



**Appskills Project – 55471**

**Work Package: 3**

**Task 3.4: Skills Mismatch in Mobile Applications**

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## 1. Introduction

The Appskil project, which is co-funded by the European Commission, aims to make recommendations to address skills gaps in ICT and, in particular, make recommendations on how to improve the development of mobile applications creation through better training and qualifications. The project will investigate, support and make recommendations for the establishment of a European ICT Sector Skills Council which would have responsibility for ensuring that training and education in ICT across the EU is responsive and fully in tune with employers' needs. The Appskil project aims to:

- Design an appropriate curriculum for future mobile applications creators which will improve business and design skills;
- Ensure that the developed curriculum links with ESCO, EQF, QCF, NQF and ensures that the curriculum includes quality principles that facilitate recognition and transferability across the European Union;
- Gather evidence of skills shortages in applications development in the AppSkil participating countries and their neighbours;
- Co-ordinate the ICT sector in terms of skills anticipation, collaboration and agile reaction to change; and
- Introduce innovative training through a massive online open course (MOOC).

The Appskil project has identified existing ICT qualifications in Europe and provided an overview of the scale and diverse nature of ICT training across the European Union. It has highlighted the scale and speed of ICT innovation and how this is driving demand for new ICT skills and abilities with employers requiring people who can design, develop and deploy new applications for mobile devices.<sup>1</sup> This report represents a culmination of the work of Work Package (WP) 3 of the Appskills project and incorporates the findings of WP3 in the context of skills gaps and mismatches in ICT.

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<sup>1</sup> Appskil Project – 55471, WP3, July 2015.



This report draws upon the previous tasks of WP3, including T3.1 Skills Demand and T3.1 Results of the Analysis Phase and T3.1.1 The Skills Mindmap; T3.2 Existing Qualifications and T3.3 Existing Skills Supply.

The results of WP3 will be used to inform the subsequent work packages of the Appskil project and could be used to develop a training programme and indeed inform the design of curricula for certificated qualifications, the purpose of which is to address the skills gaps and mismatch issues highlighted in this report.

Skills mismatch and getting the “right people into the right job” has become a global problem and one where there is a wealth of current research, particularly academic research that analyses the issues in-depth. This report attempts to unpick the complexities of **skills mismatches**, **skills shortages** and **skills gaps** and present recommendations for the Appskil project to inform the development of an ICT curriculum and qualifications for mobile applications that can meet the current and future needs of employers and learners.



## 2. Executive Summary

Skills mismatches occur when workers have either fewer or more skills than jobs require, the report uses this basic definition of skills mismatch and includes an exploration of skills mismatches from the perspective of the learner; the teacher; the jobholder and the employer.

The economic imperative for taking steps to address skills mismatches in Europe is made in the opening paragraphs followed by a critique and analysis of current research and evidence of skills mismatch in general and in ICT in particular. The unacceptably high level of youth unemployment across the European Union is cited in the report as an urgent warning to public policy makers. Issues highlighted by the report include:

- Some current economic growth in parts of Europe coupled with forecasts for high levels of job vacancies in ICT;
- The ageing nature of the current ICT workforce;
- The lack of computer science graduates; and
- The need for the ICT sector to be agile in its response to the development of new skills.

This report provides evidence of the existence of skills mismatches in mobile applications development. The report investigates the global nature of skills mismatches in ICT and the impact they have on education and employment in the European Union. The previous tasks of the Appskills project are presented as supporting evidence in this report. WP3.1 identifies the required skills set that mobile apps creators need in order to effectively develop and commercialise mobile apps: technical design, user understanding and business need. The mindmap from T3.1.1 is used to graphically illustrate the required skills.

While continual professional development (CPD), including keeping up to date with mobile applications development is important for IT specialists (in all occupational sectors, not just in ICT), the recommendations try to address the whole picture for



mobile applications development; from the perspectives of the learner, the educator, the careers adviser and not least the government (including Europe).

The policy recommendations presented in this report focus on the mobile applications development skills required by employers for the world of work, however, the qualifications offered in schools and colleges are not excluded from the recommendations. The importance of ICT education in schools and colleges (including mobile applications development) is twofold;

- The right education, training, advice and qualifications provide a progression pathway to work as an ICT specialist; and
- The ubiquitous and constantly changing nature of ICT are increasingly important to all other occupational sectors, not only to get a job in that sector but also to enhance employment and skills within the sector.

The report emphasises that employers have a role to play in the design and delivery of the curriculum for ICT, including the development of mobile applications so that the curriculum better prepares young people for the future. Government has a role to make this happen.



### 3. Background - Economic Crises – the need for skills and qualifications

Global and European financial crises continue to reverberate in the unemployment figures for the European Union's 28 member states. In July 2015 the unemployment average for the European Union was 9.5%. In Greece, however, the unemployment rate is 25% and in Spain it is 22%. The figures for youth unemployment are even more alarming; 52% in Greece and 49% in Spain compared to 20% across the European Union.<sup>2</sup>

According to the World Economic Forum (WEF)<sup>3</sup>, skills are a critical asset for individuals, businesses and societies, it is crucial to ensure that skills taught at school are relevant for the working world; that they are maintained and further improved during working life; and that they are recognised and used by employers once people are in the labour market. High and persistent skills mismatch is costly for employers, workers and society at large. However, while many employers report difficulties in finding suitably skilled workers the WEF concludes that there is no evidence that skill levels have collapsed because of economic crises. They argue that structural issues that already existed before any crises, such as uncompetitive wages, unattractive working conditions, poor recruitment policies and/or mismatch between the location of skills and jobs are also major issues. As a result, the WEF say, many shortages could be addressed by changes in training and recruitment practices, as well as by facilitating labour mobility.

