THE e-SKILLS MANIFESTO

2015

With contributions from leading figures in government, education, policy, research and industry

This Manifesto is produced by European Schoolnet and DIGITALEUROPE as part of the eSkills for Jobs 2015 campaign.

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FOREWORD

Much has been written about the digital skills gap and whether Europe is falling behind in the race for digital talent.

After some spectacular declines in ICT education enrolments and graduate numbers in the first years of the new millennium, the European Commission developed a long-term e-skills strategy to reverse the worrying trend.

Now, and since 2010, the number of ICT students is growing again. The good news today is that there are signs that the rate of growth is quicker than expected.

I am convinced that we have to be committed in the long-term if this momentum is to be maintained.

This is why the European Commission's Digital Single Market (DSM) strategy makes a specific commitment to developing digital skills. Better curricula, well-trained teachers, new pedagogies, flexible teaching and learning approaches: all these are needed to make the best possible use of digital resources, as we tackle the most important barriers to achieving a digital single market.

Competition amongst countries and higher education institutions to attract students and researchers is increasing. There is a need to maintain Europe's position as a centre of educational excellence, research and innovation. While the responsibility for doing this lies with EU countries themselves, the European Commission will support their efforts and help to increase recognition for digital skills and qualifications and raise Europe's level of ICT professionalism.

This last point is critically important. In today's economies, digital technologies are a major engine for growth, fuelled by the ideas of highly skilled ICT professionals and business leaders – or eLeaders.

Since the search for digital talent is global, obtaining adequate numbers of skilled people presents a challenge. By 2020, it is estimated that potential vacancies may reach around 800,000 for ICT professionals and that 200,000 new eLeaders will be needed. A contributory factor is the relative immaturity of the ICT profession, reflected in the limited public perception of digital jobs and skills requirements, insufficient recognition of ICT industry training and certifications and a worrying rate of ICT project failures. If this continues, the ICT skills gap risks growing to an unacceptable level. Something needs to be done. Recognising the importance of high quality ICT professional standards across borders is needed to ensure that ICT products and services are developed with an adequate regard for privacy, security and ethical conduct.

The DSM strategy highlights the need to increase the digital skills of one third of the labour force which is, effectively, almost digitally illiterate. Although the situation varies widely across Europe, in some EU countries a large number of people have either never used the internet or can only perform a limited number of basic functions such as using email. As society becomes increasingly digitalised, such people risk being economically and socially excluded. The European Commission is very aware of this issue and in 2016 will present an agenda to integrate digital skills in Europe.

We are now working to streamline digital skills in all our policies that relate to the modernisation and digital transformation of the European economy. We will aim to make the best use of all available EU and national funding instruments to support the development of digital skills. This will require a significant collaborative effort by all interested parties from across government, industry, the education community and society.

I would like to invite everyone who is taking part in the 'eSkills for Jobs' campaign and reading the 'e-skills' Manifesto to join us in this important task, which is so crucial for Europe's digital future.

Andrus Ansip
Vice-President for the Digital Single Market
European Commission

CHAPTER 1

Digital transformation of the economy

Introduction: the Strategic Policy Forum

In February 2014, the European Commission established an expert group, the Strategic Policy Forum on Digital Entrepreneurship (the Forum), comprising leaders from business, academia, international organisations, civil society and the public sector. Its work is supported by a Member States Board (MSB) of officials, leading digital transformation programmes and policy nationally and locally. The Forum focuses on the acceleration of the digital transformation of existing European industry and enterprises across all sectors of the economy. Its aim is to create new business opportunities in Europe. It also provides a place to hold a continuing, informed dialogue about this transformation.

The digital transformation of existing industry and enterprises was identified as the priority focus for two main reasons. Firstly, because this is where the biggest opportunities lie for Europe. In fact, three-quarters of the value of the digital economy for Europe is in the potential for increased productivity, competitiveness and, therefore, the job-creating ability of Europe's existing industry and enterprises. Secondly, a deeper and more disruptive wave of digital technologies is already beginning to impact Europe, and being ready to take full advantage of it in critically important public services such as health and education, is imperative.

Digital transformation: the second wave of digital technologies

Europe needs more jobs, especially for its young people. Though not a 'silver bullet', the transformational opportunities that a second wave of advanced digital technologies presents can be a significant part of the solution. Harnessing the capabilities of a second wave of advanced digital technologies can help Europe's businesses - large and small - to become highly productive, globally competitive and creators of high quality European jobs. In addition, it can support the creation of genuine social value and lead to a larger number of European citizens becoming more prosperous and enjoying better public services. Ultimately, the breakthrough innovations they enable will have massive transformative power, and will be crucial tools to support the EU in achieving the objectives set out in the Europe 2020 strategy of becoming a smart, sustainable and inclusive economy.

These advanced digital technologies include mobile communication, social media, cloud, big data analytics, smart devices, connected objects and sensors, and are fundamentally changing the way people live, work, communicate and play. They are briefly described below:

- **mobility and mobile apps:** technologies that enable voice and data connections between people, and increasingly between objects, while on the move. Applications that take advantage of this and in some cases make use of location data;

- **social media:** enterprise social media describes companies' use of social media tools for business purposes. These tools may include social networks (e.g. Facebook, LinkedIn, etc.), microblogging (e.g. Twitter), blogs, internal wikis and/or other enterprise collaborative software;

- **cloud:** cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, software, applications and services) that can be rapidly provided and released with minimal management effort or service provider interaction;

- **big data analytics:** refers to the process of collecting, organising and analysing large sets of data ('big data') from a variety of different sources to discover and derive value from patterns and other useful information;

- **the Internet of things (IoT):** describes the network of physical objects that feature an IP address for internet connectivity, and the communication that occurs between these objects and other internet-enabled devices and systems.

Big data analytics: the benefits for Europe

The implications of the second wave of advanced digital technologies for anyone doing business in today's world are highly significant. As Harvard Professor Clayton Christensen observed, "digitally-driven progress is in some cases improving efficiencies and creating incremental gains in value; in others, it is dramatically reducing costs and increasing access to markets for companies and users; and in others still, it is actively disrupting traditional industries" (Christensen C, 1997). Organisations are using these technologies to scale up at unimaginable rates and performing ten times better than their peers. This is the biggest transformation in business the world has seen in over a century (Coutu S, 2014). The untapped potential is enormous and can add social value, as well as increasing democratic participation.

The benefits arising from the ability to gather and analyse the vast amount of data available today, often referred to as big data or big data analytics, deserve

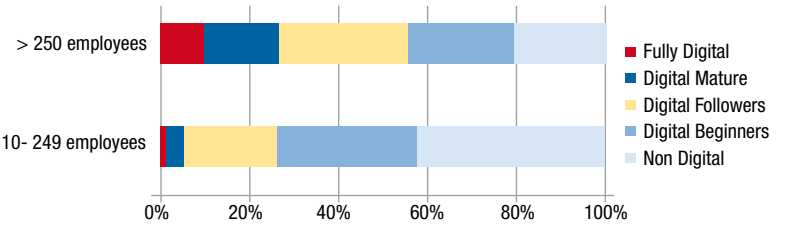
special examination. Big data analytics and the hyper-connected environments promised by the IoT are combining to empower data-driven management, re-shape processes and produce even more significant benefits - for example: wearable sensors that monitor your health, smart meters that track your energy as you use it and cars that automatically recalculate routes to avoid traffic jams, lowering CO2 emissions. There are already many new social opportunities from crime reduction to healthcare improvement to better environmental protection, new business models and indeed whole new businesses that depend on this new capability. This data is gathered from, among other things, social media, internet-enabled devices such as smart phones and tablets, machine and sensors, video and voice recordings. It is estimated that businesses that build their decision-making processes on knowledge collected from data become 56% more productive (European Commission, 2014).

Digital transformation: challenges for European SMEs

Despite the clear benefits, small European businesses are not transforming quickly enough. Innovating and transforming is not easy. Embracing digital technologies means adapting processes, organisational structures and workforces to the digital world, and moving away from 'business as usual' means taking risks and implementing new tools quickly. These are challenges that not all companies, especially the smallest ones, can successfully overcome. Many feel more comfortable with the status quo and will need a confidence boost to set out on the path to digital transformation. But, as explained by Maxence Cupper, Chief Executive Officer (CEO) of idweaver, "in business it is not the strongest that will survive, but the one who manages the change". Thus, companies need to be persuaded that the benefits of change outweigh the risks.

Currently, over 41% of EU companies still have not adopted any of the advanced technologies (mobile, social media, cloud computing and big data), while only 1.7% make full use of all (IDC, 2013). These figures mask considerable variation across the EU. While 26.8% in the UK are yet to adopt these four technologies, in Italy the number is a worryingly high 52.3%. Fewer than 7% of European SMEs have adopted big data solutions to improve their business processes, and the situation is only slightly better when it comes to using other technologies. As shown below, of EU companies of between ten and 250 employees, 28.5% use social media technologies, and only 25.7% use cloud solutions, even though cloud services are an ideal way for SMEs to access digital technologies without a capital outlay. Even when they do use such services it is often limited to basic solutions, such as email and storage capacity on demand (IDC, 2013).

Figure 1: Digital adaption rates by company size, 2012



Source: IDC European vertical markets survey 2012

Digital transformation: repercussions on jobs and skills

The adoption of advanced digital skills has profound repercussions both on the creation and destruction of jobs, and consequently on the need for new skills. A detailed analysis of the French economy showed that, while the internet had destroyed 500,000 jobs over the last 15 years, it had also created 1.2 million new ones – that is 2.4 jobs for every job lost (McKinsey, 2011). Growth brings employment – in Germany alone, it is projected that SMEs could create 670,000 new jobs by using technology effectively (The Boston Consulting Group, 2013). While digital transformation will create these new, specialised jobs, it will result in job losses too. On average, technological advances could threaten 54% of our workforce across the EU member states over the coming decades, with projections suggesting that northern EU countries will be less affected than their neighbours (Bruegel, 2014). To these should be added the potential job losses (and the impact on the economy overall) from businesses failing because they do not keep up with the pace of change.

The new jobs created require very different skill sets from the ones destroyed. Digital is profoundly changing the labour market and the skills people need to do their jobs well. Adapting the workforce to deal with the risks and opportunities resulting from new technologies is still a key challenge. There are not enough people with the necessary digital leadership skills and competences in leadership positions in organisations. In parallel, the need for new, highly specialised skills, such as for big data analytics, cyber security and cloud computing is at a critical level. Many EU member states are focussing heavily on equipping workers with the skills they will need to be part of the workforce of a digitally transformed economy and society. Such initiatives need to become broader and deeper.

Identifying the areas of improvement: better skills and support

It is undeniable that EU businesses need to transform to compete, grow and create jobs. However, as discussed above, it is also clear that Europe's small businesses are lagging behind. The Forum has examined possible reasons behind this issue and, while recognising variations across business sectors and the EU member states, identified problems in the following areas: leadership, trust, skills and support, and policy and regulation. In particular, the need for better skills and support is especially relevant for the present manifesto.

Lack of financial and practical support for digital transformation from public authorities and others has two distinct effects on Europe's progress. Firstly, in practical terms, it makes digital transformation harder for the business leader. Secondly, it sends a strong signal to the community that digital transformation is not important and not a priority for Europe.

If, despite this and the many other hurdles, more business leaders can be encouraged to make the change, then the demand for digital leadership skills will increase even further. In addition, the demand for new skills, such as big data analysts and cyber security specialists, will be generated.

Achieving better and more skills and support: recommendations

As stated by Ann Rosenberg, the Head of Global University Alliances of SAP, "Europe will only establish a global leadership position in the digital economy if the next generation of highly skilled IT talents and entrepreneurs is built. However, Europe might face a serious gap of skilled IT specialists and business economists that can exploit the opportunities of big data, cloud and other digital technologies. Therefore, promoting IT start-ups and IT graduates should be a focus area for Europe". Within this context, four main recommendations can be made with the purpose of boosting digital transformation through better support and skills:

- **re-focus funds and programmes to support digital transformation better:** While there are already many funds and instruments to help start-ups and businesses to develop, there are almost none focused specifically on helping existing companies to transform digitally. Making more funds available for digital transformation would be ideal, but in the short term, more could be done to expand the criteria used for existing funds and programmes. Specifically, the application and eligibility criteria of financial instruments and programmes provided by COSME (Competitiveness of Enterprises and Small and Medium-sized Enterprises), the European Investment Bank, the European Investment Fund or Horizon 2020 should

include digital transformation as a key objective of funded projects. This would make digital transformation part of all projects in key investment areas such as transport/infrastructure, energy, education, innovation/R&D, environment sustainability, etc. EU member states should also streamline and build upon existing programmes to match digitally skilled people with SMEs in need of those skills. One example is the Youth Guarantee scheme, which exists to make sure that people under 25 receive a good-quality offer for a job, apprenticeship or traineeship;

- **promote the importance of digital leadership:** appointing 'chief digital officers'. Digital transformation impacts all parts of a business so organisations will increasingly need people who can develop and implement an integrated digital strategy for the entire business. Digital transformation needs digital and business skills to combine i.e. there is the need for business leaders who combine an excellent understanding of the organisation, with the acumen to use digital technologies to achieve business objectives and transform the organisation;

- **make digital transformation part of the educational mainstream.** Our training and educational institutions need to produce people with the right digital leadership skills and digital entrepreneurial mindsets, especially since the demand for digital leaders will outstrip supply, as digital transformation of business takes place. Therefore, general management training and education must include more digital know-how and digital leadership skills. To this end, a dialogue should be established with representatives of professional development training institutions to consider how this can best be achieved;

- **increase the supply of new, highly specialised skills.** Given the growing demand for specialised digital skills such as big data analysts, cyber security specialists and coders/programmers, the European Commission should step up the focus on measures to fill the digital skills gaps. A sectorial approach is also indispensable to ensure that all sectors (especially traditional industries) develop a coherent and efficient transition to a digital economy.

CHAPTER 2

The Internet of things will change everything

Introduction

The Internet of things (IoT) is both one of the most over-hyped and underestimated technological revolutions that we are likely to witness.

The IoT is over-hyped in terms of the currency that forecasts of connected devices and economic benefit have gained, and the widespread anticipation of a medium-term future where everything is connected and 'just works'. But, more significantly, it is underestimated in terms of the fundamental impact that connecting all these 'things' (plus other virtual data sources) will have on our day to day lives and the functioning of our society.

This chapter focuses on unpicking what the IoT really is, how it will come about, and therefore what skills will be in demand and when.

Evolution to the IoT

To help analyse the IoT, Machina Research has coined the term 'Subnets of things' (SoTs), which is defined as an island of interconnected devices, driven either by a single point of control, single point of data aggregation, or potentially a common cause or technology standard. As discussed in the following section, when planning for participation in our future connected world, the SoTs are a significantly more relevant concept than the IoT.

Evolution to the IoT – SoTs are a natural stage of development

The first thing to note about the IoT is that it is a very different concept from Machine to Machine (M2M) and 'traditional' systems integration. The IoT cannot simply be regarded as an agglomeration of connected devices and other information sources. The development path to the IoT is long and complex and it is natural that in some way this journey will be completed in more 'bite size' chunks.

To carry the terminology further, many of today's connected-device solutions can almost be regarded as 'Intranets of things': closed environments, with little connectivity outside of the device estate, or solution, in question. The natural next step for integrating these solutions into the 'outside world' is to consider the

integration of such 'Intranets of things' to what could be regarded as 'adjacent' products, services and, of course, Intranets of things.

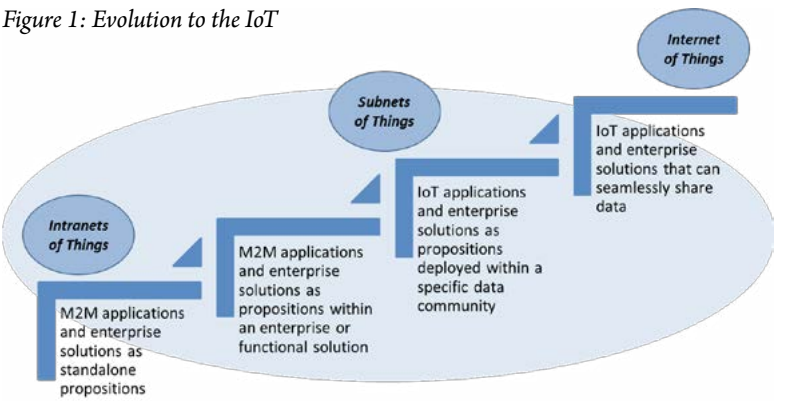
It is likely that this stage of development will be driven by common ownership of data sources, or common cause amongst the owners of data. Examples could be a utility that builds connections between its smart metering solution and its field force solution. The utility in question can do this because it owns the smart meters, the field force capability and the applications that support these capabilities and the data that those applications generate. In short, the systems, connected device and IT environment within the utility in question, and indeed within any enterprise, can be regarded as a potential SoTs.

The key thing to recognise about these SoTs is that the unique quality that they possess in terms of the potential willingness and technical feasibility of sharing data between applications enables them to develop far more quickly than a full IoT.

A logical next step is to extend the concept to data communities, which can be defined as a community of devices, sources of data and data owners that could potentially give rise to a SoTs. An example might be the group of intelligent buildings providers that use SeeControl's platform, or the group of companies that use ThingWorx's platform.

It is clear that SoTs are a significant and critical step on the path to any future IoT. Put simply, whilst it will be relatively easy to convince a defined group of similarly motivated people to 'standardise' sufficiently to create a SoTs, it will be far harder to convince everybody in IT (and related) industries to standardise so that SoTs becomes unbounded (i.e. the IoT). This progression is illustrated in Figure 1, below.

Figure 1: Evolution to the IoT



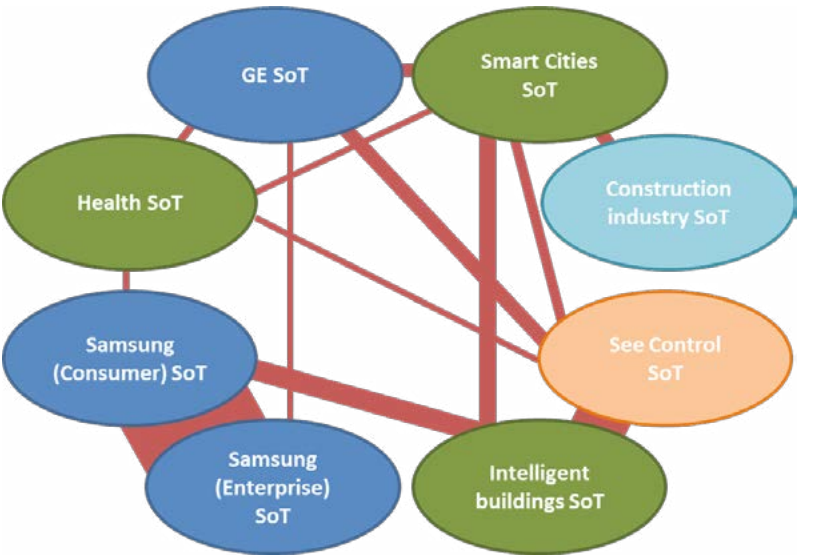
Source: Machina Research, 2015

The 'texture' of an emergent IoT is highlighted in Figure 2, below. In this diagram a range of SoTs are highlighted, including:

- enterprise SoTs (General Electric, Samsung);
- vertical specific SoTs (Health, Smart Cities, Intelligent Buildings);
- industry SoTs (Construction);
- data community SoTs (SeeControl).

