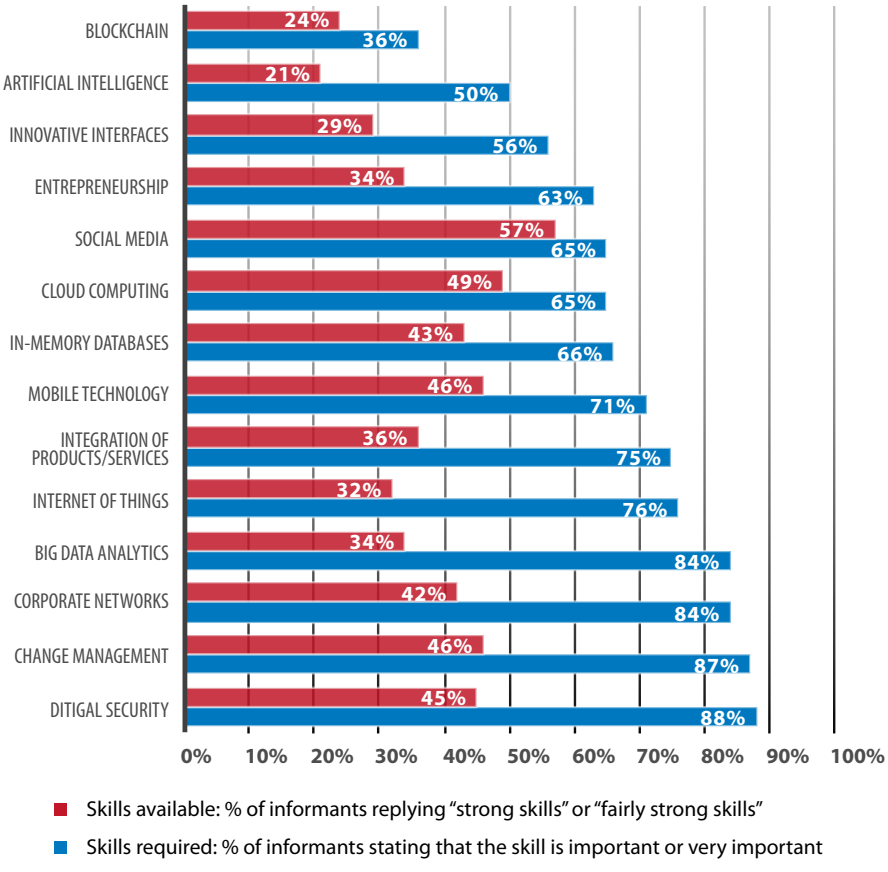
The impact of digitization on work practices has increased awareness among businesses of the need for relevant skills to ensure their digital transformation. A study by the Digital Marketing Institute on the digitization of British businesses showed that 27% of senior managers consider it to be "key to their survival". However, of the 87% of businesses convinced that digital technology will disrupt their industries, only 44% say they are adequately prepared to cope with these changes. Faced with the imperative of digitization, the development of digital skills is a major challenge: indeed, in 2015, according to a survey of 18 countries,[19] 53% of companies said they did not have enough staff with the digital skills required for digital transformation. In 2017, this figure increased to 64%.

These alarming findings are indicative of a mismatch in demand and supply of the skills required for digitization of the economy. We are now facing what has been termed a digital skills shortage. Among OECD countries, 56% of adults have no digital skills, or only enough to perform the most basic computer tasks.[20] This situation could have serious economic consequences. In the United Kingdom, where more than 90% of jobs require some digital competency, it is estimated that

16. Lanvin, Bruno; Passman, Pamela. "Building E-skills for the Digital Age", The Global Information Technology Report 2007-2008, 2008 World Economic Forum
17. ICT for Work: Digital skills in the workplace, European Commission, 2016.
18. Recommendation of the European Parliament and the Council of 18 December 2006
19. IDT and TUM, *Skills for Digital Transformation: Research Report 2017*. Based on responses from 116 business leaders in 18 countries.
20. OECD, *Skills for a Digital Life*, December 2016.

the digital skills gap is causing a loss of £63 billion per year and a loss of productivity of £1 trillion per year.[21]

The graph below shows the mismatch in demand and supply for different digital skills. It is based on the responses of 116 companies in the *Digital Skills for Transformation* survey[22] to the following two questions: "How important is it to have extensive skills in the following areas to ensure the successful digital transformation of your business?", and "to what extent does your company have skills in the following areas?".



