Department for Business Innovation & Skills

Department for Culture Media & Sport

DIGITAL SKILLS for the UK ECONOMY

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Executive Summary

Introduction

This study examines the demand and supply of digital skills in the UK and reviews the risks for the UK if the digital skills needs of the population and businesses are not addressed. The findings of the study will inform the government's digital strategy, as a key element of the Productivity Plan.

The study addressed four key questions:

1. What is the current demand for digital skills across the economy and what are the different types of digital skills requirements?

2. What barriers and market failures to the development of digital skills have emerged during the last decade?

3. What are the areas of shortage or mismatch (skill mismatch is defined as the gap between an individual's job skills and the demands of the job market) of digital skills in the workforce?

4. How can the supply of digital skills meet the demand of the labour market?

Methodology

The methodology adopted first involved an extensive literature review using a range of sources to provide an overview of the current debate on the demand for digital skills in the UK; supply of digital skills; skills gaps and future digital skills requirements. It also considered the role of education and training in the skills pipeline, through which key digital skills relevant to society and the economy can be supplied. An assessment of existing digital skills definitions, and digital frameworks was undertaken to inform the study. This assessment resulted in the identification of three broad categories of digital skills requirements:

1. Basic digital literacy skills (empowering individuals): skills needed by every citizen to become 'digitally literate'. These are the skills needed to carry out basic functions such as using digital applications to communicate and carry out basic internet searches. Cyber security sits under this category.

2. Digital skills for the general workforce (upskilling for the digital economy): all of category 1, plus skills needed in a workplace and generally linked to the use of applications developed by IT specialists. While the digital skills needed by the workforce are likely to differ across sectors, there will be some minimum requirements linked to processing information that will be applicable across all sectors.

3. Digital skills for ICT professions (digitally innovative and creative individuals, organisations and businesses): All of categories 1 and 2, plus skills needed to work across the diverse IT sector. They include digital skills linked to the development of new digital technologies, and new products and services. Such skills are needed if the UK is to compare favourably with other nations in relation to ICT investment and utilisation.

Consultations were carried out with a range of strategic stakeholders, employer-led partnerships and Government agencies. These included the Sector Skills Councils, Sector Bodies, National Skills academies, and policy level stakeholders such as the Skills Funding Agency, and representatives from the Government's Digital Economy Unit (DEU). The interviews explored the types and levels of digital skills required by different sectors and occupational groups, to test the literature review findings, and the types of bottlenecks or barriers that contribute to digital skills gaps and shortages in the UK. They also explored education and training routes into digital roles, challenges or issues that influence the supply of skills in the UK, and, future skills training in digital skills and the issues that are likely to influence the development of digitally relevant courses for specific sectors.

Five case studies were developed, focusing on job types that exemplify a variety of occupations for which recent developments in ICT have resulted in a major change in the digital skills needed to carry out the specific roles linked to these occupations in the UK, or which have resulted in the emergence of a new occupation. These are in financial services, healthcare, the creative sector, Big Data, and logistics.

The study examined existing as well as future demands for digital skills in the UK economy. The routes used to meet the digital skills needed by employers in the UK were then reviewed, also considering the current barriers and market failures facing businesses in accessing digital skills. It drew on the literature review and interviews with stakeholders. The study then reviewed the risks and opportunities associated with actions (or lack thereof) linked to addressing digital skills needs in the UK, specifically in terms of market failures resulting from digital skills gaps, and the impact of these on the economy. It also reviewed the opportunity of improving digital skills with respect to the impact on the national economy.

Key Findings

The study sets out its conclusions under three thematic areas as follows:

Key Risks

1. A shortage in suitable digital skills for digital jobs persists in the UK labour market. This is a major risk to business growth, innovation and broader societal development.

2. By not effectively linking supply of digital skills to immediate, medium, and long-term demand, the relative ranking of the UK, in terms of investment in IT and utilisation compared to other major countries, is slipping. This may make the UK a less attractive investment location and place to do business.

3. While there are digital skills needs within sectors that are primarily ‘digital’ in their operations, there are wider challenges within the economy as a whole. Digital skills need to improve continuously across the whole UK population so that all sectors and organisations can maximise their competitive potential offered by the rapidly developing applications of digital technologies.

4. There is a need for action to be taken to re-skill the workforce continuously to ensure that new market segments that require digital skills can be exploited.

5. The widespread acquisition of digital skills offers particular growth opportunities for the UK economy but opportunities are often constrained by a lack of relevant digital skills within the labour force. As demand for digital skills outstrips supply, employers across a wider range of sectors are experiencing digital skill gaps within their workforce, and encountering difficulties in filling advertised vacancies (particularly in high level roles such as developers).

Opportunities

1. There is a clear link between market competitiveness and the uptake and application of digital technology in the workplace. Firms that have a developed ICT infrastructure and that take advantage of digital technologies tend to be the most competitive. Conversely, a lack of digital investment and infrastructure can place companies at a competitive disadvantage.

2. Significant value can be added to the UK economy and society through better investment in digital skills. This not only relates to job creation but also firm productivity and scaling-up markets for companies including SMEs.

3. The contribution of digital skills to the performance of the economy is substantial. The ‘tech sector’ alone represents 6% of the UK economy with an estimated GVA per person in the region of £91,800, well above the UK average. Given the large number of opportunities that are likely to be available, strong investment in digital skills would likely bring about a very good return on investment to the UK economy.

Bottlenecks, Barriers and Market Failures

1. The shortage in digital skills represents a key bottleneck for industry and is linked to one in five of all vacancies. Currently, 72% of large companies and 49% of SMEs are suffering tech skill gaps. There is a clear mismatch in the types of skill offered by the labour market and those demanded. In different ways and to different extents, this trend is likely to be holding back the growth of tech and non-tech companies alike (but further evidence on the types of problems emerging would support the argument).

2. There is an increasing range of activities and occupations where digital skills are needed but supply is not adequate.

3. There is a lack of awareness of career opportunities within the digital sector, sometimes reflecting skill and gender stereotypes around the types of roles that exist. Barriers exist especially for women who are under represented on higher education courses in computer related subjects, and within the industry as a whole.

4. Routes for the supply of digital skills are mainly via education and training routes delivered by education institutions. There are challenges in matching the speed of change in the education sector, for example in changing curricula and training, to the speed of demand, and the rapidly changing skill sets needs in the economy and society.

5. Assessing digital skills needs is challenging: While broad types of digital skills have been defined in terms of use, formal classification and recognition of skills and learning outcomes are less clear. This makes it difficult for employers to assess the digital skills of employees and applicants.

6. While there is a policy ambition for improving digital skill provision to ensure that digital skills development is integrated in curricula across all stages of education, the provision of digital skills at present is variable and inconsistent. While IT is extensively used in the primary and secondary education levels there still is much to be done to ensure that it is effectively used in teaching and learning (especially that teachers are digitally skilled), that gender stereotypes are overcome, and that learners are motivated to acquire digital skills through an awareness of the career potential they bring.

7. The digital skills of staff across the education and training system are uneven, and it is often not mandatory for staff to 'upskill' digitally. A learner's digital education will depend on the digital competencies and skills of those teaching them, as well as awareness and adaptability of education institutions to changes in technology.

8. Many companies are neither effectively maximising the potential of new technologies nor the talents of their employees. As a result, opportunities are missed and performance is not maximised.

9. There seems to be insufficient provision, insufficient knowledge, or uneven availability, of appropriate business support services linked to the digital skills agenda.

10. Parent and teachers are not appropriately informed to support children with their decision-making around career and skills development. A significant minority of parents consider digital skills as irrelevant to career prospects. These attitudes need to change if appropriate guidance is to be offered to future participants in the labour market.

Recommendations

The recommendations focus on the role of central government in providing economic policy direction, national focus and leadership. They also point to the critical roles of employers, the education sector and local government and agencies in delivering solutions that address the digital skills gaps and shortages in the UK.

Recommendation 1: Government should provide leadership, coordination, and key resources in establishing the conditions for digital skills development

1. Ensure that digital skills are learned pervasively at all stages of education and training.
   Government should set in place changes so that digital skills are embedded in education and training, enabling individuals to participate fully in the modern digital economy, whether as tech specialists, leaders of digitally-enabled businesses or workers in digitally-enabled jobs across the economy. As a minimum, all children should leave school digitally literate, with the skills needed in the workplace and to realise social outcomes. To this end, digital literacy should be seen as a core skill alongside English and Maths.

2. Focus education policy on skills of strategic importance to the nation.
   Government should work with industry to understand which digital skills are of particular strategic importance to the nation and to identify emerging trends such as those identified in this report. Strategies should be put in place to address shortages in these areas of strategic importance, including cyber security, big data, the Internet of Things, apps, mobile and e-commerce.

Recommendation 2: Employers should take ownership of digital skills development

1. Collaborate at a national level.
   Employers should collaborate, through networks and partnerships, to develop coherent national approaches to raising digital skills levels, bringing together digital leaders from all sectors. For example, industry should take a lead role in researching key productivity gaps with their relevant business/sector, so they can understand the advantages of upskilling and future proofing their workforce.

2. Lead on setting standards.
   Employers should play a lead role in setting the minimum standards that individuals are expected to acquire through education and training, including the digital skills that are transferable across different roles, for example, cyber security, digital marketing etc.

3. Build the skills of their own employees.
   Employers should ensure existing staff have the training to keep their digital skills updated, and develop active recruitment and development strategies to maximise the digital skills of their workforce.

4. Foster lifelong learning.
   Employers should help embed a culture which recognises and builds on the latent talents of their employees, actively supporting their learning through a wide range of learning approaches, to prepare them for future roles in the UK workforce. This could involve a mixture of vocational on-the-job training and employer led short courses with academic accreditation.

Recommendation 3: The education sector should develop and adapt their offers to meet the changing needs of the digital economy, working within the policy and funding frameworks established by the Department for Business, Innovation and Skills; Education; and Culture Media and Sport

1. Coordinate with stakeholders.
   Education and training providers should ensure that they understand how the supply of educational courses, in terms of quality and quantity, can meet the demand for digital skills in the wider economy (e.g. by sector, geographically, etc.).

2. Build digital skills capacity with industry-relevance.
   School, FE and HE digital curricula should be devised in partnership with industry, to provide people with the skills they will need in their roles across the workforce. Specialist provision, such as that to be provided by the planned National College for Digital Skills, should provide people with the advanced digital skills that will make a difference to the adoption of technology by companies across all sectors. In HE, computing-related degrees should equip people with the business and interpersonal skills they need to be effective in the workplace.

3. Motivate and inspire young people, particularly females, to consider digital careers.
   More young people, particularly females, must be attracted to continue digital education and pursue careers. Schools should be better equipped to inform young people about the advantages of a career in digital, making it an attractive proposition compared to traditional vocations. They should also better promote the advantages of vocational routes such as degree apprenticeships in addition to traditional higher education routes.

4. Implement programmes to continually update the digital skills of their staff.
   Teachers in schools should be supported to deliver the new computing curriculum and to develop their teaching approaches in line with developing educational technology. This includes helping current teachers retrain through an effective programme of continuous professional development (CPD) and ensuring new teachers are equipped with the right skills to teach the new curriculum.

5. Educators in FE and HE should be able to access CPD programmes to acquire and update their digital skills.

Recommendation 4: Local and regional government and agencies should address the digital skills needs of their local areas

1. Collaborate.
   Local partnerships and networks (LEPS, Councils, FE colleges, Universities and employers) should work together to determine the skills needs for their local area, so that education and training provision is better matched to local demand. Government must encourage these partnerships to share best practice and knowledge of successful programmes and training schemes.

2. Inform.
   Local agencies should ensure that relevant and focused information is made available about digital skills training and education provision across all sectors in their geographical areas. For example, the government must encourage more SMEs to get online and to develop and grow their businesses to changing customer needs.

Introduction

The Digital Economy Unit (DEU), within the Department for Culture, Media and Sport (DCMS), in conjunction with the Department for Business, Innovation and Skills (BIS) commissioned Ecorys UK Ltd to undertake a study to help improve the understanding of the current and future demand for digital skills in the UK economy. This report first summarises the approach and methodology, then presents the findings from the literature review and the consultations carried out, and finally draws the findings together in conclusions with recommendations for further action.

Scope of the study

Digital skills underpin growth across the economy and are vital to ensuring global competitiveness and productivity. They are needed across the population to enable social inclusion and access to digital public and private services. However, market and institutional challenges mean that many businesses are struggling to obtain employees with the right skills to exploit technological opportunities, and sections of society are missing out on the benefits of the digital economy. For example, there are challenges in ensuring that the workforce have the digital skills needed to equip them for job roles that are increasingly becoming digitalised, so that the UK can be a world-leading digital nation capable of taking advantage of the opportunities that new digital technologies provide. This study examines the demand and supply of digital skills in the UK, and reviews the barriers and opportunities for the UK when addressing the digital skills needs of the population and businesses. The research questions addressed are:

1. What is the current demand for digital skills across the economy and what are the different types of digital skills requirements?

2. What barriers and market failures to the development of digital skills have emerged during the last decade?

3. What are the areas of shortage or mismatch (skill mismatch is defined as the gap between an individual's job skills and the demands of the job market) of digital skills in the workforce?

4. How can the supply of digital skills meet the demand of the labour market?

In this context, the study works within the following definitions:

- skills: the ability to perform a task to a predefined level of competence

- transferable/generic skills: skills which can be used across large numbers of different occupations

- skills gaps: deficiencies in the skills of an existing workforce, both at the individual level and overall, which prevent the firm or a sector from achieving its business objectives (linked to problems with skills inside the business)

- skills shortages: recruitment difficulties caused specifically by a shortage of individuals with the required skills in the accessible labour market (linked to problems with skills outside the business – in the general workforce)

- tech vs. digital: 'tech' is used in relation to sectors that cover companies whose focus is on IT software and services, covering telecoms services, computer games, IT and telecoms manufacturing; 'digital' technology companies work across various sectors from software development, e-commerce and telecommunications through to advertising and marketing and financial services

- digital economy**:** covers two sectoral groups – 'information and communications technology' and 'digital content' (Department for Business Innovation and Skills and Department for Culture Media and Sport 2009); however, the research literature cited in this report is sourced from a wide range of studies, therefore the context under which these studies have been carried out should be taken into account, and on the basis of the research covered by this report, we widen this definition to cover industries involved in:

    - "supporting infrastructure (hardware, software, telecoms, networks, etc.);
    - e-business (how business is conducted, any process that an organisation conducts over computer-mediated networks);
    - e-commerce (transfer of goods, for example when a book is sold online)"

The findings of the study will inform the government's digital strategy, as a key element of the Productivity Plan. DCMS will be working across government to develop actions to help the adoption of digital technologies across the whole economy to improve productivity.

The objectives and the key thematic areas of interest in this study are:

Thematic areas for exploration

Objective 1: To understand current and future demand for digital skills in the UK economy:

- current digital skills requirements: demand for digital skills and the type of digital skills needed across the economy by sector and occupation

- digital skills gaps: gaps in relation to job roles and levels of seniority/career development (occupational skills)

- future requirements: future digital skills requirements and expected skills gaps – latent and unrecognised

- remuneration/career paths: job prospects in digital-related roles compared to other career paths and related levels of remuneration

- training: current and future priorities for digital skills training and employer investment training

Thematic areas for exploration

- sectoral differences in digital skills: different sectoral requirements for digital skills

Objective 2: To understand the routes used to meet the digital skills needs of individuals and employers in the UK, and the current barriers and market failures faced by businesses in accessing digital skills:

- education and training routes: employer recruitment practices and training provision (supply)
- transferable digital skills: digital skills that can be transferred across different jobs and roles (for example, the cross-over between general digital skills and cyber security)
- influencers: issues that influence the supply/acquisition of digital skills, for example: Individual motivation and awareness, institutional flexibility and adaptability, employer knowledge about training need
- barriers: in relation to individuals, particularly women, who are underrepresented in the sector, from taking up careers in digital relevant roles

Objective 3: Identify the risks and opportunities in addressing digital skills needs in the UK:

- market failures: digital skills gaps that lead to market failures
- impact on the economy: impact of market failures resulting from digital skills gaps in the economy
- value to the economy: the value to the economy in improving digital skills of the nation

Study context

The UK digital economy

The UK's digital economy is recognised as one of the strongest globally.[1] The formation rate of new digital technology companies is rapidly growing with 53% more companies formed in 2013 than in 2010. Digital technology companies cover almost all sectors from software development, e-commerce, and telecommunications through to advertising and marketing, financial services and fashion.[2] A study by the National Institute for Economic Research (NIESR) using Growth Intelligence data reports that the digital economy is much larger than conventional estimates indicate. NIESR note that there are approximately 270,000 active companies in the UK (14.4% of all companies as of August 2012); this is much higher than the government estimated figure of 167,000 companies (10.0%) which uses conventional SIC-based definitions, and excludes companies in business and domestic software, architectural activities, engineering, and engineering-related scientific and technical consulting, among other sectors.[3]

The value of the digital economy is evident from the specific economic contribution of the 'tech' sector (comprising companies whose focus is on IT software and services, telecoms services, computer games, IT or telecoms manufacturing, and retail) to the UK economy.[4] In terms of Gross Value Added (GVA), this is estimated to be 6% of the UK total economy, which is double that associated with the legal and accounting services industry. The estimated GVA per person working in the tech industry was £91,800 in 2013 compared with £51,300 for the average UK worker.[5] The Tech Partnership also reports that in 2015, there were "1,278,000 people employed in 'tech' specialist roles. 627,000 (49%) tech specialists have jobs in the tech industry itself, whilst the other 651,000 worked in other industries across the breadth of the UK economy".[6]

However, the above calculations can underestimate the value of the wider digital economy. Digital technology can also offer competitive advantage across all sectors and industries, through improving productivity[7], performance and profitability.

[1] BOUNDS, A. & O'CONNOR, S. 2015. *Digital economy transforms UK workforce*. Financial Times (London). Published March 11. Available: http://www.ft.com/cms/s/0/5ac2e590-c741-11e4-9e34-00144feab7de.html. [Accessed March 11 2015], THOMPSON, B. 2015. *London tech hubs evolve to challenge Silicon Roundabout*. Financial Times (London). Published June 16. Available: http://www.ft.com/cms/s/0/876bcd12-140a-11e5-9bc5-00144feabdc0.html. [Accessed June 17 2015].

[2] TECHCITY 2015b. *Tech Nation: Powering the Digital Economy 2015*. Tech City UK. Available: http://www.techcityuk.com/technation/. [Accessed July 2 2015].

[3] NATHAN, M., ROSSO, A., GATTEN, T., MAJMUDAR, P. & MITCHELL, A. 2013. *Measuring the UK's Digital Economy with Big Data*. National Institute for Economic and Social Research. Published July. Available: http://www.niesr.ac.uk/sites/default/files/publications/SI024_GI_NIESR_Google_Report12.pdf. [Accessed September 17 2015].

[4] TP 2015d. *Tech Insights: The Digital Economy*. The Tech Partnership. Published March. Available: https://www.thetechpartnership.com/globalassets/pdfs/research-2015/techinsights_report_mar15.pdf. [Accessed July 26 2015].

[5] ibid.

[6] TP 2015d. Tech Insights: The Digital Economy. The Tech Partnership. Published March. Available: https://www.thetechpartnership.com/globalassets/pdfs/research-2015/techinsights_report_mar15.pdf. [Accessed July 26 2015].

[7] For example "*Rolls-Royce, an aerospace company, has halved the time it takes to manufacture fan discs and turbine discs used in jet engines, using methods developed at the Advanced Manufacturing Research Centre (AMRC) at Sheffield University*". ECONOMIST 2015e. *The productivity puzzle: Under the bonnet*. Economist. Published May 30. Available: http://www.economist.com/news/britain/21652310-britains-stall-productivity-more-serious-any-rich-world-peer-closer-look. [Accessed May 28 2015].

Digital skills for citizenship, social and economic inclusion

The rapid rate of technological innovations requires the current workforce to continually update their skills to equip them for emerging roles in the sectors in which they work, which have been influenced by new technologies. In the context of social inclusion, the application of digital skills offers wider opportunities for society and democracy.[8] Digital skills range from those that enable basic social interaction (communication skills, literacy, smartphone usage etc) through to skills that enable interaction with systems and services (for example e-commerce and e-government services) through to skills that match the needs of employers and which maximise employability. The move to 'Digital by Default'[9] online government services implies directly that citizens should have, by 'default', a set of digital skills to enable them to access these services.

There are also wider considerations in the context of social mobility. Where people have the skills to use them effectively, digital technologies can open up new opportunities. Parents can apply for school places online and receive the results via email. Individuals with online access and the relevant IT skills can book appointments online with a General Practitioner. The need for basic digital skills is also becoming increasingly important for accessing welfare services, where benefits recipients will have to access an online system to apply for their Universal Credits. Other benefits that digital skills bring include savings on household bills (for example through e-billing) and the ability to access training, support, and information on health and wellbeing online (thus saving transport costs etc.).[10]

The use of digital channels also improves the way public services are delivered at the national[11] and local[12] levels. For example, it makes it possible for citizens to participate in service delivery, and not just have them delivered through local government – such as through crowdfunding (i.e. raising funds for a project through the internet) for local services.[13] Smart monitoring devices can empower individuals to monitor their health and physical activity, promote active ageing[14] and reduce the burden on healthcare services; however, they do also require that individuals are 'literate'[15] in the use of new technologies and have the skills and knowledge to use technologies effectively. GO ON UK's "digital

[8] COMMONS 2014. *E-petitions: a collaborative system*. House of Commons, Procedure Committee. Published December 4. Available: http://www.publications.parliament.uk/pa/cm201415/cmselect/cmproced/235/23502.htm. [Accessed December 5 2014].

[9] https://www.gov.uk/government/publications/government-digital-strategy-action-6

[10] NHC 2015. *The Business Case for Digital Inclusion*. Northern Housing Consortium. Available: http://www.northern-consortium.org.uk/wp-content/uploads/The-Business-Case-for-Digital-Inclusion.pdf. [Accessed August 23 2015].

[11] CABINET 2014b. *UK to be the G8's "most digital government" by next year, with billions of savings in sight*. Cabinet Office (UK). Published January 21. Available: https://www.gov.uk/government/news/uk-to-be-the-g8s-most-digital-government-by-next-year-with-billions-of-savings-in-sight. [Accessed January 22 2014].

[12] LGA 2014. *Transforming public services, using technology and digital tools and approaches*. Local Government Association (UK). Published July 15. Available: http://www.local.gov.uk/web/guest/publications/-/journal_content/56/10180/6363281/PUBLICATION. [Accessed September 23 2014].

[13] ECONOMIST 2013. *Civic crowdfunding: Breaking ground*. Economist. Published May 18. Available: http://www.economist.com/news/international/21578039-online-start-ups-are-rallying-citizens-revamp-their-neighbourhoods-breaking-ground. [Accessed May 16 2013].

[14] IUK 2015. *Health needs of older people: apply for business funding*. Innovate UK. Published June 18. Available: https://www.gov.uk/government/news/health-needs-of-older-people-apply-for-business-funding. [Accessed June 21 2015].

[15] EP 2015. *Health literacy: how technology can help to empower patients*. European Parliament. Published July 2. Available: http://www.europarl.europa.eu/news/en/news-room/content/20150701STO72927/html/Health-literacy-how-technology-can-help-to-empower-patients. [Accessed July 2 2015].

exclusion heatmap" estimates that 12 million people and one million businesses in the UK do not have the appropriate digital skills to benefit from the digital economy.[16]

However, it is not just the 'user' end of skills that is essential, but also the 'innovator' end of skills. Effective skills in using technology, combined with the knowledge and competencies to innovate, can increase the matching of digital skills to the needs of the UK digital economy. For example, the merging of digital and creative roles in the media sector in particular demands a complex set of IT skills and competencies for individuals who work in the sector, such as mobile and cloud computing, cyber security and social media.[17] Taking into account the value of the digital economy to the UK in relation to improving productivity, performance and profitability, and the wider context of the need for the current workforce to update their skills to equip them for new and emerging occupational roles linked to technological changes, the study considers how digital skills are defined in literature; current and future demand for digital skills in the UK economy; routes used to supply digital skills; and the risks and opportunities for the UK economy if digital skills gaps and shortages are not addressed.

Methodology

Figure 1 below summarises the methodology used for the study. The study largely involved a literature review, with supplementary information from consultations with key stakeholders to test the findings from the literature review. The rest of the section sets out the activities carried out in more detail.

[16] CELLAN-JONES, R. 2015. *More than 12 million fall into UK digital skills gap*. British Broadcasting Corporation (BBC). Published October 19. Available: http://www.bbc.co.uk/news/technology-34570344. [Accessed October 19 2015], GO 2015. *About the Digital Exclusion Heatmap*. Go ON UK. Published October 19. Available: http://www.go-on.co.uk/resources/heatmap/. [Accessed October 19 2015].

[17] DASS, M., GOODWIN, A., WOOD, M. & NI LUANAIGH, A. 2015. *Sector insights: skills and performance challenges in the digital and creative sector*. UK Commission for Employment and Skills. Published June 9. Available: https://www.gov.uk/government/publications/sector-insights-skills-and-performance-challenges-in-the-digital-and-creative-sector. [Accessed July 16 2015].

Figure 1 Summary of the Methodology

Task One: Literature Review (Assessing demand and supply of digital skills)

A detailed literature review was carried out using a range of sources to provide an overview of the current debate on the demand for digital skills in the UK; supply of digital skills; skills gaps and future digital skills requirements. It also considered the role of education and training in the skills pipeline, through which key digital skills relevant to society and the economy can be supplied.

An assessment of existing digital skills definitions, and digital frameworks was carried out as part of the review; it drew on the following frameworks:

- the DIGCOMP (Ferrari 2013[18]) framework containing five broad areas of ICT competence (information, communication, content creation, safety (cyber security), and problem-solving), with 21 sub-competences

- the 2011 Canadian study[19] with an inventory of test-based digital skills indicators from other surveys

[18] FERRARI, A. 2013. *DIGCOMP: A Framework for Developing and Understanding Digital Competence in Europe*. Institute for Prospective Technological Studies. Published August. Available: http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=6359. [Accessed December 6 2013].

- the OECD definition of ICT related employment (OECD, 2010[20]) which distinguishes between ICT specialists, advanced users, and basic users

- GO-On-UK's Basic Digital Framework[21] which focuses on Basic Digital skills and looks at that in relation to five areas: managing information, communicating, transacting, problem-solving and creating

All the above frameworks are presented in Annex One.

Task Two: Stakeholder/focus group interviews

Stakeholder consultations were carried out with a range of strategic stakeholders, employer-led partnerships and government agencies. These included the Sector Skills Councils, Sector Bodies, National Skills academies, and policy level stakeholders such as the Skills Funding Agency, representatives from the government's Digital Economy Unit (DEU). A full list of the organisations that supported the study is outlined at the beginning of this report.

The interviews explored the types and levels of digital skills required by different sectors and occupational groups to test the literature review findings, and the types of bottlenecks or barriers that contribute to digital skills gaps and shortages in the UK. They also explored education and training routes into digital roles, challenges or issues that influence the supply of skills in the UK, and future skills training in digital skills and the issues that are likely to influence the development of digitally relevant courses for specific sectors. The key questions discussed in these interviews were:

1. What is the current demand for digital skills in the economy? What types of digital skills are required by employers? And where is the demand in relation to the above areas? Where are the skills gaps? Where are the future digital skills requirements?

2. At what point in the education pipeline should digital competences be developed? What should the minimum digital skills competences be for someone leaving education at different points of the education cycle (schools, Further Education (FE), and Higher Education (HE))?

3. How can the UK upskill those who are currently not in education and employment, and have no digital skills, to carry out the basic tasks that allow them to function in a society that is becoming increasingly digitalised?

4. How can the UK ensure that the digital skills of the current workforce are continually updated to equip them for current and emerging job roles in the sectors in which they work?

5. How can the UK ensure that IT training meets the demand of employers?

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[19] CHINIEN, C. & BOUTIN, F. 2011. *Defining Essential Digital Skills in the Canadian Workplace: Final Report*. Human Resources and Skills Development Canada. Available: http://www.nald.ca/library/research/digi_es_can_workplace/digi_es_can_workplace.pdf. [Accessed June 5 2014].

[20] OECD 2010. *OECD Information Technology Outlook 2010*. OECD. Published November 30. Available: http://www.oecdbookshop.org/oecd/display.asp?K=5KMJW4MQ567K&CID=&LANG=EN. [Accessed December 3 2010].

[21] http://www.go-on.co.uk/basic-digital-skills/

The findings from these interviews have been analysed and cross-referenced with the literature review findings, and have been used to inform the conclusions and recommendations.

A copy of the topic guide used for the interviews is presented in Annex Two.

Task Three: Case studies

Five case studies have been developed. These cover job types that exemplify a variety of occupations for which recent developments in ICT have resulted in a major change in the digital skills needed to carry out the specific roles linked to these occupations in the UK, or which have resulted in the emergence of a new occupation. The case studies are presented in Chapter 4.

Structure of the report

The rest of the report is structured as follows:

- Chapter 2: Assesses existing digital skills frameworks and definitions that have emerged over time, and their usefulness in a UK context

- Chapter 3: Examines existing as well as future demand for digital skills in the UK economy, and includes a number of case studies that depict how digital technologies have transformed occupations within five sectors, healthcare, financial services, creative services, analytics and logistics

- Chapter 4: Outlines the various initiatives and educational routes used to meet the digital skills needs in the UK

- Chapter 5: Discusses the impact of failing to fill the digital skills gaps and shortages in the UK

- Chapter 6: Sets out the key conclusions based on the findings from the study and a number of recommendations for the DEU

Definitions and Frameworks of Digital Skills

This chapter discusses the different definitions used for digital skills, and how this is interpreted in research literature. It includes an assessment of existing frameworks and their limitations.

Digital skills definitions

The definition of digital skills has 'broadened' over time. The first definitions of computer or ICT literacy focused on technical, operational and procedural knowledge about computer use, while later definitions covered cognitive, attitudinal, social and emotional skills.[22] Over time, a range of (sometimes partially) overlapping definitions, such as computer literacy, internet literacy, media literacy and digital literacy, has emerged.

Computer literacy is the narrowest digital concept, emphasising the technical use of computers and software, while internet literacy adds the considerations and ability to function successfully in networked media environments. Digital literacy is the broadest concept, and it includes the main aspects of the other concepts.[23] According to Ala-Mutka, digital literacy includes a continuum of skills ranging from basic, operational skills to higher order cognitive, social and attitudinal skills and abilities. Recently, some definitions have also included the types of digital skills, and the level of digital skills needed for different tasks.

Table 1 below charts the definitions used in the past decade, and reflect the increase in the uptake of digital technologies (and illustrate the degree to which these are embedded in work processes, products and services).

[22] ALA-MUTKA, K. 2011. *Mapping Digital Competence: Towards a Conceptual Understanding*. Institute for Prospective Technological Studies. Published October. Available: http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=4699. [Accessed October 30 2011].

[23] ibid

Table 1 Definitions of Digital Skills

Reference	Digital skills definition	Assessment
OECD (2004)[24]	The definition used by the OECD focuses on three categories of ICT competencies linked to three different types of users: ● **ICT specialists:** competencies under this user group cover the ability to develop, operate and maintain ICT systems. ICTs constitute the main part of their job for this user group; ● **Advanced users**: this group of users are described as '*competent users of advanced, and often sector-specific, software tools*'. ICTs are used as a tool for these users in a workplace context; and ● **Basic users**: this group of users are described as *'competent users of generic tools (e.g. office suites and internet-related tools such as browser and email clients) needed for the information society, e-government and working life'*. ICTs for this user group are mainly used as a communicating tool.	One of the few digital skills definitions that recognises the different types of digital users.
e-skills Forum (2004)	In 2004, the e-skills Forum[25] proposed a definition of e-skills. This was later adopted in the e-skills Communication in 2007.[26] The definition included the following three categories: ● **ICT user skills:** skills linked to the ability to make effective use of ICT systems and devices; ● **ICT practitioner skills:** skills linked to researching, developing, designing, strategic planning, managing, producing, consulting, integrating, installing, administering, maintaining, supporting and servicing ICT systems; and ● **E-business skills***:* skills needed to exploit opportunities provided by ICT and the internet to ensure a more effective and efficient performance of different types of organisations.	The concepts used under the three categories proposed by the e-skills Forum are not clearly defined, and the boundaries are blurred.