In all cases the 'thickness' of the red lines connecting the illustrated SoTs indicates the likely richness of communications between the relevant SoTs. Clearly the overall emerging SoTs environment will be far more complex than illustrated here, but the diagram serves to highlight the relevant concepts.

Figure 2: Texture of the IoT



Source: Machina Research, 2014

Even in a hypothetical future when all communications within the IoT are standardised and all assets can theoretically interact with all other assets, the IoT will remain 'lumpy'. For example, the level of sharing within (say) General Electric will be greater than outside the organisation. This would be a SoTs defined on the basis of access privileges (not what is theoretically possible). To illustrate this effect with an example, in a fully evolved IoT environment it may be possible to connect a medical Computerised Axial Tomography (CAT) scanner to a jet engine, but there is unlikely to ever be a good reason to do so!

In fact, the concepts of limiting the potential for interaction between data sources in a future IoT environment and enhancing the potential for interaction between data sources in a SoTs environment are effectively the same thing. Both of these concepts result in the SoTs being the most appropriate lens through which to consider our connected future.

In short, our connected future will be more of a network of SoTs than a single homogenous IoT. Today's internet provides a clear precedent: companies do not share as much information with their customers as they do within their organisations, and the data format standards used by different companies for their internal systems are often completely different.

Evolution to the IoT – enterprise IoT is a special case

Enterprise IoT is then a special case: since an enterprise can be regarded as a potential 'subnet' of the IoT, the concepts of SoTs and the IoT become one and the same in the context of an enterprise environment. In short, every enterprise has the luxury of a single (or, at least, a limited number of similarly motivated) owners or points of control that can stipulate that necessary connections are built between different data sources to support IoT applications, although it is likely that the advent of the IoT will fundamentally change the nature of the enterprise. It is also beneficial that a single entity has full ownership of the business case for any systems development, i.e. revenues and costs fall on the same profit and loss account. Clearly, a single enterprise (or group of enterprises) can then be relatively agile in their migration to IoT-like solutions, certainly when compared to the overall development needed to create a fully-fledged IoT.

In addition, enterprises are generally strongly motivated to adopt IoT-style solutions, given the potential of such solutions to change business models, increase efficiency and enhance end-user propositions. More than that, enterprises are not simply motivated to adopt IoT-style solutions to differentiate their products and services, they will also be compelled to adopt such solutions to keep up with their more leading-edge competitors. As usual with a new technological revolution, and from an enterprise perspective, it is a choice between embracing the new technology and being out-competed and losing market share. Accordingly, one can expect to see many enterprises at the leading edge of the curve of IoT solution deployment.

In summary, enterprises have both the opportunity and motivation to realise many of the benefits of the IoT before the advent of the true IoT. And, by corollary, the demands that the IoT will place on skills will ramp up in the context of SoTs, and some way in advance of the advent of any fully-fledged IoT.

The time to start developing skills that are appropriate for the IoT is now.

Implications for skills

The new environment described above has significant implications for the skills that workers will need to engage fully with and support evolving commercial environments. Clearly the IoT (and SoTs) usher in a completely new way of working, where traditional corporate boundaries are broken down and 'collaboration' within and across SoTs becomes key. However, the major specific areas that will be impacted by the advent of the IoT include:

- data analytics;
- business management;
- hardware and systems design;
- security.

Each of these areas is discussed in more detail in the following sections.

Implications for skills - data analytics for the IoT

One of the key new roles that the IoT will usher in is that of the 'data scientist'. This job role already exists in today's market of course, but with the advent of the IoT will radically increase the amount and variety of data that is available to organisations, and also empower those organisations to take more rapid and agile decisions in response to data analytics. IoT data management will become a key competence for many corporations, and the ability to deal with data in flight, streaming data and big data analyses will be a differentiator.

Such analytics could enable companies to optimise, for example, manufacturing processes in near real time, or to spot an opportunity for cross-selling more quickly, or to enhance a customer relationship or secure some operational efficiency. The same competitive dynamic that underpins the adoption of IoT-style solutions is also at play here: those companies that can best turn raw data into actionable business insight will be competitively advantaged.

In short, the advent of the IoT will make the role of the 'data scientist' far more central to the ongoing operations of many enterprises. The role must increase in breadth too, encompassing analytic, software and business acumen and combining these with communications skills. Data analytics and analytics architecture skills are thus critical, and even now are in short supply.

It should be noted that the kinds of data analytics described here are generally more vertical rather than horizontal in nature: 'data scientists' will need to be well embedded in their industries (and even specific companies), and supported by a range of sophisticated (more horizontal) analytics tools.

Implications for skills - business management for the IoT

IoT has in the past been technology centric, but it is clear that IoT concepts are fast making their way into day-to-day business management. Organisations that can most effectively navigate that change will benefit the most and quickest. IoT aligned business skills are needed to understand the technology and quantify business benefits that can flow from the innovative use of the new techniques.

For instance, any product designer that is exposed to enhanced product usage information (potentially sourced from a connected product, say a washing machine) will be able to take better, and faster, product design decisions that might impact future releases of the product. But to arrive at this scenario, the company that manufactures the product will need to have taken the decision to enable the connected product to provide the information needed to support the product designer's analyses. At a more fundamental level, the company will need to have overcome the natural tension between those on the 'hardware' side of their business that are most naturally inclined not to release a new product until it has been rigorously tested, and those on the 'software' side of their business who are more comfortable in a world of continual-beta releases.

At other levels within the corporation, the management of partner and supplier (and customer) ecosystems will become radically more complex and probably more centralised, since each company in an ecosystem will want access to ongoing and improved information about their products and services so that these same can be improved and optimised. In the case of the washing machine mentioned earlier, then any changes made by our product designer may in turn impact, for example, the manufacturers of washing machine production line equipment and those manufacturers would want to know that information.

New skills will also be needed to set and manage the extended Key Performance Indicators (KPIs) that will be needed within different SoTs, and eventually for the IoT, as IoT solutions become business critical.

Implications for skills - hardware and systems design for the IoT

Significantly more emphasis will need to be placed on the design of hardware that is connected to the IoT, in terms of optimising capabilities and costs.

On the one hand, it is very easy to future-proof a remote connected device by putting far more intelligence in the device than current use cases suggest might be necessary, and also by equipping the device with sophisticated communications and software upgrade capabilities. But such an approach drives up the costs of the remote device, increases power consumption (which can be

critical where devices are not plugged in to a mains power supply), increases the complexity of back end systems and drives up security risks.

However, deploying 'minimum specification' remote devices can significantly impact the flexibility to support future IoT applications that have potentially not yet been conceived. An example might be a smart gas meter that is connected via a Low-Power Wide-Area (LPWA) connection: the connection is suitable for the communication of meter readings, but could likely not support regular meter software updates.

Thinking through these kinds of constraints can become a massively parallel analysis, and there are relatively few scenarios in today's world where it is necessary to plan to deploy constrained-hardware devices into environments that exhibit quite the same degree of uncertainty as the IoT.

Implications for skills - security for the IoT

Intel Security has described the IoT as "a trillion points of vulnerability". Whilst there might be some debate around the number of zeros in this statement, it is clear that the challenge around IoT security is going to be:

- different to what has gone before;
- significant in terms of the potential magnitude of risks;
- all pervading.

It is clear that the future IoT security landscape will drive the need for a very specific type of skill.

As of today, IoT security skills is already one of the most pressing skills gaps, and there is a risk that if this gap is not addressed it will impact the full business value that could be reaped from the IoT, particularly if security 'scares' early on in the development of the IoT put people off the adoption of IoT-style solutions. Additionally, it is likely that this constrained environment will reinforce and extend the expected SoT stage of IoT development, since it will result in some SoTs developing faster than others, and also potentially the development of some SoTs being hindered by specific security events.

Living and working in an IoT world

In general, the IoT world can be characterised by a greater reliance on breadth of comprehension, rather than depth of knowledge. Teams will be smaller and more agile and the opportunities and challenges (and problems) that teams will have to deal with will potentially be more complex and wide-ranging than now. Solutions are likely to involve more third parties and potentially elements that are significantly removed from the area of focus of the team in question. In short, the key to working in an IoT environment is to master the art of working in a

truly flexible and collaborative way, rather than the more traditional approach of developing a central core of 'expertise'. In many ways, this is parallel to the effect that the internet has already had in terms of placing more emphasis on knowing how to find and extract information, and less on actually knowing facts.

Change management will also be key as industries evolve to participate in the new IoT environment, and IoT-centric training and development will be required so that workers can relate to the new dynamics that are likely to characterise the future economy.

CHAPTER 3

Scaling up and promoting eLeadership in Europe

Introduction

If Europe is to compete, grow, and generate jobs, it must address the current acute shortage of talent capable of leading the innovation needed to capitalise on advances in new digital technologies. Economic growth to create jobs requires that innovation opportunities are identified and exploited. This in turn demands good eLeadership skills. These are the skills that can lead to staff designing business models, taking advantage of innovation opportunities, making best use of digital technologies and delivering value to their organisations.

Tomorrow's business leaders need new skill sets to handle these challenges. The question is whether Europe's education and training institutions and teaching programmes as they are currently structured, are designed to deliver them. Some have already responded to these challenges, others still have to do a lot to keep up in this fast-changing world. This chapter summarises some results of the European eLeadership Initiative launched by the European Commission. It examines the application of the guidelines for new curricula development by higher and executive education and training institutions, and specific programmes and courses for Small and Medium Enterprises (SMEs).

The challenge

eLeadership skills are the skills required by an individual in the modern economy to initiate and achieve innovation such as:

- digital savvy: envision and drive change for business performance, exploiting digital technologies trends as innovation opportunities;
- business savvy: innovate business and operating models, delivering value to their organisations;
- strategic leadership: lead inter-disciplinary staff, and influence stakeholders across boundaries (functional, geographical).

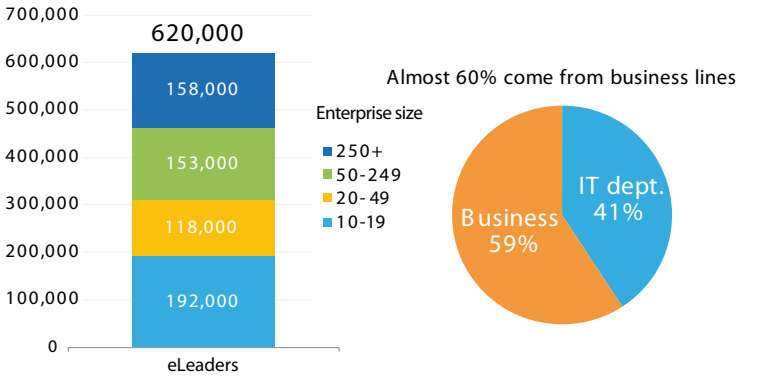
eLeadership forecast

IDC and empirica have forecast that demand for highly skilled ICT occupations (Hüsing T, Korte W B, Dashja E, 2015) will rise by an annual average of 4.6% until 2020.

One can assume a close correlation between demand for eLeadership and the highest skilled ICT jobs, resulting in a demand for eLeaders of 568,000 in 2014.

In 2015, it is estimated to be around 620,000. By applying the same growth rate it will increase to 776,000 in 2020. By using these estimates and by adding the replacement demand, Europe will need at least 200,000 additional eLeaders by 2020. This is a big challenge for the current educational ecosystem which is unlikely to address this properly unless further actions are also taken at the national policy level.

Figure 1: Quantification of potential eLeadership positions in Europe 2015



Source: empirica, Survey NL, UK, DE 2013. Data for EU, grossed up using Structural Business Statistics (Eurostat)

Education and training programmes in short supply

Only 21 programmes in Europe were found to deliver eLeadership programmes as stakeholders had defined them – delivering the capability to lead experienced executives in business transformation.

The results of a search in 2013 for eLeadership educational programmes on offer show that Europe has been through a boom in cross-disciplinary programmes at masters' level – combining business and IT - but mainly for career entrants. However, eLeadership in higher and executive education programmes is very scarce.

Policy initiatives

Providing SMEs and entrepreneurs with the skills for eLeadership still tends to be treated as a secondary policy objective compared to more well-established primary policy objectives such as the take-up of digital technologies and basic digital user skills amongst others. However, the 2007 eSkills agenda and subsequent eLeadership skills initiatives by the European Commission have triggered some EU member states to engage in public debates and helped develop appropriate responses.

Multi-stakeholder partnerships are not as well developed yet in the eLeadership field compared to other segments of the digital skills domain, such as digital literacy and ICT practitioner skills. There is a need for key stakeholders to agree on effective action, help promote awareness of the eLeadership skills topic and implement measures for boosting supply of and participation in related training.

eLeadership education and training delivery tools

As part of the European Commission eLeadership Initiative, guidelines have been developed for curricula to deliver eLeadership in enterprises. The approach supports the characterisation of those skills required for eLeadership in enterprise decision-making, and the definition of learning outcomes appropriate for key roles up to C-level. Curriculum profiles are generated and define the target content and educational experiences to be included in eLeadership curricula offered by institutions of higher and executive education.

Implementing the guidelines provides transparency to enterprises seeking eLeadership and to professionals wishing to engage in further education with the prospect of more responsibility for and success in business transformation.

The European "e-Competence Framework"

The multi-skill concept of eLeadership and its relevance for future economic and social development in the European economy has been widely supported by stakeholders.

The curriculum profiles respond to stakeholders' insistence that curriculum guidelines should leverage the improved market transparency of links to the "e-Competence Framework" (e-CF). Each curriculum profile is mapped to the e-CF and makes clear which e-CF competences are improved by which programmes.

The eLeadership curriculum profile

The eLeadership curriculum profiles, which are key to the guidelines on new curriculum development, are developed by a team of academics and industry representatives supported by education experts. The profiles provide

comparability across programmes – bringing transparency into the digital skills ecosystem. They describe and highlight the demand for eLeadership skill sets as well as help curricula to keep up with a changing environment.

The profiles are simple in structure and require few resources for maintenance and use - in line with the economic climate. Solutions today must be lightweight!

Figure 2: Components of an eLeadership curriculum profile

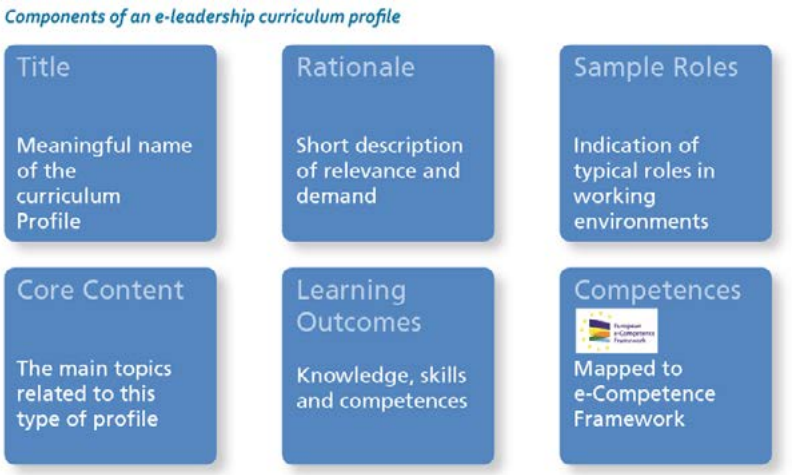


Figure 3: Example of an eLeadership curriculum profile: Business Enterprise Architecture

e-Leadership Curriculum Profile

Title	Business and Enterprise Architecture
	Market Demand
Rationale	Companies, particularly those with international operations, need to deal with complexity since this increases risks and costs, and to be agile in reacting to market changes. Designing a business to achieve these goals needs both business and ICT architectural skills. The Business & Enterprise Architecture curriculum addresses these challenges and aims to increase the capability of experienced professionals to engage with key stakeholders in linking strategy, architecture, change and value. The focus is both on developing professional competence and enhancing behavioural skills.
Entry Profile	Programmes based on this profile typically require participants who already have practical experience in IT enabled business change roles.
Core Content	The lifecycle of a business and enterprise architecture as an enabler of business strategy and execution, with the links to inter-related functions: • Strategy & Enterprise Architecture • Enterprise Architecture Solutions • Implementing Enterprise Architecture
Learning Experience	• Combine theory instructions with facilitated group review of best practices strongly set within an organizational context • Provide opportunity for student to use experience and insights from the curriculum in their working environment
Sampe Target Roles	Enterprise Architect Business Architect
	Learning Outcomes
	• Create architectural designs that help innovate business and operating models • Exploit digital trends to develop target model architectures • Envision and drive architectural change for business performance • Influence architectural stakeholders across boundaries • Build architectural capability and lead inter-disciplinary staff

e-CF competency	**Level**
A.1 IS and Business Strategy Alignment	4
A.5 Architecture Design	5
A.7 Technology Trend Monitoring	4
A.9 Innovating	4
E.7 Business Change Management	4

e-Leadership Understanding

A.3 Business Plan Development
B.6 Systems Engineering
C.3 Service Delivery
E.2 Project and Portfolio Management
E.3 Risk Management
E.9 IT Governance

European e-Competence Framework

Each curriculum profile has a name and a justification of its place in the portfolio, listing the roles it qualifies for, and summarising content. At the core of each profile comprises of the learning outcomes from completion: the knowledge, skills and competences which a programme should deliver to shape eLeadership skills.

All the profiles developed in the first phase of the initiative deliver the core competences for eLeadership in large corporations.

Learning outcomes are fully referenced to the e-CF, to offer maximum transparency and to leverage existing self-assessment and human resources planning.

Aligning programmes to curriculum profiles will accelerate skills flow, by meeting the requirements of stakeholders. Adoption of the guidelines and supply of conforming programmes will:

- impact executive training and hiring decisions;
- provide transparency to aspiring eLeaders and guide choice of further education.

The approach takes full account of different sets of eLeadership skills for different roles.

Curriculum guidelines use and implementation in higher and executive education

Several demonstrations of the guidelines took place at different business schools and universities in Europe. They showed in practice how curriculum profiles, combined with quality criteria, can help evaluate programmes provided by higher educational institutions and business schools. Business schools and universities in 12 countries have carried out evaluations of eLeadership curriculum profiles.

The approach developed and results achieved were positively received and several stakeholders have now built new programmes to meet eLeadership criteria to replace older formats and content.