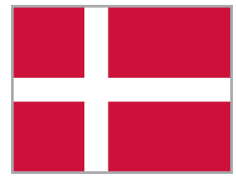
The skills shortage is particularly marked among adults (including senior citizens) and affects most countries. According to the Digital Economy and Society Index, in 2016 44% of the population of the European Union had inadequate digital skills, including 37% of the workforce, even though most jobs require at least basic skills. This situation poses a major challenge in terms of unemployment: 24 million Europeans are currently unemployed, yet it is estimated that 825,000 digital jobs will be vacant in 2020 due to a skills shortage. The development of digital skills among adults could therefore open up the world of work for the unemployed.

All sectors of activity are affected by this phenomenon, and a significant proportion of jobs related to digital technology are now in "traditional" sectors such as banking, insurance, e-commerce and e-tourism, as well as within digital services companies. A prospective analysis on job creation projections in different sectors, conducted in 2015 by France Stratégie and the Directorate for Research, Studies and Statistics (DARES), showed that the IT and telecommunications sector is set to create 110,000 new jobs over the period 2012-2022, representing an average annual growth of 1.8% (compared to 0.7% for all sectors combined). The strong growth potential in this area confirms a growing and urgent need for digital skills.

These challenges stem from the problem of supply and demand: it takes time to develop digital skills, but economic demands change rapidly, particularly in the world of digital technology.

Lifelong learning policies on digital skills help maintain employability and competitiveness

Countries that lead the way in digital skills have public policies focused on maintaining employability. Their emphasis is on ensuring that the skills of the workforce match the requirements of the labour market and addressing the skills shortage. In the medium term, employability increases economic competitiveness.



Over the past 20 years, digital skills training for employees has been a cornerstone of Denmark's labour market policy. This has been implemented alongside policies aimed at reducing the risks of social exclusion in relation to digital technology. As part of the e-Government Strategy 2011-2015, the Government has reaffirmed the importance of digital skills training, with emphasis on employability and social inclusion.

21. House of Commons Science and Technology Committee, *Digital Skills Crisis. Second Report of Session 2016-2017* (2016)
22. IDT and TUM, op. cit.

Seeking employability is also the main focus of New Zealand's Digital Skills Forum, which was launched in 2016 as a coalition of industry and government organizations with the aim of identifying key skills, challenges and opportunities in the ICT and digital sectors. In this context, joint work is being undertaken to address the shortage of digital skills. The aim is to accelerate the flow of skilled labour into the rapidly growing ICT sector in New Zealand, in order to bridge the gap between the skills required by businesses and the skills of the workforce. The Forum focuses on the needs of ICT companies, digital service companies, and other industries that rely heavily on digital technology. The Forum provides a link between industry and the government by forging a common understanding of present and future needs in digital skills.

In Sweden, the e-Skills Council plays a similar role. Interestingly, however, this body was set up by a non-governmental association representing the interests of the ICT sector, IT&Telekomförtagen, rather than originating from a government initiative. The Council researches and disseminates information on current and future demand for digital skills and makes public policy recommendations. It is a reference body for public policy proposals from the government and also puts forward proposals. For example, it drew up an "Action Plan for e-skills" that ran until 2015. This report informed public debate on the digital skills gap in Sweden. It is also used by statistical institutes and employment authorities to define trade codes.

Public policies on adult digital skills focus primarily on employability. However, securing long-term employability requires an understanding of the skills that the market will need now and in the future. This involves three key elements:

1. Improving understanding of business requires the use of a framework to analyse digital skills requirements, which can then be used to design adult training programmes targeting those requirements.
2. Close cooperation between businesses, education and training institutions and the Government (through the relevant ministries). Including these actors in the process will ensure that collaborative measures can be taken to promote access to the required digital competencies.
3. Integration of the framework into a skills development policy as the best way of addressing the constantly evolution of digital technology and ensuring that current and future digital skills are aligned with specific needs.

Over the last few years, Singapore's Infocomm Media Development Authority (IMDA), which is very proactive on digital issues, has attempted to integrate these three elements into its adult digital skills development programmes. For example, it has set up a National Infocomm Competency Framework, a road map that provides information and communications professionals and employers with the information needed to: (i) evaluate existing and required skills in the field of ICT; (ii); develop training programmes for employees; and (iii) determine the employability of potential employees as part of effective HR recruitment processes. In a few years' time, it will be interesting to see what impact these policies have had on adult digital skills in Singapore, which currently ranks ninth in the Programme for International Assessment of Adult Competencies (PIAAC).