[24] OECD 2013. *Skills for the Digital Economy*. OECD. Published May. Available: http://skills.oecd.org/developskills/documents/skillsforthedigitaleconomy.html. [Accessed May 3 2014], OECD 2005. *NEW PERSPECTIVES ON ICT SKILLS AND EMPLOYMENT* OECD. Published April 22. Available: http://www.oecd.org/internet/ieconomy/34769393.pdf. [Accessed June 1 2012].

[25] COMMISSION 2014. *e-Skills for the 21st Century Fostering Competitiveness, Growth and Jobs*. European Commission. Published October 27. Available: http://ec.europa.eu/enterprise/sectors/ict/e-skills/index_en.htm. [Accessed March 2 2015].

[26] COMMISSION 2007. *e-Skills for the 21st Century: Fostering Competitiveness, Growth and Jobs*. European Commission. Published September 7. Available: http://ec.europa.eu/enterprise/sectors/ict/files/comm_pdf_com_2007_0496_f_en_acte_en.pdf. [Accessed February 3 2010].

Reference	Digital skills definition	Assessment
DigEuLit project (Martin 2005[27])	The term digital literacy used in the DigEuLit project covers: ● **Digital competence:** defined as the knowledge, understanding, attitudes and skills relating to the digital world; ● **Digital usage:** defined as the application of digital competence within specific professional or domain contexts; and ● **Digital transformation:** defined as the use of digital technologies to enable innovation and creativity, and stimulate significant change within the professional or knowledge domain.	The DigEULit definitions are broad, but efforts have been made to differentiate between 'user types'.
European Parliament (2006[28])	The European Parliament defines digital competence as *"the confident and critical use of information society technology for work, leisure, learning and communication. It is underpinned by basic skills in ICT, i.e. the use of computers to retrieve, access, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the internet".*	The European Parliament definition is broad; it does not take into account digital competences that are likely to be needed in a work context.
Ala-Mutka (2011[29])	The IPTS report '*Mapping Digital Competence: Towards a Conceptual Understanding'* uses the following five concepts: 1. **'Computer literacy' or 'technology literacy'**: the ability to use computers and related software; 2. **Internet (or network) literacy:** skills needed to locate, select and evaluate information on the internet; 3. **Information literacy:** skills needed to locate and evaluate information, store and retrieve information, make effective and ethical use of information and apply information to create and communicate knowledge; 4. **Media literacy:** skills that enable people to analyse, evaluate, and create messages in a wide variety of media modes, genres, and formats; and 5. **Digital literacy:** the most overarching concept, which includes many of the skills discussed in the concepts mentioned above. These concepts informed the development of the DIGICOMP framework.	The skills and knowledge across the five concepts developed include several inter-related areas.

[27] MARTIN, A. 2005. *DigEuLit - a European Framework for Digital Literacy: a Progress Report*. University of Glasgow. Available: http://www.jelit.org/65/01/JeLit_Paper_31.pdf. [Accessed October 3 2010].

[28] http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Digital_literacy

[29] ALA-MUTKA, K. 2011. *Mapping Digital Competence: Towards a Conceptual Understanding*. Institute for Prospective Technological Studies. Published October. Available: http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=4699. [Accessed October 30 2011].

Reference	Digital skills definition	Assessment
Ilomäki (2011[30])	Ilomaki (2011) links digital competence to basic skills and describes it as the ability to "*retrieve, assess, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the internet".*	The definition mainly covers users' basic digital literacy skills.
WDM Consultants (2011[31])	The Canadian study "*Defining Essential Digital Skills in the Canadian Workplace*" defines digital skills as a multifaceted concept, which encapsulates four skill clusters: (1) Digital Technical Skills; (2) Digital Information Processing Skills; (3) Foundational Skills; and (4) Transversal Skills.	The framework developed under this study is comprehensive, work has been done to separate the different competencies needed for each skill cluster (see Annex for the full framework).
Development Economics (2013[32])	In Development Economics '*The Future Digital Skills needs of the UK Economy'* report, digital skills are defined '*as the attributes that allow individuals and businesses both to use digital equipment and to access, create or share digital information via the internet and thereby benefit from opportunities in the modern economy'.* The report sets out what it calls '*a functional hierarchy of these digital skills'* as: • "**Advanced digital skills**: skills linked to *'the creation and/or strategic exploitation of new digital applications, including more advanced programming and coding involved in the creation of new software, etc., but they also cover the strategic business skills needed to convert ideas into successful commercial projects and ventures'*; • **Intermediate-level digital skills**: these involve '*skills needed to implement and manage on a day-to-day basis the applications developed by those with advanced skills, but they may also provide contributions to the development of digital content, provision of system support and maintenance, etc.*'; • **Entry-level digital skills**: skills related to '*the use of digital applications designed, developed and promoted by others: involving for example searches for and/or the capturing and recording of digital data across a wide variety of business and public services, the administration of databases, the monitoring of data, contributing to the management of digital content, etc.'.*	One of the few definitions which recognises the different 'types' of digital users.

[30] ILOMÄKI, L., KANTOSALO, A. & LAKKALA, M. 2011. *What is digital competence?* European Schoolsnet. Published March. Available: http://linked.eun.org/c/document_library/get_file?p_l_id=16319&folderId=22089&name=DLFE-711.pdf. [Accessed January 3 2012].

[31] CHINIEN, C. & BOUTIN, F. 2011. *Defining Essential Digital Skills in the Canadian Workplace: Final Report*. Human Resources and Skills Development Canada. Available: http://www.nald.ca/library/research/digi_es_can_workplace/digi_es_can_workplace.pdf. [Accessed June 5 2014].

[32] DE 2013. *The Future Digital Skills needs of the UK Economy*. Development Economics. Published September. Available: http://cdn.news.o2.co.uk.s3.amazonaws.com/wp-content/uploads/2013/09/The-Future-Digital-Skills-Needs-of-the-UK-Economy1.pdf. [Accessed April 3 2014].

Reference	Digital skills definition	Assessment
Ferrari (2013[33])	Ferrari (2013) refers to digital skills as "*the ability to critically analyse and assess digital information, problem solving through the use of digital tools, creation and recreation of content and so forth*".	The distinction between skills needed at the lower end of the digital scale, and those needed in the workplace are blurred.
OECD (2013[34]), PIAAC Survey	OECD in its adult learning survey includes '*problem solving in technology-rich environments'* as one of the necessary skills needed '*in a broad range of contexts, from education through work to everyday life'*. This is defined as 'the *ability to use technology to solve problems and accomplish complex tasks'*. These are skills that are *'essential for people to be able to decide what information they need, to evaluate it critically, and to use it to solve problems'*.	OECD focus is on basic digital literacy skills.
DIGCOMP's Framework for Developing and Understanding Digital Competence in Europe (2013[35])	DIGICOMP's digital framework is based on five dimensions (information, communication, content creation, safety and problem solving) which are sub-dived into a set of competences. These competencies are linked to three proficiency levels; foundation, intermediary and advanced level. The framework sets out a range of skills and knowledge needed for each of these proficiency levels.	A comprehensive but complex framework, not all citizens, learners or users will be interested in developing all the competences listed in the framework (see Annex for a detailed framework).
European e-Competence Framework (e-CF) (European Commission 2014[36])	This framework has been mapped against the European Qualifications Framework[37]. The European e-Competence Framework (ibid) is structured from four dimensions: ● **"Dimension 1**: *5 e-Competence areas, derived from the ICT business processes Plan, Build, Run, Enable and Manage;* ● **Dimension 2:** *A set of reference e-Competences for each area, with a generic description for each competence. Forty competences identified in total provide the European generic reference definitions of the e-CF 3.0.;* ● **Dimension 3**: *Proficiency levels of each e-Competence provide European reference level specifications on e-Competence levels e-1 to e-5 that are related to the EQF levels 3 to 8; and*	This framework has been designed solely for ICT professionals.

[33] FERRARI, A. 2012. *Digital Competence in practice: An analysis of frameworks*. Institute for Prospective Technological Studies. Published August. Available: http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=5099. [Accessed August 17 2012], FERRARI, A. 2013. *DIGCOMP: A Framework for Developing and Understanding Digital Competence in Europe*. Institute for Prospective Technological Studies. Published August. Available: http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=6359. [Accessed December 6 2013].

[34] http://www.oecd.org/site/piaac/

[35] FERRARI, A. 2013. *DIGCOMP: A Framework for Developing and Understanding Digital Competence in Europe*. Institute for Prospective Technological Studies. Published August. Available: http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=6359. [Accessed December 6 2013].

[36] http://www.ecompetences.eu/

[37] http://relaunch.ecompetences.eu/wp-content/uploads/2013/11/EQF_broch_2008_en.pdf

Reference	Digital skills definition	Assessment
	• **Dimension 4**: *Samples of knowledge and skills relate to e-Competences in Dimension 2. They are provided to add value and context and are not intended to be exhaustive".*	
Go ON UK[38]	'Go ON UK' describes '*basic digital skills'* as *'the minimum skills required to safely use the internet and access the benefits it can provide'.* These include '*skills needed to benefit from a digital world'*, skills that '*allow you to shop, transact, and find the best deals online; communicate with family and friends; access digital public services; and search and apply for jobs'.*	Go ON UK framework focuses on digital literacy skills. However, it is a comprehensive framework, and one of the few that is task focused (see Annex for detailed framework).
UK Digital Skills Taskforce (2014[39]**)**	The UK Digital Skills Workforce describes digital skills 'as *the skills needed to interact with digital technologies,* and stresses these skills as *'necessary life skills'.*	The definition mainly focuses on users that need basic digital skills.
(UKforCE) – June 2014[40]	A submission from the UK forum for Computing Education (UKforCE), in response to the UK Digital Skills Taskforce call for evidence, uses SOC 2010 occupational groups to estimate which group is likely to have tasks that will require their employees to have a certain level of digital skills. The categories used were: • ***'Digital Muggle:*** *No digital skills required – digital technology may as well be magic;* • ***Digital Citizen****: the same work skills as are required to be a full digital citizen. This is the ability to use digital technology purposefully and confidently to communicate, find information and purchase goods/services;* • ***Digital Worker****: substantially more digital skills than those required for full digital citizenship but less than those of a Digital Maker. This includes, at the higher end, the ability to evaluate, configure, and use complex digital systems. Elementary programming skills such as scripting are often required for these tasks; and* • ***Digital Maker****: skills to actually build digital technology (typically software development). The Digital Maker category is interpreted quite broadly to include, at the low end, for example, workers who regularly create complex Excel macros or data files for controlling 3D printers'.*	One of the few definitions that take into account digital skills needed by different types of digital users; basic, intermediate and advanced.

[38] http://www.go-on.co.uk/

[39] UKDS 2014. *Digital Skills for Tomorrow's World: The independent report of the UK Digital Skills Taskforce*. UK Digital Skills Task Force. Published July. Available: http://www.ukdigitalskills.com/wp-content/uploads/2014/07/Binder-9-reduced.pdf. [Accessed June 22 2015], UKDS 2015. *Digital Skills for Tomorrow's World*. UK Digital Skills Task Force. Available: http://www.ukdigitalskills.com/. [Accessed June 22 2015].

[40] UKFORCE 2014. *Digital Skills Taskforce call for evidence: Submission from the UK forum for Computing Education (UKforCE)*. UK forum for Computing Education. Available: http://ukforce.org.uk/wp-content/uploads/2014/06/Digital-Skills-Taskforce-UKforCE-submission-Updated.pdf. [Accessed July 25 2015].

The above definitions highlight that 'digital skills' involves several inter-related skills concepts. While the definitions above are insightful, there are limitations when reviewed in the context of addressing digital skills gaps. In most cases, with the exception of the OECD, Development Economics and UKforCE definitions, no clear distinctions are made between the skills needed by different user groups. Other definitions are either too broad; not all citizens, learners or users will be interested in developing the competences described in some of these frameworks, or narrow; and focus on one user group. However, existing definitions and frameworks taken as a whole all cover the following broad categories:

1. Basic digital literacy skills (Empowering individuals): skills needed by every citizen to become 'digitally literate'. These are the skills needed to carry out basic functions such as using digital applications to communicate and carry out basic internet searches. Cyber security sits under this category.

2. Digital skills for the general workforce (Upskilling for the Digital Economy): all of category 1, plus skills needed in a workplace and generally linked to the use of applications developed by IT specialists. As discussed in the Development Economics report, equipping the workforce with such skills 'encourage deeper and faster usage of digital technologies by UK businesses and other organisations and measures'.[41] While the digital skills needed by the workforce are likely to differ across sectors, there will be some minimum requirements linked to processing information that will be applicable across all sectors.

3. Digital skills for ICT professions (Digitally innovative and creative individuals, organisations and businesses): all of categories 1 and 2, plus skills needed to work across the diverse IT sector. They include digital skills linked to the development of new digital technologies, and new products and services. Such skills are needed if the UK is to compare favourably with other nations in relation to ICT investment and utilisation.

Categorising digital skills under these three areas is a useful starting point when discussing the extent to which the supply of digital skills meets the demand for such skills in the economy. To develop appropriate solutions that improve the quantity and the quality of the supply of digital skills in the UK economy, training routes, for example, will need to be developed to cover the skills needed by the above three groups. This requires therefore a re-think of how digital skills are defined. The use of the above three distinct definitions of digital skills is a useful context in which to start discussions around the training needs of different user groups.

In Chapter 3, we broaden these three areas by mind mapping the skills and competencies needed under each of these three categories. This map is based on the assessment of the digital skills definitions discussed and the frameworks discussed in this chapter and the findings from the literature review and stakeholder consultations.

[41] DE 2013. *The Future Digital Skills needs of the UK Economy*. Development Economics. Published September. Available: http://cdn.news.o2.co.uk.s3.amazonaws.com/wp-content/uploads/2013/09/The-Future-Digital-Skills-Needs-of-the-UK-Economy1.pdf. [Accessed April 3 2014].

Key Findings

- The research literature has sought to characterise digital skills according to a range of definitions and categories;

    - Over recent years, the definition of digital skills has broadened out to the concept of digital literacy encompassing multiple types of skill-sets such as basic, operational, cognitive, social and attitudinal. However, many of the existing frameworks are blurred in terms of the types of skills they define (e.g. by not distinguishing between high and low level skills), and a lack of clarity around the types of digital competencies necessary for certain tasks to be performed by specific user groups. Other types of frameworks focus on specific categories of user groups rather than considering the picture as a whole.

- Considering the current definitions available, it is possible to identify the overarching digital skill needs under three key groups:

    - Skills required by all citizens to become computer literate;
    - Skills required for the general workforce in order to use digital applications;
    - Digital skills necessary for ICT professionals linked to the development of new products and services.

  In the context of the groups identified, the literature enables the identification of digital skills categorised according to competency areas, individual competences, skill and knowledge and skill levels.

- On the basis of re-thinking how digital skills are defined, and with a view to improving the quantity and quality of digital skills supply in the UK economy, the use of a framework setting out distinct definitions of digital skills as described above could support the better alignment of education and training to the demand for such skills by industry.

Current and future demand for digital skills in the UK economy

This section examines the existing as well as future demand for digital skills in the UK economy. It draws on evidence from the literature review and stakeholder consultations.

Digital skills requirements

Quantifying the existing number of staff in roles requiring digital skills is challenging since these skills are increasingly needed across all sectors and service areas. Digital skills are needed much more widely than those required by 'tech' specialists and within the 'tech', IT and telecoms sectors. For example, the Lloyds Bank '*UK* Business Digital Index', which analyses how small and medium enterprises (SMEs) and charities use digital technology, reports a rise in the average UK Index digital maturity 'score' from 100 in 2014 to 102 in the last 12 months - suggesting an upward trend, albeit slow, in SMEs using digital technology. The report also highlights 'encouraging improvements in basic digital skills, amongst SMEs, with nearly 77% of SMEs now having these basic skills'.[42]

Most industries and sectors recognise that as they become increasingly digitalised, there will be more demand for staff in general to have digital skills to varying degrees. The skills needs in various sectors reflect the particular areas and opportunities for growth that digital technology has afforded them. In 2014, the UK forum for Computing Education (UKforCE) took as its starting point the view that 'every business is a digital business', and that the number of full and part-time workers across each of the Standard Occupation Codes will require some degree of digital skills in the next 2-3 years.[43] UKforCE expects that the vast majority of the workforce will soon need 'digital citizenship skills', meaning the skills needed to use digital technologies confidently when searching for information and purchasing goods and services online, and that such skills will be needed by over half the workforce. In addition, they also note that approximately 16.5 million people will need the appropriate skills to become 'digital workers' and 'digital makers'.[44] [45]

Despite the increase in the digitisation of business processes the BBC's Basic Online Skills research highlights that 20% (10.5 million) UK adults do not have basic online skills. Of the 10.5 million, 73% (7.7million are offline) and 27% (2.8 million) are online. These figures have hardly changed since the first research was carried out two years ago in September 2013. The research also notes that those without basic online skills are most

[42] LLOYDS 2015. *UK Business Digital Index 2015*. Lloyds Bank plc. Published March 13. Available: http://resources.lloydsbank.com/insight/uk-business-digital-index/. [Accessed August 4 2015].

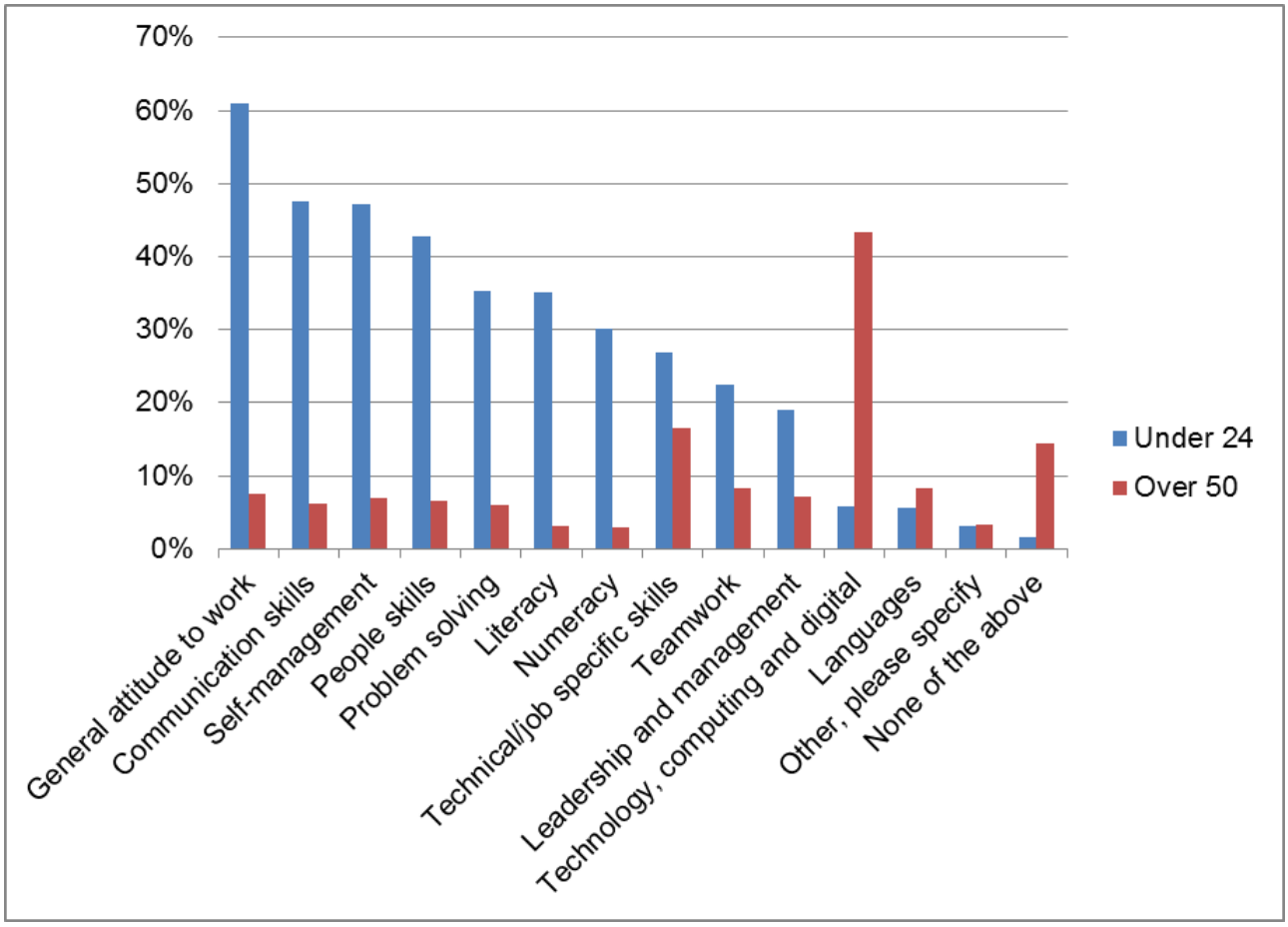
[43] UKFORCE 2014. Digital Skills Taskforce call for evidence: Submission from the UK forum for Computing Education (UKforCE). UK forum for Computing Education. Available: http://ukforce.org.uk/wp-content/uploads/2014/06/Digital-Skills-Taskforce-UKforCE-submission-Updated.pdf. [Accessed July 25 2015].

[44] Ibid.

[45] "*Digital Citizen: The ability to use digital technology purposefully and confidently to communicate, find information and purchase goods and services; Digital Worker: This includes, at the higher end, the ability to evaluate, configure and use complex digital systems; and Digital Maker: Skills to actually build digital technology (mainly software development). This broad category might also include workers who create complex Excel macros or data file for controlling 3D printers". Ibid.*

likely to be aged over 55.[46] More up to date research commissioned by Go ON UK suggests that the number of adults without basic digital skills is much higher, 12.6 million (23% of adults in the UK), do not have basic digital skills.[47] The Federation of Small Businesses (FSB) latest study with SMEs also highlights that older recruits are more likely to lack digital skills compared to their younger counterparts (Figure 2).[48]

Figure 2 When recruiting, which skills, in your view are most commonly lacking in candidates? (Candidates over 50 and candidates under 24)



These findings are in line with the views of most stakeholders consulted as part of this study. They felt that the older workforce were likely to find the increasingly digitisation of work processes a challenge. Older people, in their view, need to become used to the digital world, and learn how to adapt to technology. In addition, some stakeholders felt the older workforce who lacked digital skills were likely to be in occupations which have traditionally been 'non-digital' but have since adopted the use of digital technologies.

[46] BBC 2014. *BBC Basic Online Skills. May 2014 research* British Broadcasting Corporation (BBC). Published November. Available: http://downloads.bbc.co.uk/aboutthebbc/insidethebbc/whatwedo/learning/audienceresearch/basic-online-skills-nov-2014.pdf. [Accessed December 5 2014].

[47] Go On UK 2015. *Basic Digital Skills: UK Report, 2015.* Available: https://goon-uk-prod.s3-eu-west-1.amazonaws.com/uploads/Basic%20Digital%20Skills_UK%20Report%202015_131015_FINAL.pdf?utm_source=about_heatmap_page&utm_medium=bds_research&utm_campaign=bds_research_about_heatmap_page

[48] FSB 2015. *Reassured, optimised, transformed: driving digital demand among small businesses*. Federation of Small Businesses. Published September 10. Available: http://www.fsb.org.uk/news.aspx?rec=10052. [Accessed September 18 2015].

However, it is important not to assume that young people who are from a digitally-enriched generation (the 'digital natives') [49] by definition have the skills to use digital technologies effectively. Recent research concluded that the term 'digital native' has no generally accepted definition, that being of a particular generation does not imply that all in that generation are competent or can transfer the skills to the workplace or in academic environments.

Digital skills gaps

Research also notes that there are digital skills gaps across a range of sectors mainly as a result of the introduction of new technologies and new processes that require IT specific skills. For example, recent research carried out by the CITB (Construction Industry Training Board) in Northern Ireland highlights that whilst skills gaps amongst the existing construction workforce are not extensive, and largely job-specific, 'IT related skills is one area where skills were frequently reported as lacking' by the employers who took part in the survey. The research also cites a UKCES 2013 survey which found that of the construction establishments in Northern Ireland that reported skills gaps, 36% were in basic computer literacy skills and a similar proportion, 32%, reported a lack of advanced IT and software skills[50]. Across the general UKCES 2013 survey, 34% of the employers also highlighted that improving the IT skills of their workforce was a priority for them.[51]

The CBI 'Gateway to Growth 2014' report notes that approximately two thirds (61%) of businesses involved in their survey reported that their employees had weaknesses in IT skills competencies, a 4% increase from the last survey which was carried out in 2009. This figure was much higher than the proportion who selected literacy (54%) and numeracy (53%) suggesting that competencies in using IT software is increasingly becoming a key area of skills needs for businesses. The report also suggests that IT skills gaps are predominantly in construction firms, approximately three quarters (72%) reported that their employees lacked IT skills. Manufacturing came a close second with approximately 62% of businesses in this sector reporting weaknesses in the IT skills of their employees.[52]

[49] GALLARDO-ECHENIQUE, E. E., MARQUÉS-MOLÍAS, L., BULLEN, M. & STRIJBOS, J.-W. 2015. Let's talk about digital learners in the digital era. *International Review of Research in Open and Distance Learning,* 16, 3, 156-187. Available: http://www.irrodl.org/index.php/irrodl/article/view/2196.

[50] CITB 2014. More technology skills needed for the construction industry. Construction Industry Training Board. Published February 19. Available: http://www.citbni.org.uk/CITB/files/8c/8c7e73db-91b6-43a1-8ab4-153576dbfda0.pdf. [Accessed March 3 2015].. See also: UKCES 2013. Technology and skills in the Construction Industry. UK Commission for Employment and Skills. Published September. Available: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/305024/Technology_and_skills_in_the_construction_industry_evidence_report_74.pdf. [Accessed March 3 2014].

[51] UKCES 2013. *Technology and skills in the Construction Industry*. UK Commission for Employment and Skills. Published September. Available: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/305024/Technology_and_skills_in_the_construction_industry_evidence_report_74.pdf. [Accessed March 3 2014].

[52] CBI & PEARSON 2015. *Gateway to Growth: CBI / Pearson education and skills survey*. Confederation of British Industry. Published July 4. Available: http://www.cbi.org.uk/media/2809181/embargo_00.01_4_july_cbi_pearson_education_and_skills_survey_2014.pdf. [Accessed September 12 2015].

Table 2 Causes of Skills Gaps by Occupation

Causes	Managers	Professionals	Associate Professionals	Administrative and Clerical	Skilled Trades	Caring Leisure and Other Services	Sales and Customer Service	Machine Operatives	Elementary Occupations
	%	%	%	%	%	%	%	%	%
Base	3673	1608	1369	3909	3032	2340	4840	1488	4630
Staff new to the role	44	58	59	54	52	62	60	53	54
Training only partially completed	45	61	66	54	67	63	54	54	53
Staff lack motivation	31	28	23	27	26	34	36	33	41
Been on training but performance not improved sufficiently	26	29	24	26	24	31	35	27	34
Introduction of new working practices	33	26	26	30	21	31	25	22	21
Not received appropriate training	34	23	24	27	26	27	22	23	22
Unable to recruit staff with required skills	20	21	20	16	26	22	19	27	22
Development of new products and services	20	19	22	19	17	17	21	13	13
Introduction of new technology	23	20	22	25	19	15	17	20	12
Problems retaining staff	10	9	8	6	8	11	11	8	13
Summary: New to role/training not complete (transient factors)	60	76	78	68	78	79	72	68	69

The 2013 survey further suggests that there has been a slight increase[53] in the number of establishments providing training in new technology compared to the last survey carried out in 2011 (Table 3). It also highlights that larger organisations are likely to provide training in new technologies compared to smaller organisations (80% of organisations with over 250 employees provided training in technology, compared to just 46% of organisations with 2-4 employees). This finding is in line with the stakeholder consultations. Some stakeholders felt that larger organisations had a greater capacity to upskill their workforce, but by default of their size had rigid processes in place which were costly to change. SMEs on the other hand had the ability and flexibility to be more dynamic and adapt to market needs. However, SMEs often did not either have the capacity, or the funds to take advantage of new technologies. Therefore on the whole the general view was that SMEs were likely to struggle to adapt to technological changes.

Table 3 Types of training provided over the last 12 months (% of establishments)

	(Unweighted Base)	Job Specific	Health and Safety	Induction	New technology	Management	Supervisory
UK 2011	66,439	85	75	57	47	35	35
UK 2013	69,842	85	74	58	48	35	34
Country							
England	57,787	85	73	58	48	36	34
Northern Ireland	2,894	81	75	54	48	35	34
Scotland	4,884	87	74	58	51	33	34
Wales	4,277	87	76	58	49	37	38
Size							
2-4	9,580	80	60	40	46	23	22
5-24	40,801	86	79	64	46	36	36
25-49	10,123	92	92	83	53	57	53
50-99	5,315	94	95	88	61	66	62
100-249	2,864	97	97	92	70	76	73
250+	1,159	97	97	93	80	89	85
Sector							
Agriculture	1,710	79	67	23	46	14	13
Mining and Quarrying	103	82	90	60	38	44	46
Manufacturing	5,128	82	79	57	46	26	29
Electricity, Gas and Water	878	87	87	67	41	40	40
Construction	4,777	77	79	50	35	22	28
Wholesale and Retail	12,425	84	76	62	52	42	41
Hotels and Restaurants	6,761	84	84	69	31	42	49

[53] In real terms this is 31,226 in 2011 and 33,424 in 2013

	(Unweighted Base)	Job Specific	Health and Safety	Induction	New technology	Management	Supervisory
Transport and Communications	4,939	84	60	46	60	26	23
Financial Services	1,824	92	63	59	58	44	38
Business Services	11,127	86	59	51	54	29	25
Public Administration	861	92	81	67	53	54	49
Education	5,568	92	90	73	60	60	43
Health and Social Work	7,935	90	86	71	40	45	45
Community, Social and Personal Services	5,806	85	74	56	43	31	31

Digital skills shortages

Continuing skill shortages threaten to hinder the achievement of the productivity gains expected through the use of digital technologies, in up to half of all companies,[54] and particularly in areas such as advanced manufacturing[55] and 3-D printing,[56] as well as the need to progressively re-train employees whose jobs may be replaced through increasing automation of manual jobs,[57] in areas such as logistics,[58] or even brick-laying.[59] A study on the retail sector carried out by UKCES concludes that skills shortages amongst many retail employees hinder their transition from conventional place-based retail activity to e-commerce and blended retail.[60]

[54] TP 2015a. *Digital skills gaps holding back half of UK firms reveals the Tech Partnership*. The Tech Partnership. Published May 1. Available: https://www.thetechpartnership.com/news-events/news/employer-insights/. [Accessed June 22 2015], TP 2015b. *Employer Insights: skills survey 2015*. The Tech Partnership. Published May 1. Available: https://www.thetechpartnership.com/link/7498c7abf3664f28a644246d1da9348b.aspx?id=1335&epslanguage=en. [Accessed June 17 2015].

[55] UKCES 2015b. *Sector insights: skills and performance challenges in the advanced manufacturing sector*. UK Commission for Employment and Skills. Published June 29. Available: https://www.gov.uk/government/publications/sector-insights-skills-and-performance-challenges-in-the-advanced-manufacturing-sector. [Accessed June 30 2015].

[56] UKCES 2015a. *Rise of the machines causing skills shortages, new report finds*. UK Commission for Employment and Skills. Published June 29. Available: https://www.gov.uk/government/news/rise-of-the-machines-causing-skills-shortages-new-report-finds. [Accessed June 30 2015].

[57] ECONOMIST 2015a. *Automation angst*. Economist. Published August 15. Available: http://www.economist.com/node/21661017. [Accessed August 17 2015].

[58] BARANIUK, C. 2015. *How Algorithms Run Amazon's Warehouse*. British Broadcasting Corporation (BBC). Published August 18. Available: http://www.bbc.com/future/story/20150818-how-algorithms-run-amazons-warehouses. [Accessed August 19 2015].

[59] SKLAR, J. 2015. *Robots Lay Three Times as Many Bricks as Construction Workers*. Technology Review. Published September 2. Available: http://www.technologyreview.com/news/540916/robots-lay-three-times-as-many-bricks-as-construction-workers/. [Accessed September 8 2015].

[60] VOKES, C. & LIMMER, H. 2015. *Sector insights: skills and performance challenges in the retail sector*. UK Commission for Employment and Skills. Published July 21. Available: https://www.gov.uk/government/publications/sector-insights-skills-and-performance-challenges-in-the-retail-sector. [Accessed August 3 2015].

The digital and creative sectors in the UK which contribute 'almost nine per cent of total UK GVA', according to UKCES also faces recruitment challenges, with employers struggling to find workers with digital skills. Whilst graduate recruitment is said to be an important source of workers for the sector, there are concerns that "many graduates leave university without up-to-date technical skills, or the softer skills required to be effective in the workplace"[61].