Business school feedback

Priority has been given to developing and improving educational offers that can increase the supply of experienced and highly qualified leaders in ICT-based innovation in the private and public sector. The Academic Director at IE Business School in Madrid, Silvia Leal was proud that the IE Business School was among the first in Europe to apply the eLeadership guidelines to their higher education courses. He said that, "we strongly recommend that other universities and business schools use the eLeadership curriculum profile approach".

Furthermore, Professor Dr John Board, Dean of Henley Business School stated that "Henley, with its strong research and teaching tradition, has made direct

contributions to the eLeadership initiative, adapting key programmes to meet requirements set by eLeadership curriculum profiles".

Industry feedback

The same positive feedback has come from the ICT industry. Freddy Van den Wyngaert, Vice President (VP) and Chief Information Officer (CIO), AGFA ICS, who has implemented a major and very successful transformation of its business, and "is determined to continue this success by ensuring executives bring with them the best in eLeadership skills".

Cristina Alvarez, CIO Telefonica Spain made the same point stating that, "the European Commission initiative to improve the supply of eLeadership competences is of great interest to us; we expect to make significant use of programmes which deliver these competences".

Also representatives from major European trade unions like Laurent Zibell, Policy Adviser, IndustriALL Europe and Karl-Heinz Hageni, IG Metall have said that their organisations initiative "support all actions boosting growth and high quality jobs in Europe and consequently the European eLeadership initiative which goes into the right direction".

eLeadership education and training for SMEs

Current digital and eLeadership skills learning in SMEs is highly dominated by self-learning. Of the 118 SMEs who responded, 114 reported at least one 'important' source of learning. On average, each SME named six sources but 'ad-hoc' learning came out as the most important learning format for SMEs.

Industry or professional academies and also 'learning from consultants' were also high up on the responses with 56% and 55% respectively. Higher education institutions are seen as training providers, but mostly in respect to teaching single courses (49%) and less when it comes to teaching full programmes (23%).

Almost 600 potential higher education programmes in Europe were investigated but only six turned out to have a focus on eLeadership and are offered in a format required by SMEs. There is a job to do!

Digital and eLeadership skills training offers for SMEs need to be flexible, short-term, practical, well targeted and affordable.

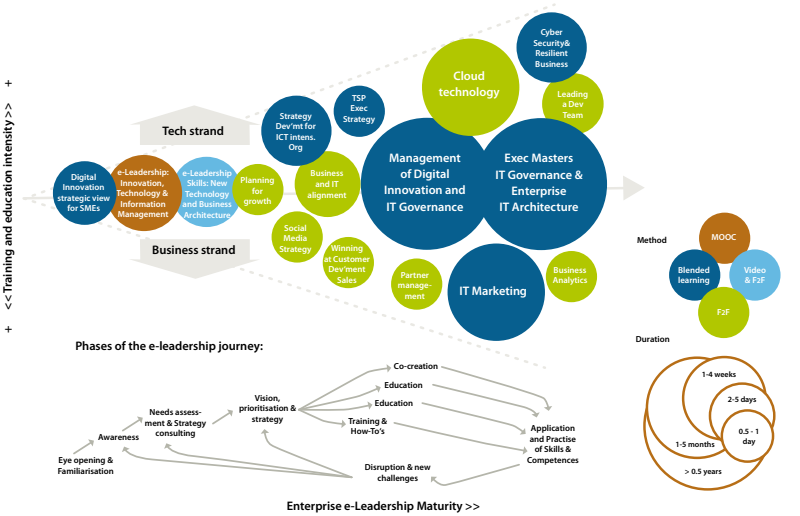
In addition, different training pathways need to be addressed as SMEs require not only a range of training and support at different stages of their development but also levels of awareness and familiarisation with the topic.

eLeadership journey

As the depth of eLeadership skills evolve and develop, enterprises' eLeadership needs, especially SMEs, will usually be either about taking the next step on the eLeadership ladder, or about diversifying and complementing existing skills at the same level.

The eLeadership journey here may go from awareness and curiosity with specific measures serving as eye openers to developing a vision for digital transformation and innovation potential. Vision will have to be translated into a plan including prioritisation and giving direction for implementation. Through information events and open lectures such as Massive Open Online Courses (MOOCs), larger numbers of individuals from the target groups could be familiarised with the topic and develop their vision. In more focused or even customised events to follow, individual needs assessment based on the individual business case and skills portfolio may be undertaken. Further stages in this journey could include the concrete training of the specific eLeadership skills and competences through a variety of offers including traditional education programmes, specific training courses and – probably most applicable for SMEs – coaching, consulting and the co-creation of knowledge.

Figure 4: The eLeadership journey as a framework for eLeadership business demand and education and training offers



Opportunities for training providers, coaches and consultants

There should be ample opportunities for different types of education and training providers to develop and offer suitable training programmes and courses for the different stages of this eLeadership journey. They could range from professional or industry academies to training providers within the chambers of commerce, coaching and consulting organisations, universities and business schools as well as publishers and other content providers. Higher education and commercial training providers are well positioned to offer a variety of courses and programmes, online or offline. There are also non-commercial or semi-commercial providers who offer courses and learning materials. Consulting and coaching might be best suited offering tailored courses to meet the specific needs of the enterprise and could also be offered also by commercial enterprises in the framework of multi-stakeholder partnerships.

An overview of possible actors and methods of eLeadership skills provision is outlined in the chart below. This gives an assessment of fitness-for-purpose of methods and actors with regard to SMEs and entrepreneurial entities.

Figure 5: Actors and methods of eLeadership skills provision

	Awareness raising and familiarisation	Competence needs assessment	(short term) Training	(longer duration) Education	Coaching, consulting and co-creation of knowledge	Bringing in interim external competences
Higher & Executive Education for professionals / life long learning	X	X	X	X	X	
SME/Start-Up consultancies		X			X	X
Multi-stakeholder partnerships including incubators, accelerators, tech clusters, excellence schemes etc.	X	X	X		X	X
Training providers			X			
Industry, associations and professional academies	X	X	X			
Venture capital, investors						X
Content providers / publishers			X			
Vendors			X			

In order to respond quickly to the large demand for eLeadership skilled workers, the education and training systems in all EU member states need to become active quickly.

A good mix of different types of eLeadership skills provision seems to be appropriate with means such as MOOCs offering the highest level of scalability by being able to reach a large number of individuals at one time at the expense of a lower fitness level with the eLeadership topic.

Short courses at higher and executive education institutions developed with the aim of explicitly addressing eLeadership issues come up with a higher fitness level for eLeadership but can only reach a certain number of individuals at a time. Dedicated coaching and consulting services also rate very highly on eLeadership fitness levels but they can be expensive.

The development and provision of learning material to support structured self-learning should also be considered as a worthwhile option as self-learning is the by far most practical way of learning for SMEs and start-ups. An overview of the fitness the different means of eLeadership skills provision and their eLeadership fit, scalability potential, SME fitness etc. is shown in the following table.

Figure 6: Means of eLeadership skills provision

Type	Description	Source	eLeader-ship skills fit	Scalability potential	Start-up fit	Scale-up fit	SME fit
Higher & Executive Education short courses	eLeadership courses targeted at SMEs and start-ups	Universities and Business Schools	●●●●	●●●	●●●	●●●●	●●●●
Coaching and consulting	Problem oriented external consulting by SME/ Start-Up experts	SME / Start-Up Consultancies	●●●●	●●●	●●●	●●●	●●●
E-Learning courses, MOOCs	Interactive, supervised e-learning with feedback, exchange among learners, assignments and examinations	Universities, MOOC platforms and other e-learning providers	●●●	●●●●●	●●●	●●●	●●●
HE, public or MSP entrepreneurship support	Multi-stakeholder partnerships etc. aimed at fostering eLeaderhisp skills	Incubators, cluster initiatives, excellence schemes; tech transfer offices, spin off support, MSPs	●●●	●●	●●●●●	●●	●
Learning material supporting structured self learning	Self-learning using dedicated sets of learning materials (online or offline)	Content providers / publishers	●●	●●●●●	●●●	●●●●	●●●●
Venture Capital, investor interference	Bringing in external (interim) management/ consultants	VC, investors	●●●●	●	●●●●●	●	●
Higher & Executive Education full eLeadership programmes	eLeadership executive programmes at highest competence levels targeted at SMEs and start-ups	Universities and Business Schools	●●●●●	●	●●	●●	●●●
Professional / managerial certification courses	(such as ITIL, PRINCE2 etc.)	Training providers	●●	●●●●	●	●●	●●
Inclusion of entrepreneurship training into initial Higher Education	Teaching entrepreneurship and eLeadership in regular BA/MSc education	Universities	●●	●●●	●●●●	●●●	●●●
Training courses on eLeadership related topics targeted to SMEs or start-ups	offered at industry and professional academies or by commercial training providers, e.g., IT professional bodies, chambers of commerce	Industry associations and professional bodies, training providers	●●	●●●●	●●●	●●●	●●●
Support to informal on-the-job learning	Encouraging / enabling on-the-job ad-hoc self learning („figuring things out“)	Web / observation	●	●●●●●	●●●●	●●●	●●●
Product specific vendor seminars, webinars, product training	e.g. from CRM, ERP or other software / service providers	Vendors	●	●●●	●●●●●	●●●●●	●●●●●

Experiences from first courses and participant feedback

To address the lack of eLeadership education and training fit for fast growing SMEs and entrepreneurs, five universities and business schools engaged with some gazelles and entrepreneurial SMEs to gather and discuss their training and education needs and to develop educational programmes. These took place during 2015 at the New Bulgarian University in Sofia, IE Business School in Madrid, Henley Business School, Antwerp School of Management and Aarhus University with more than 500 participants from industry.

The courses address a variety of the SME requirements identified above and are taught in different formats in terms of duration and intensity of the training and coaching. They are targeting course attendants at different stages in the eLeadership journey. Some are more focused on awareness raising, while others focus on envisioning and strategy development. Some examine very specific ICT skills training or fully fledged MSc programmes.

The participant feedback has been positive. Between 75% and 88% of the participants want to recommend the eLeadership courses they attended to their colleagues.

Future directions: governing the eLeadership initiative

Given the positive feedback, the demonstration activities can be seen as a success and the universities and business schools have committed themselves to continuing these in the future.

Triggered by the European Commission, this new approach to fostering eLeadership skills is now underway. The major European CIO associations including EuroCIO (also taking ownership of the eLeadership curriculum profiles) and CIONET, together with DIGITALEUROPE (the European association representing Europe's ICT industry) and PIN-SME (representing SMEs in the ICT sector) have expressed an interest to become members of the governance board of the initiative. So too are EXIN, APMG International, ASIIN and European Quality Assurance Network for Informatics Education (EQANIE) - all service providers who are supporting eLeadership curriculum profile maintenance, the creation of further curricula and providing quality assurance on programmes submitted. They are supported by a group of academic partners taking ownership of the different curriculum profiles.

CHAPTER 4

Digital skills supply and demand in Europe 2016 – 2020

Introduction

In order to remain innovative and competitive, economies need enough skilled workers to keep up with demand. New technologies are driving digital transformation and reshaping business. This in turn has an impact on how quickly digital skills and competences need to be acquired. Addressing this mismatch between the skills available and those required for the digital transformation of the economy has become a major concern for policymakers.

These changing skills needs and requirements that employers and the ICT workforce face have had an impact on the labour market statistics outlined in this chapter. This chapter describes the development in Europe, within both a core and a broader definition of ICT jobs; examines the changes in the numbers of ICT students and graduates which are a major source of talent entering this workforce, and elaborates on the trends of digital skills demand and supply to develop a forecast scenario up to 2020.

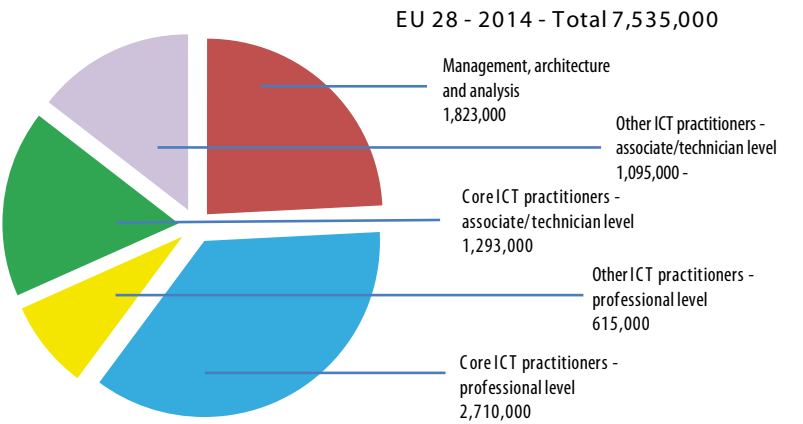
ICT has been one of, if not the most dynamic labour market in Europe and globally, both in terms of the number of digital workers as well as in terms of occupational tasks and requirements. Apart from domain skills in ICT, which has been a traditional area of expertise of ICT practitioners, there is an increasing need for other skills including transversal skills such as social skills, organisational skills and business acumen.

ICT workforce

The ICT workforce, according to our definition, in Europe in 2014 comprised of 7.5 million workers, or 3.5% of the European workforce.

The ICT workforce is defined here according to occupational categories from the ISCO-08 (International Standard Classification of Occupations) and quantifications are made using data from the Labour Force Surveys (LFS) of the EU-28 member states provided by Eurostat. Broadening the definition further to include 'blue collar' ICT mechanics and manual workers skills (in ISCO groups 7 and 8) would add 1.4 million ICT workers to a European labour force of 8.9 million ICT workers.

Figure 1: ICT professional workforce in Europe 2014 by ISCO-08 skills clusters



Source: empirica. Based on EU-LFS data (Eurostat).

Figure 2: ICT practitioner workforce in Europe 2014

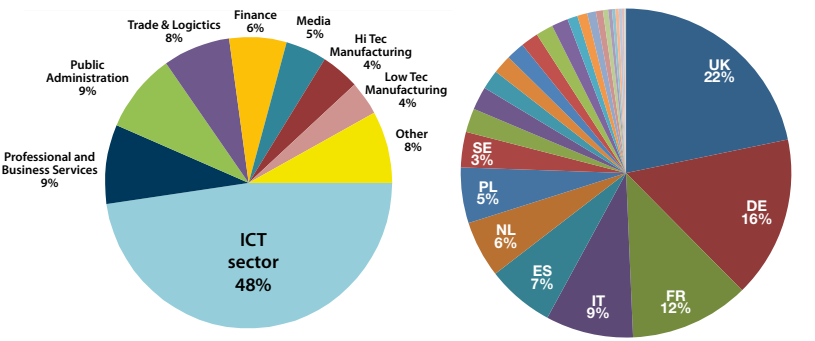
	ISCO-08 code	Worker totals (EU28)
ICT practitioner workforce		**7,535,000**
Management, architecture and analysis		**1,823,000**
Information and communications technology service managers	1330	416,000
Management and organization analysts	2421*	661,000
Systems analysts	2511	746,000
Core ICT practitioners - professional level		**2,710,000**
Software developers	2512	821,000
Web and multimedia developers	2513	151,000
Applications programmers	2514	785,000
Software and applications developers and analysts n.e.c.	2519	342,000
Database designers and administrators	2521	85,000
Systems administrators	2522	380,000
Computer network professionals	2523	105,000
Database and network professionals n.e.c.	2529	42,000
Other ICT practitioners - professional level		**615,000**
Electronics engineers	2152	238,000
Telecommunications engineers	2153	235,000
Information technology trainers	2356	25,000
Information and communications technology sales professionals	2434	117,000
Core ICT practitioners - associate/technician level		**1,293,000**
Information and communications technology operations technicians	3511	396,000
Information and communications technology user support technicians	3512	658,000
Computer network and systems technicians	3513	181,000
Web technicians	3514	57,000

		ISCO-08 code	Worker totals (EU28)
Other ICT practitioners - associate/technician level			1,095,000
	Electronics engineering technicians	3114	208,000
	Process control technicians n.e.c.	3139	208,000
	Air traffic safety electronics technicians	3155	7,000
	Medical imaging and therapeutic equipment technicians	3211	242,000
	Medical records and health information technicians	3252	18,000
	Broadcasting and audio-visual technicians	3521	212,000
	Telecommunications engineering technicians	3522	200,000

*Source: empirica. Based on EU-LFS (Eurostat). Some further estimates apply. * Note that ISCO group 2421 was multiplied by 50% in order to allow only for ICT (related) consulting.*

ICT practitioners are working in almost all industries of the economy and not just in the ICT industry sector. Three countries account for half of today's ICT jobs - the United Kingdom, Germany and France. By adding Italy, Spain, Poland and the Netherlands, this group of seven countries makes up three quarters of the European ICT professional workforce.

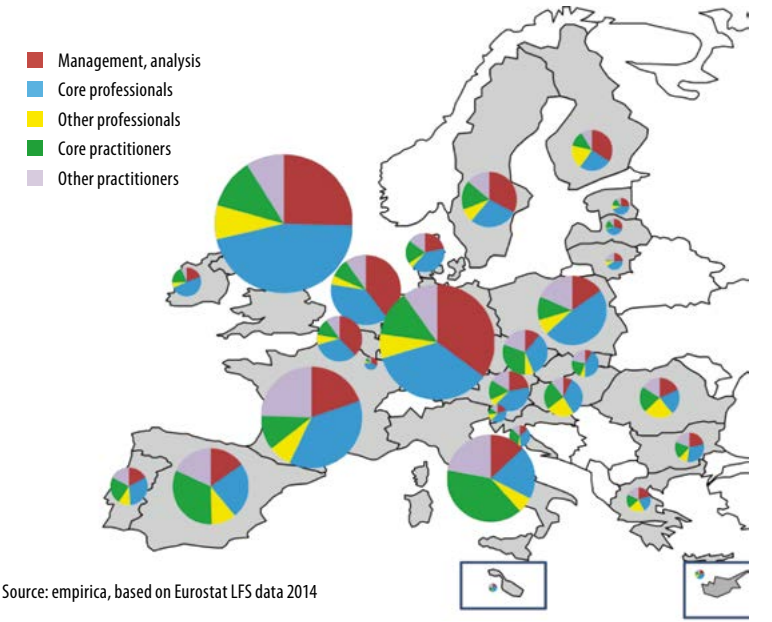
Figure 3: ICT professional workforce in Europe by ICT and non-ICT industry (2013) and ICT professional workforce by EU member state (2014)



Source: empirica

The share of the ICT professional workforce within the total workforce is 3.4% in Europe and varies significantly across the European countries. In the Netherlands, the United Kingdom, Sweden, Finland and Luxembourg this share is more than 5%. Sixteen EU member states have shares below the EU27 average (3.4%) and Greece, Lithuania, Romania and Cyprus have a share below 2.5%.