Combating digital exclusion helps to reduce the digital skills divide

Other types of policy can be used to address challenges such as exclusion relating to the use of digital technology outside the labour market. This problem is becoming more widespread with the digitization of economies and public services: banking and administrative services increasingly make use of digital technology and accessing them requires basic skills. Public policies must therefore ensure that all sectors of the population have adequate skills to prevent them being excluded from digital technology in daily life. Depending on the context, such policies could target different vulnerable groups (elderly and disadvantaged people, and those living in remote areas) and forms of exclusion (access, usage, skills, etc.).

For example, since the early 2000s, Luxembourg has developed public spaces with computers connected to the Internet called "Internetstuffen". One-on-one and group training sessions are offered at very affordable prices. The InternetFührerSchäin, a 20-hour intensive course, leads to a diploma from the Ministry of Education. Refresher courses provide the opportunity to

update or further knowledge of specific areas (such as social networking, Pack Office, communications, Internet shopping, leisure). The Internetstuffen offer courses for those particularly affected by digital exclusion, such as senior citizens and those on low incomes.

In order to combat digital exclusion more effectively, since 2004 the Republic of Korea has published its annual Digital Divide Index, a study that measures Internet usage and digital literacy among different vulnerable groups compared to the general public. The index was launched by the National Information Agency and is produced annually by a Korean company called Kantar Public to assess the effectiveness of public policies to combat digital exclusion. It incorporates the three dimensions of the digital divide (access, usage and competencies) and focuses on six population groups (disabled people, the elderly, disadvantaged people, agricultural workers and fishermen, North Korean refugees, and marriage migrants). In 2016, a "Smart Index" integrating the use of smartphones and tablets was added to reflect the changing nature of Internet usage. This data provided the government with real-time data on the nature of digital exclusion and enabled it to identify the most effective way of addressing it.

Singapore has developed a policy to combat digital exclusion among older persons. The Silver Infocomm Initiative (SII), launched in 2007 by the Infocomm Media Development Authority (IMDA), offers a wide range of training programmes for people aged over 50. This forms part of the initiative put forward by Yaacob Ibrahim, Minister of Communications and Information Technology, entitled "A nation for all ages",23 which has three key objectives:

- For the individual, to enable all Singaporeans to live long lives and grow old with confidence
- For the community, to strengthen social cohesion, particularly between generations
- For the city: to build an "age-friendly" city in which senior citizens can play an active role. In a highly digitized society such as Singapore, digital exclusion can quickly lead to social exclusion.

The SII includes three types of activity:

- *Silver Infocomm Junctions* are learning centres for senior citizens that provide two digital training courses: iBegin, for acquiring basic digital skills (how to use a computer, create an email account, online security, etc.) and iLive, aimed at senior citizens who have basic computing skills and wish to develop them so they can use the Internet on a daily basis (for public service transactions, file sharing, etc.). Personalized support is also available. The learning centres are managed by community associations or centres.
- *Silver IT Fest* is an annual event organized by the IMDA and higher education institutions with a variety of trade partners, aims to explain current developments in the digital sector to senior citizens. The event, which is held over several days, includes technical training sessions as well as exhibitions and seminars on digital technology.
- *Intergenerational IT Bootcamps* are workshops organized by schools where senior citizens receive training from pupils. The idea is to enable older persons to cross the digital divide by meeting the younger generation to discuss digital technology. Around 80 IMDA partner schools, from primary to upper secondary, have co-hosted these seminars.

The various activities undertaken as part of the SII have trained over 110,000 senior citizens since 2007.[24]

23. Suresh Nair, "When it comes to digital skills, age is just a number", Infocomm Media Trends, Insights and Analysis, Infocomm Media Development Authority, last updated 3 November 2017. URL :https://www.imda.gov.sg/infocomm-and-media-news/buzz-central/2017/6/when-it-comes-to-digital-skills-age-is-just-a-number

24. Infocomm Media Development Authority, Factsheet: Silver Infocomm Initiative, 2016.

Conclusion

Conclusion

Key information from comparative studies

The comparative studies analysed in this report identify a number of factors that can improve digital skills to varying degrees.