A lack of technical specialist skills was also found to be the main explanation for digital skills shortages in the 'tech' sector, with surveyed employers reporting 85% of hard-to-fill positions within their workforce in this area.[62] NESTA on the other hand identifies that two-thirds of "datavores" (businesses that make heavy use of data for driving their business decisions) who tried to recruit analysts in the previous 12 months, found it difficult to fill at least one vacancy.[63]

According to OFCOM, the young adult population potentially offers a valuable skills pool to employers.[64] However, other studies question whether this skills pool aligns with employer requirement. For instance, a trend within the IT and telecoms sector is that experienced and potentially older candidates are often recruited over younger new graduates. The proportion of 16-29 year olds in this sector declined from 32% in 2001 to 19% in 2011, whilst the proportion of those aged 40+ increased by fifteen percentage points from 32% to 47% over the same period.[65] This indicates that the mixture of skills required in this sector are those acquired through the experience of working in the sector, rather than through education. A concern in this respect is that without change in the nature of course content and focus, and a wider focus on the acquisition of transferable skills across the skills pipeline, the supply of new graduates is unlikely to address the skills shortages in the economy.

Table 4 below provides a summary of what the stakeholders consulted feel are the digital skills requirements, gaps and shortages in the UK.

[61] DASS, M., GOODWIN, A., WOOD, M. & NI LUANAIGH, A. 2015. *Sector insights: skills and performance challenges in the digital and creative sector*. UK Commission for Employment and Skills. Published June 9. Available: https://www.gov.uk/government/publications/sector-insights-skills-and-performance-challenges-in-the-digital-and-creative-sector. [Accessed July 16 2015].

[62] TP 2015b. Employer Insights: skills survey 2015. The Tech Partnership. Published May 1. Available: https://www.thetechpartnership.com/link/7498c7abf3664f28a644246d1da9348b.aspx?id=1335&epslanguage=en. [Accessed June 17 2015].

[63] MATEOS-GARCIA, J., WINDSOR, G. & ROSEVEARE, S. 2015b. *Analytic Britain: Securing the right skills for the data-driven economy*. NESTA (National Endowment for Science, Technology and the Arts, UK). Published July 10. Available: http://www.nesta.org.uk/publications/analytic-britain-securing-right-skills-data-driven-economy. [Accessed July 21 2015].

[64] OFCOM 2014. *Techie teens are shaping how we communicate*. OFCOM (UK). Published August 7. Available: http://media.ofcom.org.uk/news/2014/cmr-uk-2014/. [Accessed August 7 2014].

[65] E-SKILLS 2012. *Technology Insights 2012*. e-Skills UK. Available: http://www.e-skills.com/Documents/Research/Insights-2012/TechnologyInsights_2012_UK.pdf. [Accessed June 3 2015].

Table 4 Current and future demand for digital skills

Current digital skills requirements	Digital skills shortages	Digital skills gaps
Baseline digital skills: being able to browse websites, search content, use the keyboard/mouse, understand the IT jargon, social networking/media and using the basic word packages. Examples cited by stakeholders include: ● Cyber security (awareness) ● Office skills and business processing skills ● Working with office software and databases	The main gaps stakeholders believe are in the higher level skills. There was a perception that not enough people were coming through the education system with the skills necessary to keep up with the changing technological landscape.	Mainly in occupational areas linked to specialist IT skills such as: ● Data analysts ● Computer scientists ● Healthcare IT ● Product managers ● Cybersecurity specialists
Sector specific skills: Digital skills requirements are likely to be in sectors that have either traditionally been non-digital, or in occupational areas that have been automated as a result of new technologies. Examples include: ● Automated milking on farms ● 3D printing ● CAD ● Computer design in glass manufacturing ● Graphic design ● Building Information Modelling (BIM) ● Digital marketing in retail ● Agriculture – programming precision planting machines/Extracting biological information from your herd ● Digital publishing and content production. ● Publishing – E-readers replacing books. **Digital roles**: Specialist technical IT skills linked to sectors and businesses in which the demand tends to arise quicker than what the training and education systems can respond to. Examples cited here include: ● Analytics (Big Data) ● Cyber security specialists ● Web developers ● Innovators ● Programmers	Examples cited here include: ● Data analytics ● STEM professions ● Big data ● Computer scientists ● Cloud storage ● Innovators	● Senior programme developers ● Data scientists ● Artificial intelligence

Future requirements

Some forecasts predict that demand for digital skills is likely to increase in the future with research outlining a critical need for skill gaps in the digital economy to be addressed. One report published by SAS UK and the Tech Partnership suggests that demand (i.e. advertised vacancies) for 'big data' staff increased by 41% over the 2012-2013 period to 21,000 positions. Another trend noted in the SAS/Tech Partnership report was that 63% of positions were based in London, a higher proportion than seen in the other sectors such as business intelligence. The highest demand was for big data developers (accounting for around 43% of vacancies).[66]

As the UK digital economy grows, new roles in the field of 'big data' analysis are also expected to emerge over the medium term. At the same time, demand for some existing roles is expected to increase into the future. For instance, the demand for 'big data' specialists is forecast to increase by 160% between 2013 and 2020, and estimated to represent an additional 346,000 big data jobs.[67]

By 2020, it is anticipated that there will be around 56,000 gross job opportunities per annum in 'big data'.[68] These trends reflect the increasing amounts of data that will be created from internet-connected devices (the 'Internet of Things').

The Office of National Statistics (ONS) Labour Force Survey (LFS) data estimates that the number of people working in IT/Comms positions has increased at a greater rate during the past five years (8%) than was the case for workers in the UK as a whole (1%). The high rate of growth is predicted to continue across the 2013-2020 period, with growth in IT/Comms workers forecasted to increase by 19% compared with 6% within the wider market. The sector is expected to employ around 1.4 million people by 2020.[69] Over the year March 2014-2015 the LFS reported that the largest change in jobs was in the 'Professional, Scientific and Technical Sector' (163,000), with the next largest being in 'Administrative and Support Service Activities' (120,000).[70]

A UKCES report also identifies a range of trends as part of the digitalisation of the advanced manufacturing sector.[71] This includes the increasing use of computer aided design (CAD), industry and product specific software solutions and new manufacturing technologies (such as 3D printing and plastic electronics). Industry experts believe that these trends may alter the changing skills requirements of certain roles within the advanced manufacturing sector. Examples include:

- "production managers/ directors in manufacturing" - as materials and components have become smaller and more plentiful, more intensive quality assurance requirements has increased the work associated with a production manager role

[66] SAS & TP 2014. *Big Data Analytics. Assessment of Skills for Labour and Skills 2013-2020*. SAS Inc and The Tech Partnership. Published November. Available: https://www.e-skills.com/research/research-themes/big-data-analytics/. [Accessed June 3 2015].

[67] ibid

[68] ibid

[69] ibid

[70] [ONS, 2015 #51859]

[71] UKCES 2015b. *Sector insights: skills and performance challenges in the advanced manufacturing sector*. UK Commission for Employment and Skills. Published June 29. Available: https://www.gov.uk/government/publications/sector-insights-skills-and-performance-challenges-in-the-advanced-manufacturing-sector. [Accessed June 30 2015].

- “biological scientists and biochemists” - requirements for clinical trials have become less intensive as a result of digital technology, such that additional R&D activity will be undertaken in the future with a focus on innovation and product development; there will be increased demand for biological scientists within manufacturing but also within university research. R&D functions demand entrants with specialisms and higher degrees

- “production and process engineers” - as production methods become increasingly complicated, process engineers require improved skills in project management and assessing quality across multiple sites. These roles increasingly require literacy in digital design packages and bespoke software;

- “metal working production and maintenance fitters” - software development skills are increasingly important in the context of the computerisation of production machinery. Laser technology for example requires new operational skills; and

- “assemblers” - there is a growing requirement for assemblers to be IT literate within technological advances in machinery and components. As the use of laser cutting and automated production increases, assembly is likely to become easier, although additional technician roles would likely be required to support machine operation.[72]

UKCES predicts that the creative and digital sectors will “need 1.2 million new workers between 2012 and 2022, to both support growth and replace those leaving the sector”. However, it raises “concerns about the ability of the education system to supply the quantity and quality of workers needed for digital roles” In addition, UKCES forecasts that technological trends in the sector will generate a need “for individuals with specialised knowledge in cyber security, mobile and cloud computing, big data, and social media”. Workers across the sector will have to have ‘some degree of knowledge of these issues and their implications’. The sector will also need the “expertise to anticipate how markets and consumers may respond to new business models, and regulatory and legal expertise to help shape and comply with new rules on IP and data protection”.[73]

UKCES’s evidence report on the construction industry also highlights changes in the industry as a result of an increase in the use of ‘offsite construction’, where major parts of construction projects are created offsite and pre-assembled in advance. The report highlights concerns amongst industry experts of a mismatch between training provision and the demands of the sector to increasingly utilise ‘offsite construction’ techniques’.[74]

[72] Ibid.

[73] DASS, M., GOODWIN, A., WOOD, M. & NI LUANAIGH, A. 2015. *Sector insights: skills and performance challenges in the digital and creative sector*. UK Commission for Employment and Skills. Published June 9. Available: https://www.gov.uk/government/publications/sector-insights-skills-and-performance-challenges-in-the-digital-and-creative-sector. [Accessed July 16 2015].

[74] UKCES 2013. Technology and skills in the Construction Industry. UK Commission for Employment and Skills. Published September. Available: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/305024/Technology_and_skills_in_the_construction_industry_evidence_report_74.pdf. [Accessed March 3 2014].

In UKCES's report on the Aerospace and Automotive industry three key technological advances is reported to have impacted on the skills need in the industry. These are:

- additive Manufacturing (AM) – i.e. manufacturing products using digitally-controlled machines (3D printing)

- composites – consist of bulk material and a reinforcement material usually added to increase strength and stiffness

- plastic Electronics – "devices on flexible surfaces that make it possible to produce flexible, bendable or stretchable electronic products[75]

E-skills UK (the Sector Skills Council for Business and Information Technology) research has also identified five different skills set required in future employees:

- "security skills (reflecting employer concerns around data security)

- core business skills (in order to balance technical skills with wider business objective, and so that professionals can manage product development lifecycles)

- technology specific skills (high level technical knowledge for example in the networks and devices that support voice, video and data communications)

- interpersonal skills (reflecting that digital applications have become more embedded in everyday life and the need for professionals to understand customer relations; and

- analytical and research skills (in order to interpret operational data)"[76]

The literature notes that the main demand in the labour market is for employees to have digital skills in addition to other competencies and skills. In other words, as all sectors, service providers and industries become increasingly digitalised, there will be pressure on the majority of employees to have a heightened awareness and competencies in digital skills. A latent skills gap therefore exists in that many employers and organisations are failing to maximise productivity on the basis of limited existing digital skills within their workforce.[77]

This position was largely acknowledged by the stakeholders who were interviewed as part of the study. There was a concern around the emerging gap between young people growing up with digital skills, and the existing workforce falling behind. To respond to future requirements, stakeholders felt that it was crucial to upskill the existing workforce to help them to quickly adapt to current and new technologies that are likely to emerge across the sectors in which they work. For example, in certain sectors such as

[75] FELOY, M., DSOUZA, R., JONES, R. & BAYLISS, M. 2013. Technology and Skills in the Aerospace and Automotive Industries. Evidence Report 76. UK Commission for Employment and Skills. Published October. Available: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/303096/evidence-report-76-aerospace-and-automotive-exec-summ.pdf. [Accessed November 2 2015].

[76] E-SKILLS 2012. *Technology Insights 2012*. e-Skills UK. Available: http://www.e-skills.com/Documents/Research/Insights-2012/TechnologyInsights_2012_UK.pdf. [Accessed June 3 2015].

[77] ibid

construction, building and design specialists are increasingly required to use building information modelling (BIM).

To address future requirements, there was also a view that employers also needed to focus on employing or engaging with visionaries or innovators who knew the direction of technological change, and could support them to adopt technological solutions more quickly to improve their business processes. This aspect is noted later in this report where it notes the significant role for 'multipliers', people or services[78] who can engage with others to receive advice, or to provide training that can create a 'snowball' effect in a company. For many other employers there will be the challenge to ensure that older generations of IT and software (legacy systems) are 'fit for purpose' where "the layers of old technologies, far flung operations and need for 24/7 connectivity present a host of security challenges",[79] something particularly experienced by the banking sector.[80]

Case studies

This section sets out five case studies in the form of job requirements that exemplify selected occupations for which recent developments in digital technologies have transformed business processes. These case studies cover five sectors: Health, Financial Services, Creative and Media, Business Data (data management) and Logistics.

Case study one - Financial Services Industry

How has digital transformation changed the character of the sector?

Digital transformation in the financial services industry has widely been described as 'digital disruption'[81], where the development of digital financial technology ('fintech') from external technology firms has interrupted the traditional business models within the financial sector[82].

The digital transformation has largely occurred as a result of technology firms innovating in niche areas of the financial sector, creating a new demand for financial technology by customers and consequently forcing traditional financial services to compete in this market. This has been particularly challenging for the financial sector because they have been focusing on other issues, like regulation or litigation, and are now having to rapidly adapt to integrating IT into their service portfolio, not just in their management systems.[83]

[78] For example the 'Get Safe Online' service https://www.getsafeonline.org/

[79] SCANNELL, K. & CHON, G. 2015. *FT investigation: Cyber insecurity*. Financial Times (London). Published July 14. Available: http://www.ft.com/cms/s/0/698deb42-200b-11e5-aa5a-398b2169cf79.html. [Accessed July 17 2015].

[80] BELTON, P. 2015. *In your irises: The new rise of biometric banking*. British Broadcasting Corporation (BBC). Published March 20. Available: http://www.bbc.co.uk/news/business-31968642. [Accessed March 20 2015].

[81] DELOITTE 2014. *Digital disruption: Threats and opportunities for retail financial services*. Deloitte & Touche LLP. Available: http://www2.deloitte.com/global/en/pages/financial-services/articles/digital-disruption-in-fsi.html. [Accessed September 2 2015].

[82] TWENTYMAN, J. 2013b. *Management: Time to embrace digital disruption*. Financial Times (London). Published September 17. Available: http://www.ft.com/cms/s/0/5f974956-13b2-11e3-9289-00144feabdc0.html. [Accessed September 18 2013].

[83] SCHÄFER, D. 2014. *Digital threat to investment banks*. Financial Times (London). Published September 23. Available: http://www.ft.com/cms/s/2/1ccd73f2-3cd3-11e4-871d-00144feabdc0.html#axzz3mv1n2Rdk. [Accessed September 25 2014].

Digital technologies are also beginning to change the nature of investment banking by making trading more accessible, making pricing more transparent, and enabling more sales to be completed more rapidly over online platforms, especially those which use automated algorithms to react to market movements.[84] These technologies are a potential 'competitive threat' to financial services, where banking leaders are emphasising the need for their services to fully integrate digital technologies to keep up their competitive advantage.[85]

The character of the sector has fundamentally changed as a result of technological changes. Traditional banks have to respond to demands from customers who are more connected and impatient with inefficient services, and they have to remodel their operations to compete with the more nimble 'fintech' start-ups.[86]

What digital technologies have been introduced?

Advancements in technology have resulted in the growth of 'payment technologies' which respond to customers' demands for quicker, more efficient banking services. Mobile banking apps proliferated from 2010,[87] with Barclays Bank pioneering technologies such as 'Pingit' payment services on Twitter, video banking on mobile services to speak with staff on-the-go and cheque imaging technologies. To help customers take up these digital technologies, Barclays have introduced their 'Digital Eagles' programme; a number of initiatives designed to teach people how to use online banking systems.[88] Investment banks like Deutsche Bank have also launched apps; the aim is to make the market more transparent with electronic services.[89] Atom Bank is the UK's first bank to operate purely through a mobile app.[90]

What impact has it had on the sector?

The digital transformation of financial services has been very expensive for the sector; UK banks are spending billions of pounds every year on IT in order to keep up with the digital technologies that are constantly being developed. However, banks have reported positives outcomes from increasingly relying on digital technologies; around £1billion a day is processed through mobile or internet banking in the UK. The reliance on technologies is also seeing a greater cooperation between traditional financial services and technology firms to come up with solutions to the consumer demand.

[84] For example where trading platforms related to incorrect information about Twitter. BBC 2015c. *Nasdaq apologises for early release of Twitter results*. British Broadcasting Corporation (BBC). Published April 29. Available: http://www.bbc.co.uk/news/business-32523184. [Accessed April 29 2015], SIMMONS, D. 2015. *How one tweet wiped $8bn off Twitter's value*. British Broadcasting Corporation (BBC). Published April 30. Available: http://www.bbc.co.uk/news/technology-32511932. [Accessed April 30 2015].

[85] ibid

[86] TAYLOR, P. 2012a. *Focus turns to IT as tool for growth*. Financial Times (London). Published October 16. Available: http://www.ft.com/intl/cms/s/0/8e480600-0e22-11e2-8b92-00144feabdc0.html. [Accessed September 2 2015].

[87] BBA 2015. *World of Change*. British Banking Association. Published June 15. Available: https://www.bba.org.uk/news/reports/world-of-change/#.VgeSBZe8NYA. [Accessed Sepember 15 2015].

[88] Ibid.

[89] TAYLOR, P. 2012b. *Mobile devices: Investment houses jump on the apps bandwagon*. Financial Times (London). Published October 16. Available: http://www.ft.com/intl/cms/s/0/947bd394-0e22-11e2-8b92-00144feabdc0.html. [Accessed September 1 2015].

[90] WILLIAMS-GRUT, O. 2015. *Britain just gave the green light to a bank with no branches and no website — just an app*. Business Insider. Published June 24. Available: http://www.businessinsider.com/atom-bank-gets-banking-licence-from-bank-of-england-to-launch-app-2015-6?r=UK&IR=T. [Accessed September 22 2015].

There are however, increasing concerns about how secure digital banking is, with investment bank computer systems at risk of being hacked or being subject to mass-scale error. An example of the latter occurred at TSB in 2014, where a computer systems failure resulted in people being unable to withdraw cash or make payments.[91]

Alongside security issues, there are also concerns about sustaining the expanding 'fintech' industry. In 2015, 45% of technology business leaders reported that there was a skills shortage in the UK. However, given that many job roles within the sector are becoming automated through the introduction of digital banking technology, it is anticipated that a flexible approach could be taken where existing staff are retrained to become a 'digitally-skilled' workforce.[92]

Case study two – Healthcare

How has digital transformation changed the character of the sector?

Digital technologies have begun to change the character of the sector in several key ways. The way that evidence is gathered in clinical trials is beginning to change. There is also an increasing emphasis on capturing and sharing information on people's wellbeing in digital form. It is also anticipated that robotic technologies will shape the future of the health sector, for example robotic pets for patients with dementia,[93] bionic prosthetics,[94] exoskeletons for paralysed patients,[95] and design technology being used to enhance human judgement and skill to improve overall healthcare provision.[96]

The UK's healthcare system has benefited from digital transformation, particularly in terms of facilitating healthcare professionals to support their patients and allowing people to take control of their own health.[97] This has led to a significant shift in the culture of the UK's healthcare system, such as the provision of a system mediated by online or digital devices,[98] but also requiring a radical transformation of the relationships between medical practitioners and patients.[99]

[91] GOFF, S. 2014. *Lenders struggle to engage with customers*. Financial Times (London). Published September 23. Available: http://www.ft.com/cms/s/2/2efd02f8-3cbb-11e4-871d-00144feabdc0.html. [Accessed September 21 2015].

[92] GOS 2015. FinTech Futures: The UK as a World Leader in Financial Technologies. Government Office for Science. Published March. Available: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/413095/gs-15-3-fintech-futures.pdf. [Accessed October 20 2015].

[93] PYM, H. 2015. *Is this cuddly robot coming to a care home near you?* British Broadcasting Corporation (BBC). Published September 17. Available: http://www.bbc.co.uk/news/health-34271927. [Accessed September 21 2015].

[94] KELION, L. 2015. *Open Bionics robotic hand for amputees wins Dyson Award*. British Broadcasting Corporation (BBC). Published August 25. Available: http://www.bbc.co.uk/news/technology-34044453. [Accessed August 25 2015].

[95] PALMER, M. 2015. *The latest wearable fashion: exoskeletons*. Financial Times (London). Published June 17. Available: http://www.ft.com/cms/s/0/06d46d2a-e1d9-11e4-bb7f-00144feab7de.html. [Accessed June 17 2015].

[96] TWENTYMAN, J. 2015a. *3D printing of complex organs is far off*. Financial Times (London). Published June 17. Available: http://www.ft.com/cms/s/0/6b330d88-e1cc-11e4-bb7f-00144feab7de.html. [Accessed July 3 2015].

[97] ECONOMIST 2015d. *Medical apps: Smartphone diagnosis*. Economist. Published March 7. Available: http://www.economist.com/news/technology-quarterly/21645503-exposure-nasty-throat-infection-or-confirmation-heart-attack. [Accessed March 5 2015].

[98] MHN 2014. *The future's digital: mental health and technology*. Mental Health Network, NHS Confederation. Published September 25. Available: http://www.nhsconfed.org/resources/2014/09/the-future-s-digital-mental-health-and-technology. [Accessed September 12 2015].

[99] ECONOMIST 2015b. *Health care: Bedside manners*. Economist. Published May 30. Available: http://www.economist.com/news/business/21652327-small-data-patients-home-will-mean-big-cost-savings-bedside-manners. [Accessed June 9 2015].

What digital technologies have been introduced?

The most basic change that has occurred in the British healthcare system is the installation of digital clinical record systems (occurring in 96% of all GP practices) that has taken place since 1990.[100] Since then, healthcare providers have worked alongside the commercial sector to implement 'telehealth' systems, where health care is delivered over the phone or web applications. Similarly, the provision of care has been mediated by technologies; 'telecare' has been used to encourage people to live independent lives, whilst staying connected to an operating system in cases of emergency.[101] A range of 'wellbeing apps' which track basic health data have also been developed to help people control and monitor their own health.[102] Technological firms are also trying to tap into the healthcare industry, with organisations like Google developing 'magnetic nanoparticles' that could detect cancer early, although it is still a long way off completion.[103]

What impact has it had on the sector?

The impact of digital technologies on the provision of healthcare is growing; the percentage of organisations in the pharma and health technology industry has increased from 7% in 2010 to 11% in 2014, suggesting that more resources are being put into developing the sector. Although the UK is perceived as a frontrunner in generating ideas for a digital healthcare system, it is less successful at implementing them in clinical practice. This is partly due to a shortage of technical and managerial skills within the healthcare system, combined with many patients lacking the basic digital skills needed to access and utilise the digital technologies.[104]

Although the digitisation of clinical healthcare records has also had a significant operational impact on the sector, research suggests that the data accumulated is not always being used effectively, and there are concerns over security and privacy. Another concern is from the patient side of digital health care provision. Many patients do not have access to all of their records and more needs to be done to build up the infrastructure to ensure that the data can be used effectively.[105]

Initiatives are being developed to help people to utilise digital resources to encourage the adoption of a healthier lifestyle. For example, the NHS's 'Widening Digital Participation' programme that was launched in 2013 has been successful so far in reaching people who are at risk of poor health and are digitally excluded, to provide them with the opportunity to utilise digital resources to improve their knowledge about

[100] DOH 2014. *Personalised health and care 2020*. Department of Health (UK). Published November 13. Available: https://www.gov.uk/government/publications/personalised-health-and-care-2020. [Accessed June 3 2015].

[101] DOH 2013. *Digital health: working in partnership*. Department of Health (UK). Published January 31. Available: https://www.gov.uk/government/publications/digital-health-working-in-partnership. [Accessed August 4 2015].

[102] MURRAY, S. 2015b. *IT-savvy patients seek more control over their wellbeing*. Financial Times (London). Published June 17. Available: http://www.ft.com/cms/s/0/25d60e9e-e1cb-11e4-bb7f-00144feab7de.html. [Accessed June 17 2015].

[103] WARD, A. 2015. *Society stands to be winner in the race for digital health*. Financial Times (London). Published June 17. Available: http://www.ft.com/cms/s/0/51e7e792-e1ca-11e4-bb7f-00144feab7de.html. [Accessed June 17 2015].

[104] DELOITTE 2015. Digital Health in the UK An industry study for the Office of Life Sciences. Deloitte & Touche LLP. Published September. Available: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/461479/BIS-15-544-digital-health-in-the-uk-an-industry-study-for-the-Office-of-Life-Sciences.pdf . [Accessed November 2 2015].

[105] DOH 2014. *Personalised health and care 2020*. Department of Health (UK). Published November 13. Available: https://www.gov.uk/government/publications/personalised-health-and-care-2020. [Accessed June 3 2015].

healthy living. Through the programme, over 140,000 people have benefited from the online resources so far, and have adjusted their lifestyles as a result of medical information accessed through the online health resources.

Although these initiatives are helping improve patient access to digital health technologies, there are wider concerns about the culture of the NHS (where employees are discouraged from sharing information) that is constraining the extent to which practitioners implement digital technologies into their practice. Furthermore, there is a major skills gap within the health analytics subsector, because there is a lack of workers with the healthcare and analytics experience needed to work in the role effectively.[106]

Overall, the impacts of the digital transformation of the health sector are still quite difficult to capture as the take-up has not been as successful as initially anticipated. As the healthcare culture does not really support the widespread implementation of 'digital solutions' or the upskilling of current professionals, the ways in which data is being gathered and analysed is limited. There are also issues with the rise of healthcare tracking devices, and the extent to which the 'self-generated' data by patients is trusted and recognised by healthcare professionals. More needs to be done in training and upskilling the workforce in both technical and managerial skills to improve uptake of digital health technologies.[107]

Case study three – Creative sector (Digital and Social Media Marketing)

How has digital transformation changed the character of the sector?

The digital transformation of the creative industries has fundamentally changed the character of the sector; the opportunities provided from an increased reliance on data analytics seem limitless and have lead to a shift in how advertising is bought, sold and created.[108] The UK spends more on online advertising (accounting for 36% of the total spending) than any other major economy, reflective of the fact that UK consumers spend billions through the internet each year.[109]

The transformation has also led to changes in the requirements of those who are leading the industry. Marketers and advertisers not only need the creative talent, but they also need to know the technologies, how to read the data and how to market accordingly.[110]

[106] DELOITTE 2015. Digital Health in the UK An industry study for the Office of Life Sciences. Deloitte & Touche LLP. Published September. Available: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/461479/BIS-15-544-digital-health-in-the-uk-an-industry-study-for-the-Office-of-Life-Sciences.pdf . [Accessed November 2 2015].

[107] MURRAY, S. 2015a. *Healthcare benefits from better patient data*. Financial Times (London). Published February 16. Available: http://www.ft.com/cms/s/0/837f904e-9fd4-11e4-9a74-00144feab7de.html. [Accessed February 20 2015], ECONOMIST 2015b. *Health care: Bedside manners*. Economist. Published May 30. Available: http://www.economist.com/news/business/21652327-small-data-patients-home-will-mean-big-cost-savings-bedside-manners. [Accessed June 9 2015].

[108] BOND, S. 2015. *Digital is reshaping the world of advertising*. Financial Times (London). Published April 28. Available: http://www.ft.com/cms/s/0/60b8747e-bc1f-11e4-a6d7-00144feab7de.html. [Accessed April 29 2015].

[109] BAIN 2014. *Creative UK: Overview of the digital transformation of the UK creative economy*. Enders Analysis and Bain & Company. Available: http://www.bain.com/Images/REPORT_Creative_UK.pdf. [Accessed September 15 2015].

[110] HALE, T. 2015. *Review: 'Big Data Revolution' by Rob Thomas and Patrick McSharry*. Financial Times (London). Published March 18. Available: http://www.ft.com/cms/s/0/77596762-cca8-11e4-b94f-00144feab7de.html. [Accessed March 19 2015].

Case study three – Creative sector (Digital and Social Media Marketing)

What digital technologies have been introduced?

A number of digital technologies have been utilised by marketing and advertising industries to make use of the increasing amount of data from analytics programmes. One such technology is 'programmatik' advertising, where the buying and selling of advertising space is carried out by automated computer systems. Similarly, with data from users' browsing histories, social media applications and mobile global positioning systems, advertising campaigns are now targeting buyers in specific locations. This has gone beyond just individual devices; marketers are now turning towards 'cross-device' targeting, where users will be targeted with a seamless advertising campaign across different devices.

What impact has it had on the sector?

The creative industries have struggled to keep up with the proliferation of digital applications, social media and the growth of new technologies, resulting in mixed opinions on whether digital marketing does deliver business results. The problem stems from the constantly expanding range of digital technologies that have been implemented across different devices, and finding suitable ways to measure all the data that is generated.[111] As a result of the on going changes, businesses have also had to restructure their spending to keep up with technological changes. For example, spend on mobile advertisements was £69 billion in 2015, and it is expected to rise to around £100 billion in 2016.[112]

The market demands are therefore having a significant impact on the skills needs of the creative sector's workforce. Employment in digital technology is anticipated to increase by six per cent by 2020, and there is expected to be a rapid 'hollowing out' of the digital and creative sector, where the need for intermediate skills decreases and demand instead increases for high–level and low-level skills. A key problem with the creative industry is that it is very fast-paced and needs a continually 'refreshed' workforce to maintain a competitive advantage. It is therefore necessary for the sector to ensure that employers are investing in workforce training and that education providers are supplying a workforce with a sufficient number of highly-skilled workers to sustain the UK's creative industry.[113]

[111] BOND, S. 2015. *Digital is reshaping the world of advertising*. Financial Times (London). Published April 28. Available: http://www.ft.com/cms/s/0/60b8747e-bc1f-11e4-a6d7-00144feab7de.html. [Accessed April 29 2015].

[112] COOKSON, R. 2015.c. *Five campaigns that could drive future campaign strategies*. FT (London 25 April) Available: http://www.ft.com/cms/s/2/1ed7477c-c65d-11e4-a13d-00144feab7de.html. [Accessed April 28 2015].

[113] WILLIAMS, M., HILLAGE, J., PINTO, R. & GARRETT, R. 2012. Sector Skills Insights: Digital and Creative. Evidence Report 49. UK Commission for Employment and Skills. Published July. Available: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/304485/Sector_Skills_Insights_Digital_and_Creative_evidence_report_49.pdf. [Accessed October 29 2015].

Case study four – Business data (big data)

How has digital transformation changed the character of the sector?

A key digital transformation in businesses has been the capturing and utilisation of 'big data'. As large and often unstructured pieces of data, 'big data' are being used by organisations to make their operations more effective and efficient, build better relationships with customers, and to develop new revenue streams, the need to analyse this data is increasing in demand.

Often the data is created internally within organisations, and is captured and analysed in 'real time'.[114] 'Big data' has become very valuable to UK businesses; in 2011 this was worth £25 billion, and is expected to rise to £41 billion annually, by 2017. However, research has found that the take-up of 'big data' for businesses is not ubiquitous; some industries (such as the insurance sector) are already using 'big data' analytics to inform decision making, whilst other industries (such as the financial sector) are just starting to use the technologies.[115]

What digital technologies have been introduced?

Until recently, the storage of such information was very costly. In recent years the cost of data storage has decreased as a result of the emergence of 'cloud' storage services (the storage of data over an internet-based application). High performing computing (HPC) centres have also been developed to help businesses analyse their data.

In the manufacturing sectors, organisations have been using 'big data' in design decisions, to cut down costs of prototyping. Similarly, companies have been using big data analyses of social media to gain a better understanding of customers' responses in real time.[116] More technology companies, like MicroStrategy, Microsoft and SAS have built 'data-discovery' tools as a way for more non-technical employees to navigate through big data datasets.[117]

What impact has it had on the sector?

The utilisation of' 'big data' by business has had a big impact. However, demand for employees who have the necessary analytic skills far outstrips the supply across all sectors. Research suggests that since 2013, the number of 'big data' vacancies has risen 212% per year. This encompasses a vast range of positions and skills including developers, architects, consultants and analysts. There is also a shortage of people with technical skills and other transferable skills such as business acumen, managerial skills, communication skills and a good knowledge of applying big data insights into policy and business strategy.[118]

[114] WATERS, R. 2014. *Big data sparks cultural changes*. Financial Times (London). Published March 25. Available: http://www.ft.com/cms/s/0/938200c4-adb5-11e3-9ddc-00144feab7de.html. [Accessed March 26 2014].

[115] POST 2014. *Big Data in Business*. Parliamentary Office of Science and Technology (UK). Published July. Available: http://researchbriefings.files.parliament.uk/documents/POST-PN-469/POST-PN-469.pdf. [Accessed August 15 2015].