Figure 4: The structure of the ICT workforce in European countries (EU27) in 2014



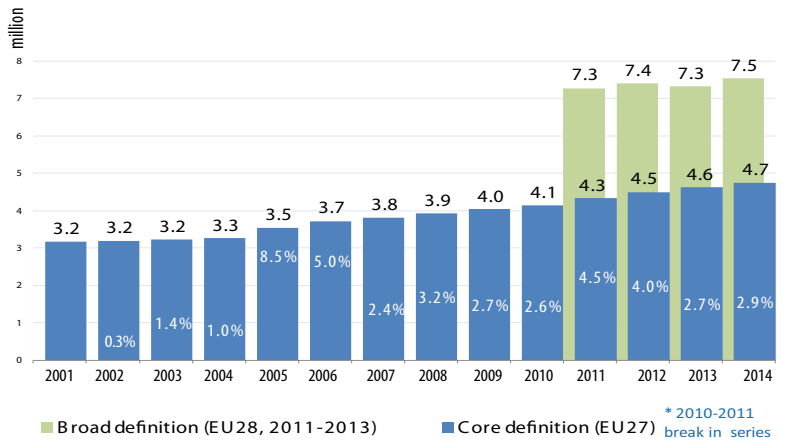
Source: empirica

There are also significant differences in the workforce structure between countries. Countries with a larger ICT workforce also tend to have a higher share of high-level skills in the ICT workforce. In the Netherlands, which features the largest share of management, architecture and analysis jobs, their share is 40%, followed by Belgium (38%), Germany (35%), Finland (34%), Sweden (33%), Luxembourg (31%) and Latvia (30%). Countries with a share below 15% are, in ascending order, Hungary, Slovakia, the Czech Republic, Italy and Croatia.

Developments

The development of the ICT workforce in Europe between 2000 and 2014 has been very dynamic. The size of the 'ICT workforce' naturally depends on the definition used. In a minimum definition that only includes a core set of practitioners, there is an average compound growth rate of 4.3% from 2000-2010, and a 3.2% growth rate between 2011 and 2014 (with a break in the series between 2010/11). In a broader definition, today's ICT workforce in Europe amounts to 7.5 million workers and the growth of the workforce has been on average 1.2% between 2011 and 2014 (there is no data available before 2011 for the broader definition).

Figure 5: Development of ICT employment and average annual growth rates in Europe 2000 – 2014

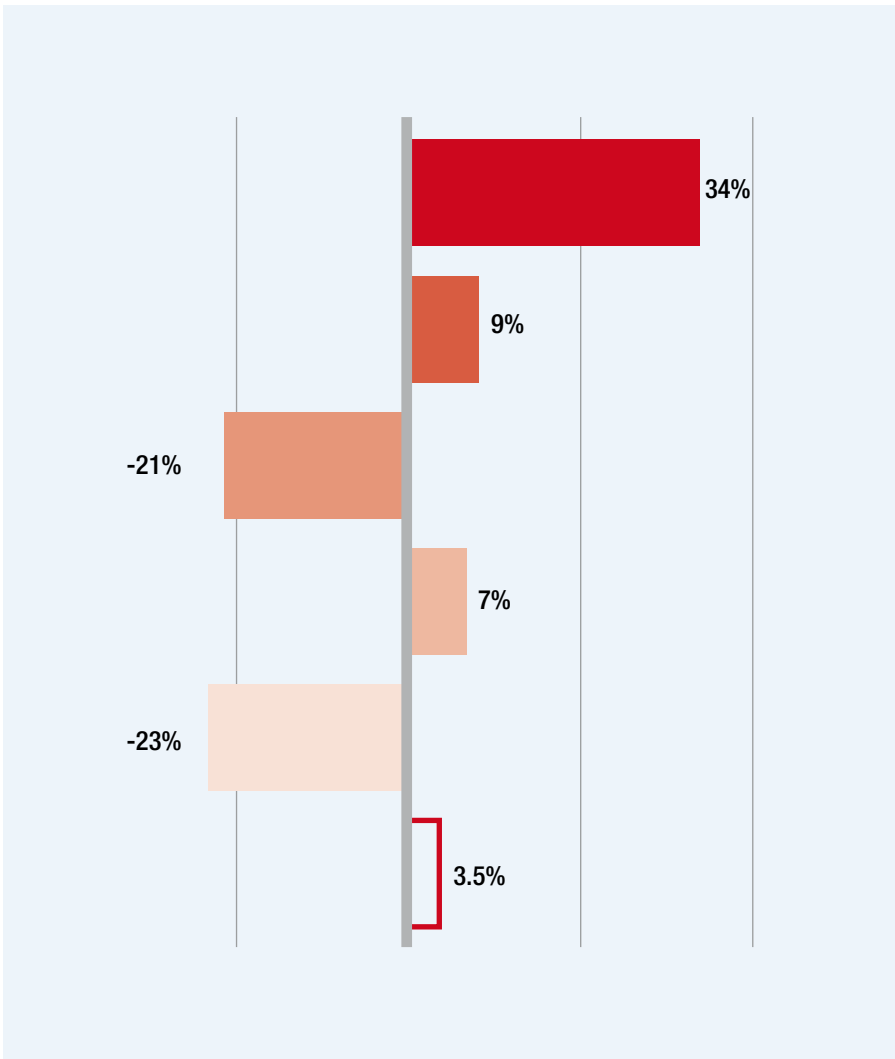


Source: Eurostat LFS. Narrow definition: 2000-2010 ISCO-88 groups 213, 312: 'Computing professionals' and 'Computer associate professionals'. Break in series 2011: ISCO-08 groups 25 'ICT professionals', 35 'information and communications technicians'. Broad definition: see elsewhere in this chapter.

It is important to note that between 2008 and 2010, when the financial crisis hit most other labour markets, ICT employment increased on average by 2.65% per year. From 2011 onwards, when statistical institutes switched to a new taxonomy, it was possible to produce a broader statistic of the ICT workforce, including many more ICT jobs, as is described by the 'broad definition'.

In the broader definition there is more variance and less growth for the four years of measurement available. In the more detailed data, it is possible to see that massive changes in the structure of the workforce are happening right now. There is a surge in 'management' and 'plan/design' positions: IS management and governance, architecture and analysis. Europe has added 459,000 jobs in this category in only three years.

Figure 6: Growth of ICT professional workforce (EU27) 2014 compared to 2011 (3.5% total)



There is also high demand for 'core ICT jobs', such as software and application developers, web and multimedia experts, database designers and administrators, system administrators and network and operations practitioners.

At the same time, a decrease in the number for some other jobs can be seen such as peripheral, enabling and maintenance occupations. This includes telecoms and electronics engineers, sales and training professionals and technology specific maintenance and operation technicians.

Management, architecture and analysis	ICT managers Management and organization analysts (partly) Systems analysts
Core ICT practitioners - professional level	Software developers Web and multimedia developers Applications programmers Other software and applications developers and analysts Database designers and administrators Systems administrators Computer network professionals Other database and network professionals
Other ICT practitioners - professional level	Electronics engineers Telecommunications engineers IT trainers ICT sales professionals
Core ICT practitioners - associate/ technician level	ICT operations technicians ICT user support technicians Computer network and systems technicians Web technicians
Other ICT practitioners - associate/ technician level	Electronics engineering technicians Process control technicians not elsewhere classified Air traffic safety electronics technicians Medical imaging and therapeutic equipment technicians Medical records and health information technicians Broadcasting and audio-visual technicians Telecommunications engineering technicians

Source: empirica

Digital skills demand and shortages

Today, like in almost all of the recent years (except for those in the aftermath of the dotcom bubble bursting), the demand for ICT workers is outstripping supply. Online vacancy data (Jobfeed.com) has been analysed to estimate the number of open positions for ICT professionals. Based on the results, it is estimated that there are currently 373,000 open positions for ICT professionals in Europe.

Among these, 16% (58,000) are vacancies for highly qualified positions in ICT management, architecture and analysis and 84% (315,000) are vacancies for all other ICT professionals. This is a rather surprising finding given the dynamics of the number of highly qualified positions and deserves some further research in the future. It is an increase compared to the previous survey-based (CIOs and HR managers) estimate of 2013. The results of a representative empirica survey in 2012 of CIOs and HR managers in eight European countries showed demand for digital skills at around 274,000 in 2012.

While it can be estimated that the number of vacancies has increased by 99,000 between 2012 and 2015, at the same time the number of ICT jobs has increased by 272,000 to a total of 7,674,000.

The open vacancy data that is available from different sources for several countries shows that there is a severe excess demand for ICT jobs classified in the core practitioner category. The most sought after IT positions currently are software development, database design and administration jobs. These jobs are in high demand with many unfilled vacancies reported.

ICT professional workforce forecasts

In the 'Main Forecast Scenario', developed by empirica and IDC, the ICT workforce in Europe will grow from 7.5 million in 2014 to 8.2 million in 2020, of which 6.1 million will be ICT practitioners and 2.1 million will be ICT management and analysis level employees.

This is based on an economic growth scenario which predicts a slow recovery for the period 2015-2020 and moderate IT investment growth of around 3% per year after 2015. In the education domain, a slight increase in the number of ICT graduates (1%) and in labour mobility within the EU from countries of low demand to countries with excess demand was modelled.

Demand is increasing, despite the modest economic circumstances, to over eight million in 2015 and an estimated 8.9 million in 2020. The excess demand or shortage (calculated as the number of open posts) amounts to 365,000 vacancies in 2015 and 756,000 vacancies in 2020. This figure can best be described as 'demand potential' or 'job potential' for ICT jobs.

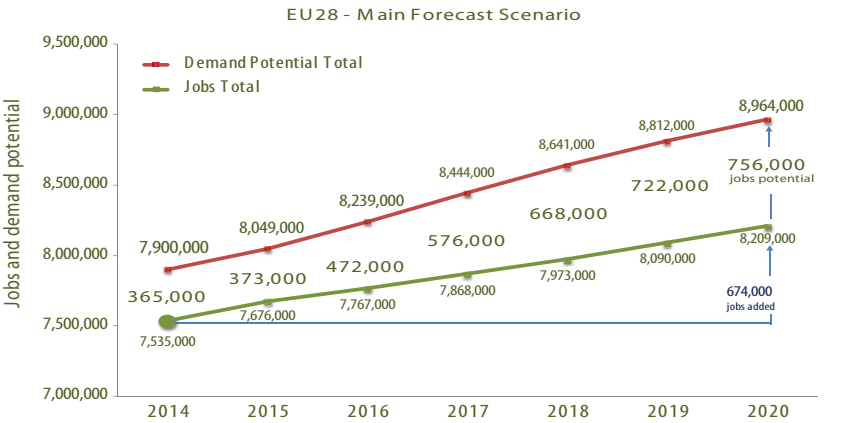
It should be seen as a theoretical figure to describe the demand potential for new ICT jobs which, by using the above assumptions, could be created in Europe due to an digital skills demand that is likely to occur especially in the years closer to 2020.

Figure 7 – Digital skills jobs – 'Main Forecast Scenario': development ICT professional digital skills jobs in Europe 2014 – 2020

	EU28 (millions)	2014	2015	2016	2017	2018	2019	2020
JOBS	ICT Management	1,823,000	1,840,000	1,852,000	1,912,000	1,986,000	2,065,000	2,149,000
	ICT Practitioners	5,712,000	5,836,000	5,915,000	5,956,000	5,987,000	6,025,000	6,060,000
		7,535,000	**7,676,000**	**7,767,000**	**7,868,000**	**7,973,000**	**8,090,000**	**8,209,000**
DEMAND	ICT Management	1,880,000	1,898,000	1,994,000	2,092,000	2,189,000	2,284,000	2,375,000
	ICT Practitioners	6,020,000	6,152,000	6,244,000	6,352,000	6,452,000	6,529,000	6,589,000
		7,900,000	**8,049,000**	**8,239,000**	**8,444,000**	**8,641,000**	**8,812,000**	**8,964,000**
VACANCIES	ICT Management	57,000	58,000	143,000	180,000	203,000	218,000	226,000
	ICT Practitioners	307,000	315,000	329,000	396,000	465,000	504,000	530,000
		365,000	**373,000**	**472,000**	**576,000**	**668,000**	**722,000**	**756,000**

Source: empirica and IDC Europe model forecast.

Figure 8: 'Main Forecast Scenario': ICT professional jobs and demand in Europe (EU-27) 2014 – 2020

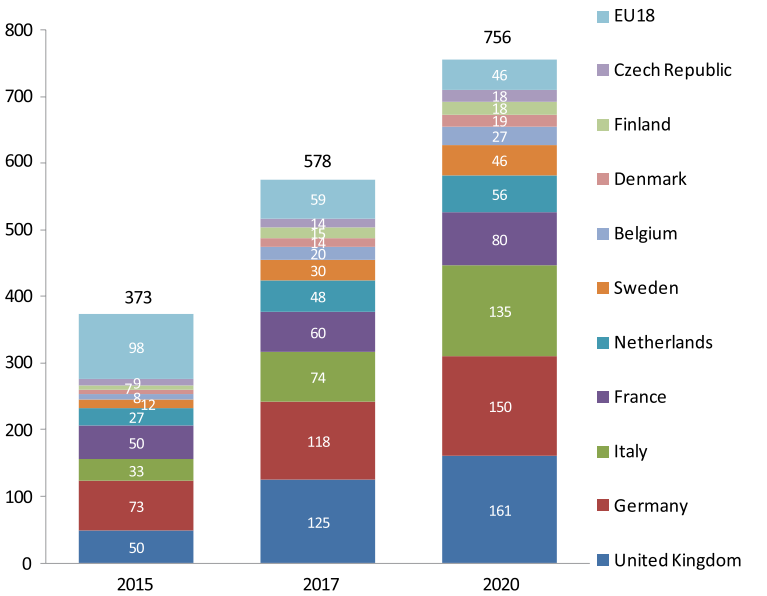


Source: empirica

Currently a relative majority of vacancies exists in Germany, and the comparably lower graduate figures in the United Kingdom and in Italy suggest that the problem of skills shortages will severely worsen in these countries. While in absolute figures increasing from 73,000 (2015) to 150,000, the share of German vacancies in the European will remain at 20%.

Figure 9: 'Main Forecast Scenario': digital skills vacancies estimate 2015 – 2020. '

Digital skills estimate 2015 – 2020 - 'Main forecast scenario': Distribution of vacancies per country ('000s)



Source: empirica

By contrast, the number of vacancies in the UK is likely to grow significantly from 50,000 to 161,000 (13% to 21%) while in Italy, the number of vacancies is expected to rise from 33,000 to 135,000 (9% to 18%). These figures, of course, strongly depend on (among other factors) the cross border mobility of IT workers into countries with the highest demand.

The 'Main Forecast Scenario' features a modest but steady job growth of on average 112,000 ICT workers per year until 2020, a figure which is curbed by supply. More than 750,000 more jobs could be created if the skills were available. The largest bottlenecks are in the UK and Germany, but also in Italy. Taken together, these three countries will account for almost 60% of all vacancies in Europe.

Outlook

Demand for ICT skills keeps growing at a tremendous pace. The trend in core IT jobs has seen up to 4% growth per annum while the growth in management jobs has seen up to 8% growth per annum. However, demand for medium-level skilled associate and technician jobs is declining. In total, despite the financial crisis, new jobs are being created in Europe continuously. Therefore, there is a need for a constant increase in the quality and the relevance of digital skills. At the same time, although graduate figures seemed to have stabilised, supply from universities does not seem to have kept up.

The largest job growth is in highly skilled jobs, such as in management, architecture and analytics positions, and also for software development and application specialist positions, including databases. In addition, the pace of change is still increasing in ICT jobs, and new job profiles arise which cannot yet be fully covered in statistical classification, such as big data and cloud computing specialists. Many of the new jobs may not even be solely ICT jobs but will mix digital and functional skills, for instance in finance, marketing, or consulting. This is a huge opportunity for new job creation in all industry sectors, beyond traditional ICT studies. However, ICT needs to be incorporated into other and new educational pathways.

ICT has traditionally been a field where the initial and formal education did not determine the career trajectory. However, recent endeavours have been made to achieve a higher level of professionalisation within the industry which increasingly includes formal education and certification requirements. There is an immense opportunity today for new education approaches, modes of delivery, curricula designs and learning outcomes.

Figure 10: ICT workforce in Europe in 2014

	Management, architecture and analysis	Core ICT practitioners - professional level	Other ICT practitioners - professional level	Core ICT apractitioners - associate/ technician level	Other ICT practitioners - associate/ technician level	TOTAL	Share of workforce
UK	417,000	751,000	131,000	192,000	146,000	1,638,000	5.4%
DE	421,000	422,000	82,000	153,000	118,000	1,197,000	3.0%
FR	175,000	329,000	65,000	97,000	217,000	882,000	3.4%
IT	84,000	125,000	37,900	256,000	143,000	646,000	2.9%
ES	76,000	118,000	53,000	161,000	91,000	499,000	2.9%
NL	167,000	159,000	17,000	36,100	41,000	420,000	5.1%
PL	63,000	197,000	30,000	44,900	76,000	412,000	2.6%
SE	86,000	75,000	21,100	44,600	36,200	262,000	5.5%
BE	67,000	59,000	12,500	21,500	17,600	177,000	3.9%
CZ	19,000	56,000	11,200	52,000	33,200	172,000	3.5%
FI	49,000	37,300	27,100	17,600	12,800	144,000	5.9%
AT	31,100	56,000	7,800	22,200	22,400	139,000	3.4%
RO	24,900	28,000	32,700	28,100	21,800	136,000	1.6%
DK	28,200	51,000	5,600	25,300	19,200	130,000	4.8%
HU	9,400	43,100	30,200	31,500	13,600	128,000	3.1%
PT	21,000	38,300	12,800	28,400	20,900	121,000	2.7%
BG	16,100	23,400	7,200	14,000	14,200	75,000	2.5%
IE	14,400	35,700	4,500	14,300	4,700	74,000	3.9%
SK	5,700	26,600	3,700	14,300	13,900	64,000	2.7%
GR	10,500	11,500	11,100	9,600	9,300	52,000	1.5%
HR	5,300	13,800	1,700	13,400	5,000	39,100	2.5%
SI	5,700	11,300	3,200	3,500	3,900	27,500	3.0%
LT	6,000	10,300	2,300	600	5,500	24,800	1.9%
EE	6,100	10,800	1,900	3,400	2,200	24,400	3.9%
LV	7,100	9,300	400	4,000	2,600	23,400	2.7%
LU	4,900	7,400	1,000	1,500	1,300	16,200	6.6%
CY	1,600	3,100	900	1,100	1,000	7,700	2.1%
MT	1,100	2,100	300	1,100	1,600	6,300	3.4%
EU28	1,823,000	2,710,000	615,000	1,293,000	1,095,000	7,535,000	3.5%

Source: empirica based on EU-LFS (Eurostat)

Figure 11: ICT graduates (first degrees in ISCED 5A and first qualifications in 5B) in Europe 2012

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
EU28	109,000	121,000	128,000	130,000	125,000	122,000	115,000	115,000	114,000	111,000
France	16,100	18,100	20,000	19,700	18,400	17,600	19,100	20,000	20,700	20,000
UK	31,000	27,700	29,600	28,200	25,200	23,800	19,200	19,200	19,500	19,900
Germany	8,400	11,100	12,800	14,200	16,100	16,500	17,200	16,800	16,500	16,800
Spain	19,300	19,700	18,600	17,300	15,800	14,600	15,100	15,100	14,800	11,900
Poland	5,900	10,700	13,100	14,800	14,200	13,000	12,400	12,500	12,300	10,900
Netherlands	1,770	3,600	4,000	4,700	4,500	4,100	4,000	3,900	3,700	4,000
Czech Rep.	1,220	1,500	1,640	2,100	2,400	2,900	3,000	2,900	2,800	2,900
Greece	1,210	1,330	2,900	2,000	1,100	2,200	2,200	2,300	2,300	2,700
Italy	2,800	3,200	3,500	3,500	3,400	2,900	2,900	2,800	2,400	2,200
Hungary	640	1,290	1,330	2,900	3,000	2,600	2,200	2,200	1,970	1,670
Sweden	2,200	2,200	2,100	2,000	1,630	1,430	1,360	1,400	1,620	1,660
Romania	3,800	4,400	4,400	4,500	4,400	4,600	2,800	2,100	2,000	1,600
Denmark	1,390	1,520	1,220	1,000	840	870	900	1,240	1,430	1,540
Austria	560	1,080	1,500	1,970	2,000	1,820	2,000	1,630	1,560	1,520
Croatia	460	360	450	470	630	1,150	1,250	740	1,120	1,500
Belgium	2,700	2,800	2,700	2,500	2,600	1,840	1,140	1,340	1,370	1,380
Slovakia	960	1,100	1,060	1,090	1,370	1,480	1,580	1,500	1,380	1,270
Ireland	4,000	3,400	1,080	1,160	1,240	1,330	1,410	1,630	870	1,250
Bulgaria	640	730	710	760	750	760	800	980	1,100	1,240
Finland	1,610	1,780	1,810	1,720	1,750	3,000	1,060	1,230	1,120	1,110
Lithuania	610	780	910	1,200	1,160	970	910	970	820	840
Portugal	890	1,030	1,100	910	1,180	1,240	1,010	770	780	700
Slovenia	120	140	180	200	270	290	340	430	540	690
Latvia	520	540	560	610	610	600	580	580	620	610
Estonia	300	360	540	500	560	380	380	400	410	410
Malta	40	50	50	130	90	150	150	150	230	210
Cyprus	190	210	210	180	230	220	190	180	300	210
Luxembourg	60	110	110	140	70	30	30	30	30	30

Source: based on Eurostat, some estimates.