Among children, four main key points can be taken from the ICILS, PISA and ePIRLS studies:

- **The earlier students are introduced to computing, the better their digital skills.** The link between experience and skill level is particularly strong in less developed countries. Schools should therefore integrate ICT learning into their curricula from the first year of schooling.
- **The provision of equipment in schools and homes is not enough because it is utilization that has an impact on the level of skill.** The availability of equipment does not guarantee effective and useful Internet use by children. However, this is more relevant in developed countries where there are few barriers to accessing computer equipment.
- **A diverse range of activities is associated with better digital skills.** Encouraging children to diversify their online activities can help improve their digital skills.
- **The use of ICT by teachers has a positive effect on pupils' digital skills**, especially when this approach is applied across all subjects, and not restricted to computing classes. Teacher training in ICT is therefore crucial.

With regard to **adult skills, these are closely linked to socioeconomic factors, specifically educational attainment.** Among the adult population, the greatest discrepancy in digital skills (more than gender or age) is between higher education graduates and people who have not completed upper secondary education. **This may indicate that the highest-performing countries in terms of digital skills are those with the least educational inequality.** The democratization of access to further education, particularly at degree level, therefore promotes the development of digital skills among adults.

Lessons in terms of public policy

Analytical studies and case studies of the best-performing countries in terms of digital skills can be used to formulate recommendations for public policies promoting digital skills.

To achieve the best conditions for the development of digital skills, **two types of public policy must be taken into account: policies that create a supportive framework, and sectoral policies for basic and further training.** These two dimensions are equally important, as the latter can be effective only if supported by the former.

Non-sectoral policies should focus on three areas:

- **Technological infrastructure,** through investments aimed at providing quality high-speed Internet access, reducing access costs, connecting populations in remote regions, switching from 2G to 3G, 4G etc.
- **Digitization of businesses,** by providing a framework and incentives for businesses to adopt new technologies and update their working practices by integrating digital technologies. This would **create a demand for digital skills that would foster and enhance the development of such skills** internally and externally (workplace training courses, specialist courses in higher education, etc.)
- **The development of online content** (relevant content locally, content in local languages, etc.) to create a virtuous circle in which enriched content is both a driver and a consequence of digital competencies.

These three areas, while not directly linked to digital education, are key drivers for the proper implementation of sectoral policies on the development of digital skills. With regard to sectoral policies, our recommendations are as follows:

- At school, go **beyond teaching basic technical skills as part of an IT or technology course**, as this is not sufficient for today's needs. It is essential to teach specialist skills such as programming or robotics and develop logical thinking in order to keep pace with changing technologies, and this should form an integral part of educational policies.
- **Support any educational or reform policy relating to digital technology in the curriculum by providing teacher training** in this area. Such training should take place at two levels: **training in ICT**, so that digital skills can be transmitted to pupils effectively, and **training in the integration of ICT into teaching methods, so that**

digital technology is not just an objective but also a vector for teaching across all subjects.

- Develop **monitoring of digital skills** to ensure that needs are properly identified and tailored solutions are found. This is valuable both for pupils and adults. An understanding of the labour market in terms of business requirements and the skills available within the workforce is essential for devising targeted training programmes and ensuring that individuals develop the necessary skills to secure their employability (and, in doing so, the competitiveness of businesses).
- Draft policies that promote digital technology **through collaboration between the government, educational and training institutes and businesses**, and to encourage joint action between these actors.
- Ensure that these policies attain all population groups, particularly those that are most vulnerable (such as older persons, deprived groups and immigrants) through **complementary policies to combat digital exclusion**.

Notes on international studies

Current international studies on public policies in this field should produce some specific results to help make policies efficient in the short and medium term. Several of the studies used in this report will produce new data within a few years and these can then be compared with initial findings. A number of working groups are being set up at the international level, such as the ET2020 Working Group for Digital Skills and Competences of the European Union, to formulate future policies.

Unfortunately, there is an imbalance in current comparative studies on the impact of public policies on digital skills. Despite an increase in the number of initiatives for pupils in developed countries, there are relatively few comparative studies on key populations, such as:

- Older persons, whose status as a key population group has come about as a result of the reversal of the age pyramid in high-income countries, and for whom digital skills are crucial.
- Developing countries, which have specific characteristics (a mobile-oriented technology environment, different economic uses and needs) and which merit further analysis to determine best practice with regard to public policies.

The high number of regional and national digital skills initiatives are guiding decision-makers towards digital skills policies that meet the needs of society. Such initiatives are fertile ground for more detailed comparative studies to develop the digital skills of tomorrow's citizens. However, they need to undergo some form of recalibration so that all countries wishing to do so can develop their digital competencies.