[116] Ibid.

[117] TWENTYMAN, J. 2013a. *IT tools: All aboard for data discovery journeys*. Financial Times (London). Published June 26. Available: http://www.ft.com/cms/s/0/1bfd966c-d29b-11e2-88ed-00144feab7de.html#axzz3mv1n2Rdk. [Accessed June 28 2013].

[118] SAS & TP 2014. Big Data Analytics. Assessment of Skills for Labour and Skills 2013-2020. SAS Inc and The Tech Partnership. Published November. Available: https://www.e-skills.com/research/research-themes/big-data-analytics/. [Accessed June 3 2015].

Case study four – Business data (big data)

To try and address the skills shortages and gaps, 'big data' software developers have been offering training in data science across the world.[119] Furthermore, the development of 'data-discovery' tools has helped to simplify the analysis of big data, so that non-technical staff can more easily understand the findings from big data analyses.[120] However, the sector cannot rely on software that simplifies 'big data' analysis. Organisations from across the UK are also beginning to develop training courses and opportunities to provide a better supply of big data analysts. For example, in 2014, KPMG launched their 'UK Data Science Summer School', which was aimed at attracting 100 PhD students across Europe and giving them an intensive 5-week course to turn them into data scientists. Online course providers – such as 'Cloudera' – have trained thousands of people in big data analytics. Organisations like SAS have pledged millions of pounds to support the UK education system through providing free software for universities and learning aids in schools, to help encourage a new generation of big data analysts.[121]

Although there are growing demands for big data analysts in the business sector, there are still concerns related to the legal and ethical usage of data and deciding what is, and what is not appropriate to utilise for business purposes. As the sector has grown so rapidly, it has become a 'grey area' in ethics, and there are concerns about the potential misuse of the data.[122] However, whilst ethical debates are continuing within the field of 'big data', recent developments indicate that the businesses using advanced analytics technologies are generating significant productivity gains. [123] With such outcomes, it is likely that the demand for big data specialists will continue to proliferate.

[119] SOLMAN, P. 2014. *Demand for analytics skills outstrips supply in all sectors*. Financial Times (London). Published March 25. Available: http://www.ft.com/cms/s/0/58d19eca-adb6-11e3-9ddc-00144feab7de.html. [Accessed March 26 2014].

[120] TWENTYMAN, J. 2013a. *IT tools: All aboard for data discovery journeys*. Financial Times (London). Published June 26. Available: http://www.ft.com/cms/s/0/1bfd966c-d29b-11e2-88ed-00144feab7de.html#axzz3mv1n2Rdk. [Accessed June 28 2013]..

[121] SAS & TP 2014. Big Data Analytics. Assessment of Skills for Labour and Skills 2013-2020. SAS Inc and The Tech Partnership. Published November. Available: https://www.e-skills.com/research/research-themes/big-data-analytics/. [Accessed June 3 2015].

[122] PRITCHARD, S. 2014. *Moral and legal points weigh on information use*. Financial Times (London). Published March 25. Available: http://www.ft.com/cms/s/0/2507750c-adb5-11e3-9ddc-00144feab7de.html. [Accessed March 26 2014].

[123] BAIN 2014. *Creative UK: Overview of the digital transformation of the UK creative economy*. Enders Analysis and Bain & Company. Available: http://www.bain.com/Images/REPORT_Creative_UK.pdf. [Accessed September 15 2015], BELTON, P. 2014. *Location services: How GPS delivery is changing shopping*. British Broadcasting Corporation (BBC). Published December 24. Available: http://www.bbc.co.uk/news/business-30442712. [Accessed December 26 2014], ECONOMIST 2015c. *Investing in logistics: Golden sheds*. Economist. Published February 21. Available: http://www.economist.com/news/britain/21644157-money-pouring-warehouses-golden-sheds. [Accessed February 19 2015], BARANIUK, C. 2015. *How Algorithms Run Amazon's Warehouse*. British Broadcasting Corporation (BBC). Published August 18. Available: http://www.bbc.com/future/story/20150818-how-algorithms-run-amazons-warehouses. [Accessed August 19 2015].

Case study five – Logistics

How has digital transformation changed the character of the sector?

Technology is being used in the logistics sector to consolidate delivery transport flows, and to make operations more efficient.[124] The logistics sector has started to use technologies so that it can use the data that was collected to model operations, sales patterns and transport flows more precisely, in order to improve efficiency and to cut down on costs.[125] Automation of distribution centres[126] is also increasing demand for rapid home delivery by customers.[127]

What digital technologies have been introduced?

In 2005, radio frequency identification (RFID) tags were introduced in a bid to make the supply chain more efficient. This technology is attached to individual items so they can be tracked whilst in transit, retailers also use these tags in order to have a better overview of the stock they currently have in their warehouses or stores. More recently, companies have looked towards utilising automation software or cloud-based networks to improve efficiency across the supply chain.[128] A benefit of cloud-based systems is that they are cheaper to install, they fix supply-chain problems at their source and can be used by companies across networks, regardless of the locality of the user.[129]

Currently, the logistics sector is working on introducing drones (or unmanned aerial vehicles) in order to make the delivery of goods cheaper and more efficient. For example, DHL is piloting its Parcelcopter 2.0 project, which uses drone technology to deliver time-sensitive goods (like medicine) to remote locations, quicker and more effectively than aeroplanes or ferries could achieve.[130] Similarly, Amazon is at the forefront of developments with drones and logistics that are challenging regulatory systems regarding airspace and safety.[131]

What impact has it had on the sector?

The digital transformation of the logistics sector has happened quite rapidly, and the sector is struggling to meet the demand in skilled workers. Technical changes in

[124] FTA 2015. *Logistics Report 2015*. Freight Transport Association. Available: http://www.fta.co.uk/about/logistics_report.html. [Accessed September 15 2015].

[125] DEMPSEY, M. 2014. *Analytic programs can learn to make accurate predictions*. Financial Times (London). Published October 21. Available: http://www.ft.com/cms/s/0/24ec2706-4fb9-11e4-908e-00144feab7de.html. [Accessed September 14 2015].

[126] BOUNDS, A. 2015. *Supermarket warehouses worth more than stores*. Financial Times (London). Published September 2. Available: http://www.ft.com/cms/s/0/49bb4402-4817-11e5-af2f-4d6e0e5eda22.html. [Accessed September 4 2015], KNIGHT, W. 2015. *Inside Amazon's Warehouse, Human-Robot Symbiosis*. Technology Review. Published July 7. Available: http://www.technologyreview.com/news/538601/inside-amazons-warehouse-human-robot-symbiosis/. [Accessed July 7 2015].

[127] PLIMMER, J. 2015. *Amazon launches one-hour delivery in London*. Financial Times (London). Published June 30. Available: http://www.ft.com/cms/s/0/f458f184-1f13-11e5-aa5a-398b2169cf79.html. [Accessed July 1 2015].

[128] PALMER, M. 2014. *Demands on supply chain help to boost technological innovation*. Financial Times (London). Published October 21. Available: http://www.ft.com/cms/s/0/322d7b4c-4f99-11e4-908e-00144feab7de.html. [Accessed November 2 2014].

[129] BIRD, J. 2015. *Integration of systems drives speed while reducing cost*. Financial Times (London). Published October 21. Available: http://www.ft.com/cms/s/0/91ee3bde-5066-11e4-8645-00144feab7de.html#axzz3mv1n2Rdk. [Accessed September 10 2015].

[130] DHL 2014. *Unmanned Aerial Vehicles in Logistic: A DHL perspective on implications and use cases for the logistics industry*. DHL Customer Solutions & Innovation. Available: http://www.dhl.com/content/dam/downloads/g0/about_us/logistics_insights/DHL_TrendReport_UAV.pdf. [Accessed September 20 2015].

[131] BBC 2015a. *Amazon details drone delivery plans*. British Broadcasting Corporation (BBC). Published May 8. Available: http://www.bbc.co.uk/news/technology-32653269. [Accessed May 8 2015], BBC 2015b. *Amazon suggests a separate airspace for delivery drones*. British Broadcasting Corporation (BBC). Published July 29. Available: http://www.bbc.co.uk/news/business-33698812. [Accessed July 30 2015].

Case study five – Logistics

managing logistics have created a greater demand for individuals with IT skills alongside their managerial capabilities. Furthermore, these skills needs are required in a context of an 'environmental low-carbon agenda', which requires a further generic skillset of being able to manage the digital transformation of logistics in an environmentally-friendly way.[132]

As a result of the new demands of the logistics sector, there is a shortage of workers who are highly-skilled enough to be able to analyse the datasets and translate the findings into solutions for the management of the supply chain. There are also concerns that people with the required digital skills might reject a career in logistics in favour of other potentially more "exciting" sectors. Employers are also finding it difficult to upskill existing employees to the appropriate level in the timeframes needed to make effective change. [133]

Developments in logistics show that extensive IT usage is having positive outcomes, for example helping businesses to monitor their stock status, allowing for better planning and a more accurate level of stock to meet anticipated demand. Similarly, automated systems are also helping warehousing operations to move quicker and more efficiently, thus reducing costs and increasing organisational efficiency.[134]

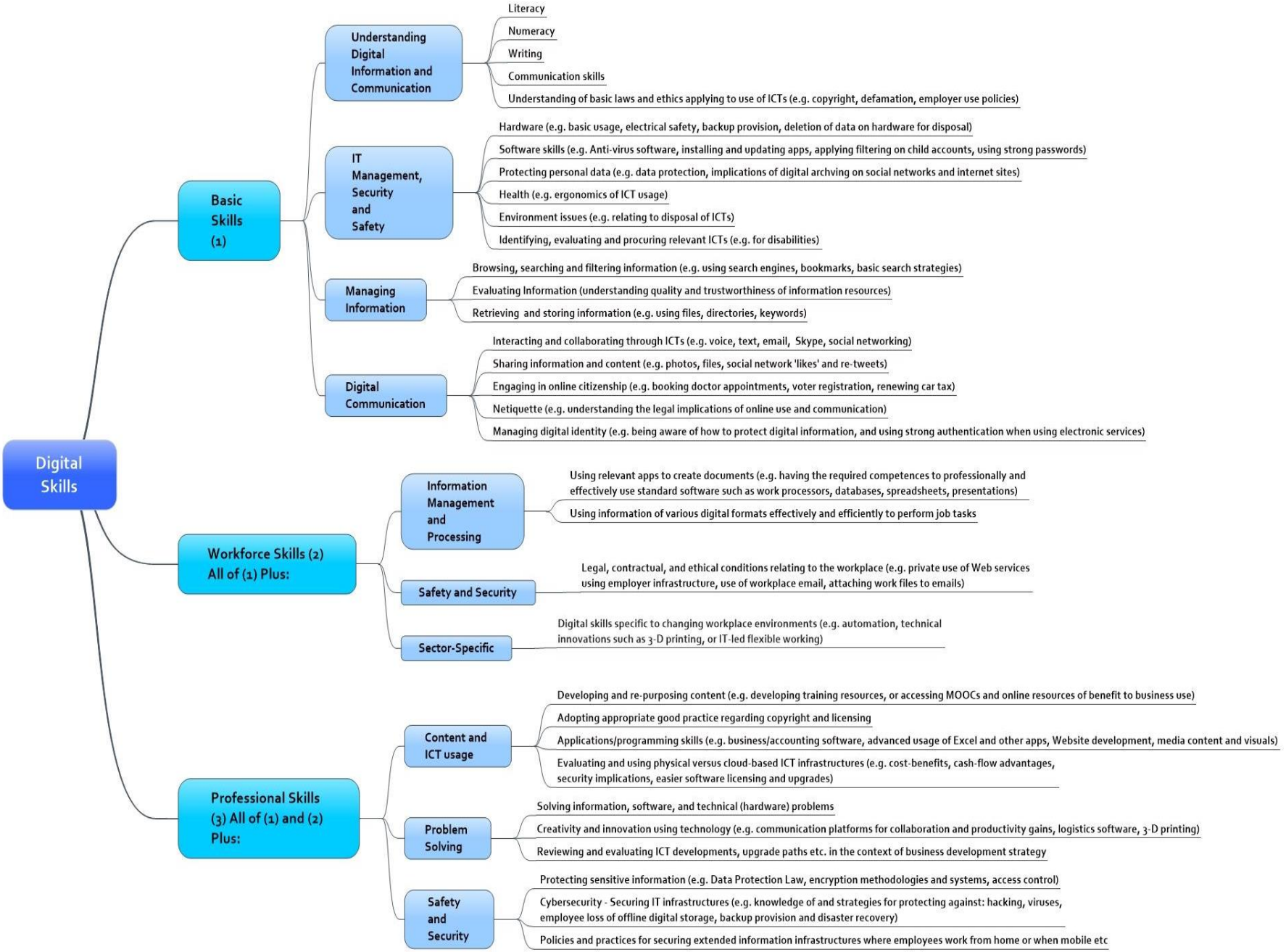
Figure 3 below takes into account the findings from the study on the different types of digital skills that are currently in demand and also are likely to be needed in the future. Links are made between the skills levels required for each type of user group, with the potential skills and knowledge needed to carry out tasks linked to specific competences. It builds on the three definitions developed in Chapter 2.Overall, the findings suggests that while digital skills gaps are likely to be across the three user groups, skills shortages on the other hand are more likely to be at the 'Professional Skills' level**.**

[132] GAMBIN, L., HOGARTH, T., ATFIELD, G., LI, Y., BREUER, Z. & GARRETT, R. 2012. Sector Skills Insights: Retail. Evidence Report 53. UK Commission for Employment and Skills. Published July. Available: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/304319/Sector_Skills_Insights_Retail_evidence_report_53.pdf. [Accessed October 29 2015].

[133] FTA 2015. *Logistics Report 2015*. Freight Transport Association. Available: http://www.fta.co.uk/about/logistics_report.html. [Accessed September 15 2015].

[134] FTA 2015. *Logistics Report 2015*. Freight Transport Association. Available: http://www.fta.co.uk/about/logistics_report.html. [Accessed September 15 2015].

Figure 3 Digital Skills Mapping



Key Findings

- Demand for digital skills is evident, both as a common demand for all employees to have basic skills, and vertically, relating to sector-specific skills. However, the education and training system is not currently delivering potential employees with the relevant skills. Education and training courses at all levels need to adapt to ensure that the development of digital skills are aligned to key requirements:

    - High level digital skills needs are evident, for example in key industry sectors including construction and advanced materials, and the creative sector. As the tools available and production processes progress in these and other sectors, employees are expected to take on new roles that often require management and assessment of increasingly complex issues as well as creative inputs; and
    - In the IT and telecoms sectors, employees aged 40+ make-up a higher proportion of the current workforce than in previous decades, suggesting that the skill-sets offered by the more experienced groups are in greater demand by employers.

- Given the current level of demand identified, forecasts predict that the need for digital skills will intensify, highlighting the need for all employees to have digital skills in addition to other skills and competencies:

    - Existing research has identified that there are a number of key skills requirements including those associated with 'tech' specialists, big data analysts, developers, security skills, technology specific skills, analytic and research skills;
    - The literature suggests that the main demand in the labour market is for employees to have digital skills as one element of their overall skill-set and this need will strengthen as society and the economy further digitalises; and
    - A latent skills gap has already been identified by existing research and is likely to grow larger without the introduction of new policies and initiatives.

Routes used to meet UK digital skills requirements (supply of digital skills)

This section reviews the routes used to meet the digital skills needed by employers in the UK, and the current barriers and market failures facing businesses in accessing digital skills. It draws on the literature review and interviews with stakeholders.

Education and training routes

A common theme in the literature is the challenge that employers face in recruiting employees with the appropriate digital skills required by their organisation. A key issue cited in the literature is that the education system is failing to provide graduates whose skills align sufficiently with employer requirements. Universities UK research into the way in which data skills are taught as part of undergraduate degrees found that training in data analytics is widespread across STEM and social science courses. However, the quantity of provision varied markedly between institution and degree subject.[135]

There is a degree of consensus within the literature that the education sector could better and more consistently integrate the acquisition of digital skills across the curriculum, and embed digital skills as a core component of degree programmes.[136] This, and the issue of employability, is the subject of the current independent Shadbolt (focusing on accreditation) and Wakeham Reviews for BIS.

The former will review computer science degree accreditation and graduate employment outcomes to explore in more detail what lies behind the relatively high rates of computing science graduate unemployment and to look at what more can be done to improve this.

The latter will: “Look at the provision of STEM degree courses and how their associated accreditation arrangements support graduate employability. It will identify whether there are areas which need further investigation. The review will focus on gaining a better understanding of the skills requirements of employers, how STEM graduates’ skills and knowledge relate to labour market demand, and how existing accreditation systems support this”.[137]

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[135] UUK 2015. *Making the most of data: Data skills training in English universities*. Universities UK. Published July 13. Available: http://www.universitiesuk.ac.uk/highereducation/Documents/2015/MakingTheMostOfDataDataTrainingSkillsInEnglishUniversities.pdf. [Accessed July 21 2015].

[136] MATEOS-GARCIA, J., WINDSOR, G. & ROSEVEARE, S. 2015b. *Analytic Britain: Securing the right skills for the data-driven economy*. NESTA (National Endowment for Science, Technology and the Arts, UK). Published July 10. Available: http://www.nesta.org.uk/publications/analytic-britain-securing-right-skills-data-driven-economy. [Accessed July 21 2015].

[137] BIS 2015a. *Computer science degree accreditation and graduate employability: Shadbolt review - terms of reference*. Department for Business, Innovation and Skills (UK). Published February 25. Available: https://www.gov.uk/government/publications/computer-science-degree-accreditation-and-graduate-employability-shadbolt-review-terms-of-reference. [Accessed July 21 2015], BIS 2015e. *STEM degree provision and graduate employability: Wakeham review - terms of reference*. Department for Business, Innovation and Skills (UK). Published February 25. Available: https://www.gov.uk/government/publications/stem-degree-provision-and-graduate-employability-wakeham-review-terms-of-reference. [Accessed July 21 2015].

There are diverse education and training routes through which digital skills can be acquired by individuals. Further education, higher education and learning through community provision all constitute routes for the supply of digital skills. Employers can also address skills shortages by deploying training and continuous professional development opportunities for employees to bridge digital skills gaps in their businesses. The views from stakeholders involved in the study highlights that the routes into digital careers vary considerably across sectors. Traditionally, employers employ graduates from higher education for more professional roles, particularly within the financial or STEM industries, but some stakeholders suggested that increasingly employers are turning towards apprenticeships or employing candidates who have NVQ qualifications. For many employers, the ever-changing landscape of digital skills means that it is more valuable having employees who can learn the relevant skills on-the-job. Indeed, more increasingly stakeholders commented that employers now expect new starters to already have a set of core IT skills to hit the ground running within a new post.

Data from the 2014 Higher Education Statistics Agency (HESA)[138] presents a mixed picture on the enrolments for undergraduate and postgraduate study courses in the field of computer science, as well as in engineering and technology. The data highlights that enrolments between 2008 and 2013 have been consistently higher for engineering and technology degrees compared with computer science for both undergraduate and postgraduate degrees (Figures 4 and 5). This has been accompanied by a dramatic reduction in the number of computer scientists. In the last decade to 2012, “there was a 23.3% drop in the number of students studying Computer Science at undergraduate level and a 33.8% drop in the number of students entering at graduate level”[139]. However, latest figures suggest that this trend may be reversing; there was a 1% increase in full time Computer Science enrolments between 2012/13 to 2013/14[140].

At the FE level, enrolments for some IT related apprenticeship frameworks have also been on a decline between 2010/11 to 2014/15 (Figure 6)).[141] Figures on Apprenticeship Programme Starts by Sector Subject Area’ for Information, Communication and Technology (ICT) overall highlights an increase of just over 2,000 enrolments between 2013/14 and 2014/15[142].

[138] Available : https://www.hesa.ac.uk/

[139] NEXTGEN 2012. *New figures reveal crash in Computer Science degrees*. Next Gen Skills. Published March. Available: http://www.nextgenskills.com/new-figures-reveal-crash-in-computer-science-degrees/. [Accessed June 1 2014].

[140] Available: https://www.hesa.ac.uk/sfr210: Table 4

[141] Available: https://www.gov.uk/government/statistical-data-sets/fe-data-library-apprenticeships

[142] Available: https://www.gov.uk/government/statistical-data-sets/fe-data-library-apprenticeships

Figure 4 Employment figures for undergraduate students studying computer science and engineering and technology

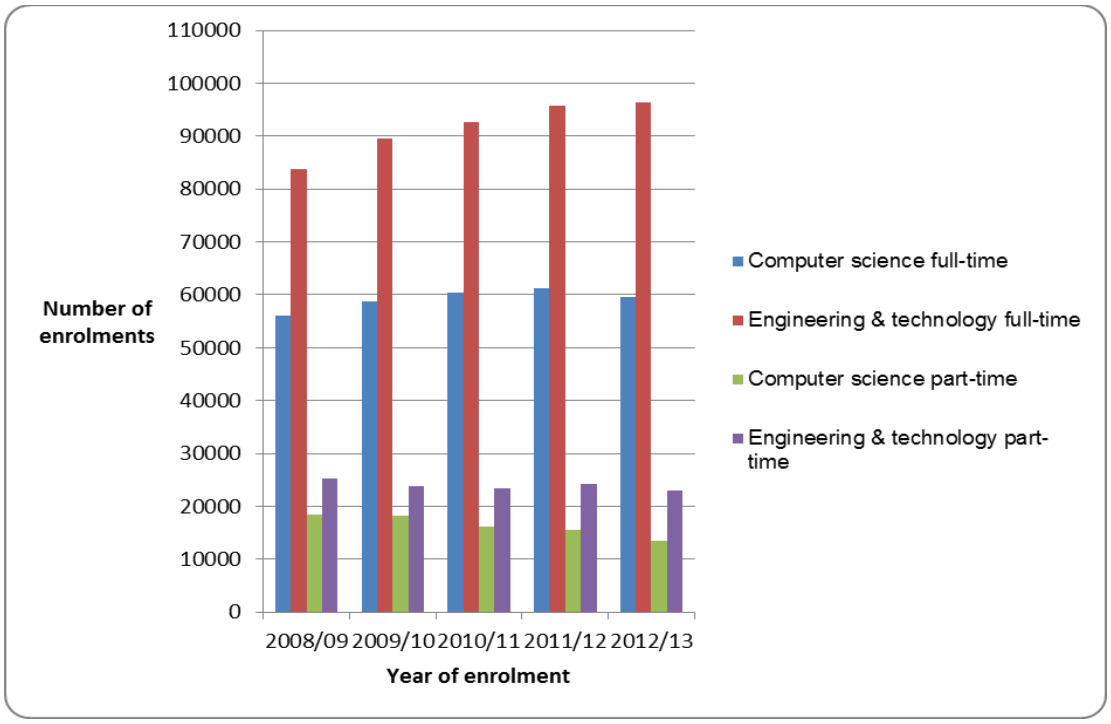


Figure 5 Employment figures for postgraduate students studying computer science and engineering and technology

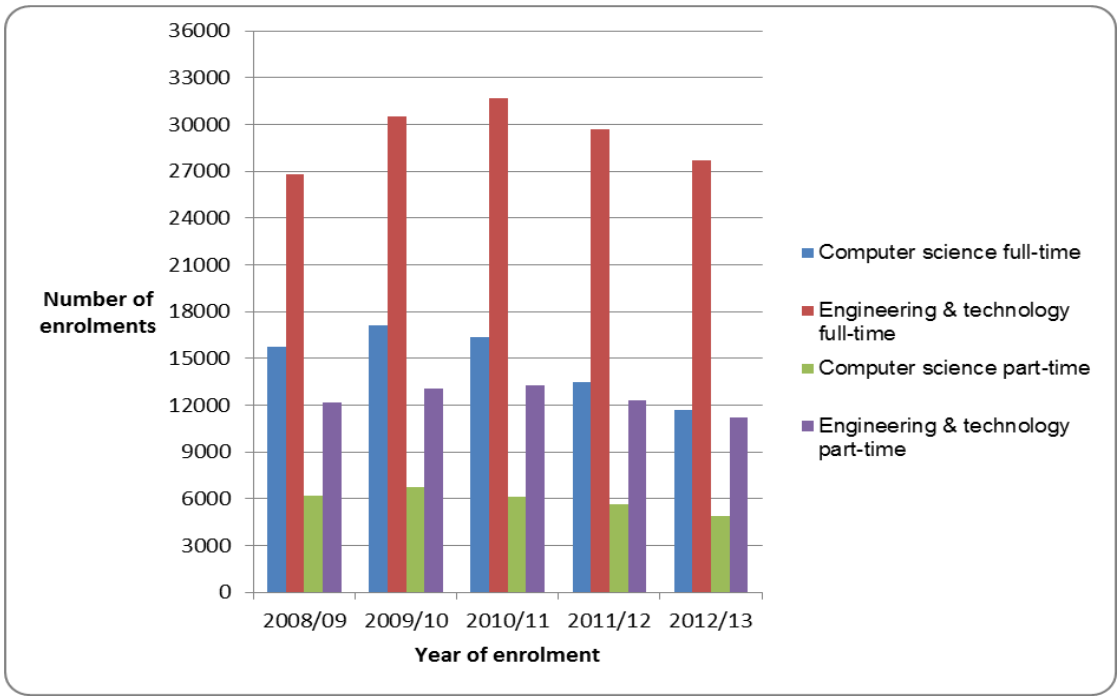
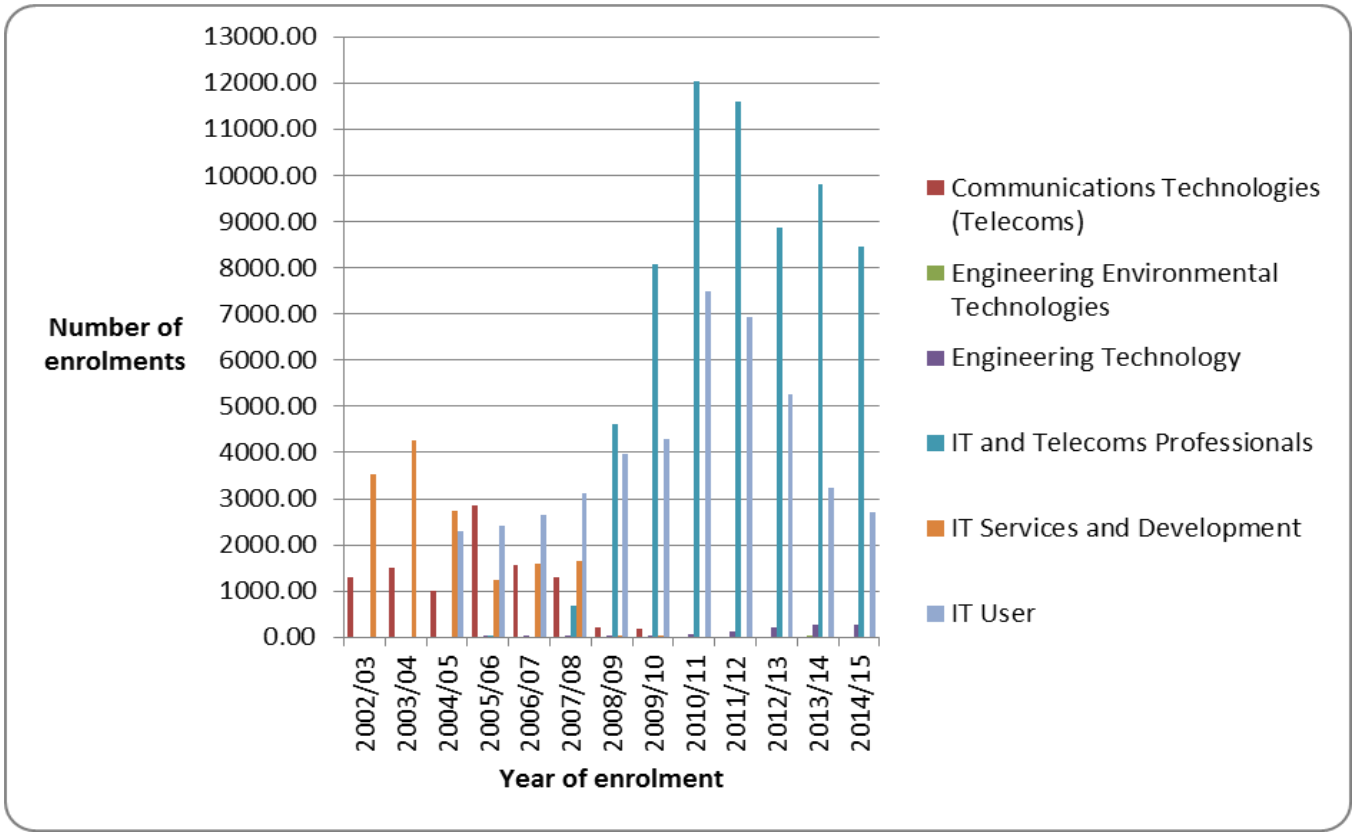


Figure 6 Enrolment figures for IT related apprenticeship programme subject areas



Research by the charity 'Tablets for Schools' also notes that whilst "almost 70% of primary and secondary schools in the UK now use tablet computers", it is not clear what impact this is having on educational outcomes.[143] The use of IT in schools has been tracked by the British Educational Supplies Association, they report that "as technology develops teachers will need the time and resources to explore it, pool their expertise and decide what will best help them and their students".[144] IT skills therefore underpin effective use of IT in school education, and it must also be underpinned by effective teaching and learning for all groups, especially in the context of gender, for example making coding relevant and attractive to female learners.[145] Also, initiatives such as the British Chambers of Commerce Business collaboration with the Government Equalities Office links teachers with businesses to provide them with knowledge and motivation to "encourage more girls to study science, technology, engineering and maths". [146]

Some studies have made recommendations on to how to strengthen the supply pipeline, by identifying actions for school, colleges, universities, the labour market and industry. Perhaps most pertinent for this review are those recommended actions for universities and

[143] COUGHLAN, S. 2014. *Tablet computers in '70% of schools'*. British Broadcasting Corporation (BBC). Published December 3. Available: http://www.bbc.co.uk/news/education-30216408. [Accessed December 4 2014].

[144] BESA 2014. *BESA - ICT Use in Schools 1991-2015*. British Educational Supplies Association. Available: http://www.besa.org.uk/sites/default/files/his2015_0.pdf. [Accessed September 12 2015].

[145] DAVIES, S. 2014b. *Girl power cracks code to storm the land of geeks*. Financial Times (London). Published May 8. Available: http://www.ft.com/cms/s/0/0bef5d18-d755-11e3-a47c-00144feabdc0.html. [Accessed May 10 2014].

[146] BCC 2015. *Taking teachers out of the classroom is key to widening girls' participation in science*. British Chambers of Commerce. Published July 16. Available: http://www.britishchambers.org.uk/press-office/press-releases/taking-teachers-out-of-the-classroom-is-key-to-widening-girls%E2%80%99-participation-in-science.html. [Accessed August 20 2015].

vocational education, labour market and industry, made as part of the NESTA "Analytic Britain" report.[147] The report recommends actions ranging from stronger teaching of mathematics and statistics in schools and colleges, integrating data analytics with the teaching of other subjects, and improving the quality and quantity of information about data analytics career prospects and role models in schools and colleges.

All the stakeholders consulted for this study agreed with the above, and felt that digital skills had to be embedded across education and training provision. There were however mixed views on whether digital skills training should be given the same priority as Maths and English. Others felt that at the higher technical end, people needed to have some knowledge of Maths and English to understand the basic aspects of computing. When stakeholders were asked at which point in the education pipeline should the different digital skills be developed. The responses were as follows:

1. *Basic digital skills.* Stakeholders agreed that digital skills training had to start from a very young age and in primary schools, so that all children had the basic knowledge of how to use the internet safely. They also felt that young people had to acquire basic digital literacy skills by the time they leave mandatory education. Recent research by the ECDL Foundation suggests that young people, whilst proficient in some areas, lack the basic digital skills needed when they move into employment. It also notes that *"exposure to technology*" does not necessarily "equate to the ability to use it", The research highlights that young people do not necessarily have the skills to use technologies safely and effectively, and that "the failure to provide youth with a complete set of skills in a formal manner' could lead " to a new digital divide between digital lifestyle skills and digital workplace skills". [148].

2. *Digital skills for the general workforce (Intermediate skills)*. This answer was more varied because some stakeholders felt it depended on the context in which these skills were needed. Although several felt that basic workplace digital skills had to be taught around GCSE age so that young people had the necessary skills to prepare them for employment.