CHAPTER 5
Digital skills in the United States

Introduction

As an advanced economy and leader in many technology fields, the United States' (US) future hinges on a workforce with broad overall digital competencies and science, technology, engineering and maths (STEM) skills, as well as highly trained individuals with advanced degrees in fields such as computer science (CS) and engineering. With world-class universities, industries and research laboratories that attract the best and brightest from across the globe, the upper stratum of the US' digital workforce is strong. However, the quantity of workers with digital skills falls short of market demand. This shortage is fueled by a failure to provide CS and other digital training to many students in primary and secondary schools, a restrictive immigration system that turns away many skilled foreigners (including graduates from the US' own prestigious universities), and slow adjustment by the university system to accommodate and train a larger number of CS students.

Digital skills in the marketplace

Digital skills are becoming increasingly important in all sectors of the economy, and indeed have revolutionised industries from marketing to manufacturing. IT jobs in the US are growing much faster than other occupations. Over the last decade, the US economy has added over 1.1 million new IT jobs (Bureau of Labor Statistics), a 36% increase compared to just a 3% increase in the overall US job market. The vast majority of these IT jobs are in fact not in the IT industry itself, but in industries that use IT. While both IT and overall jobs took a hit during the recession in 2008, IT jobs recovered quickly, increasing again the next year and by 2011 had surpassed 2008 levels (Bureau of Labor Statistics). While unemployment rates reached 9.4% in the US economy in 2010, unemployment for STEM graduates hovered around 4%, with two STEM job openings listed for every unemployed worker with a STEM degree during the Great Recession (Change the Equation).

Today, recent graduates with advanced degrees in engineering and CS are quickly snapped up by the marketplace. Many apply their STEM skills to jobs beyond traditional technology industries, including finance (Lindenburger M, 2014). Every sector of the economy demands workers with STEM skills, not just traditional technology-based industries (Nager A, 2014). Eighty-one percent of STEM graduates hold jobs closely related to their degrees, compared to 72.5% among all graduates. Median starting salaries for CS and engineering graduates are estimated at around $67,300 and $64,400, respectively, 80%

higher than starting salaries for humanities and liberal arts majors (National Association of Colleges and Employers, 2014).

High wages and employment rates derive from high demand for these digitally-skilled workers. In fact, the US faces an acute shortage of qualified STEM workers, with as many as half a million US jobs unfilled for want of adequately skilled workers (Lapowsky I, 2015). The majority of Chief Executive Officers (CEO) report that they have trouble finding workers with advanced IT training. Bidding wars for scarce talent have increased wages, forcing many industries to forego the benefits conferred through IT adoption. Given projected job growth and current graduation levels, the US' STEM shortage is likely to deepen.

Digital skills in US primary and secondary schools

Despite the significant demand for CS and digital skills in the workforce, US primary and secondary schools have for the most part failed to adapt and teach in-demand computer concepts. While recent progress is encouraging, the fact remains that most US students do not have the opportunity to take rigorous CS classes before college.

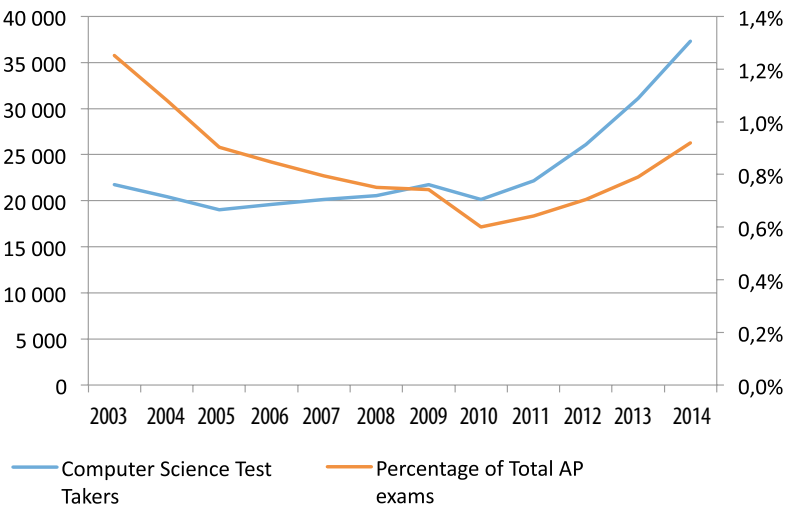
Technology can play at least three main roles in education - first as a vehicle for improving access to excellent teachers and other educational opportunities, second as a teaching aid that facilitates learning, and third as for a means of helping students develop ICT-related skills needed in the knowledge economy (UNESCO Institute for Statistics, 2006). With a student-to-computer ratio of three to one, the US has made a considerable investment in using ICT to accomplish the first goal (National Center for Education Statistics). However, computers in US schools are used to teach technology courses that typically focus not on computing concepts but basic skills, including typing and training on obsolescent word editing and spreadsheet software. Only 37% of US states have standards that include computing concepts, rather than just skills and capabilities (Computer Science Teachers Association).

With regard to STEM education, US high schools stress biology, chemistry, and physics, in that order, with CS an afterthought in schools that teach it at all, and engineering barely represented. Unfortunately, 51% of schools offering CS report that it is common for students with both an interest in and aptitude for CS, to be 'crowded out' of CS courses because traditional STEM courses are deemed more important (Computer Science Teachers Association).

However, some school districts are attempting to reach students at earlier ages. In ten years, all public schools in New York City will offer CS classes (Turkel D, 2015). Early in 2015, the state of Arkansas passed legislation mandating that CS be taught at all public and charter high schools (Lapowsky I, 2015).

As the maze of individual state standards (or lack thereof) in CS and digital skills training lacks coherence, the Advanced Placement (AP) CS exam is a de-facto national benchmark that can measure the progress of CS education. Disappointingly, CS tests comprise a tiny share of all AP tests taken, and that share has declined over the past decade (although it has rebounded somewhat since 2010). This is especially problematic, because students who took the AP CS exam are eight times more likely than other incoming freshmen to major in CS (Mattern K, Shaw E and Ewing M, 2015).

Figure 1: AP CS test takers



Source: College Board, AP Program Participation and Performance Data 2015

One issue is that the CS AP exam is not available in most schools, which in part reflects of the lack of focus on CS education in high schools. In fact, only 18 % of schools offering AP calculus exams offer the AP CS exam (College Board, 2013-2014). In addition, white and Asian males are over-represented among AP CS test takers, and only 20% of test takers are female, the heaviest gender bias of any AP exam. Unfortunately, these rates contribute directly to wide gender gaps in the labour market. Currently, 76% of US workers in computer occupations are male (Bureau of Labor Statistics). Moreover, Hispanic and black students are underrepresented. On average they score significantly lower on the exams.

Though total enrollment in the CS AP courses remains small, it has increased by 85% since 2010 after being stagnant for much of the 1990s and 2000s (College Board, 2015). This increase seems to have been in part prompted by 25 states passing reforms allowing CS to count as a maths or science course, whereas prior to

that all states counted CS as an elective. In states where CS is treated as an elective, average class sizes are only 6.2 students, compared to 9.5 in states where CS counts as fulfilling a graduation requirement (Code.org and Computing in the Core).

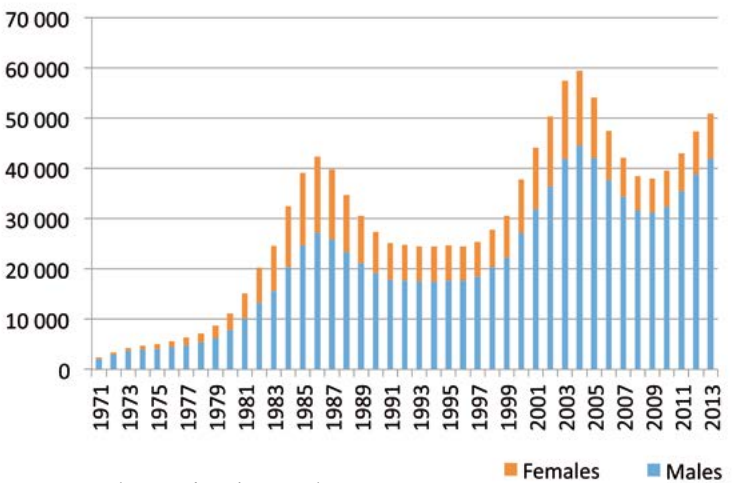
Additionally, there have been some efforts in the US to create private or public charter schools focused around technology education. For instance, San Diego's High-Tech High school, IBM-funded Pathways in Technology Early High School (P-TECH), and Microsoft's School of the Future in Philadelphia, among many others, offer non-traditional, STEM-focused education opportunities to students looking to dive deep into technology education before college (Kolderie T and McDonald T, 2009).

Digital skills in US universities

While the US' primary and secondary schools have lagged behind in recognising the importance of digital skills, the US boasts world-class CS departments at the tertiary level. Led by Massachusetts Institute of Technology (MIT), Harvard, and Stanford, the US has 19 of the top 50 international CS departments (U.S News Education).

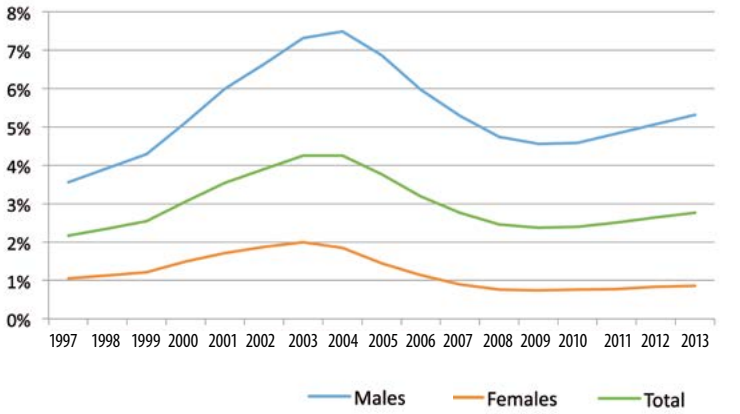
In 2013, US universities graduated 50,962 computer scientists with bachelor's degrees—a high-water mark for recent years that reflects a possibly temporary spike in interest in CS - as well as 24,603 computer scientists with advanced degrees (National Center for Educational Statistics, 2014). Only about 5% of bachelor's students in CS are foreign born, but 49% of post-baccalaureate students in CS are from outside the U.S (National Science Foundation, 2012).

Figure 2: Bachelor degrees in CS, 1971-2013



Source: National Center for Educational Statistics

Figure 3: CS Bachelor's degrees conferred to males and females as a percentage of total degrees, 1997-2013



Source: National Center for Educational Statistics

Despite the recent increase in CS degrees, there is some evidence that universities are not expanding enrollment enough to respond to increased demand. Offering more courses is costly for universities, especially state-supported universities on limited budgets, as CS is more expensive to teach than most non-STEM fields. Universities, public and private, also face challenges in adjusting their number of faculty in response to growing demand in particular fields and lagging demand in others, especially when faculty members are tenured. Instead of addressing these challenges head on, many universities have taken steps to limit the number of students in CS courses by increasing tuition for CS majors or restricting the size of the major by implementing weed-out classes. Others lessen the quality of the courses they offer by resorting to enormous lectures or online courses (Lazowska E, Roberts E and Kurose J, 2014).

Non-traditional initiatives

While the US school system has not fully responded to the increased importance of CS and digital skills, more employers, parents, and even students recognise the benefits of learning CS. In response, a new generation of non-profit organisations and advocacy groups, learning programmes, and courses have sprung up in response. Non-profit organisations such as Code.org, Code Academy, CS10k, Computer Science First, Black Girls Code, CompuGirls, and Girls who Code seek to democratise access to CS education across gender lines and socioeconomic divides; introduce CS to students at a younger age; train more teachers; and put CS into more schools.

As non-profit organisations, these initiatives are mostly funded through a combination of grants from private foundations, gifts from individuals and corporate philanthropy. In particular, corporate philanthropy plays a major role in funding these efforts. For example, Google partners with the Boys and Girls Clubs of America to provide CS opportunities for youth, Microsoft recently dedicated $75 million to funding non-profit CS education efforts, and several other large corporations have demonstrated commitments to provide funds to connect students with high-quality CS and STEM education programmes.

In addition, computer learning programmes aimed at adults are increasingly popular. Many Americans are realising that further education courses in computers can complement their current skill set and improve their career prospects. The recent TechHire Initiative, launched by the Obama administration in March 2015, will invest $100 million to train or retrain professionals in digital skills (Lapowsky, I, 2015). Private initiatives like Recurse Center and others also provide continued CS education allowing people to reinvent their digital skill sets. As the benefits of 'double-deep' skills, or complementary expertise in both digital skills and in another field, grow, many workers may seek to take basic courses to endow themselves with additional skills they need to succeed (Moschella D, 2015).

Immigration bolsters the US' high-skills workforce

High-skilled immigration is the US' saving grace in mitigating its STEM-skills shortage. The US has long been an attractive destination for skilled workers. With the US debate on immigration still focused on low-skilled immigration from Latin America, US policymakers have been unable to increase the availability of green cards and other visas that allow globalised talent to relocate to the US. H-1B guest worker visas are capped at a restrictive 85,000 per year, despite the fact the US received 235,000 applicants for fiscal year 2016. Most H-1B guest workers are employed in IT or engineering jobs. Slots for permanent residents lag well behind the demand for STEM workers to emigrate. Even foreign students who graduate from US universities find that opportunities for staying and working in the US are limited.

Conclusion

The US is at a crossroads in its attempts to endow its workforce with digital skills. While world-class universities produce top graduates in computer fields, the US educational system has largely failed to produce the quantity of skilled workers to satisfy domestic demand. Additionally, the US immigration system fails to accept enough foreign workers to fill this gap. However, both public and private initiatives outside of the education system have recently begun to offer digital skills to both students and professionals.

CHAPTER 6

Digital skills in Japan

Introduction: the economy and information technology industry situation

Japan's GDP is currently the third largest worldwide after the US and China with a growth rate of about 2%. One of the main factors impacting the low growth rate is population decrease. IT sector growth remains at a stable but low level in 2015. Preparations for the Tokyo Olympic Games and Paralympics in 2016 will boost IT budgets in government offices and the public sector, communications and social infrastructure industries such as media and transit/transit services will benefit.

A high growth rate is expected in cloud computing, big data, mobility, social media and the new business areas such as Internet of things (IoT) as opposed to in the more conventional business areas. As a result, business structures are changing the domestic IT market. In the past, IT was being used for productivity improvements and increasing efficiency by focusing mainly on system integration but more recently, enterprises are using IT for new business development and new market creation. However, information security is a major concern and if not addressed properly by business, academia and government, it will have a serious impact on society.

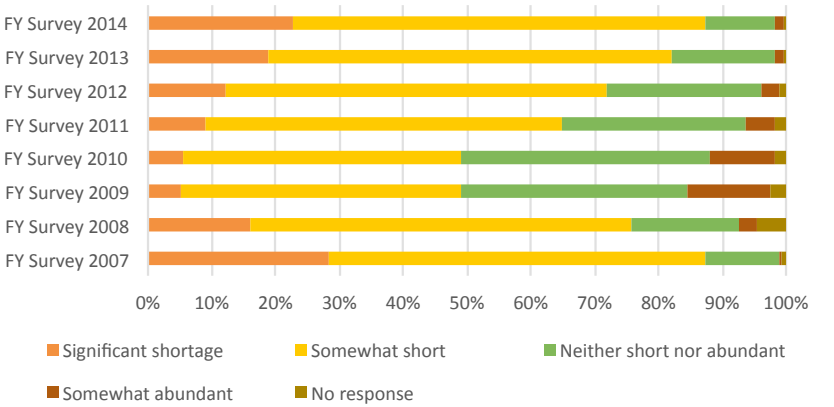
The Information Technology Promotion Agency (IPA) promotes the various activities of the IT industry under the umbrella of the Japanese Government METI (Ministry of Economy, Trade and Industry). Its main mission is to develop information security, increase reliability of software and ensure IT human resources development.