Annexes

Annexes

Overview of studies analysed

A. PISA

Organization	Year(s)	Countries studied	Population studies
OECD	2012-2015	Germany, Australia, Austria, Belgium, Chile, Republic of Korea, Costa Rica, Croatia, Denmark, Spain, Estonia, Finland, Greece, Hong Kong China, Hungary, Ireland, Iceland, Israel, Italy, Japan, Jordan, Liechtenstein, Lithuania, Macau China, Mexico, Norway, New Zealand, Netherlands, Poland, Portugal, Czechia, Russian Federation, Serbia, Shanghai China, Singapore, Slovakia, Slovenia, Sweden, Switzerland, Taipei China, Turkey, Uruguay	15-year-old students

The study entitled "**Students, Computers and Learning: Making the Connection**" (2015) compares the digital skills of 15-year-old students in different countries and the educational environments set up to develop these skills. It is based on data collected in 2012.

B. ICILS: International Computer and Information Literacy Study

Organization	Year	Countries/territories studied	Population studied
IEA (International Association for the Evaluation of Educational Achievement)	2013	21 economies: Australia, Buenos Aires, Chile, Croatia, Czechia, Denmark, Germany, Hong Kong China, Republic of Korea, Lithuania, Netherlands, Norway, Newfoundland and Labrador (Canada), Ontario (Canada), Poland, Russian Federation, Slovakia, Switzerland, Thailand, Turkey.	60,000 eighth-grade students in 3,300 schools

Computer and Information Literacy (CIL) refers to the individual's ability to use a computer to search, create and communicate as a way of participating at home, school, work and in the community. This definition focuses on the use of digital technology for communication. The IEA ICILS study measures international differences in CIL level and computer use among eighth-grade students in compulsory schooling.

This study aims to show the importance of defining the student's learning environment when measuring CIL results.

C. ePIRLS

Organization	Year	Countries studied	Population studied
IEA (International Association for the Evaluation of Educational Achievement)	2016	14 countries: Canada, Taipei China, Denmark, Georgia, Ireland, Israel, Italy, Norway, Portugal, Singapore, Slovenia, Sweden, United Arab Emirates and United States of America	Fourth-grade students in compulsory schooling (mean age 9.5 years)

The "online reading" extension of the Progress in International Reading Literacy Study (PIRLS) measures online reading and information analysis skills among fourth-grade students in 14 countries.

D. PIAAC

Organization	Year	Countries studied	Population studied
OECD	2011-2012 2014-2015	33 countries/economies: Germany, United Kingdom, Australia, Austria, Canada, Chile, Republic of Korea, Denmark, Estonia, Finland, Flanders, Greece, Northern Ireland, Ireland, Israel, Czechia, Japan, Lithuania, Netherlands, Norway, New Zealand, Poland, Russian Federation, Singapore, Slovakia, Slovenia, Spain, Sweden, Turkey	Approximately 250,000 individuals representing 815 million adults aged 16 to 65 years.

The **Survey of Adult Skills** assesses adults' performance in three key information literacy skills: literacy, numeracy, and problem solving in technology-intensive environments in 33 countries/economies.

The indicator used to assess digital skills is "problem solving in technology-intensive environments". It measures problem-solving skills and computer skills in the workplace (email, the Internet, spreadsheets, word processing software, programming languages, online transactions, online discussions, etc.). It is based on the OECD definition of digital skills (2013) as "the use of digital technologies, communication tools and social networks to acquire and evaluate information, communicate with others and perform practical tasks".

E. DEDI: Digital Economy and Society Index

Organization	Year	Countries studied	Population studied
European Commission	2016-2017	28 European countries: Denmark, Finland, Sweden, Netherlands, Luxembourg, Belgium, United Kingdom, Ireland, Estonia, Austria, Germany, Malta, Lithuania, Spain, Portugal, France, Slovenia, Czechia, Latvia, Slovakia, Hungary, Cyprus, Poland, Croatia, Italy, Greece, Bulgaria, Romania	Adults aged 16-74

Evaluates the level of digitization of the economy and society of European Union countries, based on five indicators:

- Connectivity of economies
- Human capital (level of digital proficiency)
- Use of the Internet (nature and degree of diversification of Internet activities)
- Integration of digital technologies by companies
- Digitization of public services and administrative procedures

For this report, we took account only of the two indicators which relate to digital skills: "human capital" and "Internet use".

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