3. *Digital skills for ICT professions* (*Advanced skills*). Again, some felt that this was dependent on the context; however, the general view was that these skills are more likely to be developed at the higher education level. One issue raised was that higher education was not effectively keeping up with the pace of technological changes. Therefore while it was possible to gain the basic skills, it was largely up to employers to further train the employee in adapting and building their skills and knowledge to the needs of the business. Other stakeholders felt that these skills are only really necessary for those who choose a career that requires a high level of digital skills. One stakeholder warned against teaching young people 'advanced-level' skills too soon because if they are not applied regularly, then they will be forgotten and the education investment will be wasted.

[147] MATEOS-GARCIA, J., WINDSOR, G. & ROSEVEARE, S. 2015b. *Analytic Britain: Securing the right skills for the data-driven economy*. NESTA (National Endowment for Science, Technology and the Arts, UK). Published July 10. Available: http://www.nesta.org.uk/publications/analytic-britain-securing-right-skills-data-driven-economy. [Accessed July 21 2015].

[148] Available: http://www.ecdl.org/media/TheFallacyofthe%27DigitalNative%27PositionPaper1.pdf

The role of in-work training in addressing digital skills gaps is also emphasised in a study by Fujitsu, based on a survey of 1,000 UK adults 1,400 UK employees and 100 people without home internet access. The study identified that while employees may have a strong understanding of the digital tools available within the workplace, this does not necessarily translate into the optimum application and use of these tools. The study also highlighted that 42% of employees surveyed had a lack of awareness of the digital options available to them[149] and 39% of respondents also felt that not enough was being done to educate people on digital services, and how to use them.[150]

In this context, survey respondents felt that individual companies or organisations behind particular digital applications should be responsible for educating the public on how to use digital services.[151] Nearly one quarter of survey respondents also felt that the government was responsible for educating people on how to use digital services, whilst a similar proportion felt that central (13%) or local (9%) government was responsible for this. A lesser proportion (16%) felt that this responsibility rests with the individuals using the service themselves.[152]

The above findings are in line with those from the stakeholder consultations. Most stakeholders felt that it was the government's responsibility to provide support to people who lacked basic digital skills, by subsidising or providing free basic IT skills through the provision of a national training programme. Almost all of the stakeholders also felt that it was the responsibility of employers to upskill or reskill their workforce in line with the needs of their businesses. In the STEM sectors, where the development of digital technology is fast-paced, some stakeholders suggested that it should be down to industry experts to share their knowledge and support the upskilling of the current workforce. There were, however, concerns around the ability of industries to organise themselves and provide digital skills training for their workforce. One stakeholder felt that it would be important for the government to have a leadership role in this aspect.

Influencers and barriers

There are a number of factors that are likely to influence individuals to either pursue digital careers or acquire digital skills. One of the most prominent is motivation and awareness of digital career opportunities, given that an individual will often have to 'opt in' to a particular education or training option, except in the case of mandatory in-work training. Ultimately, choice and motivation governs the degree to which individuals elect to undertake study degrees with a digital skills focus such as computing. Several stakeholders agreed with this view and indicated that there was a general lack of awareness of the employment opportunities around digital careers, particularly for young people. Overall, the general view was that more needed to be done to raise awareness of digital careers and to improve the perceptions of the sector which is currently often portrayed as a *'male-dominated'* and '*geeky'* industry.

[149] FUJITSU 2015. *Digital Inside Out: Creating a digital-first Britain*. Fujitsu Consulting. Available: http://blog.uk.fujitsu.com/digital-inside-out/. [Accessed July 15 2015].

[150] ibid

[151] ibid

[152] ibid

Linked to the above, there appears to be particular barriers to undertaking further training and education in the field of digital skills, particularly for women. Women are under-represented on IT related higher education courses. In 2011, just 18% of IT and Telecoms professionals were female compared with an overall figure of 48% for the UK workforce as a whole.[153] This trend has recently led the UK Digital Skills Taskforce to suggest that 'tech' companies and employers of leading 'tech' professionals should do more to diversify their staff e.g. through the provision of mentoring in schools to encourage participation of different groups in digital skills courses. Early signs are however encouraging with women making up a slightly higher percentage than men in BIS funded basic digital skills programmes[154].

While only limited research reports address the nature of these barriers in depth, they are likely to reflect wider patters of horizontal occupational segregation, whereby women are under-represented in particular sectors and industries which are traditionally seen as representing "men's work". The Tech Partnership 2015 IT Scorecard also indicates a contradictory situation where "females consistently achieve higher grades than males in IT-related subjects, but they still just fill 17% of IT & Telecoms professional occupations".[155] As a recent article in Marketing Magazine suggests, the culture of the 'tech' sector might be holding women because "the technology sector is often associated with long hours, an intense dedication to the job at the expense of life outside and a workforce dominated by men".[156]

Similarly, a report by the UK Digital Skills Taskforce suggests that negative stereotypes of the 'tech' sector are prevalent across society. The value of digital skills to all jobs is not fully understood and the significant and successful role that digital companies play in the economy is not appreciated. This finding relates equally to school children, but also teachers and parents who are regarded as being in a poor position to advise children on career development in digital sectors. Furthermore, 23% of parents considered digital skills as irrelevant to their children's future career prospects.[157]

Another barrier is said to be the level of qualifications held by ICT teachers. Only 44.9% of secondary school ICT teachers have a post A-level qualification relevant to ICT and the overwhelming majority of primary school teachers do not have a computing background. A recent survey found that 60% of teachers did not feel confident delivering the new ICT curriculum.[158] This seems to suggest that training should be offered to ICT teachers to ensure that they can add value to their ICT lessons and address the skills gap.

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[153] E-SKILLS 2012. *Technology Insights 2012*. e-Skills UK. Available: http://www.e-skills.com/Documents/Research/Insights-2012/TechnologyInsights_2012_UK.pdf. [Accessed June 3 2015].

[154] "figures supplied to BIS from the Tinder Foundation - end 2014/15 Financial Year

[155] TP 2015e. *Women in IT Scorecard (Sep 15)*. The Tech Partnership. Published September 8. Available: https://www.thetechpartnership.com/globalassets/pdfs/research-2015/womeninit_scorecard_2015.pdf. [Accessed September 27 2015], TP 2015c. *Employment Bulletin (Sep 15)*. The Tech Partnership. Published September 8. Available: https://www.thetechpartnership.com/globalassets/pdfs/research-2015/employmentbulletin_sep15_final.pdf. [Accessed September 27 2015].

[156] ANON 2015b. *Is the culture of the tech sector holding women back?* Marketing Magazine. Published July 3. Available: http://www.marketingmagazine.co.uk/article/1354234/culture-tech-sector-holding-women-back? [Accessed August 4 2015].

[157] UKDS 2014. *Digital Skills for Tomorrow's World: The independent report of the UK Digital Skills Taskforce*. UK Digital Skills Task Force. Published July. Available: http://www.ukdigitalskills.com/wp-content/uploads/2014/07/Binder-9-reduced.pdf. [Accessed June 22 2015].

[158] Ibid

As acknowledged in the literature that has been reviewed, education has the potential to counter wrong perceptions around digital careers, and raise awareness and knowledge about the importance of digital skills across every employment sector. In particular, early education can act as a strong influencer in this respect in countering negative stereotypes around digital skills and digital technology (for example where these paths are perceived as 'geeky').

The digital skills training acquired through education and training routes will only be relevant to employers where institutions as well as teachers and trainers have a flexible and adaptable approach, ensuring that the skills developed reflect current market developments as well as employer demand. The House of Lords report also emphasises that: "no child should leave school without basic digital literacy. Universities should ensure all graduates are "digitally competent". Apprenticeships should have a greater emphasis on digital skills".[159] In addition, and as also emphasised earlier, digital skills must not be viewed in isolation from other skills such as soft skills.

Responses to the demand for digital skills in the UK

Research highlights the difficulties that employers are having in recruiting people with right digital skills, and places the responsibility for increasing supply of digital skills with government, universities and businesses.[160] Many studies also stress the importance of partnership working and cooperation between employers, education institutions as well as central and local government in developing and delivering approaches to the supply of digital skills. An example is the National College for Digital Skills, an initiative outlined in the government's Productivity Plan.[161] When established, this specialist further education college will aim to foster close collaboration with industry, so that students can be prepared to adequately meet the needs of the labour market.[162]

There are a range of initiatives designed to address digital skills gaps and shortages in the UK, which suggests that there is a lot going on at the system level (through the BBC activities for example), at the policy level (government initiatives), local and regional initiatives, and at the sector level through industry and business groups. However, the extent to which these initiatives are clearly 'visible' to potential beneficiaries is less clear. Some stakeholders also agreed with this view, and felt that there was a need for some leadership in this area, and for the government to utilise these existing structures and networks to support the development of digital skills. Examples of such initiatives are outlined below; this is not meant to be fully representative but provides an overview of the types of initiatives that currently exist in the UK. A detailed list is provided in Annex 3.

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[159] BURNS, J. 2015. *Digital skills should be core subjects, says report*. British Broadcasting Corporation (BBC). Published February 17. Available: http://www.bbc.co.uk/news/education-31501917. [Accessed February 17 2015], LORDS 2015. *Make or Break: The UK's Digital Future*. House of Lords, Digital Skills Select Committee. Published February 17. Available: http://www.publications.parliament.uk/pa/ld201415/ldselect/lddigital/111/11102.html. [Accessed February 17 2015].

[160] SAS & TP 2014. *Big Data Analytics. Assessment of Skills for Labour and Skills 2013-2020*. SAS Inc and The Tech Partnership. Published November. Available: https://www.e-skills.com/research/research-themes/big-data-analytics/. [Accessed June 3 2015].

[161] TREASURY 2015b. *Productivity plan launched*. HM Treasury (UK). Published July 10. Available: https://www.gov.uk/government/news/productivity-plan-launched. [Accessed July 21 2015], TREASURY 2015a. *Fixing the foundations: creating a more prosperous nation*. HM Treasury (UK). Published July 10. Available: https://www.gov.uk/government/publications/fixing-the-foundations-creating-a-more-prosperous-nation. [Accessed July 21 2015].

[162] NCDS 2015. *National College for Digital Skills*. National College for Digital Skills. Published July. Available: http://www.ncdigitalskills.org.uk/. [Accessed July 21 2015].

Government initiatives

At the government level there has been a range of initiatives aimed at supporting the development of digital skills. In the context of education and qualifications schemes have included:

1. A new computing curriculum was introduced in schools in England in September 2014. A similar curriculum will be introduced in Wales from 2016.[163] This was a response to concerns from schools, teachers and industry that the existing ICT curriculum lacked inspiration and did not ensure that every pupil had the skills and knowledge to be digitally confident. The new curriculum was developed to support students across Key Stages 1-4 to gain the computational thinking skills to enable them to adapt to emerging technologies, and to prepare them for current and future career paths. The new curriculum saw England becoming the first country in the world to mandate coding at primary and secondary level.[164] In Wales, the Welsh Government announced in July 2015 that it will develop a new "framework that will introduce digital competence across the curriculum to help pupils of all ages widen and develop their digital skills will be available to schools by September 2016."[165]

2. Degree Apprenticeships[166] were launched in September 2015. Over 40 companies worked with Tech Partnership, the network of employers collaborating to create digital skills, to launch 300 degree apprenticeships in 9 universities to enable young people to obtain a fully integrated honours degree in a computer science related discipline, alongside job training. Students receive a salary and fees jointly paid by government (two thirds) and employers (one third). The degree apprenticeships will be rolled out to other universities, and with more employers. Degree apprenticeships will also be available in other disciplines.

3. A National College for Digital Skills: the ambition is for the National College to be a beacon for digital skills provision, providing high quality training driving up standards in Further Education provision across the country. It is anticipated the National College will open its doors in September 2016, with the ambition of reaching 5,000 students within five years.[167]

[163] WALES 2015a. *Conference will spread innovation in digital competence*. Welsh Government. Published June 24. Available: http://gov.wales/newsroom/educationandskills/2015/10297518/?lang=en. [Accessed September 27 2015], WALES 2015b. *New plans to embed digital competence into curriculum*. Welsh Government. Published June 10. Available: http://gov.wales/newsroom/educationandskills/2015/10258869/?lang=en. [Accessed September 27 2015].

[164] DFE 2013. *Statutory guidance: National curriculum in England: computing programmes of study*. Department for Education (UK). Published September 11. Available: https://www.gov.uk/government/publications/national-curriculum-in-england-computing-programmes-of-study/national-curriculum-in-england-computing-programmes-of-study. [Accessed August 3 2015].

[165] ANON 2015c. *Welsh Government launches new digital competence initiative*. Pembrokeshire Herald. Published July 2. Available: http://www.pembrokeshire-herald.com/16751/welsh-government-launches-new-digital-competence-initiative/. [Accessed August 23 2015].

[166] SFA 2015d. *SFA: higher and degree apprenticeships*. Skills Funding Agency (UK). Published August 28. Available: https://www.gov.uk/government/collections/sfa-higher-and-degree-apprenticeships. [Accessed September 11 2015].

[167] NCDS 2015. *National College for Digital Skills*. National College for Digital Skills. Published July. Available: http://www.ncdigitalskills.org.uk/. [Accessed July 21 2015].

4. An independent review of computer science degree accreditation: To improve course quality and graduate employment outcomes. The government has asked Professor Sir Nigel Shadbolt to lead an independent review of computer science degree accreditation and graduate employment outcomes to explore in more detail what lies behind the relatively high rates of computing science graduate unemployment and to look at what more can be done to improve this.[168]

5. Skills Funding Agency Review of Digital Skills Qualifications in Further Education**:** Following industry feedback that FE digital courses were not rigorous enough and were not meeting the needs of employers, the Skills Funding Agency has been commissioned to undertake a review of Digital Skills Qualifications.[169] The Review will make recommendations on how any reforms of Technical and Professional Education can best support responsive, employer-led, high level digital skills. The independent review is independently chaired by Liz Williams (BT) and is due to report in early 2016.

6. Computer science degree conversion courses: In September 2015 bids were sought for funding to support innovative approaches to increase the number of graduates pursuing computing science in disciplines in particular demand from industry such as data analysis and cyber security. This competition was part of a wider call for bids by the Higher Education Funding for England (HEFCE) in engineering disciplines.[170] Pilot courses lasting one year, predominantly at post-graduate level, will start in the 2016-17 academic year.

7. The apprenticeship system is being reformed to enable employers to design apprenticeship standards that reflect their needs.[171] Nine standards have already been created for digital roles, with three ready for delivery. Those in existence in August 2015 covering digital industries being: network engineer, software developer, software tester, digital marketer, cyber intrusion analyst; data analyst; infrastructure technician, unified communications trouble-shooter, digital & technology solutions professional.[172] In addition, a consultation (closing October 2015) was launched regarding the proposal to increase the number of apprenticeships through a levy on employers from 2017 onwards.[173] Employers have emphasised that it is important to ensure that absorption capacity exists for the IT-related apprenticeships and that they are of the required quality, since "in 2013-14, just 10,000 of the 440,000 starts were in IT and telecoms, while just 16,000 were in engineering."[174] In June 2015 HMRC announced their first funding for 15 'digital apprenticeships' "at HMRC's Newcastle upon Tyne-based Digital

[168] BIS 2015a. *Computer science degree accreditation and graduate employability: Shadbolt review - terms of reference*. Department for Business, Innovation and Skills (UK). Published February 25. Available: https://www.gov.uk/government/publications/computer-science-degree-accreditation-and-graduate-employability-shadbolt-review-terms-of-reference. [Accessed July 21 2015].

[169] SFA 2015e. *Training providers and awarding organisations to 'talk digital' at workshops*. Skills Funding Agency (UK). Published May 20. Available: https://www.gov.uk/government/news/training-providers-and-awarding-organisations-to-talk-digital-at-workshops. [Accessed September 11 2015].

[170] HEFCE 2015. *Funding for higher education in England for 2015-16: HEFCE grant letter from BIS*. Higher Education Funding Council for England. Published January 30. Available: http://www.hefce.ac.uk/news/newsarchive/2015/Name,100772,en.html. [Accessed September 2 2015].

[171] SFA 2015b. *A guide to apprenticeships*. Skills Funding Agency (UK). Published July 24. Available: https://www.gov.uk/government/publications/a-guide-to-apprenticeships. [Accessed August 28 2015].

[172] SFA 2015a. *Apprenticeship standards*. Skills Funding Agency (UK). Published August 21. Available: https://www.gov.uk/government/collections/apprenticeship-standards. [Accessed September 10 2014].

[173] SFA 2015c. *Make your views heard: BIS apprenticeship levy consultation*. Skills Funding Agency (UK). Published August 21. Available: https://www.gov.uk/government/news/make-your-views-heard-bis-apprenticeship-levy-consultation. [Accessed September 12 2015].

[174] O'CONNOR, S. 2015. *UK employers call for quality apprenticeships*. Financial Times (London). Published August 31. Available: http://www.ft.com/cms/s/0/4293ce4e-4c20-11e5-b558-8a9722977189.html. [Accessed September 1 2015].

Delivery Centre, candidates will be paid £23,367 in addition to studying for a degree".[175]

8. In April 2014, the government launched the Digital Inclusion Strategy; it aims to bring the government, the third sector and the private sector together to reduce the number of people without basic digital skills by 25% before 2016.[176] The government plans to report on its progress in a revised version of the strategy report due to be released in early 2016.

9. NIACE[177] are currently leading a BIS funded programme looking at digital Family Learning. They are running a pilot programme with Family learning providers in Hull, Manchester and Sheffield and linking them with local technology businesses so that young people and their parents can understand better what is required should they want to gain a digital career.

10. Over the last four years, BIS (working with partners such as Tinder Foundation[178]) has supported 1.55m individuals to gain basic digital skills. Over this current Parliament (2015-2020), the ambition is to enable a further one million people to acquire such skills. To help achieve this ambitious goal, HMRC have recently committed additional funding to support 45,000 learners in the 10 most deprived areas of England over the 2015-16 financial year.[179]

11. The Department for Communities and Local Government along with the Department for Business Innovation and Skills and the Department for Culture, Media and Sports are involved in the industry led Digital High Street initiative which highlights, amongst other things, the need for IT skills to engage with the 'digital high street': "Basic Digital Skills - Eliminate the current gap in digital skills in our communities by 2020 to ensure that all digitally capable residents of our communities – individuals, SMEs and VCSEs – have basic skills."[180]

[175] BATEMAN, K. 2015. *HMRC tells Computer Weekly about its first 15 apprenticeships available under the government-led Tech Industry Gold Apprenticeship scheme*. Computer Weekly. Published July 30. Available: http://www.computerweekly.com/news/4500250822/HMRC-launches-paid-digital-apprenticeship-with-funded-degree-bonus. [Accessed October 12 2015].

[176] CABINET 2014a. *Government Digital Inclusion Strategy*. Cabinet Office (UK). Published December 4. Available: https://www.gov.uk/government/publications/government-digital-inclusion-strategy. [Accessed December 12 2014]. - The Strategy is being revised and the updated version will be released in 2016

[177] NIACE 2013. *The Inquiry into Family Learning in England and Wales*. National Institute of Adult Continuing Education (NIACE). Available: http://www.niace.org.uk/sites/default/files/resources/The%20Inquiry%20into%20Family%20Learning%20in%20England%20and%20Wales.pdf. [Accessed October 12 2015].

[178] MILNER, H. 2014. *BIS supports Tinder Foundation for Future Digital Inclusion programme*. Tinder Foundation. Published November 11. Available: http://www.tinderfoundation.org/our-thinking/blog/yay-bis-supports-tinder-foundation-future-digital-inclusion-programme. [Accessed September 3 2015].

[179] HMRC 2015. *HMRC Digital Inclusion Pilot: Grant description and guidance for applicants*. HM Revenue and Customs (UK). Available: https://www.ukonlinecentres.com/images/funding/2015-16/HMRCDigitalInclusionPilot-GuidanceApplication.pdf. [Accessed October 14 2015].

[180] DHSAB 2015. *Digital High Street 2020 Report*. Digital High Street Advisory Board. Published March. Available: http://thegreatbritishhighstreet.co.uk/pdf/Digital_High_Street_Report/The-Digital-High-Street-Report-2020.pdf. [Accessed June 4 2015].

12. Digital Strategy: The Chancellor's Productivity Plan at Budget 2015 (July 2015) announced that government will publish a digital transformation plan to set out "concrete actions the government will take to support the adoption of digital technologies across the economy". This will be a cross-government publication which sets out a clear digital agenda over the next 5 years and actions that government is taking now to achieve these aims. Building digital skills, for individuals and businesses, will be a key component of the strategy which is due to be published in early 2016.

Businesses have been supported through:

1. The Small Business Digital Capability Programme under the banner of Do More Online,[181] helping small businesses acquire the digital skills, aiming to support an extra 1.6 million businesses to transact online by 2018, through changing perceptions and providing targeted support.[182]

2. In November 2014, to help businesses accelerate their online presence and digital competences,[183] the government funded Tech City UK to launch the pilot of the free online training platform (Massive Open Online Course - MOOC) 'Digital Business Academy'. It is designed to teach digital business skills, with "free online business courses delivered by world-class business experts from UCL, Cambridge Judge Business School and Founder Centric".[184] Eight initial courses have included establishing a business start-up, developing and managing digital products, marketing, performance management and tracking.[185]

3. Short courses for digital skills**:** In November 2014 a pilot of Short Courses in digital skills were announced.[186] This pilot of modular, flexible and relevant short courses in key digital skills areas (initially focused on web design, database management and digital marketing to ensure small businesses can create an effective web presence), has been designed and accredited by business, setting new benchmarks for further education provision to meet current skills needs.

4. Access to internet infrastructure has been supported through £40 million made available through 2015-2016 where "more than 40,000 small and medium businesses (SMEs) across the UK have now benefitted from the government's Broadband Connection voucher scheme."[187]

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[181] STEELE, J. 2015. *Help for small businesses to 'Do More Online'*. Go ON UK. Published April 28. Available: http://www.go-on.co.uk/blog/help-for-small-businesses-to-do-more-online/. [Accessed September 5 2015].

[182] BIS 2015c. *Do More Online*. Department for Business, Innovation and Skills (UK). Published September. Available: http://www.greatbusiness.gov.uk/domoreonline/. [Accessed September 12 2015].

[183] BAKER, G., LOMAX, S., BRAIDFORD, P., ALLINSON, G. & HOUSTON, M. 2015. *Digital capabilities in small and medium enterprises*. Department for Business, Innovation and Skills (UK). Published September 9. Available: https://www.gov.uk/government/publications/digital-capabilities-in-small-and-medium-enterprises. [Accessed September 10 2015].

[184] TECHCITY 2015a. *Digital Business Academy*. Tech City UK. Published September. Available: http://www.digitalbusinessacademyuk.com/. [Accessed September 11 2015].

[185] LOMAS, N. 2015. *U.K. Gov't-Funded Startup Skills Courses Get 12,000 Early Sign Ups*. Techcrunch.com. Published April 21. Available: http://techcrunch.com/2015/04/21/u-k-govt-funded-startup-skills-courses-get-12000-early-sign-ups/. [Accessed August 25 2015].

[186] BIS & DCMS 2014. *New qualifications launched to meet UK demand for digital skills*. Department for Business, Innovation and Skills (UK). Published November 26. Available: https://www.gov.uk/government/news/new-qualifications-launched-to-meet-uk-demand-for-digital-skills. [Accessed August 28 2015].

[187] DCMS 2015. *40,000 UK businesses have their broadband boosted*. Department for Culture Media and Sport (UK). Published September 3. Available: https://www.gov.uk/government/news/40000-uk-businesses-have-their-broadband-boosted. [Accessed September 10 2015].

5. Coordinated information was made available to SMEs via LEPS[188] through the Small Business Digital Capability Programme.[189] Evaluation of the scheme to help SMEs improve their digital skills and ultimately trade and grow online found that it "has helped to address an information-related 'market failure' which will persist for the foreseeable future as technology is moving so rapidly" and where one of the four main recommendations was that "there would be value in investing further resources in on going support for small businesses' digital capabilities, as this appears to be a particularly popular, practical and effective way of improving business productivity."[190]

6. Further importance on upskilling SMEs is placed through the government's target "that £1 in every £3 government spends will be with small businesses by 2020. This would mean an extra £3 billion per year (in 2013 to 2014 terms) going to small and medium-sized firms directly or through the supply chain."[191] The SMEs will need to have both the absorption capacity to take-up the financial opportunities, and the efficiency and productivity which can be enhanced through effective use of IT.

System, Sector and Business Level Initiatives

At the system level initiatives include:

1. The BBC's 'Make it Digital'[192] national campaign. Under this campaign every Level 7 schoolchild will receive a Microbit coding computer.[193] Major industry partners[194] and stakeholders[195] will provide 5,000 Traineeships,[196] and "the BBC Make it Digital Traineeship will help up to 5,000 young unemployed people boost their digital skills and get a foot on the jobs ladder".[197]

2. The NHS has pilot schemes on digital literacy, to train 100,000 patients in digital literacy.[198] The NHS England scheme aims to train front-line medical staff in IT skills.[199]

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[188] And LEPs and Go on UK have partnered through a steering group, for example establishing a "*google+ group to enable LEPs to continue the conversation and share best practice*." BROCKLESBY, A. 2015. *Go ON UK and the 39 LEPS*. Go ON UK. Published July 20. Available: http://www.go-on.co.uk/blog/go-on-uk-and-the-39-leps/. [Accessed August 3 2015].

[189] COYLE, G. 2015. *LEP Digital Skills Steering Group*. LEP Network. Published July 1. Available: http://www.lepnetwork.net/blog/lep-digital-skills-steering-group/. [Accessed August 3 2015].

[190] BIS 2015d. *Evaluation of the Small Business Digital Capability Programme Challenge Fund*. Department for Business, Innovation and Skills (UK). Published September. Available: https://www.gov.uk/government/publications/small-business-digital-capability-programme-challenge-fund-evaluation. [Accessed September 10 2015].

[191] CABINET 2015. *Big opportunities for small firms: government set to spend £1 in every £3 with small businesses*. Cabinet Office (UK). Published August 27. Available: https://www.gov.uk/government/news/big-opportunities-for-small-firms-government-set-to-spend-1-in-every-3-with-small-businesses. [Accessed September 11 2015].

[192] http://www.bbc.co.uk/makeitdigital

[193] http://www.bbc.co.uk/programmes/articles/4hVG2Br1W1LKCmw8nSm9WnQ/introducing-the-bbc-micro-bit

[194] http://www.bbc.co.uk/programmes/articles/5pz65GHsSfy9mDY7M4510Qc/discover-more-with-our-partners

[195] MAIDMENT, J. 2015. *Partnership is key to achieving digital inclusion*. Go-On UK. Published March 13. Available: http://www.go-on.co.uk/blog/partnership-is-key-to-achieving-digital-inclusion/. [Accessed August 20 2015].

[196] http://www.bbc.co.uk/mediacentre/latestnews/2015/bbc-announces-5000-digital-traineeships

[197] http://www.bbc.co.uk/makeitdigital

[198] NGUYEN, A. 2013. *NHS England to train 100,000 people in basic online skills*. Computer World. Published September 13. Available: http://www.computerworlduk.com/news/careers/nhs-england-train-100000-people-in-basic-online-skills-3470659/. [Accessed August 20 2015].

[199] NHS 2013. *NHS Code4Health programme will improve digital literacy for clinicians*. NHS England. Published March 3. Available: http://www.england.nhs.uk/2015/03/03/code4health/. [Accessed August 20 2015].

3. The New Model in Technology and Engineering[200] (NMITE) is the first 'greenfield' UK University to be launched for 30 years, planning to open in September 2017 to "radically change the way engineering and related technologies are taught in the UK".

4. The Connected Housing Initiative (CHI) promotes digital skills training for residents, and encourages partnerships with businesses to provide access to internet infrastructure."[201]

Urban areas, with their geographical concentration of people, businesses, and infrastructure, are well suited to a 'digital ecosystem' approach noted later in this section, For example:

1. Manchester Digital supports businesses through: Employer Skills Group, Digital Skills Festival. Apprenticeship Matching Service, a Peer Club, Training and CPD.[202]

2. Digital Birmingham[203] focuses on IT skills for employers, establishing local networks, and specific actions such as developing digital skills for carers (a substantial cost for local authorities, and therefore a logical investment to generate productivity gains[204]). Digital Birmingham evaluated a project on mobile telecoms and found that "Mobile internet was shown to enable people to better self-manage their health, leading to greater independence and wellbeing."[205]

3. The Digital Youth Academy supports digital apprentices in London and report that 84% of the apprentices were recruited by SMEs.[206]

4. In Sunderland "The North East Tech Skills Hub is a joint venture between Sunderland Software City and the Tech Partnership." [207] It links schools with small businesses, with the businesses helping to enhance the business and tech understanding of teachers (sharing and multipliers), and highlighting the opportunities for careers in the digital arena.

[200] http://nmite.org.uk/

[201] TEDMAN, E. 2015. *Connected Housing Intiative speaks out on the fight against digital exclusion*. 24Publishing. Published January 12. Available: http://www.24dash.com/news/housing/2015-01-12-Connected-Housing-Intiative-speaks-out-on-the-fight-against-digital-exclusion. [Accessed August 23 2015].

[202] MANCHESTER 2015. *Manchester Digital – What we do*. Manchester Digital. Published September. Available: https://www.manchesterdigital.com/what-we-do. [Accessed September 19 2015].

[203] BIRMINGHAM 2015a. *Digital Birmingham*. Birmingham City Council. Published September. Available: http://digitalbirmingham.co.uk/. [Accessed September 1 2015].

[204] SFC 2015. *Digital working*. Skills for Care Ltd. Published September. Available: http://www.skillsforcare.org.uk/Skills/Digital-working/Digital-literacy.aspx. [Accessed September 12 2015].

[205] BIRMINGHAM 2015b. *Mobile: Helping to Close the Digital Divide 2015. A Qualitative Evaluation of the Vodafone Mobile Devices Project*. Birmingham City Council. Published March 31. Available: http://digitalbirmingham.co.uk/publication/1935/. [Accessed August 13 2015].

[206] DYA 2015. *Digital Youth Academy*. Digital Youth Academy. Published September. Available: http://www.digitalyouthacademy.com/. [Accessed September 2 2015].

[207] SUNDERLAND 2014. *New hub launched to meet demand for digital skills*. Sunderland Software Centre. Published November 27. Available: http://www.sunderlandsoftwarecity.com/2014/11/new-hub-launched-to-meet-demand-for-digital-skills/. [Accessed August 24 2015].

5. Similar initiatives exist in other countries, such as in USA where the city of Chicago has an initiative Smart Chicago bringing together city government (including services for families, housing, library, and education), businesses and business organisations and social actors, “cross-cutting training to support employment, in-depth education targeted to users’ needs, private sector partnerships to support training, and coordination with the marketing & communications campaign.”[208]

6. At the sector level the Digital Tourism initiative in Scotland is a £1.2m programme providing tourism businesses with “advice surgeries, workshops, events to raise awareness, case studies, online guides and resources and conferences with inspiring speakers.”[209]

Examples of action at the local enterprise and local government level include:

1. Through a Better Broadband for Oxfordshire project Oxford County Council is targeting women who are running small businesses, who wish to start a business, who are returning to the workplace, and who wish to “improve their digital skills for personal development.”[210]

2. Local Enterprise Partnerships (LEPs) are taking initiatives to provide recognition at local levels.[211] These include a skills passport for students going on work placements in the Marches LEP, The West of England LEP has developed a charter mark for schools, and a BIS national pilot for an initiative linking skills funding to clearly identified local needs. Through the Digital High Street Skills initiative in Cornwall, the Cornwall and Isles of Scilly Local Enterprise Partnership (LEP) “has secured almost £100k of government funding to help small businesses develop their knowledge of the internet, social media and the benefits of getting their business online.”[212]

3. The Highland Council (Scotland) Digital First Programme aims to achieve 40% of all transactions online over four years, saving £1.3 million,[213] but specifically acknowledging the need to invest in citizen skills (to help generate the cost savings) through nominating digital champions (multipliers) and developing a local digital ecosystem by working “in partnership with other agencies to support customers who find digital engagement challenging.”[214]

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[208] CHICAGO 2015. *Smart Chicago. Digital Skills Initiative*. Smart Chicago. Published September. Available: http://www.smartchicagocollaborative.org/work/broadband-technology-opportunities-program/digital-skills-initiative/. [Accessed September 21 2015].

[209] SCOTLAND 2015. *Tourism digital skills initiative to be launched*. Skills Development Scotland. Published August 21. Available: https://www.ourskillsforce.co.uk/news/2015/august/tourism-digital-skills-initiative-to-be-launched/. [Accessed September 21 2015].