The challenge of IT human resources development

Following the 2007-2008 financial crisis the volume and quality of information communications technology (ICT) labour has been a serious issue in Japan. As a result, Japan is looking to increase digital skills within the workforce by developing human resources within businesses and across the new hire base, by developing the employment of female workers, as well as by outsourcing from overseas. However, tens of thousands of workers do not have the skill sets to match specific job profiles such as 'data scientist' and 'information security specialist' and as a result Japan is losing business opportunities. Enterprise retraining initiatives are insufficient to meet demand for job profiles in new,

globally popular, business areas. On the other hand, business growth combined with a shifting of traditional business models to new business models is expected in Japan. It is also expected that young entrepreneurs and start-up companies will lead and accelerate this shift.

Figure 1: Chronology of ICT workforce shortages



Source: IPA, 2015

IT human resources development activities

To solve the issues outlined above, the IPA is taking a number of steps.

1) Human resources development

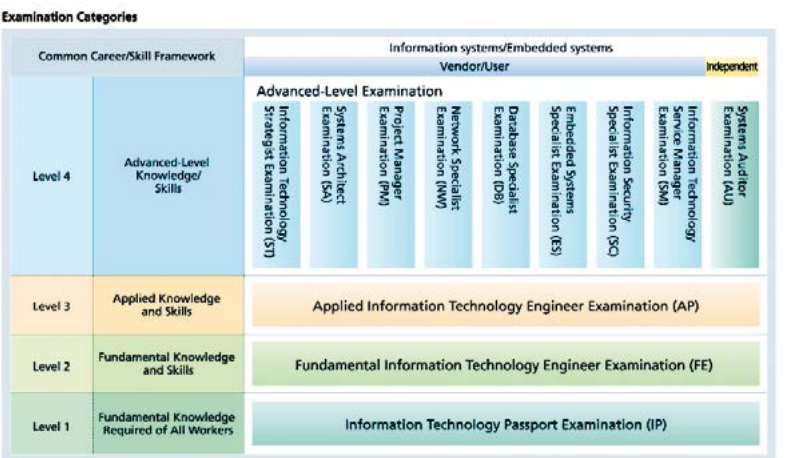
To address the challenges of IT human resource development, an understanding of the current state of digital skills in Japan is required. The IPA has published a White Paper on IT human resources annually since 2007 based on a survey of the IT industry, IT in other industries and academic institutions. The responses give an insight into the current status and trends of IT human resources. The findings are used for human resource development strategy and the development of educational curricula by personnel departments, educational institutions and academia. Currently, the data is used only in Japan but the IPA would like to exchange the data with other countries to compare and contrast the findings globally.

2) Qualifications in IT

Since 2004, the IPA has overseen an IT certification scheme developed by the Japanese government (METI; Ministry of Economy, Trade and Industry). The scheme is organised into skill levels (levels one to three) and is underpinned by exams taken by people from any industry sector. The highest level, level four, is for advanced professionals as shown in the chart below. About 400 examination committee members set exam questions from industry and academia and exams take place twice a year.

About 460,000 business people and students have taken these exams each year. Some businesses value the skills covered by this scheme so highly that they have made passing this exam a condition for staff promotions or salary increases. The scheme has also been used in Asian countries with, for example, levels one to three being developed in Bangladesh, Malaysia, Mongolia, Myanmar, the Philippines, Thailand and Vietnam.

Figure 2: National IT examination / certification in Japan



Source: IPA, 2015

3) Digital skills framework

To measure ability and digital skills in industry and academia, a skills framework was first developed in 2002 and reviewed thereafter. The 'i Competence Dictionary' (iCD) was published in 2014 replacing a 'Common Career Skills Framework' created in 2008. The iCD expands the skills framework substantially to reflect the diversification of business and the changing outlook of human resources from a conventional to a business

development role. The definitions of tasks and necessary skills outlined in the iCD are important for organisations as a support for recruitment and organisational change. Therefore, the contents of the iCD are presented by organisational 'task' to be done and the 'skill/s' required to perform that task.

The iCD has helped to improve human resources development and communications within companies. It has been promoted in association with all industry sectors, agencies and educational institutions through seminars and workshops and has been adopted by many companies. Internationally, it is used in Vietnam, Philippines and Thailand and has been promoted in seminars and workshops in the Association of Southeast Asian Nations (ASEAN) area.

4) 'MITOH' project (MITOH meaning 'un-trodden')

The MITOH project supports the discovery of young talent adept at innovation in new technology areas and capable of applying their ideas in a practical way. The project, which focuses on young people aged 25 years old or younger, was started in 2000. It was initially developed for the IT software industry but its remit has been expanded to hardware and audio-visual in recent years.

Through the MITOH project, young people are mentored by a project manager who has a high level of experience in the field of IT. The project manager's brief is to evaluate in detail the originality of the ideas presented by their mentee. The project manager reviews the content of the young person's project, the theme selected for development, gives advice, guides the innovation process, monitors project progress and evaluates the final result. An outline of how MITOH works is shown in the diagram below.

Figure 3: Outline of MITOH project

Source: IPA, 2015

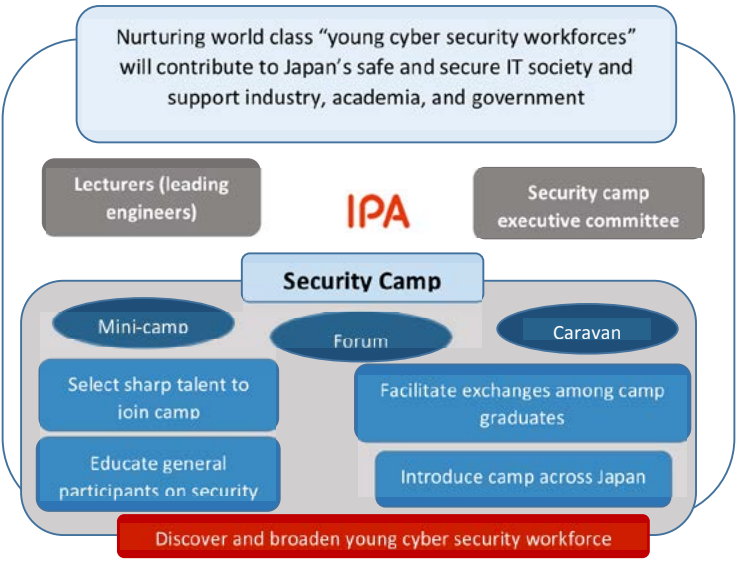
So far, about 1600 'creators' have been discovered and after the training and mentoring programme 270 people have become 'super creators'. The super creators discovered and trained through MITOH are now actively employed in various IT fields. For example, they teach students at schools, or work in university research institutes, or they are investigating further new innovative technologies and developing new businesses avenues in the IT sector or other new markets.

5) Information security human resources and security camp

Cyber attacks and information security crime is becoming increasingly complex and ingenious, and its impact on the IT sector is increasingly negative. As a result, growing the number of people skilled in information security is a necessary part of digital skills development. 'The bill for basic cyber security' is the foundation of Japan's cyber security strategy. In this environment, the IPA has started a 'skills index corresponding to information security reinforcement' and is promoting this activity to enterprises.

The IPA also holds a national information security camp in Japan for young students interested in cyber security. This event, which offers practical training, is held jointly with the IPA's 'security camp implementation council'. The diagram below illustrates how the camp is organised.

Figure 4: Outline of national information security camp



Source: IPA, 2015

The IPA has promoted the development and supported the adoption of an IT examination system and IT skills framework across a number of Asian countries. The IPA has also visited European countries, the United States (US) as well as Asian countries to exchange information and data on IT human resources development.

As part of this exchange with the EU information on the IT sector, workforce, human resource development and skill frameworks (notably the development of a mutual body of knowledge) has been shared and some collaborative work has taken place. Finally, the EU was invited to give a presentation at the IPA's global symposium in Tokyo last autumn. The IT human resource situation in the EU and Japan is similar and as a result the mutual sharing of information and best practice is valuable for both IT industries.

Recommendations

Further information and data exchange on digital skills between Japan, the EU and the US will help to improve IT talent globally, support industry growth and spread the reach of technological improvements to everyone in Japan, Asia, the EU and the US.

It would also be helpful, for comparative purposes, to publish annual or biannual data on ICT workforces and to complete a European framework on skills needs given the diversity of culture, economics, language and history across the EU. Global workshops with countries outside of the EU would also add insights.

Finally, given the diversity within the EU country environment, a strong and objective index for examining and certifying skills is also recommended.

CHAPTER 7

Digital skills in the public sector: lessons from Estonia

Introduction

Gone are the days when information and communications technology (ICT) skills simply meant the ability to use Excel and Word. Today, ICT processes are becoming an integral part of daily life in any industry. Digital skills programmes need to specialise and diversify both their subjects and audience to enhance value creation.

Given that Estonia is a relatively new state and the comparatively low age of the average public sector employee, basic IT skills (office programmes, web-based group work solutions) are relatively good in the public sector, and their development no longer requires a concerted effort. Estonia has reaped all the initial benefits of digitalisation – its public administration and citizens are now fully digital. Digitally signed documents have been the default form of communication for over a decade – for example, 99% of tax returns and 100% of banking are done electronically. There is a single electronic ID system for Estonian citizens and a single technical and administrative platform for ICT-based public sector services.

But Estonia is hardly unique – many other European governments are reaching a state of 'digital by default'.

Now Estonia has to grapple with 'what comes next'? How does it exploit technology to change the underlying business of government? The high level of digital skills of school graduates as well as Estonians' innate desire to use technology to make their lives better is a good base.

However, three areas of digital skills development are particularly important for the future:

- increasing the quality of strategic planning and preparation of ICT projects;
- data analytics;
- cyber security.

These priorities are not unique to Estonia - they constitute a major challenge for most public administrations beyond a certain point of development in Europe.

Strategic planning and preparation of ICT projects

In order to get the best value from public ICT investments the Estonian Ministry of Economic Affairs (responsible for ICT policy in Estonia) has made a conscious choice to place ICT project planning and management skills squarely at the centre of its national ICT policy priorities. As the body responsible for making funding decisions for ICT projects funded by EU structural funds, the ministry also has the ability to implement this priority.

Government agencies tend to treat technology as a tool to make incremental progress instead of as an enabler for fundamental change in how the public sector works. As a result, public bodies often spend large sums on needless ICT development while failing to take advantage of the real benefits digitalisation can offer. There have been cases of where grandiose (and expensive) ICT solutions designed for public services with a handful of users when a well-administered Excel table would have sufficed. The public sector does not necessarily have the financial and competitive motivation of the private sector and therefore does not seek constant improvement. Even when they may have the best of intentions, the technical and business sides often do not speak the same language.

To overcome these shortcomings, a business case-based approach to ICT investment management has been introduced. Every potential ICT investment needs to be presented with an economic impact assessment that shows value creation for both the public body running the service and its users. In addition, each project must pay for itself within five years via cost savings for the public sector. Exceptions can be made if a project could make a significant impact for citizens or business and therefore justifies making an investment even when costs for the implementer remain the same or even grow.

As a key principle for any large-scale investment public bodies must prepare a company-wide ICT strategy that is based on an agency's business goals and looks at how ICT can help achieve these. This ICT strategy should contain both new projects that create a qualitative innovation leap and more incremental bottom-up initiatives. Once a year, all areas of government present their ICT strategies and investment needs.

Results are already being seen from the introduction of this business-case based approach – public bodies are starting to analyse their business processes and cooperating across multiple agencies to be more effective. For example, the national tax authority devised a new registry of employees and in so doing solved a problem whereby employers had to forward information about new employees to several agencies. By using the new system, it is now possible for an employer to register a new employee in one system, and the information is forwarded automatically to other agencies. The new system's main objective

was to cut down on tax evasion from paying employees 'under the table', but the smart implementation of this approach also reduced the administrative burden for businesses and facilitated communication with the government.

A key importance is outlining a project's criteria for success and measurable metrics. It must be clear for each project when and where its success will be measured. For instance, in the above example of the employee register, the agency identified their objective as increasing tax receipts during the first year of the system's use but it was achieved in just nine months!

These achievements have been underpinned by a series of initiatives to share best practices and develop skills for strategic planning, by using a business case-based approach and employing metrics.

In 2014, when the business case-based approach was introduced, a consultant was hired to prepare the business cases for the first projects and help agencies devise their strategies. These were in turn presented to other agencies' IT managers.

To improve the exchange of information, monthly meetings of public sector IT managers have been organised. At biannual seminars the most successful organisations present their strategies, business cases and workflows. Additionally, materials containing simple guidelines and concrete tips have been developed.

It has also been important, in parallel to IT managers, to raise the ICT skill levels on the business side i.e. the managers responsible for the development of various policy areas such as healthcare, education etc. In 2015, a series of seminars entitled 'IT manager + 3' will be launched. The goal of the series is to bring together business process owners and IT managers and improve their cooperation in planning ICT projects. A public body's IT manager is selected. Then they plan the meeting and decides which three people from their agency would benefit most from deeper collaboration. The workshops are prepared based on concrete case studies and an outside consultant is used to help identify specific areas of concern. A core component of the workshop is how to design services and prepare business cases for planning ICT projects.

Finally, ICT solutions and new approaches cannot be successfully adopted without the support of top management. To address this, annual 'High-Level Information Society Courses' have been organised and allow the heads of the agencies to come together for a few days and receive an overview of information society topics that are relevant to improving public administration. Areas such as ICT project management, data analytics, cyber security and technological breakthroughs need the support and awareness of management.

Data analytics

The public sector is awash with data, both from its own public registers and from the wider world of the Internet of things (IoT) and big data. This data, combined and analysed, is allowing the quality of services and decisions in the public and private sector to improve. Unfortunately, there is a lack of skills to turn data into decisions.

The Estonian government has planned a series of actions to develop and disseminate data analytics skills from simply raising awareness to supporting projects that put these skills to use.

In 2014 data analytics awareness raising seminars were introduced targeting agency heads and area managers. Without an understanding of the need to use data more effectively and the opportunities it offers for running an organisation efficiently, even the hardest working analysts and their toolbox are useless. The seminars were designed to include representatives from both the demand side (the public sector) and the supply side (providers of data analytics solutions). Participants were introduced to the most successful examples of data analytics in both the public and private sector in order to illustrate the positive impact of using data analytics more effectively.

As a next step, trainings sessions were planned combining theoretical and practical assignments for area managers. In addition, practical workshops will bring together agencies' management and their analysts with entrepreneurs offering analytics solutions to solve specific business problems.

It is encouraging that private sector representatives have shown a desire and readiness to create a joint public private data analytics working group to develop this topic further. This working group will be developed over the course of 2015 to create a cooperation network whereby public sector bodies will receive guidance on how to use their data better; what architecture supporting data analytics should look like; what are the most suitable software tools for data analytics in specific cases and which competencies are necessary to increase the data analytics capability of an agency.

This integrated approach to developing data analytics in the public sector allows for the promotion of awareness and skills, and is backed up with financing for data analytics development projects.

Cyber security

Today our entire lives, including the functioning of the public sector, are today incredibly dependent on technology. As further services are developed it is important that the skills to keep them secure are also developed in parallel. Awareness of cyber security threats as well as the skills to prevent them and deal with their consequences are of critical importance.

Since 2006, Estonian public bodies have been required to follow governmental ICT security standards and have been subject to government supervision of compliance with these rules from 2011. Since 2012, every Estonian public sector body is required to have a Chief Information Security Officer (CISO). But having a CISO and regulations in place is of little use if top management does not understand the basic principles of cyber security. Top managers need to be able to understand the value of their CISOs and the critical nature of cyber threats.

Equally important is the dissemination of broadly recognised principles of risk management in the public sector, which requires managers not only to be better informed about cyber security risks but also enables them to make better decisions and raise the security level of services.

Testing the security knowledge of the heads of public bodies is an integral part of the annual 'High-Level Information Society' courses. Managers' knowledge of cyber threats are examined with surprise tests and followed up with an analysis and a joint discussion of their behaviour and the lessons that could be learnt from these exercises.

The most effective part of the cyber security awareness programme has come from the many cyber security exercises which are organised each year. In 2015, for example, a series of table top exercises were arranged which brought together the heads and experts of different bodies to work through various scenarios of service interruptions arising from cyber attacks. Each section focused on a specific domain. The goal of the exercise was to find gaps in knowledge, cooperation models and regulation. Such practical exercises have allowed various services' (e.g. electricity, data connectivity) complications and continuity problems to be addressed. It has also made top management aware of cross-dependencies and to encourage initiatives to improve circumstances before the scenarios transpire in real life.

Finally, Estonia has started a multinational initiative for developing and implementing human behavioural guidelines for cyber hygiene. The goal is to develop and adopt a standard for cyber hygiene for both end users and strategic decision makers. This standard will be implemented through an eLearning platform. The initial roll-out includes public bodies from six countries: Estonia, Austria, Finland, Latvia, Lithuania and the Netherlands, as well as the EU External Action Service and Military Staff. The standard will be applied initially in defence ministries but there are discussions to adopt this system more broadly across the public sector.

Conclusion

These three areas of focus illustrate that public sector digital skills in Estonia (and most likely elsewhere) are interlinked with developing general strategic management. It no longer makes sense to speak about separate digital skills. Instead, understanding how ICT changes the business of government is becoming a pre-requisite for successful government.

CHAPTER 8

Educational priorities in the connected world

Introduction: digital skills, everyday life and formal education

Technologies are shaping our existence. Their presence in our everyday life alternates between the committed and the mundane, the necessity and the enjoyment. We live in a hyper-connected world. With a penetration rate of 96% in 2014 (ITU, 2014), the number of mobile cellular subscriptions is approaching the number of people on earth. In 2014, 81% of households in the European Union's 28 member states (EU 28) had internet access (Eurostat, 2015), while 95% of 16-24 year olds in the EU are regular internet users (Grand Coalition for Digital Jobs).

With higher levels of internet penetration worldwide, it is increasingly important for all citizens to be competent in the use of technologies. If technologies are part of our daily lives, everyone must be equipped with the skills required for using these technologies, including the young. Meanwhile, kids go online, whether equipped or not, from a very young age: Ofcom (2013) reports that 93% of all 5-15 year olds in the UK used the internet in 2013 and 82% of all 5-7 year olds.

Yet in schools, another picture emerges, highlighting the difference between highly equipped and connected schools on the one hand and schools in unreached regions on the other with outdated devices, deserted computer rooms, crammed tools, poor computer-learner ratios and low levels of digital skills. While there are certainly pockets of innovation, the rich digital panorama encountered in our everyday life is not reflected in the day to day experiences within schools: less than half of children in the EU are in schools that are highly digitally equipped (European Schoolnet, 2013). Schools seem to keep running after reality despite being asked to forecast future needs and prepare the younger generations for unforeseeable demands.

Young people and digital skills

The contrast between the use of technologies in everyday life and the uptake in schools highlights one of the paradoxes that is encountered when discussing technology, digital skills and formal education. This contrast is part of a series of dilemmas and tensions that blur the issue of enhancing young people's digital skills despite the recent engagement from governments and educational systems to take up the challenge of the digital divide.