[210] OXFORD 2015. *Digital skills boost for all women in Oxfordshire*. Oxford County Council. Published July 14. Available: https://www.oxfordshire.gov.uk/cms/news/2015/jul/digital-skills-boost-all-women-oxfordshire. [Accessed August 21 2015].

[211] LEP 2014. *LEP Network - Skills Discussion*. LEP Network. Published December 2. Available: http://www.lepnetwork.net/modules/downloads/download.php?file_name=59. [Accessed June 14 2015].

[212] EYRIEY, N. 2014b. *Small business digital skills boost*. Business Cornwall. Published December 8. Available: http://www.businesscornwall.co.uk/news-by-industry/retail/small-business-digital-skills-boost-123. [Accessed August 24 2015].

[213] HIGHLAND 2015a. *Digital First Programme*. The Highland Council. Published February 24. Available: http://www.highland.gov.uk/news/article/8404/digital_first_programme_aims_to_have_at_least_40_of_transactions_online_and_deliver_13_million_in_savings_over_next_four_years. [Accessed August 24 2015].

[214] HIGHLAND 2015b. *Members agree to nominate 6 Digital Champions as part of Digital First Programme*. The Highland Council. Published February 26. Available: http://www.highland.gov.uk/news/article/8426/members_agree_to_nominate_6_digital_champions_as_part_of_digital_first_programme. [Accessed August 24 2015].

4. Business Cornwall is in partnership through Software Cornwall "to nurture talented developers and to attract new skilled workers to the region."[215]

5. Dynamo North East is developing a digital ecosystem of IT organisations and employers, technology hubs, education, local government and employer support initiatives. Activities include promoting apprenticeships, code clubs, and activities aiming to "retain graduates, train apprentices, attract mature hires and supporting the learning sector from primary school to tertiary education."[216]

Third sector and sector organisations have particular roles to play at various levels:

1. For example, support for digital skills development in young people is being provided through iDEA (Inspiring Digital Enterprise Award), a joint initiative between the Duke of York and Nominet Trust, "which aims to support 16-25 year olds to develop and improve their digital and entrepreneurial skills."[217] The award is accompanied by digital badges to promote the recognition of the skills.[218]

2. Google is involved in Charity Online, partnered with the Media Trust and the Charity Technology Trust, this is a "free initiative designed to help 30,000 small or medium-sized charities boost their fundraising by improving their digital skills".[219]

3. The ACRE (Action with Communities in Rural England) network helping to overcome digital exclusion through the provision of superfast broadband "by engaging with local partnerships, helping with demand stimulation and digital skills initiatives."[220]

4. Third sector capacity building is being promoted by Digital Outreach in north-east England, through "digital skills support and training to a number of micro to medium sized voluntary and community sector organisations.[221]

5. Military personnel leaving the forces are supported through the social enterprise X-Forces, in re-entering the labour market by acquiring relevant skills. For example "The UK business of EMC Corporation will be investing £250,000 in their Military Leavers Programme, providing seven weeks of training to ex-military personnel of all branches

[215] EYRIEY, N. 2014a. *Attracting the best digital talent*. Business Cornwall. Published May 30. Available: http://www.businesscornwall.co.uk/news-by-industry/digital-industries/attracting-the-best-digital-talent-123. [Accessed August 24 2015].

[216] DNE 2015. *Growing the North East IT economy*. Dynamo North East. Published September. Available: http://www.dynamonortheast.co.uk/. [Accessed September 12 2015].

[217] PT 2014. *New initiative to boost digital skills*. The Princes Trust. Published March. Available: http://www.princes-trust.org.uk/about_the_trust/headline_news/national_news_2014/1403_boost_digital_skills.aspx. [Accessed September 21 2015].

[218] IDEA 2015. *iDEA – the Duke of York Inspiring Digital Enterprise Award*. Nominet Trust. Available: https://www.onemillionyoungideas.org.uk/. [Accessed September 14 2015].

[219] PUDELEK, J. 2013. *Google launches free digital skills initiative for small and medium-sized charities*. Haymarket Media Group. Published February 6. Available: http://www.thirdsector.co.uk/google-launches-free-digital-skills-initiative-small-medium-sized-charities/communications/article/1169834. [Accessed June 4 2015].

[220] ACRE 2015. *Digital Inclusion*. Action with Communities in Rural England. Published September. Available: http://www.acre.org.uk/rural-issues/digital-inclusion. [Accessed September 15 2015].

[221] DO 2015. *Capacity building – digital skills in front line organisations*. Digital Outreach. Published September. Available: http://www.digitaloutreach.org.uk/clients-projects/projects/capacity-building-digital-skills-in-front-line-organisations/. [Accessed September 12 2015].

and ranks free of charge, equipping them with the skills they need to design, sell and support enterprise IT".[222]

6. The Institution of Engineering and Technology aims to increase the number of female engineers and scientists from the current level of 6%, and in a partnership with the trade union Prospect formed a working group, noting that apart from the skills training there is a need for: "Flexible working, fair pay and a more inclusive culture should be on all organisations' agenda because they are proven to improve overall staff retention, and are good for business".[223]

7. The British Chambers of Commerce has a project (School and Business Partnership pilot project, a collaboration between the government Equalities Office and Chambers of Commerce) that: "finds that taking teachers out of the classroom to engage with businesses, can help to encourage more girls to study science, technology, engineering and maths".[224]

8. Young Enterprise (An enterprise education charity established in 1962), focusing not just on the 'hard' skills of IT etc., but also on the important business and entrepreneurship skills of "creativity, innovation and adaptability".[225]

The sharing of knowledge, resources and skills (using skilled multipliers to generate 'snowball' effects) is undertaken through a range of initiatives. For example:

1. The Samsung 'Digital Classroom Initiative' which involving 20 schools.[226]

2. The 'Your Life' campaign[227] is supported by companies and "is a three-year campaign to helping young people in UK build the skills needed to succeed in the current competitive global economy."

3. Argos is providing training for its customers, so that consumers are upskilled in IT: "Argos has announced that it will offer digital workshops in 120 of its stores across the UK, to help some of the 6.4 million British adults who are still not online develop digital skills. The workshops will kick off in stores around the UK on 25 October, and run through to mid-January 2015. Up to 10,000 people will also be given a free tablet to help them communicate, connect and develop their digital skills."[228]

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[222] ANON 2015a. *EMC Team-up to Tackle Britain's IT Skills Shortage*. X-forces.com. Published February 20. Available: http://x-forces.com/news-and-events/140-launch-of-x-forces-technology-training-with-emc-2. [Accessed August 21 2015].

[223] IET 2015. *New group to help companies recruit and retain more women engineers and scientists*. Institution of Engineering and Technology. Published March 9. Available: http://www.theiet.org/policy/media/press-releases/20150309.cfm. [Accessed August 20 2015].

[224] BCC 2015. *Taking teachers out of the classroom is key to widening girls' participation in science*. British Chambers of Commerce. Published July 16. Available: http://www.britishchambers.org.uk/press-office/press-releases/taking-teachers-out-of-the-classroom-is-key-to-widening-girls%E2%80%99-participation-in-science.html. [Accessed August 20 2015].

[225] YE 2015. *Young Enterprise: Our Programmes*. Young Enterprise. Published August. Available: http://www.young-enterprise.org.uk/. [Accessed August 20 2015].

[226] DAVIES, J. 2014a. *Samsung on mission to help narrow UK skills gap with digital classrooms initiative, says UK boss Andrew Griffiths*. The Drum. Published November 19. Available: http://www.thedrum.com/news/2014/11/19/samsung-mission-help-narrow-uk-skills-gap-digital-classrooms-initiative-says-uk-boss. [Accessed August 23 2015].

[227] http://yourlife.org.uk/

[228] CURTIS, S. 2014. *Argos launches online skills workshops for 'digitally deprived'*. Guardian (UK). Published October 13. Available: http://www.telegraph.co.uk/technology/news/11159442/Argos-joins-effort-to-get-digitally-deprived-online.html. [Accessed August 20 2015].

4. Other examples involve linking the digital skills of publishers to libraries to build digital skill capacity in library staff. Such initiatives in effect build a snowball effect, first raising capacity in library staff, to raise capacity in users, which can further increase demand for the resources marketed by publishers.[229] Also, "the Society of Chief Librarians is pleased to have supported a new BT and Barclays initiative to bring free Wi-Fi and hands-on digital support to over 50 libraries across England".[230]

5. SAS, a commercial supplier of business analytics software and services, is investing in the development of digital skills in education as well as in work settings. This includes the provision of a free online resource to 400 schools across the UK, providing 80 universities with access to analytics software, and the launch of a new data science curriculum course made available to students and existing data scientists.[231]

There also is an extensive commercial provision of digital skills. For example, the Google Digital Academy has commercial courses based in London for 'future digital leaders', and performance marketing, along with an online "postgraduate level certification in Digital Marketing taught online over 6-months". Freeformers, which labels itself as a "Digital Transformation Company", provides customised digital training to individuals, teams, and companies.

All the above interventions indicate the potential for multi-layered approaches to the acquisition of digital skills, where basic skills can be embedded at the 'system' level (through the education system), and more advanced skills through diverse sources, such as training businesses to be more responsive to their short-term and immediate needs in digital skills. This does not, however, mean that government-supported initiatives should be focused just on levelling up the digital playing field (for example overcoming many types of digital divides through digital inclusion strategies), but government also needs to promote that digital skills must be continually enhanced at the most innovative levels, to ensure that businesses can compete effectively at the international level. There are commercially-led developments in this context, such as at the European level, the Google Digital News Initiative promoting innovative digital journalism by investing "150 million euros (£107 million) over the next three years as part of an agreement with European news publishers which aims to support the journalism industry." Google also aims to help 200,000 businesses in the UK acquire digital skills, and provide computer science training for 25,000 teachers.

Two themes emerge from the initiatives noted above. First, interventions need to be joined-up, and second, they need to be end-user focused, whether it is on a particular segment of people or businesses (such as remote rural people, a disabled segment of the population, or particular business sectors), or on a particular geographical area (noting that many interventions are often implemented on administrative geographical areas rather than on geographies of functional need). Citizens Online summarise this as a "need to create local 'sustainable digital ecosystems' which can provide a joined up experience of

[229] RA 2013. *Digital Skills Sharing*. The Reading Agency. Published April 5. Available: http://readingagency.org.uk/digitalskills/. [Accessed June 18 2015].

[230] ELFORD, E. 2015. *Libraries Supporting Community Digital Skills*. Society of Chief Librarians. Published July 29. Available: http://www.goscl.com/libraries-supporting-community-digital-skills/. [Accessed August 24 2015].

[231] ibid

on going access, active communication, training and support in the community, backed up by further online help."

A third theme emerging is the value of multipliers through the development of a network of digital champions, for example, Big Lottery Fund's "£2 million initiative to create more than 1,400 digital champions across the UK." This is being undertaken through a partnership between the commercial digital skills provider Digital Unite, Age UK, Citizens Online, and the Scottish Council for Voluntary Organisations (SCVO). They will collaborate "to provide bespoke training, share and improve practices and develop consistent ways of evaluating success."

A fourth theme is the value of sharing knowledge, resources and skills, particularly at the local and community level.

It is clear from the above that the information base about digital skill opportunities is very diffuse and unstructured. However, given the wide range in 'ecosystem' approaches noted above it is highly unlikely that a 'one size fits all' information portal can provide all the required information. At the very least there could be an authoritative 'entry point' for those wishing to acquire and upgrade digital skills, pointing people, businesses, and organisations to relevant resources, services, and sources of advice and intermediary support.

Also, the impact of these (and many other) initiatives as a whole is not clear, as most are delivered in silos, and while some are formally evaluated others are not. Hence, there is need at the very least for a comprehensive mapping of all these initiatives, to understand impact (for example through a meta-analysis), and for government to have a role in linking up these initiatives, and to raise awareness to ensure that individuals and employers, particularly SMEs (who can particularly benefit from tech apprenticeships) are aware of initiatives that are targeted at them.

Key Findings

- A number of worrying trends appear to be emerging suggesting that young people are less interested in developing specialist tech skills or entering a high-end tech career. However, the reasons for these trends are not very clear:
  - data from 2012 indicated that computer science as a standalone degree course was associated with a 23.3% drop in the number of undergraduate students and a 33.8% drop in the number entering graduate courses; a similar phenomenon can be detected with IT apprenticeships; these trends contribute to a mismatch of the types of skills offered by the labour market and those demanded by employers (see Chapter 4).
  - however, computer science is one component of the IT landscape of skills; many other types of courses that have a strong digital skills focus (e.g. data science), nevertheless, future studies could explore the reasons for the seemingly growing lack of interest in computer science educational and career pathways, with a view to recommending measures to overcome the barriers in the uptake of traditional computer science courses and apprenticeships

Key Findings

- To address the shortage in digital skills, industry and sector initiatives, and initiatives between government and industry have been established. However, these may operate in silos, may not operate on a sufficient scale to address the scale of the skills shortage, or the information about their availability may not be readily available to potential beneficiaries:

  - The National College for Digital Skills is a key example of an industry-led education provider that when established will seek to address the skills shortage and provide credible opportunities for young people
  - business have also provided free software to schools and skills training directly to students and other individuals
  - government has been working with industry to develop new industry standards for upcoming roles such as in the field of big data analytics
  - recommendations have been put forward by NESTA to encourage reform of curricula so that data analytics skills have a greater opportunity to flourish
  - however, given the persistent lack of digital skills reported by stakeholders, the initiatives identified by this study may not be sufficient compared to the scale of the skills shortage. In addition, while there are many individual studies (sector-specific etc.) there as yet is not a high-level meta-analysis across the studies to show the national picture on a consistent basis. In addition, it could be helpful to see what elements of these initiatives are working well so that the case can be made for their scaling-up over an appropriate timeframe

- There are behavioural, cultural and/or awareness issues with certain segments of the population, which are acting as barriers to the development of digital skills or are restricting individuals from entering digital skills professions. The Fujitsu study indicated that many people do not have an understanding of the digital options available to them and considered that it is the responsibility of government and business to educate people on digital services. Only 16% considered that it was the responsibility of individuals to improve their knowledge and skills:

  - some studies indicate that there is a general lack of knowledge of digital careers among students, parents and teachers
  - other barriers exist particularly for women in entering IT focused professions. In addition, the digital industry has often been regarded as ‘geeky’ and male-dominated
  - there are opportunities to clearly highlight benefits associated with accessing relevant IT-related courses and pursuing IT-focused careers

    There is a current lack of coherent and integrated information about IT skills opportunities, and this can particularly affect the ability of SMEs to identify opportunities for training and development

Risks and opportunities in addressing digital skills needs in the UK

This section reviews the risks and opportunities associated with actions (or lack thereof) linked to addressing digital skills needs in the UK, specifically in terms of market failures resulting from digital skills gaps, and the impact of these on the economy. It also reviews the opportunity of improving digital skills with respect to the impact on the national economy.

Risks and opportunities

The risks of not, or insufficiently, addressing the digital skills needs outlined above relate to their potential contribution to business growth, and also on broader societal development. The challenge in relation to business growth is that the performance of digital sector companies cannot be optimised where there are difficulties recruiting staff with appropriate digital skills. Furthermore, organisations are rarely able to innovate where there is a mismatch of skills. In this context, it is likely that existing staff may be under pressure to fulfil roles that are outside of their skill set and remit.[232] A further consideration is that organisations across a range of sectors will be disadvantaged, and their growth stifled, where they fail to harness digital technology, and apply digital skills that might lead to advancements in the way they operate.

Conversely, the widespread development of digital skills presents a major opportunity for the economy, and the nation as a whole. A number of studies investigating the relationship between the effective application of IT and improved productivity have found that an increased investment in IT plays a major role in the doubling of productivity growth rates within the United States economy.[233] Multinational firms in the United States have been found to be 8.5% more productive on average than UK domestic owned firms, mainly due to the impact of their use of ICT.[234]

Research undertaken by E-skills UK (the Sector Skills Council for Business and Information Technology) which focuses on understanding the existing IT and Telecoms landscape, highlights that whilst the UK compares favourably with other nations in terms of IT investment and utilisation, its ranking has fallen across recent years. Its performance in this area is consistently less than that of the US and Nordic States, with the US assuming first place at the top of the IT competitiveness index. In identifying that “ICT infrastructure

[232] CBI 2015. *Skills emergency could 'starve growth' - CBI/Pearson survey*. Confederation of British Industry. Published July 13. Available: http://news.cbi.org.uk/news/skills-emergency-could-starve-growth-cbi-pearson-survey/. [Accessed Augut 3 2015].

[233] MILLER, B. & ATKINSON, R. D. 2014. *Raising European Productivity Growth Through ICT*. Information Technology & Innovation Foundation. Published June 2. Available: http://www.itif.org/publications/raising-european-productivity-growth-through-ict. [Accessed June 8 2014].

[234] ibid

remains key to IT competitiveness", the lack of ICT infrastructure has been cited as a reason for countries failing to utilise their large pools of skilled IT employees.[235]

This challenge is also considered in a 2015 NESTA report; 'Skills of the Datavores: Talent and the data revolution' which identifies that data-driven companies are over 10% more productive than "dataphobes", companies that do not exploit their data.[236] The central message in this research is that the application of digital technologies and skills has the capacity to maximise an organisation's, and therefore the UK's competitive advantage.

This maximisation is not limited to those sectors specialising in 'tech' or digital products and services, rather, digital and IT literacy can level productivity and efficiency gains across all sectors. On this issue, the E-Skills study highlights that:

"The IT supply chain, as a sector in its own right, clearly offers the UK continued economic opportunities, but perhaps of equal if not greater significance are the potential opportunities across the rest of the economy resulting from businesses in all sectors of the economy maximising their use of ICT, broadband and internet access".[237]

Moreover, according to a 2013 Oxford University study, many traditional jobs are susceptible to trends around computerisation and the introduction of advanced robotics.[238] The study makes the case that the recent high levels of growth and unemployment are associated with technological advances meaning that robots are increasingly replacing manual labour.

However, given the pace of technological change, it seems that new technologies will further disrupt labour markets. The main cause for concern relates to advances in computing and robotics that are designed to perform non-routine tasks (traditionally routine tasks were susceptible to computerisation). It is mentioned that this is likely to change the nature of work across many industries. By estimating the probability of computerisation for 702 detailed occupations, the Oxford study makes the claim that 47% of total US employment is at risk of computerisation in administrative, transport, service and production occupations.

While the study does not address the timeframe within which the relevant sectors will be subject to fundamental changes, it does highlight the need for action to be taken to re-skill the workforce to ensure that emerging market segments requiring digital skills can be exploited.

[235] E-SKILLS 2012. *Technology Insights 2012*. e-Skills UK. Available: http://www.e-skills.com/Documents/Research/Insights-2012/TechnologyInsights_2012_UK.pdf. [Accessed June 3 2015].

[236] MATEOS-GARCIA, J., BAKHSHI, H. & WINDSOR, G. 2015a. *Skills of the Datavores: Talent and the data revolution*. NESTA (National Endowment for Science, Technology and the Arts, UK). Published July 13. Available: http://www.nesta.org.uk/publications/skills-datavores-talent-and-data-revolution. [Accessed July 30 2015].

[237] E-SKILLS 2012. *Technology Insights 2012*. e-Skills UK. Available: http://www.e-skills.com/Documents/Research/Insights-2012/TechnologyInsights_2012_UK.pdf. [Accessed June 3 2015].

[238] FREY, C. B. & OSBORNE, M. A. 2013. *The Future of Employment: How Susceptible are Jobs to Computerisation?* University of Oxford. Published September 17. Available: http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf. [Accessed July 1 2015].

Stakeholders involved with this study largely agreed with the above. The emerging theme across the interviews was that the UK faces a number of barriers which have stifled the extent to which it can compete with other countries in terms of digital technologies. First, there are barriers around infrastructure and the provision of broadband which is not as effective compared to other countries, particularly in rural areas. Overall, stakeholders felt that the government had to ensure that this basic infrastructure is in place before the UK can capitalise on the opportunities that new digital technologies offer to the economy.

Second, employers also needed to be more proactive in improving their business processes, by taking advantage of the opportunities that new technologies offer to their business. For example, some sectors – like the construction industry – are more 'traditional' and slow to embrace innovation. One stakeholder felt that more needed to be done by sector leaders who have a good knowledge of how technology can revolutionise their industry – through case study examples – of how businesses could improve their processes by introducing new technologies.

A few stakeholders also suggested that the lack of high level technical digital skills in the UK was due to recent immigration legislation. One view was that UK was shutting off its 'immigration pipeline' that would have otherwise supplied a very talented flow of employees to work at the forefront of the UK's technology industry. The re-introduction of the work-study visa would allow more non-UK citizen graduates to remain in the UK, to allow the UK to capitalise on their skill set.[239] Such concerns show that there is a complex balance between long-term aims of being 'nationally sustainable' in skill developments and business needs, and the more immediate and short-term needs of business to service their skills needs now.

Value to the economy in improving digital skills of the nation

The UK is in a strong position to capitalise on the opportunities brought about by the digital economy, both as a provider and a consumer. The UK is seen as well placed to benefit from transformations in the global economy brought about by the generation of large amounts of digital information or data.[240] In terms of the acquisition and improvement of digital skills across the population as a whole, PriceWaterhouseCoopers estimated that the potential of economic benefits resulting from getting everyone in the UK online is in excess of £22 billion.[241] Martha Lane Fox, the co-founder of lastminute.com, also reflected on the wider 'community' benefits of technology in delivering the 2015 Richard Dimbleby Lecture. Her observations reflect the tone and content of much of the literature:

"It is in within our reach for Britain to leapfrog every nation in the world and become the most digital, most connected, most skilled, most informed on the planet. And I think that if we did that, it would not only be good for our economy, but it would be good for our culture, our people, our health and our happiness."

[239] See also: WARRELL, H. 2015b. *Ease foreign graduate visa restrictions, business leaders urge*. Financial Times (London). Published February 22. Available: http://www.ft.com/cms/s/0/8644d698-b930-11e4-98f6-00144feab7de.html. [Accessed February 23 2015].

[240] MATEOS-GARCIA, J., BAKHSHI, H. & WINDSOR, G. 2015a. *Skills of the Datavores: Talent and the data revolution*. NESTA (National Endowment for Science, Technology and the Arts, UK). Published July 13. Available: http://www.nesta.org.uk/publications/skills-datavores-talent-and-data-revolution. [Accessed July 30 2015].

[241] PRICEWATERHOUSECOOPERS 2009. *Champion for Digital Inclusion: The Economic Case for Digital Inclusion*. PricewaterhouseCoopers. Published October. Available: http://www.go-on.co.uk/wp-content/uploads/2014/08/pwc_report.pdf. [Accessed June 4 2013].

The current “Dot Everyone” campaign builds on the 2015 lecture through seeking government support for the creation of a public organisation for the digital age.[242]

The ‘tech’ sector alone created an extra 77,000 jobs across the UK, and contributed over £91 billion to the UK economy[243]. This level of impact has the potential to be realised right across the economy for businesses, individuals and in delivery of public sector services.[244] The country in this respect stands to benefit from increased productivity where technologies can be applied and integrated across wider business models”.[245] An Adroit Economics 2012 ICT Impact model estimated that where ICT is optimised by businesses, an additional £47 billion GVA in the UK economy could be generated by 2017-2019, potentially translating into half a million new jobs, across many occupations and sectors.[246] This impact would benefit the four nations of the UK, with the contribution estimated at £41.4 billion for England, £3.7 billion for Scotland, £1.5 billion in Wales and £0.7 billion in Northern Ireland.[247]

While some research points to digital technology and computerisation as a reason for stagnant jobs growth during the recession,[248] there is a broader recognition of the potential for the internet to stimulate job creation. This is evidenced in the McKinsey Global Institute 2011 survey with 4,800 small and medium size enterprises (SMEs), that the internet created 2.6 jobs for each lost to technology related efficiencies.[249] There are particular dynamics within SMEs which present potential for greater growth where digital technologies are embraced. However, where the application of digital technology is low, SMEs growth can be restricted since they are often the most challenged when it comes to developing the skills of their workforce:

“A Boston Consulting Group study of small and medium-sized enterprises (SMEs) found the 25% of SMEs that use mobile services most intensively have revenues that grow up to twice as fast as their peers and create jobs up to eight times faster. The report says SMEs behind the digital curve ‘are at risk of being left further behind’”.[250]

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[242] FOX, M. L. 2015. *Dot Everyone – making Britain brilliant at the Internet*. Martha Lane Fox. Published March 31. Available: https://marthalanefoxblog.wordpress.com/2015/03/31/dot-everyone-making-britain-brilliant-at-the-internet/. [Accessed June 3 2015].

[243] TP 2015d. *Tech Insights: The Digital Economy*. The Tech Partnership. Published March. Available: https://www.thetechpartnership.com/globalassets/pdfs/research-2015/techinsights_report_mar15.pdf. [Accessed July 26 2015].

[244] MANYIKA, J., CHUI, M., BUGHIN, J., DOBBS, R., BISSON, P. & MARRS, A. 2013. *Disruptive technologies: Advances that will transform life, business, and the global economy*. McKinsey Quarterly. Published May. Available: http://www.mckinsey.com/insights/business_technology/disruptive_technologies. [Accessed June 3 2013], D'EMIDIO, T., DORTON, D. & DUNCAN, E. 2015. *Service innovation in a digital world*. McKinsey & Company. Published February. Available: http://www.mckinsey.com/insights/operations/service_innovation_in_a_digital_world. [Accessed February 23 2015].

[245] FUJITSU 2015. *Digital Inside Out: Creating a digital-first Britain*. Fujitsu Consulting. Available: http://blog.uk.fujitsu.com/digital-inside-out/. [Accessed July 15 2015].

[246] E-SKILLS 2012. *Technology Insights 2012*. e-Skills UK. Available: http://www.e-skills.com/Documents/Research/Insights-2012/TechnologyInsights_2012_UK.pdf. [Accessed June 3 2015]. FUJITSU 2015. *Digital Inside Out: Creating a digital-first Britain*. Fujitsu Consulting. Available: http://blog.uk.fujitsu.com/digital-inside-out/. [Accessed July 15 2015].

[247] PRICEWATERHOUSECOOPERS 2009. *Champion for Digital Inclusion: The Economic Case for Digital Inclusion*. PricewaterhouseCoopers. Published October. Available: http://www.go-on.co.uk/wp-content/uploads/2014/08/pwc_report.pdf. [Accessed June 4 2013].

[248] FREY, C. B. & OSBORNE, M. A. 2013. *The Future of Employment: How Susceptible are Jobs to Computerisation?* University of Oxford. Published September 17. Available: http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf. [Accessed July 1 2015].

[249] DU RAUSAS, M. P., MANYIKA, J., HAZAN, E., BUGHIN, J., CHUI, M. & SAID, R. 2011. *Internet matters: The Net's sweeping impact on growth, jobs, and prosperity*. McKinsey & Company. Published May. Available: http://www.mckinsey.com/insights/high_tech_telecoms_internet/internet_matters. [Accessed June 5 2014].

[250] TWENTYMAN, J. 2015b. *SMEs risk falling behind digital curve*. Financial Times (London). Published March 2. Available: http://www.ft.com/cms/s/2/3dd9b96c-ac6c-11e4-9d32-00144feab7de.html. [Accessed March 2 2015].

In the context of SMEs, and the links to the education sector, the National Foundation for Educational Research (NFER) proposes very clear linkages:

- "schools and colleges cannot produce 'work-ready' employees alone without input from employers such as SMEs

- having a single line of communication (face-to-face where possible) helps SMEs to understand the importance of the role of a school or and break down barriers; a dedicated careers coordinator is invaluable for brokering long-term connections

- SMEs should be involved with the content of careers information

- schools and colleges need to show that employers can get involved and can offer flexible methods of engagement such as providing apprenticeships or work placements

- relationships between education organisations and businesses need to be driven by schools and colleges who need to learn how to "sell" themselves"[251]

Literature on digital skills tends to recognise the value of future investment in the roll out of initiatives to support the development of digital skills, and increasingly sees improving digital skills and the adoption of digital solutions as a central government priority.[252] Research into the obstacles and difficulties that firms and citizens face regarding adopting and optimising digital technologies indicates that future UK ICT policy should offer more ICT support to business. Particularly in order to assist SMEs in adopting more advanced digital solutions and seeking to improve digital skills both within the workforce and the population.[253]

Although the majority (77%) of employee respondents to the Fujitsu survey discussed above believed that the future success of their organisation hinged on the effective use of digital technology, only 11% felt that their employer spent enough in this area. Overall, more than half (52%) hoped to see their organisation investing more in digital services and applications in the future.[254]

[251] NFER 2015b. *Improving employability skills, enriching our economy: Summary report*. National Foundation for Educational Research (UK). Published March. Available: http://www.nfer.ac.uk/publications/IMSL01/IMSL01_home.cfm. [Accessed July 16 2015], NFER 2015a. *Improving employability skills, enriching our economy: Case study report*. National Foundation for Educational Research (UK). Published March. Available: http://www.nfer.ac.uk/publications/IMSL02/IMSL02_home.cfm. [Accessed July 16 2015].

[252] FUJITSU 2015. *Digital Inside Out: Creating a digital-first Britain*. Fujitsu Consulting. Available: http://blog.uk.fujitsu.com/digital-inside-out/. [Accessed July 15 2015].

[253] Ibid.

[254] Ibid.

Key Findings

- While risks associated with the shortage in digital skills are concerning employers, the opportunities linked to stronger investment in up-skilling the workforce are significant:
    - a key risk associated with the shortage in digital skills relates to its negative impact on business growth, innovation and broader societal development. In addition, the UK's ranking in terms of investment in IT and utilisation compared to the US and Nordic countries has fallen in recent years
    - however, the opportunities associated with investment in strengthening the skills base are significant. For example, US multinationals are 8.5% more productive on average than UK domestic owned firms, mainly due to the impact of their use of ICT
    - other studies have pointed to the wider economic benefits of strengthening digital skills for the population as a whole and across all sectors. For example, the potential economic benefits resulting from getting everyone in the UK online is in excess of £22 billion
    - it has been estimated that where ICT is optimised by businesses, an additional £47 billion GVA in the UK economy could be generated by 2017-2019, potentially translating into half a million new jobs, across many occupations and sectors

- The positive impact that relevant digital skills can have on firms is often related to the extent to which appropriate infrastructure and skills are utilised. Further research is needed to explore the barriers to the use of technology by businesses so that targeted policy interventions can be provided to address this problem:
    - 25% of SMEs that use mobile services most intensively have revenues that grow up to twice as fast as their peers and create jobs up to eight times faster.
    - the lack of ICT infrastructure (for example, superfast broadband with no geographical limitation on access) has been cited as a reason for countries failing to utilise their large pools of skilled IT employees.
    - data-driven companies are over 10% more productive than companies that do not exploit their data and digital opportunities to maximum advantage.
    - further evidence is needed to gain a better understanding on the lack of exploitation of digital skills and poor use of infrastructure by business to examine the main barriers to developing appropriate ICT company strategies.

Key Findings
- to overcome bottlenecks, there could be opportunities in strengthening digital skills and infrastructure in companies through the provision of appropriate business support services. A Fujitsu study indicated that UK ICT policy should offer more ICT support to business, particularly in order to assist SMEs in adopting more advanced digital solutions and skills. - further research could shed light on feasible forms of support to better exploitation of ICT capabilities within firms. The aim should be to identify areas of support that can help to raise firm productivity and foster stronger company demand for digital skills.

Conclusions and recommendations

Conclusions

The main messages emerging from the literature and the stakeholder interviews, particularly in relation to the supply and demand for digital skills are:

Key Risks

1. A shortage in suitable digital skills for digital jobs persists in the UK labour market. The lack of suitably qualified persons, matched to the specific digital skills needed by employers, is linked to a quarter of all job vacancies. This is a major risk to business growth, innovation and broader societal development.

2. By not effectively linking supply of digital skills to immediate, medium, and long-term demand, the relative ranking of the UK, in terms of investment in IT and utilisation compared to other major countries, is slipping and this may make the UK a less attractive investment location and place to do business.

3. Computer science degrees, and related courses and apprenticeships, are proving less popular in recent years. These are worrying trends considering the demand for digital skills by employers and because young people do not seem to fully understand the opportunities that can be accessed through the acquisition of appropriate skills.

4. While there are digital skills needs within sectors that are primarily 'digital' in their operations, there are wider challenges within the economy as a whole. Digital skills need to improve continuously across the whole UK population so that all sectors and organisations can maximise the competitive potential offered by the rapidly developing applications of digital technologies. As the British Academy review of the UK landscape for quantitative skills notes: "we all need to become more data literate to operate successfully in increasingly 'data–rich' environments".[255]

5. The development of new technologies and robotics may remove jobs across a range of sectors including occupations that involve non-routine tasks, such as in transport, services and production occupations. This reinforces the point that the UK workforce needs to strengthen its digital skill-base so that the labour market can adapt to new market opportunities involving advanced technologies.