The problem of the digital skills gap centres around two issues: first, the demand for a highly skilled workforce in ICT and second, the need to raise the basic level of digital skills. The Grand Coalition for Digital Jobs forecasts 825,000 unfilled vacancies for ICT professionals by 2020, while recognising that by the same date 90% of jobs will require some level of digital skills.

Both these issues are at the core of the European agenda and education has to play a committed role in solving them. While they should be differentiated and tackled by different actions, at the same time, these issues should be considered as highly intertwined as one side is not possible without the other: it would be unthinkable of having a wide cohort of top ICT professionals without heavily investing in fostering digital skills at the base.

"A digital Europe needs digital skills"

Despite the need to find short-term solutions to the current and upcoming shortage of ICT professionals, it is necessary to tackle general digital skills proficiency. It is a priority for formal education systems to address the need to raise the level of digital skills of all learners and, by default, of all teachers. A higher threshold of digital skills will allow for an easier upskilling and for a higher number of young people to make the leap from general users to ICT professionals.

In several countries, young people under the age of 24 outnumber the total amount of internet users (Dawkins et al, 2014). Children grow up surrounded by technology but as several international studies confirm, their familiarity and ease is not always supported by the necessary digital skills. Only 8% of 15 year olds taking part in the PISA 2009 survey (OECD, 2014) showed the ability to use the internet in an efficient way, valuing the credibility and usefulness of the information. In the more recent ICILS report (2014), 17% of students did not reach the lowest level of information and communication literacy. The same study showed that 25% of students demonstrated low levels of computer and information literacy in seven out of nine participating EU countries. The ICT in Schools Survey (European Schoolnet, 2013) showed that young people, at least in Europe, are confident rather than competent users of technologies: they show a familiarity and ease with technological devices that is not necessarily backed up by evidence of good performance. Students who use devises frequently at school and at home held more positive opinions about ICT's impact on their learning compared to students reporting low access and use at school but high access and use at home.

Digital skills in the curriculum

It would be inaccurate to state that formal education is not tackling the question of digital skills. In 2012 all countries in Europe put in place national or regional strategies that addressed the development of digital skills in their curricula

(Eurydice Network, 2013). There seems to be two main policy approaches - the first is focusing on the general skills for the use of technological devices and the second is teaching coding as a possible alternative to modernising what schools currently provide in terms of digital skills. These two approaches are not mutually exclusive.

According to a survey carried out in 2015 by European Schoolnet with Ministries of Education, 16 of the 21 participating countries now integrate coding in the curriculum at national, regional or local levels and Finland has included coding in its core curricula for 2016. The introduction of coding to formal education has been a fast developing priority: England set the example as one the first European countries to make computer programming in primary and secondary schools mandatory from September 2014 onwards (European Schoolnet, 2014). Despite quick and relatively wide adoption, almost all countries participating in the 2015 survey claimed that coding is only one of the priorities that they are adopting for the development of digital skills. Among the priorities, countries report the need to develop ICT users' skills. While there was a tendency to see the technical aspects of digital skills as key, today there is wider understanding that being conversant with technologies requires going beyond technical operational abilities and engaging in a critical way with the online world (Erstad O, 2010). However, there is a perceived lack of guidance on the competences that teachers should be developing.

There needs to be a wide and coherent understanding of digital skills. Alongside technical and operational skills, coding and programming as well as the ability to understand how programmes are built and function, it is important to prepare young people to "think digitally" (Rissola, G. 2015) not only in terms of computational thinking but also in terms of developing an accurate awareness of the affordances of technologies. Acquiring a digital mindset would involve problem solving abilities through digital means and the possibility of moving from being users to producers. Young people are often the producers of technological outputs. Therefore, providing them with the right mindset for engaging with technologies and a higher level of skills will certainly facilitate the move from general digital skills to specialised ICT professionalisation.

If educational policies are offering the scope for the development and actualisation of digital skills, another issue to tackle is teacher training which is unfortunately carried out on a voluntary individual basis during teachers' spare time. Teachers' knowledge of technologies is often at a basic level (Morris, A. 2010) and this not enough to prepare students for new social challenges. Innovation or efficient uptake is not triggered when training is offered at the operational level. Although training in ICT is considered by teachers to be a priority and an urgent need (OECD, 2013), teacher participation in ICT training is rarely compulsory - only around 25-30% of students in Europe are taught by teachers for whom ICT training is compulsory.

Trucano (2005) believes that teacher training is a critical component if investment in ICT is to be maximised and he specifies several ways to optimise teacher training in ICT use including:

- teacher professional development should be planned as a process, not an event;
- preparing teachers to benefit from ICT use is about more than just technical skills.

In addition, technical and operational skills that are needed by all learners to be effective and efficient users of technologies and enable them to have an active role in our digitalised society are barely touched upon in the current digital skills panorama.

The professional development of teachers in the area of digital skills is certainly crucial. With the change in skills requirements and curricula specification, teachers urgently need to receive training in how to develop the digital skills of learners (from teaching them how to code to alerting them to internet security issues). Despite a common understanding that continual professional development is a critical priority, preparing prospective teachers is another area that requires a convergence of political actions.

Two thirds of teachers in Europe are over 40 years old (Eurydice, 2015). The ageing teacher population implies the need to replace and therefore retrain a large number of teachers over the next decade. Are the current Initial Teacher Training provisions up to the digital skills challenge? How are digital skills perceived within Initial Teacher Training?

Educational priorities

The remit of education is to prepare a whole generation for a connected future - not necessarily to prepare them for a job but to prepare them for life challenges. When there are shortages of students enrolled in computer science and engineering, it is already too late. Discourses of digital skills enhancement should start much earlier to provide young people with the awareness that, first, technology is part of our life, and therefore we need to know how to use it in an efficient way; and, second, that ICT careers are for everyone and can include a variety of interesting jobs.

The main point is the need to develop the right attitudes towards technologies including raising awareness on possible future careers, together with the right skills. It is unrealistic to assume that we can prepare today, from as early as primary school, the 'computer scientists' and ICT professionals of tomorrow. However, this discourse does not diminish the fundamental role that formal education has to play. If schools cannot forecast future needs and technological uptakes and prepare learners with a full set of skills and knowledge needed for a professional career in ICT, then they can certainly enhance learners' proficient

use of technologies, enthuse them about technologies, and show them that technologies can open a plethora of present and future opportunities. Schools can and should take technological devices off the leisure shelf and place them at the centre of young people's learning experience.

An agenda for the development of digital skills in education: recommendations

- today full participation in society requires the ability to use technologies. Digital skills should be perceived as a 'life skills' and should be understood as important as literacy and numeracy;

- it is the remit of formal education to prepare learners for the life challenges that they face, and thus to equip them with the basic skills for a safe and efficient use of technologies;

- education systems should ensure that a wide and coherent understanding of digital skills is shared among educational stakeholders;

- schools and teachers should enthuse learners about possible careers in technologies. They should ensure that students are ready to take up technological careers not only by providing them with the basic skills but also by fostering the right attitudes towards technologies as well as by tackling common prejudices that surround careers in ICT.

CHAPTER 9

Digital inclusion and empowerment: addressing imbalance

Introduction

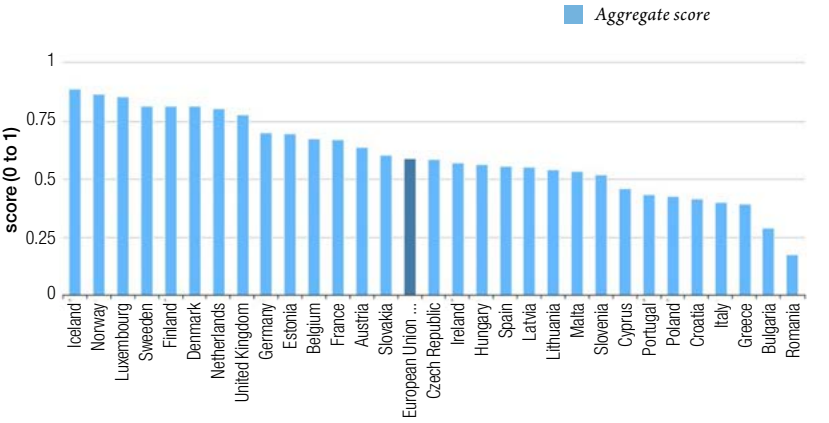
The Europe 2020 strategy attributes a key role to information and communication technologies (ICTs) and digital skills to promote growth and jobs in the European Union (EU). Initiatives like the Digital Agenda for Europe (now replaced by Digital Single Market strategy), an Agenda for New Skills and Jobs, Youth on the Move, European Platform Against Poverty and Social Exclusion promote the use of ICTs for social and economic inclusion.

From young people using ICTs to improve life chances to raising the skills and working conditions for workers to creating systems to support families to provide care for elderly and to building industry capable of delivering solutions for the challenges of health and demographic change, being able to participate fully and actively in today's society requires the ability to use technologies. Digital competence is now considered a 'life skill'.

However, 18% of the EU population aged between16-74 has never used the internet and 47% of the population has insufficient digital skills (Eurostat, 2015). This means a large group of citizens are at risk of losing a job or not receiving proper education and risk being excluded from accessing services such as eHealth, eParticipation and eGovernment.

Digital inclusion and empowerment of all citizens (including facilitated access to internet and eServices, digital skills and usages of digital tools) are crucial for achieving the social inclusion objectives of EU.

Figure 1: Basic skills and usage, by Aggregate scores



European Commission, Digital Agenda Scoreboard

Source: European Commission

The digital divide exists not only within different vulnerable groups but also within the EU 28 countries. Some of them have been traditionally seen as digital leaders - Scandinavian countries, Netherlands, UK and Germany. On the other hand, others such as Italy, Greece, Cyprus, Portugal, as well as some of the new members states - Romania, Bulgaria, Croatia - are significantly behind in eSkills levels as well as other information society indicators.

With the policy goal of addressing the specific digital inclusion needs of low-skilled people, the ageing population, unemployed youth and other vulnerable groups, the key challenges are:

- How can digital inclusion, digital competence, ICT mediated social interventions and social innovation support groups at risk of socio-economic exclusion?

- How can the EU and member state policies support these processes and the related actors?

There are a set of EU and member country policy initiatives and quite a large number of pan-European and national stakeholders who work to ensure digital opportunities for all European citizens. However, more coordination and targeted actions could be envisaged.

The digital gap and vulnerable groups: focus on the ageing population and unemployed youth

The digital divide is directly linked with social and economic divides and has diverse effects. The traditional vulnerable groups to be addressed by eInclusion policies are:

- seniors and elderly people;
- the unemployed (with a special emphasis on unemployed youth);
- people with low incomes and education;
- migrants and ethnic minorities.

Digital skills and the empowerment of seniors

Digital skills and the empowerment of seniors is becoming more and more important due to Europe's ageing population and limited resources to provide health and other services offline.

Basic digital skills for seniors are provided by many governments, NGOs and private donor supported programmes. For example, in Latvia, senior digital skills development is mostly supported the by CSR project of Lattelecom (largest Latvian ICT company), which started a campaign 'Connect Latvia' in 2011. Since then more than 31,000 seniors have been provided with basic and also more advanced digital skills. Another player in Latvia is the Library Network with more than 860 public libraries that act as local digital training and consultancy centres for seniors.

In addition to basic digital skills, targeted digital training and support for elderly people should be provided to ensure they can properly benefit from eHealth, eGovernment, social services and eParticipation. Normally this kind of training involves both sides – the elderly person who receives the service and the service provider eg. social workers, carers, municipal workers or other service providers. For example, within the Carer+ project care workers and care givers were trained to apply digital technologies in their world with seniors and later acted as digital skills trainers for seniors. Many social workers and care workers across Europe could benefit from the project's experience.

Finally, we should be able to provide digital skills that encourage senior people into entrepreneurship, starting their small businesses, social enterprises or voluntary work.

Over the last few years there have been many interesting examples of digital inclusion activities for seniors provided by young people. These intergenerational learning programmes allow two way learning. Young people are acting as ICT skills trainers for seniors while seniors act as life skills and employment skills mentors for young people. This approach has an extra value for both target

groups - seniors not only receive digital skills but also become more socially and economically involved. Young people on the other hand receive their first work experience as eFacilitators and also benefit from the mentor's support. This intergenerational learning-teaching approach should be explored more.

Another successful example is the eScouts (saite) project which has been tested and implemented in eight countries (Bulgaria, Germany, Italy, Poland, Spain, Latvia, Lithuania and Croatia. The project helps to facilitate the socio-digital inclusion of elderly and young people which improves local community life by means of the intergenerational dialogue and mutual support. Within the learning circle, the young support senior people in ICT usage and, in return, seniors mentor the young people in their efforts to access the labour market and face the challenges of adult life, completing in this way a circle of learning, exchange and conviviality.

A final example is the IT guide Sweden initiative, where young immigrants help senior citizens with accessing the internet and explaining everything there is to know about computers and mobile telephones, while seniors help migrant youth to integrate into Swedish society by giving language, cultural and legislative assistance and other advice.

Unemployed citizens (particularly young unemployed workers)

The unemployed, especially young people who are out of work are another social group which cannot succeed without regular digital skills updates.

Unfortunately being born in a digital era has proven an insufficient condition for being digitally competent. Although digital competences are essential for employment, a large section of today's youth lack the ability to use them creatively and critically. According to EU Digital Agenda Scoreboard 2014, 39% of the economically active EU workforce has insufficient digital skills while 14% has no digital skills at all. Nearly half of the European labour force (47 %) is not confident that their computer and internet skills are sufficient in today's labour market (European Commission).

Young people without proper digital skills are at risk of social exclusion and must be a priority target for EU social and eInclusion policies. Around five million young people (under 25) were unemployed in the EU 28 area in 2014, of whom over 3.2 million were in the euro area. This represents an unemployment rate of 21.4% in the EU (23% in the euro area). More than one in five young Europeans on the labour market cannot find a job while five million young Europeans aged between 15 and 24 are not employed, or in education or training (NEETs, European Commission).

Several EU scale initiatives have been introduced to address the issues of insufficient digital skills and youth unemployment:

- the Grand Coalition for Digital jobs which was set up to mobilise efforts and address the imbalance between 900,000 digital job vacancies and high rate of youth unemployment in Europe;

- the Youth Guarantee Fund Creation which helps young people under 25 within four months of leaving school or losing a job either to find a good-quality job suited to their education, skills and experience or acquire the necessary education, skills and experience required to find a job in the future through an apprenticeship, traineeship or continued education;

- Europe Code Week which is a grassroots initiative aiming to bring coding and digital literacy to everybody in a fun and engaging way and targets young people and children to teach them about coding and ICT skills.

The role of eInclusion intermediaries

The involvement of vulnerable groups in digital skills training and using of eServices can best be achieved at the grassroots level. In this context, digital inclusion and social inclusion actors such as telecentres, public internet access points, public libraries, municipal LLL centres, third sector organisations including NGOs - eInclusion intermediaries - play a crucial role.

According to the 'Survey on eInclusion Actors in the EU27' carried out by JRC and DG CONNECT within MIREIA project (Project MIREIA - Measuring the Impact of eInclusion Actors on Digital Literacy, Skills and Inclusion goals of the Digital Agenda for Europe) there is estimated to be around 250,000 eInclusion intermediaries in the EU27 (the research does not include Croatia).

As the survey notes: "there is a huge variety of eInclusion intermediary actors and roles. Most of these actors belong to the public sector (58%) and mainly consist of public libraries, municipal/local government organisations and government-run telecentres. Third sector organisations make up almost 40% of the universe and include associations, charitable organisations, or foundations and NGOs combined. The private sector (6%) is mostly represented by private training organisations" (European Commission, 2013).

The main services that eInclusion intermediaries provide to citizens are:

- digital access and basic skills trainings;
- introduction and consultation to various eServices;
- consultation on digital tools and devices;
- ICT skills trainings for employment, entrepreneurship and social innovation;
- access to eLearning platforms;
- support for participation and community development;
- coding activities are also organized and supported by many of these organisations.

In the majority of the members states the eInlcusion intermediary organisations form national or regional networks. At the European level, these networks are represented by Telecentre Europe, a European non-for-profit organisation (NGO) which unites 56 members from 27 countries and represents a network of more than 20,000 telecentres across Europe.

eFacilitators or digital competence facilitators working at telecentres are key actors for providing digital competences for citizens in general and especially vulnerable groups. It is estimated that around 250,000-375,000 people in the EU are currently working in this field of employment. This staff is in need of constant training and knowledge updates.

More than that, the staff of organisations in the sectors of education, employment, health, immigration and social services which have direct access to large networks of end users are facing a need to act as digital service promoters and digital skills facilitators for their customers. Therefore, competences to promote and facilitate general and specific digital skills becomes a part of professional profiles of professions like youth career consultants, state employment agency officials, social workers, care workers and others.

Policy recommendations

- existing eInclusion intermediaries or telecentres need to be publicly supported to have a better reach and existing infrastructures (public libraries, civic centres, schools) should be equipped as telecentres to cover underserved areas. These digital inclusion actors could become more efficient and help digitally excluded citizens when cooperating with existing organisations which work with 'digital offliners' and vulnerable groups such as employment agencies, immigration services, municipal social services and welfare system entities. Cooperation could actively be supported by national and regional policies;

- the impact of telecentres could be increased by supporting the professionalisation of these organisations. Policies should support and initiate the development and spreading of learning content (for end users) and methodology (for telecentre staff), instruments for continuous training and evaluation, tools for awareness raising and managing, sustaining and enlarging telecentres;

- the eFacilitator profile is a key component for approaching vulnerable target groups. This profile could be supported by professionalisation of staff by formal and social recognition. As there is no such thing as a European recognition process valid for all countries, policy should support national or even regional procedures for recognition of this profile. National or regional education authorities should foster the recognition of this profile and should build links to existing profiles and employment possibilities;

- pan-European, national and regional awareness raising and trust building campaigns play an important role for involving and convincing digitally excluded citizens. These campaigns need to have coordinated efforts and they should be led by National or local coalitions and Digital Champions, cooperating with sectoral actors. The impact of such campaigns should be measured and the best practices showcased and replicated in members states;

- innovative methodologies' and approaches has to be explored and introduced to reduce social and economic exclusion as a result of increased digital skills of target groups – e.g. intergenerational learning experiments, social enterprises by seniors and young people and others;

- EU social and other funds have to be used to support the activities and projects to help reduce the digital divide. The EU funded activities should focus and help to upscale innovative projects and campaigns that have demonstrated real and measurable impact and are often designed and introduced by third sector organisations.

RECOMMENDATIONS

The digital world is evolving quicker than ever and Europe risks being left behind. The Internet of things (IoT), big data analytics and digital innovation are all here to stay and Europe currently lacks the structure to seize the opportunities created by these fast moving developments.

If Europe can capitalise on these advances and put the necessary infrastructure in place, particularly those proposed within the European Commission Digital Single Market strategy, the benefits will be enormous. Put simply, Europe will be more productive and competitive.