6. While the study does not address the timeframe within which the relevant sectors will be subject to risks, it does highlight the need for action to be taken to re-skill the workforce continuously to ensure that new market segments requiring digital skills that are likely to open can be exploited.

[255] MANSELL, W. 2015. *Count us in: Quantitative Skills for a New Generation*. British Academy. Published June. Available: http://www.britac.ac.uk/policy/count_us_in_report.cfm. [Accessed July 3 2015].

7. The widespread acquisition of digital skills offers particular growth opportunities for the UK economy, but opportunities are often constrained by a lack of relevant digital skills within the labour force. As demand for digital skills outstrips supply, employers across a wider range of sectors are experiencing digital skill gaps within their workforce, and encountering difficulties in filling advertised vacancies (particularly in high level roles such as developers). Digital data analysts are also required to interpret meaning within the 'big data' sets that are increasingly generated across a wide range of services.

Opportunities

1. Job roles focused on the use of digital skills command a higher than average salary reflecting prospects for the industry, but also the skills shortages that exist within certain roles in particular digital jobs provide tangible opportunities for those appropriately qualified.

2. There is a clear link between market competitiveness and the uptake and application of digital technology in the workplace. Firms who have a developed ICT infrastructure, and take advantage of digital technologies tend to be the most competitive; conversely, a lack of digital investment and infrastructure can place companies at a competitive disadvantage.

3. Significant value can be added to the UK economy and society through better investment in digital skills. This not only relates to job creation, but also firm productivity and scaling-up markets for companies including SMEs.

4. The contribution of digital skills to the performance of the economy is substantial. The 'tech sector' alone represents 6% of the UK economy with an estimated GVA per person in the region of £91,800, well above the UK average. Given the large number of opportunities that are likely to be available, strong investment in digital skills would likely bring about a very good return on investment to the UK economy.

Bottlenecks, Barriers and Market Failures

1. The shortage in digital skills represents a key bottleneck for industry and is linked to one in five of all vacancies. Currently, 72% of large companies and 49% of SMEs are suffering tech skill gaps. There is a clear mismatch in the types of skills offered by the labour market and those demanded, and in different ways and to different extents, this trend is likely to be holding back the growth of tech and non-tech companies alike (but further evidence on the types of problems emerging would support the argument).

2. There is an increasing range of activities and occupations where digital skills are needed, but supply is not adequate. For example, from addressing a wide range of societal challenges, to enhancing public service delivery, to cyber security etc:

    a) There is a clear need for existing workforce to further develop their digital skills, be able to apply these across the increasing range of technologies that are available across different sectors and occupations, and this need is likely to intensify going forward;

b) In some sectors, such as retail, existing digital skills are not being fully exploited even though more efficient use of digital technologies is likely to add value to the bottom line. Employers need to be made aware of the benefits of utilising the skills of their existing staff and introduce appropriate measures;

c) An important and common thread to all of this is the increasing potential in utilising business analytics. As new methods of collecting and analysing data emerge, there will be increasing demand for individuals that can make sense of client and consumer trends to support managerial decision-making. The need to combine existing (degree) courses with skills development around the use of technologies to support business analytics is important.

3. There is a lack of awareness of career opportunities within the digital sector, sometimes reflecting skills and gender stereotypes around the type of roles that exist. Barriers exist especially for women who are under represented on higher education courses in computer related subjects, and within the industry as a whole.

4. Routes for the supply of digital skills are mainly via education and training routes delivered by education institutions. There are challenges in matching the speed of change in the education sector, for example in changing curricula and training, to the speed of demand, and the rapidly changing skill sets needs in the economy and society.

5. Assessing digital skills needs is challenging: While broad types of digital skills have been defined in terms of use, formal classification and recognition of skills and learning outcomes are less clear, and this makes it difficult for employers to assess the digital skills of employees and applicants.

6. While there is a policy ambition for improving digital skill provision to ensure that digital skills development is integrated in curricula across all stages of education, the provision of digital skills at present is variable and inconsistent. While IT is extensively used in the primary and secondary education levels there still is much to be done to ensure that it is effectively used in teaching and learning (especially that teachers are digitally skilled), that gender stereotypes are overcome, and that learners are motivated to acquire digital skills through an awareness of the career potential they bring.

7. The digital skills of staff across the education and training system is uneven, and often it is not mandatory for staff to ‘upskill’ digitally. A learner’s digital education will depend on the digital competencies and skills of those teaching them, as well as awareness and adaptability of education institutions to changes in technology.

8. Many companies are not effectively maximising the potential of new technologies nor the talents of their employees. As a result, opportunities are missed and performance is not maximised.

9. There seems to be insufficient provision, insufficient knowledge, or uneven availability, of appropriate business support services linked to the digital skills agenda. Reform of company ICT strategies is likely to advance more quickly if appropriate information, advisory, and training services are provided.

10. Parent and teachers are not appropriately informed to support children with their decision-making around career and skills development. A significant minority of parents consider digital skills as irrelevant to career prospects. These attitudes need to change if appropriate guidance is to be offered to future participants in the labour market.

Recommendations

The literature research and analysis that has informed this study, and the interviews undertaken with key stakeholders as part of this study, have helped to structure the issues and challenges. The conclusions point to a need for central government leadership, but while there have been calls for comprehensive central government resourcing it is clear that there is significant latent capacity in sectors, businesses, and employees, that can be mobilised.

Overall central government has the 'resource' to empower the uptake of digital skills through infrastructure, qualifications frameworks, curricula etc. Businesses, education (especially vocational and higher education) and sector organisations (also in partnership with the third sector and communities) can combine resources to support initiatives for digital skills developments. In many instances employees themselves have latent digital skills that have yet to be 'recognised' (either formally as qualifications, or as potential skills to benefit the business they are working in).

Taking the Citizens Online 'digital ecosystem' as a key metaphor, there cannot be a single top-down national digital ecosystem of digital skills. Indeed, looking across the range of activity at many levels, the national ecosystem is a dynamic and constantly changing aggregation of multi-level ecosystems. Nevertheless, the multi-level ecosystems can be energised and supported through government initiatives, and a range of them was noted in previous sections.

The overall messages show that central government should not be expected to be the core provider of digital skills development. Instead, there needs to be a process where those who need the skills (employers) can be rapidly and flexibly provided with employees with the skills. The recommendations in Table 5 therefore focus on the role of central government in providing economic policy direction, national focus and leadership. They also point to the critical roles of employers, the education sector and local government and agencies in delivering solutions that address the digital skills gaps and shortages in the UK.

Table 5 Recommendations

Recommendations
Recommendation 1: Government should provide leadership, coordination, and key resources in establishing the conditions for digital skills development
1. Ensure that digital skills are learned pervasively at all stages of education and training. Government should set in place changes so that digital skills are embedded in education and training, enabling individuals to participate fully in the modern digital economy, whether as tech specialists, leaders of digitally-enabled businesses or workers in digitally-enabled jobs across the economy. At a minimum all children should leave school digitally literate, with the skills needed in the workplace, and to realise social outcomes. To this end, digital literacy should be seen as a core skill alongside English and maths.
2. Focus education policy on skills of strategic importance to the nation. Government should work with industry to understand which digital skills are of particular strategic importance to the nation and to identify emerging trends such as those identified in this report. Strategies should be put in place to address shortages in these areas of strategic importance, including cyber security, big data, the Internet of Things, apps, mobile and e-commerce.
Recommendation 2: Employers should take ownership of digital skills development
1. Collaborate at a national level. Employers should collaborate, through networks and partnerships, to develop coherent national approaches to raising digital skills levels, bringing together digital leaders from all sectors. For example, industry should take a lead role in researching key productivity gaps with their relevant business/sector, so they can understand the advantages of upskilling and future proofing their workforce.
2. Lead on setting standards. Employers should play a lead role in setting the minimum standards that individuals are expected to acquire through education and training, including the digital skills that are transferable across different roles, for example, cyber security, digital marketing etc.
3. Build the skills of their own employees. Employers should ensure existing staff have the training to keep their digital skills updated, and develop active recruitment and development strategies to maximise the digital skills of their workforce.

4. Foster lifelong learning.

   Employers should help embed a culture which recognises and builds on the latent talents of their employees, actively supporting their learning through a wide range of learning approaches, to prepare them for future roles in the UK workforce. This could involve a mixture of vocational on-the-job training and employer led short courses with academic accreditation.

Recommendation 3: The education sector should develop and adapt their offers to meet the changing needs of the digital economy working within policy and funding frameworks established by the Department for Business Innovation and Skills; Education; and Culture, Media and Sports.

1. Coordinate with stakeholders.

   Education and training providers should ensure that they understand how the supply of educational courses, in terms of quality and quantity, can meet the demand for digital skills in the wider economy (e.g. by sector, geographically, etc.).

2. Build digital skills capacity with industry-relevance.

   School, FE and HE digital curricula should be devised in partnership with industry, to provide people with the skills they will need in their roles across the workforce. Specialist provision, such as that to be provided by the planned National College for Digital Skills, should provide people with the advanced digital skills that will make a difference to the adoption of technology by companies across all sectors. In HE, computing-related degrees should prepare people to have the business and interpersonal skills they need to be effective in the workplace.

3. Motivate and inspire young people, particularly females, to consider digital careers.

   More young people, particularly females must be attracted to continue digital education and pursue careers. Schools should be better equipped to inform young people about the advantages of a career in digital, making it an attractive proposition compared to traditional vocations. They should also better promote the advantages of vocational routes such as degree apprenticeships in addition to traditional higher education routes.

4. Implement programmes to continually update the digital skills of their staff.

   Teachers in schools should be supported to deliver the new computing curriculum and to develop their teaching approaches in line with developing educational technology. This includes helping current teachers retrain through an effective programme of continuous professional development (CPD) and ensuring new teachers are equipped with the right skills to teach the new curriculum.

   Educators in FE and HE should be able to access CPD programmes to acquire and update their digital skills.

Recommendation 4: Local and regional government and agencies should address the digital skills needs of their local areas
1. Collaborate. Local partnerships and networks (LEPS, Councils, FE colleges, Universities and employers) should work together to determine the skills needs for their local area, so that education and training provision is better matched to local demand. Government must encourage these partnerships to share best practice, and knowledge of successful programmes and training schemes.
2. Inform. Local agencies should ensure that relevant and focused information is made available about digital skills training and education provision across all sectors in their geographical areas. For example, the government must encourage more SMEs to get online, to develop and grow their businesses to changing customer needs.

Annex one: Summary of digital skills frameworks

Name of framework	Competence areas	Competences *(linked to each competence area)*	Proficiency levels *(needed for each competence)*	Examples of knowledge
DIGICOMP Framework	**Information**	**1.1 Browsing, searching and filtering information** - To access and search for online information, to articulate information needs, to find relevant information, to select resources effectively, to navigate between online sources, to create personal information strategies **1.2 Evaluating Information** - To gather, process, understand and critically evaluate information **1.3 Storing and retrieving information** - To manipulate and store information and content for easier retrieval, to organise information and data	**Foundation** - I can do some online searches through search engines. I know how to save or store files and content (e.g. texts, pictures, music, videos, and web pages). I know how to go back to the content I saved. I know that not all online information is reliable. **Intermediate** - I can browse the internet for information and I can search for information online. I can select the appropriate information I find. I can compare different information sources. I know how to save, store or tag files, content and information and I have my own storing strategy. I can retrieve and manage the information and content I saved or stored. **Advanced** - I can use a wide range of strategies when searching for information and browsing on the internet. I am critical about the information I find and I can cross-check and assess its validity and credibility. I can filter and monitor the information I receive. I can apply different methods and tools to organise files, content and information. I can deploy a set of strategies for retrieving and managing the content I or others have organised and stored. I know whom to follow in online information sharing places (e.g. micro-blogging).	**1.1 Browsing, searching and filtering information** : - Understands how information is generated, managed and made available - Is aware of different search engines - Understands which search engines or databases best answer to his/her own information needs - Understands how information can be found in different devices and media - Understands how search engines classify information Understands how feeds mechanism works Understands indexing principles **1.2 Evaluating information** **-** Can analyse retrieved information - Evaluates media content - Judges the validity of content found on the internet or the media, evaluates and interprets information - Understands the reliability of different sources - Understands online and offline information sources - Understands that information sources need to be cross-checked - Can transform information into knowledge - Understands power forces in the online world **1.3 Storing and retrieving information 29/07/2015** **-** Understands how information is stored on different devices/services - Can enumerate different storage media - Knows different storage options and can select the most appropriate

	Communication	**2.1 Interacting through technologies** **-** To interact through a variety of digital devices and applications, to understand how digital communication is distributed, displayed and managed, to understand appropriate ways of communicating through digital means, to refer to different communication formats, to adapt communication modes and strategies to the specific audience **2.2 Sharing information and content** - To share with others the location and content of information found, to be willing and able to share knowledge, content and resources, to act as an intermediary, to be proactive in the spreading of news, content and resources, to know about citation practices and to integrate new information into an existing body of knowledge **2.3 Engaging in online citizenship** - To participate in society through online engagement, to seek opportunities for self-development and empowerment in using technologies and digital environments, to be aware of the potential of technologies for citizen participation **2.4 Collaborating through digital channels** - To use technologies and media for team work, collaborative processes and co-construction and co-creation of resources, knowledge and content	**Foundation** - I can interact with others using basic features of communication tools, (e.g. mobile phone, VoIP, chat or email). I know basic behaviour norms that apply when communicating with others using digital tools. I can share files and content with others through simple technological means. I know that technology can be used to interact with services and I passively use some. I can collaborate with others using traditional technologies. I am aware of the benefits and risks related to digital identity. **Intermediate**: I can use several digital tools to interact with others using more advanced features of communication tools (e.g. mobile phone, VoIP, chat, email). I know the principles of online etiquette and I am able to apply them in my own context. I can participate in social networking sites and online communities, where I pass on or share knowledge, content and information. I can actively use some basic features of online services. I can create and discuss outputs in collaboration with others using simple digital tools. I can shape my online digital identity and keep track of my digital footprint **Advanced** -I am engaged in the use of a wide range of tools for online communication (emails, chats, SMS, instant messaging, blogs, micro-blogs, SNS). I can apply the various aspects of online etiquette to different digital communication spaces and contexts. I have developed strategies to discover inappropriate behaviour. I can adopt digital modes and ways of communication that best fit the purpose. I can tailor the format and ways of communication to my audience. I can	**2.1 Interacting through technologies:** **-** Is aware of different digital communication means (e.g. email, chat, VoIP, video-conference, SMS) - Knows how messages and emails are stored and displayed - Knows the functionality of several communication software packages -Knows the benefits and limits of different means of communications and distinguishes the most appropriate ones to the context **2.2 Sharing information and content** - Knows the benefits (for him/herself as well as for others) of sharing content and information with peers - Judges the value of the resource to be shared and the target audience to share it with - Knows which content/knowledge/resources can be publicly shared - Knows how/when to acknowledge the source of a particular content **2.3 Engaging in online citizenship** - Knows that technology can be used for engagement in democratic actions (e.g. lobbying, petitions, parliament) - Knows how technologies and media can enable different forms of participation **2.4 Collaborating through digital channels:** - Knows that collaborative processes facilitate content creation - Knows when content creation can benefit from collaborative processes and when not - Understands the dynamics of collaborative work and of giving and receiving feedback - Can judge the contribution of others to his/her own work - Has an understanding of different roles needed in diverse forms of online collaboration **2.5 Netiquette:** **-** Knows about agreed practices in digital interactions

		2.5 Netiquette - To have the knowledge and know-how of behavioural norms in online/virtual interactions, to be aware of cultural diversity aspects, to be able to protect self and others from possible online dangers (e.g. cyber bullying), to develop active strategies to discover inappropriate behaviour **2.6 Managing digital identity** - To create, adapt and manage one or multiple digital identities, to be able to protect one's e-reputation, to deal with the data that one produces through several accounts and applications	manage the different types of communication I receive. I can actively share information, content and resources with others through online communities, networks and collaboration platforms. I am actively participating in online spaces. I know how to get actively engaged in online participation and I can use several different online services. I frequently and confidently use several digital collaboration tools and means to collaborate with others in the production and sharing of resources, knowledge and content. I can manage several digital identities according to the context and purpose, I can monitor the information and data I produce through my online interaction, I know how to protect my digital reputation.	- Understands the consequences of own behaviour - Knows about ethical issues in digital media, such as visiting improper websites and cyber bullying - Understands that different cultures have different communication and interaction practices **2.6 Managing digital identity** - Knows the benefits of having one or more digital identities - Understands the interlinks between the online and offline world Understands that several actors can positively or negatively contribute to construct his/her digital identity
	Content creation	**3.1 Developing content** **-** To create content in different formats including multimedia, to edit and improve content that s/he has created or that others have created, to express creatively through digital media and technologies **3.2 Integrating and re-elaborating** - To modify, refine and mash-up existing resources to create new, original and relevant content and knowledge **3.3 Copyright and Licences** - To understand how copyright and licences apply to information and content **3.4 Programming** - To apply settings, programme modification, programme applications, software, devices, to understand the principles of programming, to understand what is behind a programme	**Foundation**: I can produce simple digital content (e.g. text, or tables, or images, or audio, etc.). I can make basic changes to the content that others have produced. I can modify some simple function of software and applications (apply basic settings). I know that some of the content I find can be covered by copyright. **Intermediate**: I can produce digital content in different formats (e.g. text, tables, images, audio, etc.). I can edit, refine and modify the content I or others have produced. I have basic knowledge of the differences between copyright, copy left and creative commons and I can apply some licences to the content I create. I can apply several modifications to software and applications (advanced settings, basic programme modifications). **Advanced**: I can produce digital content in different formats, platforms and	**3.1 Developing content** **-** Knows that digital content can be produced in a variety of forms - Knows which software/application fits better the kind of content s/he wants to create - Understands how meaning is produced through multimedia (text, images, audio, video) **3.2 Integrating and re-elaborating** - Contributes to the public knowledge domain (e.g. wikis, public forums, reviews) **-** Knows that resources can be built from diverse and non-sequential information sources - Knows about different databases and resources that can be remixed and re-used - Knows that content should be referenced **3.3 Copyright and licences** - Considers licences regulation principles of use and publication of information. - Understands copyright and licence rules - Knows that there are different ways of licensing intellectual property production - Understands differences between copyright, creative commons, copy left and public domain

			environments. I can use a variety of digital tools for creating original multimedia outputs. I can mash-up existing items of content to create new ones. I know how different types of licences apply to the information and resources I use and create. I can interfere with (open) programmes, modify, change or write source code, I can code and programme in several languages, I understand the systems and functions that are behind programmes	licenses **3.4 Programming** **- Knows how digital systems and processes work** **-** Knows how software works - Understands technological ecosystems - Knows about the architectural principles behind technologies
	Safety	**4.1 Protecting devices** **-** To protect own devices and to understand online risks and threats, to know about safety and security measures **4.2 Protecting personal data** **-** To understand common terms of service, active protection of personal data, understanding other people privacy, to protect self from online fraud and threats and cyber bullying **4.3 Protecting health** **-** To avoid health-risks related with the use of technology in terms of threats to physical and psychological wellbeing 4**.4 Protecting the environment** **-** To be aware of the impact of ICT on the environment	**Foundation**: I can take basic steps to protect my devices (for instance: by using anti-viruses, passwords, etc.). I know that I can only share certain types of information about myself or others in online environments. I know how to avoid cyber bullying. I know that technology can affect my health, if misused. I take basic measures to save energy. **Intermediate**: I know how to protect my digital devices, I update my security strategies. I can protect my and others online privacy. I have a general understanding of privacy issues and I have basic knowledge of how my data is collected and used. I know how to protect myself and others from cyber bullying. I understand the health risks associated with the use of technologies (from ergonomic aspects to addiction to technologies). I understand the positive and negative aspects of the use of technology on the environment **Advanced**: I frequently update my security strategies. I can take action when the device is under threat. I often change the default privacy settings of online services to enhance my privacy protection. I have an informed and wide understanding of privacy	**4.1 Protecting devices** **-** Knows that there are several risks associated with the use of technologies - Knows about current and up-to-date strategies to avoid risks - Understands the risks associated with online use **4.2 Protecting personal data** - Understands the terms of use of online services (i.e. the fact that service providers may use personal data that they collect about users) and can act prudently in this knowledge - Knows that many interactive services use information about him or her to filter in commercial messages in more or less explicit manners - Can distinguish between data protection and data security Knows about appropriate behaviour in the digital domain - Understands how his/her own digital footprint can be seen by others - Knows how data about his/her digital identity can or cannot be used by third parties - Understands the risk of identity theft and other credentials' thefts - Knows how to protect other people data that apply to his/her own context (as a worker, a parent, a teacher, etc.) **4.3 Protecting health** **-** Knows the effect of prolonged use of

			issues and I know how my data is collected and used. I am aware of the correct use of technologies to avoid health problems. I know how to find a good balance between online and off-line worlds. I have an informed stance on the impact of technologies on everyday life, online consumption, and the environment.	technologies - Knows about the addictive aspects of technologies **4.4 Protecting the environment** - Can determine if appropriate and safe digital means are available, that are efficient and cost-effective in comparison with other means - Has a comprehensive mental map of how the online world works. - Understands the technologies s/he is using at a level that is sufficient to underpin good purchasing decisions, e.g., about devices or internet service providers - Understands the environmental impact of computers and electronic devices and how s/he can make them last longer by recycling parts of it (such as changing hard disks)
	Problem solving	**5.1 Solving technical problems** **-** To identify possible problems and solve them (from trouble-shooting to solving more complex problems) with the help of digital means **5.2 Identifying needs and technological responses** - To assess own needs in terms of resources, tools and competence development, to match needs with possible solutions, adapting tools to personal needs, to critically evaluate possible solutions and digital tools **5.3 Innovating and creatively using technology** **-** To innovate with technology, to actively participate in collaborative digital and multimedia production, to express oneself creatively through digital media and technologies, to create knowledge and solve conceptual problems with the support of digital tools **5.4 Identifying digital competence**	**Foundation**: I can ask for targeted support and assistance when technologies do not work or when using a new device, programme or application. I can use some technologies to solve routine tasks. I can make decisions when choosing a digital tool for a routine practice. I know that technologies and digital tools can be used for creative purposes and I can make some creative use of technologies. I have some basic knowledge, but I am aware of my limits when using technologies. **Intermediate**: I can solve easy problems that arise when technologies do not work. I understand what technology can do for me and what it cannot. I can solve a non-routine task by exploring technological possibilities. I can select an appropriate tool according to the purpose and I can evaluate the effectiveness of the tool. I can use technologies for creative outputs and I can use technologies to solve problems. I collaborate with others in the creation of	**5.1 Solving technical problems** - Knows how a computer or digital device is built Knows where to look for solving a problem - Knows sources of information and where to find help for problem-solving and trouble shooting. - Knows where to find the relevant knowledge for the solution of technical and theoretical problems **5.2 Identifying needs and technological responses** **-** Understands the potential and limitations of digital devices and resources - Knows the range of things that can be done using technologies. - Is aware of the most relevant or popular digital technologies used by others (e.g. peers, reputed experts). - Has reasonable knowledge of available technologies, their strengths and weaknesses and whether and how they might support the achievement of personal goals **5.3 Innovating and creatively using technology** - Uses a widely diverse and well-balanced mix of digital and non-digital technologies for different

		gaps - To understand where own competence needs to be improved or updated, to support others in the development of their digital competence, to keep up-to-date with new developments	innovative and creative outputs, but I don't take the initiative. I know how to learn to do something new with technologies. **Advanced:** I can solve a wide-range of problems that arise from the use of technology. I can make informed decisions when choosing a tool, device, application, software or service for the task I am not familiar with. I am aware of new technological developments. I understand how new tools work and operate. I can critically evaluate which tool serves my purposes best. I can solve conceptual problems taking advantage of technologies and digital tools, I can contribute to knowledge creation through technological means, I can take part in innovative actions through the use of technologies. I proactively collaborate with others to produce creative and innovative outputs. I frequently update my digital competence needs.	problems and will dynamically change options over time **-** Can solve a theoretical problem, of individual or collective interest, through or with the support of digital tools - Knows how to find the relevant knowledge for the solution of theoretical problems - Understands how meaning is produced through multimedia and technologies **5.4 Identification of digital competence gaps** **-** Understands the wider context of digital tools in a 'digital age' characterised by globalisation and networks - Understands where ICT comes from, who develops it and for what purposes. - Has first-hand knowledge and expertise of the major digital technologies used in his/her field.

Annex two: Topic Guide

Digital Skills for the UK Economy

Topic guide for stakeholder consultations

Introduction to the study for stakeholders

The Digital Economy Unit (DEU), within the Department for Culture, Media and Sport, has commissioned Ecorys UK Ltd to undertake a study to help improve the understanding of the current and future demand for digital skills in the UK economy. This is an important activity in the preparation of the '*Digital Transformation Plan*', due to be published in the autumn, which is an action of the UK government 'Productivity Plan'.

Assessing the demand and supply of digital skills in the UK needs to be strongly evidence-led. Therefore, the DEU is very keen that the study takes into account the views of stakeholders, and in particular employer-led partnerships that have insights into digital skills' requirements in the UK.

This study is focusing on the following overarching research questions:

- What is the current demand for digital skills across the economy and what are the different types of digital skills requirements?
- What barriers and market failures to the development of digital skills have emerged during the last decade?
- What are the areas of shortage or mismatch (skill mismatch is defined as the gap between an individual's job skills and the demands of the job market) of digital skills in the workforce?
- How can the supply of digital skills meet the demand of the workforce?

The definition of digital skills has 'broadened' over time, however there are limitations when these are reviewed in the context of addressing digital skills gaps or shortages in the economy. For example, some definitions and frameworks are too broad, and not all citizens, learners or users may be interested in developing the competences described in these frameworks. Or, the frameworks may have a narrow focus, being targeted at a particular type of digital user. However, existing definitions and frameworks taken as a whole all cover the following broad categories:

1. Basic digital literacy skills (Empowering individuals): Skills needed by every citizen to become 'digitally literate'. These are the skills needed to carry out basic functions such as using digital applications to communicate and carry out basic internet searches. Cyber security sits under this category.
2. Digital skills for the general workforce (Upskilling for the Digital Economy): All of category 1, plus skills needed in a workplace and generally linked to the use of applications developed by IT specialists. As discussed in the Development Economics report, equipping the workforce with such skills *'encourage deeper and faster usage of digital technologies by UK businesses and other organisations and measures*'.[256] While the digital skills needed by the workforce are likely to differ across sectors, there will be

[256] http://cdn.news.o2.co.uk.s3.amazonaws.com/wp-content/uploads/2013/09/The-Future-Digital-Skills-Needs-of-the-UK-Economy1.pdf

some minimum requirements linked to processing information that will be applicable across all sectors.

3. Digital skills for ICT professions (Digitally innovative and creative individuals, organisations and businesses): All of categories 1 and 2, plus skills needed to work across the diverse IT sector. They include digital skills linked to the development of new digital technologies, and new products and services. Such skills are needed if the UK is to compare favourably with other nations in relation to ICT investment and utilisation.

To develop appropriate solutions that improve the quantity and quality of supply of digital skills supply in the UK economy, training routes, for example, will need to be developed to cover the skills needed by the above three groups (these are set as a hierarchy of digital skills). This requires a re-think of how digital skills are defined, and the use of three *distinct definitions of digital skills* that cover the above user groups.

Definitions

Skills: "the ability to perform a task to a predefined level of competence"

Transferable/generic skills: "skills which can be used across large numbers of different occupation"

Skills gaps: "deficiencies in the skills of an employer's existing workforce, both at the individual level and overall, which prevent the firm from achieving its business objectives" (linked to problems with skills inside the business)

Skills shortages: "recruitment difficulties caused specifically by a shortage of individuals with the required skills in the accessible labour market" (linked to problems with skills outside the business – in the general workforce).

The key questions of interest to the study are:

- What is the current demand for digital skills in the economy? And where is the demand in relation to the categories set out above? Where are the skills gaps? Where are the future digital skills requirements?
- At what point in the education pipeline should the above competences set out in the categories outlined above be developed? What should the minimum digital skills competences be for someone leaving education at different points of the education cycle (Schools, FE, and HE)?
- How can the UK upskill those who are currently not in education, and have no digital skills, to carry out the basic tasks that allow them to function in a society that is becoming increasingly digitalised?
- How can the UK ensure that the digital skills of the current workforce are continually updated to equip them for current and emerging job roles in the sectors that they work in?
- How can the UK ensure that IT training meets the demand of technology enablers?

Section 1: The aim of this section is to understand the current and future demand for digital skills in the UK economy

1. Current digital skills requirements: Demand for digital skills across the economy by sector and occupation.

- For strategic stakeholders: What is the current demand for digital skills in the UK economy? And in which categories and skills level is the demand greatest?
- For employer led partnerships: What is the current demand for digital skills in your sector? What kind of digital skills are needed in the workplace to improve business processes? And in which of the categories set out above, and skills levels is the demand greatest? How does this differ with respect to SMEs and large organisations?

2. Digital skills gaps/shortages: in relation to job roles and levels of seniority/career development (occupational skills).

- For strategic stakeholders: Where are the primary digital skills gaps in relation to specific job roles? What about digital skills gaps in relation to levels of seniority/career development?
- For employer-led partnerships: Where are the primary digital skills gaps in relation to specific job roles and to levels of seniority/career development in your sector? Are these likely to differ between SMEs and large organisations?
- For both strategic stakeholders and employer-led partnerships: Where are the digital skills shortages or mismatch (Skill mismatch is defined as the gap between an individual's job skills and the demands of the job market)?

3. Future requirements: Future digital skills requirements and expected skills gaps – latent and unrecognised.

Research suggests that as all sectors, service providers and industries become digitalised, there will be pressure on the majority of employees to become digitally competent.

- Where do you think the future digital skills requirements will arise? What kind of digital skills are required in your sector to improve business processes? Or to make the sector more competitive with respect to other nations?
- Where do you expect the digital skills shortages to arise? Why? (To be discussed in relation to SMEs and large organisations)

4. Remuneration/career paths: Job prospects in digitally-related roles compared to other career paths.

Literature suggests that government, industry and education should do more to promote digital degrees and careers, particularly amongst women who are underrepresented in the field.

- What types of initiatives should be adopted to encourage potential learners, particularly women, to take up career paths linked to digital roles?
- For employer-led partnerships: How do pay (and other benefits) for digital roles compare with other career paths in your sector? What about across different sectors?

5. Training: Current and future priorities for digital skills training and employer investment training.

- Where are the current and projected priorities for training? (For sector bodies – add 'in your sector')?
- Should digital skills training be given the same priority as subjects such as Maths and English in schools and in Further Education?

6. Sectoral differences in digital skills: Assess the different sectoral requirements

- Are there major differences in the digital skills needs between different sectors? (e.g. financial, manufacturing, retail), and between large and small businesses?

Section 2: The aim of this section is to understand the routes used to meet the digital skills of individuals and employers in the UK, and the current barriers and market failures faced by businesses in accessing digital skills

7. Education and training routes: Employer recruitment practices (demand)

- For employer-led partnerships: Which education and training routes into digital skills do employers recruit from in your sector, and why? (To be discussed in the context of Schools, FE and HE)
- Conversely, which routes are not generally/widely used, and why?
- How do employers in your sector address their digital skills needs?

8. Education and training routes: training provision (supply).

There is some degree of consensus within some literature that the education sector should look to integrate digital skills across the curriculum, and embed digital skills as a core component in education and training

- At what point in the education pipeline should the different skills be developed? (Refer to the different skills levels; Basic digital literacy, Intermediate, Advanced etc.)
- What should the minimum digital skills requirement be for someone leaving education at different points of the education cycle (Schools, FE, and HE)? Should there be a minimum requirement in order to access the job market?
- How can those who are currently not in education, and have no digital skills, be upskilled to carry out the basic tasks that allow them to function in a society that is becoming increasingly digitalised?
- How can the digital skills of the current workforce be continually updated to equip them for current and emerging job roles in the sectors that they work in? Whose responsibility is it to upskill the workforce?
- What role can employers play with respect to education and training? What role can the government play with respect to upskilling the current workforce who lack digital skills?
- Should employers and government roles differ depending on the type of user category (Explore this in relation to different skills levels)?

- Should employers be solely responsible for investing in the training of their employees with respect to current and future digital skills requirements?