But there is still a long way to go. One of the most urgent problems is the acute skills shortage. Without the talent capable of driving change and exploiting these developments, Europe cannot succeed, grow and compete in the future.

There have been some significant steps in the right direction, the EU eSkills strategy launched in 2007 and the 'Grand Coalition for Digital Jobs' in 2013, but the challenge is multi-faceted and needs to be tackled on a number of fronts.

This manifesto has reviewed the demand and supply of digital skills in Europe, examining a number of areas where more reform is necessary, and makes recommendations to get Europe ready to embrace further digital transformation.

It also includes contributions from the United States (US) and Japan, offering valuable insight into work carried out elsewhere and best practice which could be shared.

1. Acknowledge the huge demand for ICT skills

Demand for ICT skilled workers is growing at an alarming rate. According to a forecast in Chapter 4 (Digital skills supply and demand in Europe 2016 - 2020), there will be over 750,000 vacancies in the European ICT sector by 2020. The problem will be particularly acute in Germany, Italy and the UK.

These vacancies are not just in 'core' IT jobs, but increasingly in the high skilled jobs sector such as in management, architecture and analytics positions. In addition, demand for ICT skilled workers is across all industries.

As demand is already outstripping supply, there is an urgent need to address the 'supply' side by increasing in the quality and the relevance of digital skills in the workforce.

2. Identify skills gap correctly and quickly

In this age of rapid digital change, the stark reality is that the market will go where the skilled workforce is. If this isn't in Europe, it will be in another part of the world.

Equipping the European workforce with the right skills to deal with the opportunities resulting from new technologies and to fulfil the demand for ICT skilled workers is the key challenge.

As a result, there needs to be alignment between skills and demand. The "e-Competence Framework" is already in place to map skill sets to ICT jobs and address the skills gap in Europe – this important work needs to be stepped up.

3. Provide the right education eco-system to supply skilled, employable workers to take full advantage of the IoT

As noted in Chapter 2 ('The Internet of things will change everything'), the time to start developing skills that are appropriate for the IoT is now.

However, the only way to train and re-skill the workforce is to have the right educational institutions in place to offer the necessary courses and training. These courses must be tailored to the needs of stakeholders – i.e. the skills that the current market demands.

The pipeline for talent into tertiary education courses must be high quality if Europe is to be a frontrunner in digital talent provision. As evoked in Chapter 8 ('Educational priorities in the connected world') this means transforming pupil confidence in information, communications and technology (ICT) into competence.

While there are certainly pockets of innovation, the digital panorama and richness we encounter in our everyday life is not reflected in the everyday experiences within schools. More European schools should take technological devices off the leisure shelf and bring them to the core, at the centre of the learning life of young people. This will require the development of a common European standard for teachers to develop digital skills and less reliance on the individual motivation of teachers to use digital technology on a project basis.

The US education system faces similar education challenges and a primary conclusion of Chapter 5 ('Digital skills in the US') is that digital skills and digital transformation should be taught throughout the education system – from primary education to universities to on-the-job training and beyond.

The US is already acting on this - the Obama administration has recently invested $100 million to train or re-train professionals in digital skills.

4. Improve the quality of eLeadership

The skills shortage also extends to business leaders who need new skill sets to handle the challenges of new digital technologies. Europe requires an estimated 40,000 new eLeaders annually until 2020 (empirica, 2010).

Chapter 3 examines the work already being done to improve digital skills and eLeadership, especially within business schools, arguing that the teaching of these skills must be strengthened and widened to ensure that suitable training programmes are available to everyone (and notably to SMEs) at every stage of their 'eLeadership journey'. Lessons on the development of eLeadership skills in the public sector, including cyber security awareness, are shared in the case study of Estonia (Chapter 7, 'Digital skills in the public sector: lessons from Estonia').

As sectors become more connected within themselves and to each other, business management skills will have to evolve. Change management expertise will be highly valued, teams will be smaller and more agile (Chapter 2) and, as there will be greater reliance on ecosystems of third parties, collaboration skills will be a core strength.

5. Make self-learning courses and training programmes to re-skill people accessible to all

If real digital transformation is going to happen, then everyone needs to be 'tech savvy'. Self-learning is an important and practical tool for SMEs to increase their digital skills. This approach must be encouraged for individuals of all ages, male and female, who want to improve their digital skills as the online world develops further.

The development and provision of widely available, focused, flexible and affordable online courses should be a key action point for the EU.

The assessment of the US digital skills pipeline in Chapter 5 reveals that while US universities produce top computer science graduates, the education system is failing to provide adequately skilled workers to satisfy demand. However, non-profit organisations and advocacy groups have launched initiatives to enable people to improve their digital skills, thereby helping to plug the skills gap.

6. Explore innovative approaches to bridge the digital divide

An alarming percentage of the EU population has never used the internet and 47% of the population has insufficient digital skills (Eurostat, 2015). This is particularly acute in older people and the young unemployed as Chapter 9 ('Digital inclusion and empowerment: addressing imbalance') highlights.

With an ageing population, a concerted effort across the EU is required to improve the digital skills of these excluded citizens. In Chapter 9 there are some examples of innovative intergenerational learning programmes happening within the EU which allow 'two way learning' – young people act as ICT skills trainers for seniors and at the same time seniors act as life skills and mentors for young people. This type of approach has had a real impact and could be rolled out across the EU.

7. Empower businesses to take full advantage of new digital and advanced technologies in order to compete globally and create jobs

It is a worrying fact that over 41% of EU companies still have not adopted any of the advanced technologies (mobile, social media, cloud computing and big data), while only 1.7% make full use of them (Chapter 1, 'Digital transformation of the economy'). Businesses both large and small must take full advantage of this new wave of digital technology - especially in key areas such as health and education – in order to grow, compete and create jobs.

But it is not just industry. The public sector (as demonstrated by Chapter 7 highlighting the progress made by Estonia's Ministry of Economic Affairs) must also embrace digital transformation and not miss out on the opportunities these new technologies can offer.

8. Encourage all enterprises to recognise data management as a key skill

Big data analytics and the ever more connected environment created by the IoT mean that data management is a key skill required by all enterprises. As noted in Chapter 2, "the ability to deal with data in flight, streaming data and big data analyses will be a differentiator".

As a result, the role of the 'data scientist' is changing – this role is no longer an 'add –on' in companies, but should be at the core of the business and management decision-making process. "IoT concepts are fast making their way into day-to-day business management," is a key message in Chapter 2 and "organisations that can most effectively navigate that change will benefit the most and quickest."

9. Recognise the importance of security and the skills to deal with it

As Europe's dependency on technology increases, so the need to keep data secure becomes essential. Awareness of this issue at all levels within enterprises and the wider regulatory world, as well as the skills to deal with cyber-attacks, are ever more critical. IoT security skills is already one of the most pressing skills gaps.

In both Japan (Chapter 6, 'Digital skills in Japan') and Estonia (Chapter 7), governments have put new regulations in place as well as organised seminars and cyber security exercises to increase employee and public awareness. Examples of best practice could be rolled out in other EU member states.

10. Work together to fund and support digital transformation

Member states alone cannot take advantage of digital transformation. Action is required across the EU. The EU's Digital Single Market strategy and the Strategic Policy Forum on Digital Entrepreneurship, as noted in Chapter 1, are important factors in this process. But the EU needs to step up support at the highest level.

11. Share best practice

Two chapters of this manifesto examine the steps taken in Japan and the US to tackle the challenge of improving digital skills and harnessing the advantages of new digital technologies. These offer valuable insights and, as the chapter from Japan suggests, there should be closer collaboration and sharing of demand and supply data as well as best practice especially given the global nature of IT.

12. Harmonise existing and new regulation across the EU

The current EU regulatory environment is not making it easy for businesses to take advantage of the opportunities digitalisation presents. Europe needs to identify gaps in regulation and harmonise where necessary in areas such as patents if innovation and entrepreneurship is to flourish at a competitive pace.

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BIBLIOGRAPHICAL REFERENCES

Bruegel (2014). "Chart of the Week – 54% of EU jobs at risk of computerisation". *http://www.bruegel.org/nc/blog/detail/article/1399-chart-of-the-week-54-percent-of-eu-jobs-at-riskof- computerisation/#republishing*

Bureau of Labor Statistics (2014). "Labor Force Statistics from the Current Population Survey (median weekly earnings of full-time wage and salary workers by detailed occupation and sex, 2014)". *http://www.bls.gov/cps/cpsaat39.htm*

Bureau of Labor Statistics (2015). "Current Population Survey (median weekly earnings of full-time wage and salary workers by detailed occupation and sex, household data annual averages)". *http://www.bls.gov/cps/cpsaat39.htm*

Change the Equation. "Vital Signs". *http://changetheequation.org/stemdemand*. *http://www.innovationfiles.org/debunking-the-myth-of-a-stem-surplus/*

Christensen, C (1997). "The Innovator's Dilemma". Harvard Business Review Press

Code.org and Computing in the Core (2015). "Make CS in K-12 Count!" *http://csedweek.org/files/Code_CinC_state_one_pager.pdf*.

College Board. "AP Program Participation and Performance Data 2015 (AP Exam Volume Change, 2003-2013)". *http://research.collegeboard.org/programs/ap/data/participation/ap-2015*

College Board. "AP Course Audit (Computer Science and Calculus, 2013-2014, US". *https://apcourseaudit.epiconline.org/ledger/search.php*

Coutu, S (2014). "The Scale-up Report on UK Economic Growth". *http://www.scaleupreport.org/scaleup-report.pdf*

CS Teachers Association (2013). CSTA National Secondary School CS Survey. *http://csta.acm.org/Research/sub/Projects/ResearchFiles/CSTASurvey13Results.pdfpage 3*

CS Teachers Association. "Running On Empty: The Failure to Teach K–12 CS in the Digital Age (State-by-State Results, Concepts Adoption Rates)". *http://runningonempty.acm.org/roemap.html*

Dawkins et al (2014). "Children's Rights in the Digital Age". Cooperative Research Centre

empirica (2015). "eLeadership – Digital Skills for SMES and Start-Ups"

Erstad, O (2010). "Conceptions of Technology Literacy and Fluency". In P. Penelope, B. Eva & M. Barry (Eds.), International Encyclopedia of Education (pp. 34-41). Oxford: Elsevier

European Commission (2014). "European Commission and Data Industry Launch €2.5 billion Partnership to Master Big Data"

European Commission (2014). "Scoreboard 2014 – Digital Inclusion and Skills in the EU 2014". *http://ec.europa.eu/digital-agenda/en/news/scoreboard-2014-digital-inclusion-and-skills-eu-2014*

European Commission (2015). "Youth Guarantee Memo 2015 – Questions and Answers". *http://europa.eu/rapid/press-release_MEMO-15-4102_en.htm*

European Commission - Rissola G & Garrido M (2013). "Survey on eInclusion Actors in the EU27". *http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=6720*

European Schoolnet (2013). "Survey of Schools: ICT in Education". *http://www.eun.org/observatory/surveyofschools*

European Schoolnet *http://www.eun.org/c/document_library/get_file?uuid=d5f47be2-6d3b-4d8a-82d1-5f37ed9c7366&groupId=43887*

European Schoolnet (2014). "Computing our future Computer programming and coding - Priorities, school curricula and initiatives across Europe". *http://www.eun.org/c/document_library/get_file?uuid=521cb928-6ec4-4a86-b522-9d8fd5cf60ce&groupId=43887*

Eurostat (2015). "Individuals who Have Never Used the Internet". *http://ec.europa.eu/eurostat/tgm/tabledo?tab=table&init=1&language=en&pcode=tin00093&plugin=1*

Eurostat (2015). Data on Information Society Statistics (Households and individuals) *http://ec.europa.eu/eurostat/statistics-explained/index.php/Information_society_statistics_-_households_and_individuals*

Eurydice (2013), "Developing Key Competences" *https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/index.php/Publications*

Eurydice (2013). "The Teaching Profession in Europe"

Hüsing T, Korte W B, Dashja E (2015). "E-skills and e-leadership Skills 2020. Trends and Forecasts for the European ICT Professional and Digital Leadership Labour Market". Empirica Working Paper, Bonn. *http://eskills-guide.eu/fileadmin/LEAD/Working_Paper_-_Supply_demand_forecast_2015_a.pdf*

ICILS (2014). "Preparing for Life in a Digital Age. The IEA International Computer and Information Literacy Study. International Report"

IDC (2013). Analysis carried out for the Digital Entrepreneurship Monitor

Infoplease (2010). "US Unemployment Rate". *http://www.infoplease.com/ipa/A0104719.html*.

Intel Security. *http://www.securingtomorrow.com/blog/knowledge/3-key-security-challenges-internet-things/*

ITU. (2014). ICT Statistics. *https://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2014-e.pdf*

Kolderie T, McDonald T (2009). "How Information Technology Can Enable 21st Century Schools". Information Technology and Innovation Foundation. *http://www.itif.org/files/Education_ITIF.pdf*

Kocak Usluel Y, Kuskaya Mumcu F, Demiraslan, Y (2007). "ICT in the Learning – Integration and Obstacles"

Lazowska E, Roberts E and Kurose J (2014). "Tsunami or Sea Change? Responding to the Explosion of Student Interest in CS". Presentation to the NCWIT summit. *http://lazowska.cs.washington.edu/NCWIT.pdf*

Lapowsky I, (2015). "Obama Has a $100M Plan to Fill the Tech Talent Shortage". Wired Magazine. *http://www.wired.com/2015/03/techhire-initiative/*

Lapowsky, I (2015). "So, Arkansas Is Leading the Learn to Code Movement". Wired Magazine. *http://www.wired.com/2015/03/arkansas-computer-science/*

Lindenberger, Michael (2014). "Exxon Mobil CEO: Schools are failing as too few workers have STEM skills". The Dallas Morning News. h*ttp://bizbeatblog.dallasnews.com/2014/12/exxon-mobil-ceo-schools-are-failing-as-too-few-workers-have-stem-skills.html/*

Mattern K, Shaw E and Ewing M (2015). "Is AP Exam Participation and Performance Related to Choice of College Major?" College Board. *https://research.collegeboard.org/publications/content/2012/05/info-go-summary-ap-exam-participation-and-performance-related-choice*

McKinsey (2011). "Internet Matters: The Net's Sweeping Impact on Growth, Jobs, and Prosperity"

Morris, A (2010). "Are Teachers Technophobes? Investigating Professional Competency in the Use of ICT to Support Teaching and Learning". Procedia Social and Behavioural Sciences 2

Moschella, D (2015). "The Emerging Double-Deep Economy". Leading Edge Forum. *https://leadingedgeforum.com/publication/the-emerging-double-deep-economy-2318/*

Nager, A (2014). "Everybody Needs STEM Talent". Innovation Files. *http://www.innovationfiles.org/everybody-needs-stem-talent/*

National Association of Colleges and Employers (2014). "Salary Survey: Top-Paid Majors for the Class of 2014". *http://naceweb.org/s04162014/top-paid-majors-class-of-2014.aspx*

National Association of Colleges and Employers (2015). "First-Destination Survey: Overall Starting Salary for Class of 2014". *https://www.naceweb.org/salary-resources/starting-salary-class-2014.aspx*

National Center for Education Statistics, (2014). "Digest of Education Statistics -number and internet access of instructional computers and rooms in public schools, by selected school characteristics. Selected years, 1995 through 2008, 2008." *http://nces.ed.gov/programs/digest/d10/tables/dt10_108.asp*

National Center for Educational Statistics, (2014). "Digest of Education Statistics -bachelor's, master's, and doctor's degrees conferred by postsecondary institutions, by field of study. Selected years, 1970-71 through 2012-13". *http://nces.ed.gov/datalab/tableslibrary/viewtable.aspx?tableid=8856*

National Center for Educational Statistics (2014). "Digest of Educational Statistics -degrees in computer and information sciences conferred by postsecondary institutions, by level of degree and sex of student. Selected years,1970-71 through 2012-13". Table 325.35. *http://nces.ed.gov/programs/digest/2014menu_tables.asp*

National Center for Educational Statistics (2014). "Digest of Educational Statistics -bachelor's degrees conferred by postsecondary institutions, by race/ethnicity and sex of student. Selected years, 1976-77 through 2012-13." *http://nces.ed.gov/programs/digest/d14/tables/dt14_322.20.asp*

National Science Foundation (2012). "Science and Engineering Indicators 2012, Higher Education in Science and Engineering (Appendix Table 2-19). *http://www.nsf.gov/statistics/seind12/c2/c2s2.htm*

OECD (2010). "PISA 2009 Assessment Framework: Key Competencies in Reading, Mathematics and Science". OECD Publishing

OECD (2013). "TALIS 2013 Results: An International Perspective on Teaching and Learning"

Ofcom (2013). "Children and Parents: Media Use and Attitudes Report"

Rissola, G (2015). "Interview with Telecentre Europe Managing Director, Gabriel Rissola". Microsoft.com *http://news.microsoft.com/europe/2015/10/21/in-europe-digital-skills-matter-an-interview-with-telecentre-europe-managing-director-gabriel-rissola/*

The Boston Consulting Group (2013). "Ahead of the Curve: Lessons on Technology and Growth from Small Business Leaders". *http://www.bcg.com.cn/en/files/publications/reports_pdf/BCG_Ahead_of_the_Curve_Oct_2013.pdf*

Trucano, M (2005). "Knowledge Maps: ICT in Education". Washington, DC: infoDev / World Bank

Turkel, D (2015). "New York City's Mayor will Require all of the City's Public Schools to Teach CS". Business Insider. *http://www.businessinsider.com/mayor-de-blasio-will-require-nyc-schools-to-teach-computer-science-2015-9*

UNESCO Institute for Statistics (2006). "ICTs and Education Indicators". Communication Statistics Unit

University of Maryland (2015). "Proposal for Affordable Flagship Excellence, Access, and State Economic Growth: Differential Pricing of Degrees in Business, Engineering, and CS at UMCP". *http://www.umd.edu/Flagship2020/pdf/Differential%20pricing,%20UMCP%20proposal,%205-1-15.pdf*

US News Education. "Best Global Universities for CS". *http://www.usnews.com/education/best-global-universities/computer-science*

Grand Coalition
for Digital Jobs

THE e-SKILLS MANIFESTO

Not just in Europe, but around the world, the industrial economy and many of its institutions are beginning to fail. At the same time, the contours of new enterprises, industries and a new civilisation are becoming clear. For this reason, Europe is at a critical juncture, faced as it is with a growing digital capability gap between the demands for digital transformation on the one hand, and the skills, know-how and capability of the workforce on the other. To harness the potential of the digital revolution and to keep pace with global competition, Europe urgently needs to build an eskilled workforce. Working together, industry, education and government have the power to ensure long-term action and success that will deliver jobs, competitiveness and growth.

This Manifesto is a blueprint for making this happen. It is based on a broad cross-section of perspectives and is a must-read for those that have a stake in acquiring, nurturing and retaining eskilled talent in the 21st century.