9. Transferable skills: Across digital roles (for example, the cross-over between general digital skills and cyber security).

The literature indicates that there is a lack of prospective employees who hold the right 'mix' of skills for employers seeking to fill digital skill vacancies, and the importance for recruits to combine technical digital skills, with a range of more transferable skills.

- Which digital skills are transferable across the different digital roles? (discuss in the context of 'technical' skills and 'business' skills)

10. Influencers: Issues that influence the supply/acquisition of digital skills, for example: Individual motivation and awareness, institutional flexibility and adaptability, employer knowledge about training needs.

- What are the key issues that influence the supply/acquisition of digital skills? (Explore with respect to the following:
  - For the individual (e.g. motivation, awareness)
  - At institutional level (e.g. quality and relevance and adaptability to changing technology of courses, accessibility of information about provision)
  - At the employer level (e.g. lack of understanding/awareness of training needs)

11. Barriers: to employment or training in digital relevant roles – differences according to different groups.

A key barrier cited in literature in relation to the uptake of education and training in digital skills is the perception that these paths will prepare an individual solely for technical occupation, rather than having value across a very wide range of sectors.

- What barriers prevent individuals from undertaking digital roles or training? Are these the same for different groups? (e.g. women, those already in the workforce, returners etc.)

Section 3: The aim of this section is to identify the risks and opportunities in addressing digital skills needs in the UK

12. Market failures: Digital skills gaps/shortages that lead to market failures.

Research highlights that whilst the UK compares favourably with other nations in terms of IT investment and utilisation, its global ranking has fallen across recent years. Its performance in this area is consistently under that of the US and Nordic States

- What are the key barriers that prevent the UK from capitalising on the opportunities that new digital technologies offer to the economy?
- In which areas/sectors is supply best meeting demand? Are there any clear success factors that could be extended to other areas? (this could be examples of occupations for which recent developments in ICT have resulted in a major change in job roles/an emergence of a new occupation)

13. Impact on the economy: Impact of market failures resulting from digital skills gaps in the economy.

    - What would be the impact of failing to fill the digital skills gaps/shortages discussed in previous sections?

14. Value to the economy: The value to the economy in improving digital skills of the nation.

    - What would be the value to the economy of improving digital skills, including impact for the individual, and on business productivity and growth?

Annex three: Digital skills initiatives

Title of Initiative	Lead Organisation	Target Group	Digital Skills Level	Location	Date Introduced / to be Introduced	Description	Reference
Schools computing curriculum	Department for Education	Young People	KS1 - Basic Skills KS2 and KS3 - Workforce Skills KS4 - Professional Skills	England	Sep-14	The new curriculum was introduced to support students in gaining the computational thinking skills to enable them to adapt to emerging technologies and to prepare them for current and future career paths. England is the first country in the world to mandate coding at primary and secondary level.	https://www.gov.uk/government/publications/national-curriculum-in-england-computing-programmes-of-study/national-curriculum-in-england-computing-programmes-of-study
Digital competence curriculum	Welsh Government	Young People	Basic Skills	Wales	c. Sep-16	The Welsh Government are working on a framework that will introduce and facilitate digital competence across the schools curriculum, so that students of all ages can develop their basic digital skills.	http://www.pembrokeshire-herald.com/16751/welsh-government-launches-new-digital-competence-initiative/
eBusiness Support	Welsh Government	Businesses	Workforce Skills	Wales	Ongoing	eBusiness is a business support package funded by the Welsh Government. It involves online and dedicated one-one support to help businesses to integrate ICT systems to help drive their businesses forward. The support is provided by Business Wales	http://business.wales.gov.uk/e-business-support-welsh-government
Degree Apprenticeships	Skills Funding Agency	Anyone aged 16 or over	Professional Skills	England	Sep-15	The Degree Apprenticeships are being planned to help people obtain a fully integrated honours degree in a computer science related discipline, alongside job training. The degree apprenticeships are targeted at younger people, with courses for 16-18 year olds being fully funded, but anyone over the age of 16 can apply, provided their employer will pay a minimum of 50% of the fees.	https://www.gov.uk/government/collections/sfa-higher-and-degree-apprenticeships https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/412019/Higher_Apprenticeship_and_Degree_Apprenticeship_Delivery_from_April_2015_to_April_2016.pdf

Title of Initiative	Lead Organisation	Target Group	Digital Skills Level	Location	Date Introduced / to be Introduced	Description	Reference
National College for Digital Skills	UK Government	Young People	Professional Skills	UK	Sep-16	The National College for Digital Skills is a new initiative that has been designed to provide high quality training to drive up standards in Further Education provision across the country. Aiming to reach 5000 students across 5 years, the college will focus on delivering a higher-level technical provision, offering a range of qualifications and apprenticeships.	http://www.ncdigitalskills.org.uk/ https://www.gov.uk/government/news/maths-and-science-must-be-the-top-priority-in-our-schools-says-prime-minister
Independent Review of computer science degree accreditation.	Department for Business Innovation and Skills (commissioner) and Sir Nigel Shadbolt (lead reviewer)	Computer Science under-graduates and graduates	Professional Skills	England	Autumn 2016	Professor Sir Nigel Shadbolt will lead an independent review of computer science degree accreditation and graduate employment outcomes to explore in more detail what lies behind the rates of graduate employment and to look at what more could be done to improve this.	https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/407456/15-137-shadbolt-review-computer-science-degrees-tor.pdf
Skills Funding Agency Review of IT Skills	Skills Funding Agency	Employers, Education Providers, Young People	Workforce Skills	England	Jun-15	Following industry feedback that FE digital courses were not rigorous enough and were not meeting the needs of employers, the Skills Funding Agency has been commissioned to undertake a review of Digital Skills Qualifications. The review will make recommendations on how any reforms of Professional and Technical Education can best support responsive, employer-led, high-level digital skills.	https://www.gov.uk/government/news/training-providers-and-awarding-organisations-to-talk-digital-at-workshops
Computer science degree conversion courses	Higher Education Funding for England	Graduates	Professionals Skills	England	Sep-16	Bids were sought for funding to support innovative approaches to increase the number of graduates pursuing computer science in disciplines in particular demand from industry such as data analysis and cyber security. This competition was part of a wider call for	http://www.hefce.ac.uk/news/newsarchive/2015/Name,100772,en.html

Title of Initiative	Lead Organisation	Target Group	Digital Skills Level	Location	Date Introduced / to be Introduced	Description	Reference
						bids by the HEFCE in engineering disciplines. The pilot courses will be predominantly at post-graduate level.	
Apprenticeship system reforms	Skills Funding Agency	Employers	Workforce Skills and Professional Skills	England	2017	The system is being reformed through consultations with employers about designing apprenticeships to meet their organisation's needs. Ten standards have been created for digital roles, with those in existence in August 2015 covering digital industries such as: network engineer, software developer, digital marketer, cyber intrusion analyst, data analysis, infrastructure technician, unified communications trouble-shooter, and digital and technology solutions professional.	https://www.gov.uk/government/collections/apprenticeship-standards
Digital Inclusion Strategy	Cabinet Office	Everyone, and employers (particularly SMEs and VCSEs.)	Basic Skills	UK	Apr-14	The Digital Inclusion Strategy aims to bring the Government, the third sector and the private sector together to reduce the number of people without basic digital skills by 25% before 2016.	https://www.gov.uk/government/publications/government-digital-inclusion-strategy
Future Digital Inclusion Programme	Department for Business Innovation and Skills (commissioner) and Tinder Foundation (lead partner)	'Socially excluded' people	Basic Skills	UK	Nov-14	The Future Digital Inclusion programme has been delivered to support 1.55 million individuals gain basic digital skills.	http://www.tinderfoundation.org/our-thinking/blog/yay-bis-supports-tinder-foundation-future-digital-inclusion-programme.

Title of Initiative	Lead Organisation	Target Group	Digital Skills Level	Location	Date Introduced / to be Introduced	Description	Reference
The Digital High Street	Department for Communities and Local Government	High street consumers and employers	Basic Skills	UK	Apr-14	The 'Digital High Street' initiative is being delivered alongside the 'Great British High Street' initiative to try to eliminate the current gap in digital skills in communities by 2020, to ensure that all residents in communities (including individuals, SMEs and VCSEs) have basic skills.	http://thegreatbritishhighstreet.co.uk/pdf/Digital_High_Street_Report/The-Digital-High-Street-Report-2020.pdf
Small Business Capability Programme (under the broader initiative of 'Do More Online')	Department for Business Innovation and Skills and Go ON UK	SMEs	Basic Skills and Workforce Skills	UK	Apr-14	This programme (under the banner of 'Do More Online' helped small businesses acquire digital skills, aimed at supporting an extra 1.6 million businesses to transact online by 2018, through changing perceptions and providing targeted support. The local element of the programme was evaluated and provided co-ordinated information to help address the IT related 'market failures'.	http://www.go-on.co.uk/blog/help-for-small-businesses-to-do-more-online/ http://www.go-on.co.uk/blog/go-on-uk-and-the-39-leps/.? Note that these pages don't work - I think they have been removed.
Digital Business Academy	UK Government (commissioner) and Tech City UK (lead delivery organisation)	Businesses	Basic Skills and Workforce Skills	UK	Nov-14	Tech City UK launched a pilot of the free online training platform, Massive Open Online Course (MOOC) as part of its Digital Business Academy. Through this, digital business skills are taught, with courses being delivered by key industry experts. Eight initial courses have included establishing a business startup, developing and managing digital products, marketing, performance managing and tracking.	http://techcrunch.com/2015/04/21/u-k-govt-funded-startup-skills-courses-get-12000-early-sign-ups/. ?Link does not open
Short Courses for Digital Skills	Department for Business, Innovation and Skills and Department for Culture, Media	Employees in the digital sector	Basic Skills and Workforce Skills	England	Nov-14	The pilot scheme, delivered through modular and flexible courses in key digital skills areas (e.g. in web design, database management and digital marketing) has been made to ensure that small businesses can create an	https://www.gov.uk/government/news/new-qualifications-launched-to-meet-uk-demand-for-digital-skills Note that this was

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	and Sport					effective web presence. These have been accredited by businesses, therefore setting new benchmarks for further education provision to meet current skills needs.	published under the Coalition Govt
Broadband Connection Voucher Scheme	Department for Culture, Media and Sport	SMEs	Basic Skills and Workforce Skills	UK	2015	The scheme helps small and medium sized enterprises get connected to 'superfast broadband', by getting vouchers on a first come, first service basis. So far, 40,000 small and medium businesses (SMEs) have benefited from the scheme.	https://www.gov.uk/government/news/40000-uk-businesses-have-their-broadband-boosted
Make it Digital	BBC	Young people	Basic Skills	UK	Summer 2015	Through this initiative, every Year 7 child (or equivalent) will be given a microbit computer, in a bid to inspire digital creativity. Also under the scheme, up to 5000 young unemployed people will have access to traineeships which will be delivered by major industry partners and stakeholders.	http://www.bbc.co.uk/programmes/articles/4hVG2Br1W1LKCmw8nSm9WnQ/introducing-the-bbc-micro-bit
Code4Health	NHS England	Healthcare professionals	Basic Skills and Workforce Skills	England	Mar-15	NHS staff will be provided with specialist training and support to create and deliver their own IT programmes/products so that they can be more involved in the development of online tools that can improve the provision of care.	https://www.england.nhs.uk/2015/03/03/code4health/
Widening Digital Transformation	NHS England	'Socially excluded' people	Basic Skills	England	2013	The programme is aimed at reducing the barriers to healthcare by supporting people (in particular old and/or disabled people) with their digital health literacy, so they can book appointments and order repeat prescriptions online and have better access to health care.	http://www.computerworlduk.com/news/careers/nhs-england-train-100000-people-in-basic-online-skills-3470659/ http://www.tinderfoundation.org/what-we-do/nhs-

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							widening-digital-participation
New Model in Technology and Engineering (NMITE)	New Model in Technology and Engineering	Young People	Workplace Skills and Professional Skills	Herefordshire	2017	NMITE is the first 'greenfield' UK university to be launched for 30 years, to completely transform the way in which engineering and related technologies are taught in the UK.	http://nmite.org.uk/about/
Connected Housing Initiative (CHI)	National Housing Federation, Government Digital Service and Digital Unite	Social housing residents	Basic Skills	UK	Jan-15	CHI promotes digital skills training for residents, and encourages partnerships with businesses to provide access to internet infrastructure.	http://www.24dash.com/news/housing/2015-01-12-Connected-Housing-Intiative-speaks-out-on-the-fight-against-digital-exclusion
Manchester Digital	Manchester Digital	Employers	Workforce Skills	North West of England	Apr-01	Manchester digital supports businesses through: employer skills groups, digital skills festival, apprenticeship matching service, a peer club, training and CPD.	https://www.manchesterdigital.com/what-we-do.
Digital Birmingham	Digital Birmingham	Employers	Basic Skills and Workforce Skills	Birmingham	Apr-06	Digital Birmingham focuses on IT skills for employers, establishing local networks and specific actions such as developing digital skills for carers.	http://digitalbirmingham.co.uk/about/
Digital Youth Academy	Digital Youth Academy	Digital apprentices	Basic Skills and Workforce Skills	London	N/A	The Digital Youth Academy supports digital apprentices in London.	http://www.digitalyouthacademy.com/

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The North East Tech Skills Hub	Sunderland Software City and the Tech Partnership	Employers and young people	Basic Skills and Workforce Skills	North East of England	Nov-14	This initiative links schools with small businesses, with the businesses helping to enhance the tech understanding of teachers, and highlighting the opportunities for careers in the digital arena.	http://www.sunderlandsoftwarecity.com/2014/11/new-hub-launched-to-meet-demand-for-digital-skills/
Digital Tourism	Skills Development Scotland	Tourism businesses	Basic Skills and Workforce Skills	Scotland	Autumn 2015	This programme has been developed to provide tourism businesses with 'advice' surgeries, workshops, events to raise awareness, case studies, online guides and resources and conferences with inspiring speakers.	https://www.ourskillsforce.co.uk/news/2015/august/tourism-digital-skills-initiative-to-be-launched/
Digital Highlands and Islands Project	Highlands and Island Enterprise	All consumers	Basic Skills and Workforce Skills	Scotland	2015 - 2016	A £146m investment programme to roll out a fibre network across the Highlands and Islands in Scotland, it includes skills training and tailored business support	http://www.hie.co.uk/regional-information/digital-highlands-and-islands/default.html
Digital Scotland	Scottish Government	All consumers	Basic Skills and Workforce Skills	Scotland	2013 - 0ngoing	A partnership of private, public and third sector organisations who are working together to deliver a wide variety of programmes and projects to ensure that Scotland can take full advantage of the opportunities offered by the digital age. This initiative is part of the Scottish Government's aim for Scotland to become a world class digital nation by 2020.	http://www.digitalscotland.org/partnership/ http://www.digitalscotland.org/superfast-broadband/the-programme/
Better Broadband for Oxfordshire	Oxford County Council	Female heads of businesses	Basic Skills and Workforce Skills	Oxfordshire	Jul-15	This project is targeting women who are running small businesses, who wish to start a business, who are returning to the workplace and who wish to improve their digital skills.	http://www.betterbroadbandoxfordshire.org.uk/home This page could not be found.

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Digital High Street Skills (Cornwall)	Cornwall and the Isles of Scilly Local Enterprise Partnership (LEP)	SMEs	Basic Skills and Workforce Skills	Cornwall	Dec-14	This initiative has secured around £100k of Government funding to help small businesses develop their knowledge of the internet and social media, as part of getting their business online.	http://www.businesscornwall.co.uk/news-by-industry/retail/small-business-digital-skills-boost-123
Digital First Programme	The Highland Council	All consumers	Basic Skills	Scotland	Feb-15	This programme aims to achieve 40% of all transactions online over four years, saving £1.3million, by specifically acknowledging the need to invest in citizen skills (to help generate the cost savings), through nominating digital champions and developing a local digital ecosystem by working "in partnership with other agencies to support customers who find digital engagement challenging"	http://www.highland.gov.uk/news/article/8404/digital_first_programme_aims_to_have_at_least_40_of_transactions_online_and_deliver_13_million_in_savings_over_next_four_yearshttp://www.highland.gov.uk/news/article/8426/members_agree_to_nominate_6_digital_champions_as_part_of_digital_first_programme
Software Cornwall	Cornwall College and dBs Code?	Employers	Basic Skills, Workforce Skills and Professional Skills	Cornwall	Apr-15	The initiative has been set up to support the growth of the software industry in Cornwall	http://www.softwarecornwall.org/about-us/
Dynamo North East	Dynamo North East	Technology sector	Workforce Skills and Professional Skills	North East of England	Feb-14	Dynamo Northeast is developing a digital ecosystem of IT organisations and employers, technology hubs, education, local government and employer support initiatives. Activities include promoting apprenticeships, code clubs, and activities aiming to "retain graduates, train apprentices, attract mature hires and supporting the learning	http://www.dynamonortheast.co.uk

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						sector from primary school to tertiary education.	
Inspiring Digital Enterprise Award (iDEA)	Duke of York and Nominet Trust	Young people	Basic Skills	London	Mar-14	iDEA is a joint initiative between the Duke of York and Nominet Trust "which aims to support 16-25 year olds to develop and improve their digital and entrepreneurial skills". The award is accompanied by digital badges to promote the recognition of the skills.	http://www.princes-trust.org.uk/about_the_trust/headline_news/national_news_2014/1403_boost_digital_skills.aspx Page not found
Charity Online	Google	SMEs	Basic Skills and Workforce Skills	UK	Feb-13	This is a "free initiative designed to help 30,000 small or medium-sized charities boost their fundraising by improving their digital skills."	http://www.thirdsector.co.uk/google-launches-free-digital-skills-initiative-small-medium-sized-charities/communications/article/1169834
Action with Communities in Rural England (ACRE) Digital Inclusion	The ACRE Network	People living in rural areas	Basic Skills	UK	2014	This network is helping to overcome digital exclusion through the provision of superfast broadband "by engaging with local partnerships, helping with demand stimulation and digital skills initiatives".	http://www.acre.org.uk/rural-issues/digital-inclusion. Page not found
Digital Outreach Capacity Building	Digital Outreach	SMEs and VCSEs	Basic Skills and Workforce Skills	North East of England	Feb-15	This initiative is working through the provision of "digital skills support and training to a number of micro-to-medium sized voluntary and community sector organisations."	http://www.digitaloutreach.org.uk/clients-projects/projects/capacity-building-digital-skills-in-front-line-organisations/
Military Leavers Programme	X-Force	Military leavers	Professional Skills	UK	N/A	Military personnel leaving the forces are supported through the social enterprise X-Forces in re-entering the labour market by acquiring relevant skills. For example "The UK business of EMC Corporation will be investing £250,000 in	http://x-forces.com/news-and-events/140-launch-of-x-forces-technology-training-with-emc-2.

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						their Military Leavers Programme, providing seven weeks of training to ex-military personnel of all branches and ranks free of charge, equipping them with the skills they need to design, sell and support enterprise IT."	
Working Group to support women in engineering	Institution of Engineering and Technology (IET) and Prospect	Women in engineering	Professional Skills	UK	Mar-15	A working group has been formed for female engineers and scientists, to ensure there is a need for "flexible working, fair play and a more inclusive culture should be on all organisations' agenda because they are proven to improve overall staff retention, and are good for business."	http://www.theiet.org/policy/media/press-releases/20150309.cfm
School and Business Partnership pilot project	Government Equalities Office and Chamber of Commerce	Female students	Basic Skills	UK	Jul-15	This project has found "that taking teachers out of the classroom to engage with business can help to encourage more girls to study science, technology, engineering and maths."	http://www.britishchambers.org.uk/press-office/press-releases/taking-teachers-out-of-the-classroom-is-key-to-widening-girls'-participation-in-science.html
Young Enterprise	Young Enterprise	Young People	Workforce Skills	UK	1962	This charity focuses not just on the 'hard' skills of IT etc., but also on the important business and entrepreneurship skills of "creativity, innovation and adaptability".	http://www.young-enterprise.org.uk/about-us/our-history/
Digital Classroom Initiative	Samsung	Young People	Basic Skills	UK	Nov-14	This initiative gives pupils access to tablets and digital devices in the classroom to demonstrate that children are more engaged in lessons when lessons are mediated by technology.	http://www.thedrum.com/news/2014/11/19/samsung-mission-help-narrow-uk-skills-gap-digital-classrooms-initiative-says-uk-boss

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Your Life	Chancellor of the Exchequer	Young People	Basic Skills and Workforce Skills	UK	Nov-14	This campaign is supported by a number of technology companies and "is a three-year campaign to helping young people in the UK build the skills needed to succeed in the current competitive global economy."	http://yourlife.org.uk/
Argos Internet Workshops	Argos	Adults	Basic Skills	UK	Oct-14	In partnership with Go ON UK, members of Argos' staff helped participants learn the basics "of how to use a tablet, connect to and surf the internet, use a search engine, set up email, stay safe online and more."	http://www.telegraph.co.uk/technology/news/11159442/Argos-joins-effort-to-get-digitally-deprived-online.html
Digital Skills Sharing	The Reading Agency	Library Staff	Workforce Skills	UK	Jan-13	This initiative was developed to build digital skills capacity in library staff. Such initiatives in effect build a snowball effect, first raising capacity in library staff, to raise capacity in users which can further increase demand for the resources marketed by publishers.	http://readingagency.org.uk/digitalskills/
Get Online Week	Society of Chief Librarians Supports UK Digital Inclusion Charter	Library Staff and Users	Basic Skills	UK	Oct-14	This initiative has been delivered to ensure that public libraries have the staff and resources that are needed to help customers to attain and improve their digital skills capabilities.	http://goscl.com/society-of-chief-librarians-supports-uk-digital-inclusion-charter-2/
Google Digital Academy	Google	Employees at partner clients, media agencies or creative agencies	Professional Skills	London	2013	This is a commercial initiative run by Google, for 'future digital leaders'	http://googledigitalacademy.com/courses.html

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Freeformers	Freeformers	Businesses and young people	Workforce Skills and Professional Skills	UK	2012	This organisation creates programmes that help to teach relevant and practical digital skills across different organisations and businesses, in a bid to drive the company's digital strategy.	https://freeformers.com/
Digital News Initiative	Google	Newspapers and Journalists	Workforce Skills	UK	2015	Google teamed up with large European new publishers (including the UK's Financial Times and the Guardian) to help promote innovation in digital journalism, as the rise in online 'news curators' is threatening the 'traditional' news outlet.	http://www.thecourier.co.uk/news/uk/google-partnering-with-publishers-for-new-107m-digital-news-initiative-1.869480
Code Club	Code Club	Young People	Basic Skills and Workforce Skills	UK	2012	This initiative is targeted at children aged 9-11, who are offered the opportunity to attend free, volunteer-led after school coding clubs, so that children can learn to programme. They have also created online training for their volunteers to ensure that they have enough information to adequately run an effective after school club.	https://www.codeclub.org.uk/about
Girls in Tech	Girls in Tech	Women in technology	Professional Skills	UK	2014	The 'Girls in Tech' initiative has been developed to help "support and raise the visibility of women in technology, entrepreneurship and innovation."	http://girlsintechuk.com/about/mission/
Women in Business	Women in Business	Women in Business Network	Professional Skills	UK	Jan-05	This is a word-of-mouth, extensive network which links together women in business across the UK, and across different sectors.	http://wibn.co.uk/about-wibn/

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WISE Campaign	Women in Science, Technology and Engineering	Young women	Professional Skills	UK	Jan-84	This organisation aims to inspire girls and women to study (and build their careers) through science, technology, engineering and maths (STEM) organisations. They advise both women interested in being part of the STEM jobs, and the organisations in how they can create environments so women can provide their best work.	https://www.wisecampaign.org.uk/about-us
Young Rewired State	Young Rewired State	Young people	Professional Skills	UK	2009	Young Rewired State is an initiative based in the UK (but with a global reach) which brings together and supports young digital makers by providing them with events where they can meet like-minded people.	http://www.yrs.io/
Teen Tech	Teen Tech	Young people	Basic Skills, Workforce skills and Professional Skills	UK	2008	This initiative was set up to "help the 'X-Factor' generation understand their true potential and the real opportunities available in the contemporary STEM workplace". Events take place across the UK, bringing together industry leaders and universities, to deliver great experiences for young people to inspire them to go into STEM.	http://www.teentech.com/about-teentech/
Spring Online	Digital Unite	Older people	Basic Skills	UK	2002	Spring Online's aim is "to introduce older people to the world of technology at the local level by encouraging and supporting outlets such as libraries, community centres, schools and sheltered housing schemes to open their doors and hold taster sessions."	http://digitalunite.com/spring-online/about-spring-online

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Apps for Good	Apps for Good	Young people	Basic Skills, Workforce Skills and Professional Skills	UK	Mar-10	Apps for Good is an education initiative which "equips students to research, design and make digital products and take them to market… [their] goal is to produce more able, self-confident, collaborative young people, ready to make a difference to their world."	http://www.appsforgood.org/public/about-us
Techy Tea Party	EE	Everyone	Basic Skills	UK	Sep-14	Techy Tea party is an annual event that happens across EE's shops and offices which "over tea, biscuits and cake, are helping thousands of people to learn the basics" of digital skills.	http://ee.co.uk/ee-and-me/tech/techy-tea-party Page not found
One Digital	Big Lottery Fund and Digital Unite	Everyone	Basic Skills	UK	Sep-15	The organisation "will establish a self-perpetuating and sustainable digital champion model so that all partner organisations can provide digital skills support for the long-term, whoever and wherever their learners are." This will be done by training 1400 digital champions to deliver basic digital skills.	http://digitalunite.com/blog/one-digital-new-collaborative-approach-delivering-digital-skills-across-uk-0
Digital Eagles	Barclays	Older people	Basic Skills	UK	Aug-13	This initiative has been set up by Barclays to help older people to learn the basics of using the computer and internet so that they don't miss out on the benefits that can come when using online banking.	http://www.barclays.co.uk/DigitalEagles/P1242671738729 http://www.barclays.co.uk/P1242689629973
Reboot UK	Big Lottery Fund and Tinder Foundation	Homeless people, families in poverty and people with mental health problems.	Basic Skills	UK	Jun-15	This initiative will help to "rebuild the lives of people through personalised digital skills training and community-based support which will enable them to be more in charge of their own lives." It is based on the premise that these groups are ones which could benefit most significantly from digital skills but are also those who are least likely to	https://www.biglotteryfund.org.uk/global-content/press-releases/uk-wide/250615_uk_funding-to-build-skills-and-bridge-the-digital-divide

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						have them.	
Digital Champions	Big Lottery Fund and Age UK	Older people	Basic Skills	Oxfordshire, Leicestershire and Rutland	Jun-15	Age UK is working to provide digital champions in these areas to approximately 2000 older people, through "working with local organisations and businesses including health and social services, care homes, clubs, hairdressers and taxi drivers. Community work includes pop-up taster sessions in local shops, GP surgeries and hospitals."	http://www.ageuk.org.uk/latest-press/1400-digital-champions-to-bring-the-benefits-of-being-online-to-thousands/
Get IT Together	BT and Citizens Online	Disadvan-taged Commun-ities	Basic Skills	UK	2012	This project has been developed to help build up the capacity of the community to ensure digital inclusion and to see through the delivery of 'digital champions' to help improve digital inclusion. The project trained 20,000 people directly and indirectly worked with 25,000 people to help improve their basic skills.	http://www.citizensonline.org.uk/wp-content/uploads/GetItTogetherRev2a.pdf
Citizens Online	Big Lottery Fund and Citizens Online	Local commun-ities	Basic Skills	Brighton, Plymouth, Gwynedd and Highlands Council	Jun-15	This project will "train, recruit and deploy digital champions to improve the online skills of 4000 people. It will] deliver a project that aims to support the uptake of digital skills and services in each area by creating a sustainable and supportive partnership network."	http://www.citizensonline.org.uk/2015/09/1400-digital-champions-to-bring-the-benefits-of-being-online-to-thousands/

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Basic Digital Skills	SCVO	Frontline voluntary and community sector	Basic Skills	Scotland	Jun-15	This project is being delivered to "develop and assess the contribution that frontline voluntary and community sector organisations can make in improving the skills of people."	https://www.biglotteryfund.org.uk/global-content/press-releases/uk-wide/250615_uk_funding-to-build-skills-and-bridge-the-digital-divide
Online Today!	Royal National Institute of Blind People (RNIB)	People with sight or hearing impair-ments	Basic Skills	UK	Sep-14	This roject will work with 37 national and local partners across the UK, sharing expertise with volunteers who will be trained as a 'technology support squad', who can help people with sight or hearing impairments and engage with technology to help support their lives.	https://www.biglotteryfund.org.uk/global-content/press-releases/uk-wide/240914_uk_bons_online-skills-to-become-accessible
Fix the Web	Citizens Online	Disabled and older people	Basic Skills	UK	N/A	This initiative has been designed to tackle the issue of 'inaccessible websites' for many disabled and older people who cannot easily navigate their way around the websites. 'Fix the Web' provides a "quick and easy way for people to make complaints - as well as to introduce a volunteer-led process for those complaints to be reported back to website owners to get fixed."	http://www.citizensonline.org.uk/fix-the-web/
Tech North	Tech North (established through Tech City UK)	Northern businesses	Professional Skills	North of the UK	2015	This is a government-funded initiative that has been delivered through TechCity UK. "The specific goal of Tech North is to accelerate the development of the North's digital economy through the promotion and support of digital entrepreneurship"	http://technorthhq.com/

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Digital Skills Maps	Go ON UK	Digital champions	Basic Skills	UK (and several other countries across the world)	2013	This initiative is being developed by Go ON UK ,which aims to support people wanting to become digital champions to help others learn basic digital skills.	https://www.digitalskills.com/about-us SSL Connection Error
Digital Leaders Programme	Digital Leaders	Everyone	Basic Skills, Workplace Skills and Professional Skills	UK	2012	The Digital Leaders initiative offers "an accessible and rapidly expanding cross-sector network of over 27,000 individuals supported by an extensive programme of physical and online events."	http://digitalleaders.co.uk/20122013-programme/
Student Digital Leaders	Schools Student and Teachers network (SSAT)	Young people	Basic Skills	UK	2011	This is a wide network that has been created to support 'student digital leadership' in schools, so that young people have easy access "to shared resources, collaborative opportunities and simple accreditation in the form of open badges which schools can use independently, or which can be used as evidence for accreditation in other schemes."	https://www.ssatuk.co.uk/cpd/student-leadership/student-digital-leaders/
Digipals	Blackburn College	Young people	Basic Skills	Blackburn	2013	The scheme created "a young team of friendly digital enthusiasts - aka the Digipals. Their aim was to share new technologies for improving the learning experience for others."	http://www.blackburn.ac.uk/student-services/learner-entitlements/technology-enhanced-learning/
Lloyds Banking Group Digital Academy (part of the Helping Britain Prosper Plan)	Lloyds Banking Group	People and organi-sations	Basic skills	UK	2015	Lloyds Banking Group has decided to make sure that 1 out of 4 of its colleagues "would be trained to help people and organisations use the internet to improve digital skills and financial capability". They aim to deliver around 20,000 'digital champions' by 2017	http://www.lloydsbankinggroup.com/Media/Press-Releases/2015/lloyds-banking-group/lloyds-banking-group-commits-to-20000-digital-champions-by-2017/

Title of Initiative	Lead Organisation	Target Group	Digital Skills Level	Location	Date Introduced / to be Introduced	Description	Reference
English My Way	Tinder Foundation, BBC and the British Council	ESOL learners	Basic Skills	UK	2014	The 'English My Way' programme combines the provision of ESOL teaching alongside providing online centres to help increase the digital literacy skills for learning, "to help them progress to being advocates for the programme within their communities creating a 'domino effect' and leading to greater employment opportunities".	https://www.gov.uk/government/news/thousands-to-benefit-from-exciting-new-ways-of-learning-english
SMB Digital Skills Workshops	Vodafone	SMEs	Basic Skills and Workplace Skills	Leeds and London	2015	Digital skills workshops are being offered to SMEs in these areas as part of a pilot scheme to see how Vodafone can help smaller businesses to compete online.	http://www.techweekeurope.co.uk/networks/broadband/vodafone-digital-workplace-smbs-172455
Digital Mentors	Eon	Everyone	Basic Skills	UK	2015	Eon supported three digital mentors with basic digital skills to help get them online. The pilot scheme was so successful that they are in the process of launching their second round of the scheme.	https://www.eonenergy.com/About-eon/Community/help-getting-online/the-skills-and-the-tools/digital-mentors

Annex four: Consolidated Bibliography

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