A more worrying phenomenon identified by the WEF is what they describe as **qualification mismatch**. Affecting workers, firms and the overall economy, qualification mismatch occurs when a worker's qualification level is higher or lower than that required by the job. Although the match between what people can actually do and the content of their jobs may improve over time, qualification mismatch can be persistent and leave an adverse or "scarring" effect on an individual's career. In addition, unused skills, according to the WEF will atrophy, resulting in a partial loss of

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<sup>2</sup> [http://ec.europa.eu/eurostat/statistics-explained/index.php/Unemployment\\_statistics](http://ec.europa.eu/eurostat/statistics-explained/index.php/Unemployment_statistics)

<sup>3</sup> WEF, Global Agenda Council on Employment, Matching Skills and Labour Market Needs, Davos-Klosters, 2015.



the (initial) investment in them. Even when adjustment takes place, it may be costly and prevent the adoption of new technologies.

At the same time as major economic crises, digitisation created six million jobs globally in 2011 despite the global economic downturns, as ICT is widely adopted in all corners of society. Experts believe a new wave of big data and smartphone applications has the highest potential in terms of job creation. In the European Union alone it is predicted that about 900,000 ICT jobs could remain unfilled by 2020, mostly in the higher-end segment of the market, a figure that may vary according to the pace of the recovery.<sup>4</sup>

*“Skills development does not come about as fast as technological development, which is why we are faced with a paradoxical situation: although millions of Europeans are currently without a job companies have a hard time finding skilled digital technology experts..... moreover, there is a need for digital skills for nearly all jobs where digital technology complements existing tasks. In the near future 90% of jobs - in careers such as engineering, accountancy, nursing, medicine, art, architecture, and many more - will require some level of digital skills. At the end of the day every citizen needs to have at least basic digital skills in order to live, work, learn and participate in society.”*

*European Commission: The Grand Coalition for Digital Jobs 2013*

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The WEF concludes that stemming the rise in structural unemployment, and in some types of skills mismatch resulting from the economic crises requires immediate action as well as a long-term comprehensive strategy. They see job creation as key to tackling high and increasingly persistent unemployment and underemployment in many countries. However, promoting jobs without paying due attention to their quality and to the skills required may only buy time and ultimately prolong the jobs crisis. Public employment services have an important role in ensuring that the return to job growth does not come at the expense of lower-quality skill matches. Employment strategies should not only focus on the immediate benefit of filling a job vacancy, but

<sup>4</sup> <http://www.euractiv.com/sections/eskills-growth/employers-tackle-unpredictable-skills-mismatch-ict-sector-301938>

<sup>5</sup> <http://ec.europa.eu/digital-agenda/en/grand-coalition-digital-jobs-0>



also consider the long-term consequences of training and placement decisions on individuals' employability and adaptability.

Reducing skills mismatch with lasting effect and helping economies make the most of their workforce skills requires collaborative effort from all stakeholders. First, action is needed to reduce the gap between knowledge generated in the educational system and the skills demanded by employers. Second, continuing intervention is necessary during the employment life cycle, targeting continuous skill development and use.

*“Building a workforce fit for the digital age requires all stakeholders to work closely together: companies and governments, schools and universities. We need to improve the awareness about the exciting opportunities that exist in digital technology, in smaller and larger organisations. We need to adapt curricula and provide more in-house training opportunities. This is not trivial and requires decisive action, resources and a vision shared by all stakeholders.”*

*European Commission: The Grand Coalition for Digital Jobs 2013*

In the UK, the House of Lords Select Committee on Digital Skills<sup>6</sup> reports that there is a shortage of medium- and high-level digital skills in the UK. The Select Committee believes that the UK is at a critical juncture with regard to digital skills, the digital agenda is fast moving and all encompassing.

*“Skills such as coding are the new literacy. Whether you want to be an engineer or a designer, a teacher, nurse or web entrepreneur, you will need digital skills. All of us, whether public policy makers, companies, educators and individuals, have a collective responsibility to ensure that Europe’s workforce has the right digital skills...to remain at the avant-garde of digital technology and to enable our children to access tomorrow’s jobs.”*

*European Commission: The Grand Coalition for Digital Jobs: The e-Skills Manifesto 2014*

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<sup>6</sup> House of Lords Select Committee on Digital Skills, 17 February 2015, *Make or Break: The UK’s Digital Future*



The Select Committee argues that this needs immediate attention if the UK is to remain competitive globally. To keep ahead of the international competition, the UK must ensure it has the necessary pool of digitally skilled graduates and others at the higher level, to support and drive research and innovation throughout the whole economy. The Select Committee suggests that the long-term solution to the shortage of medium- and high-level skills requires action at all levels of the ‘talent pipeline’, from primary to secondary, further and higher level education.

The Appskills project aims to investigate and make recommendations to address skills gaps in ICT in Europe and in particular improve the development of mobile apps creation through better training and qualifications. The project will make recommendations for the establishment of a European ICT Sector Skills Council which would have responsibility for ensuring that training and education in ICT across the EU is responsive and fully in tune with employers’ needs.

The objectives of the Appskills project include:

- Designing of an appropriate curriculum for future mobile apps creators which will improve business and design skills;
- Ensuring that the developed curriculum links with ESCO, EQF, QCF, NQF and quality principles to facilitate recognition and transferability across the EU;
- Gathering evidence of skills shortage in apps development the participating and neighbouring countries in order to identify the skills gaps at an EU level;
- Coordinating the ICT sector in terms of skills anticipation and collaboration; and
- Introduction of innovative training through a MOOC (Massive online open course).



#### 4. Shortages, gaps and mismatches explored - What do we mean by skill mismatch?

“You just can’t get the staff these days,” a common refrain from employers both big and small when faced with filling job vacancies. While it seems that the lack of basic skills of prospective employees makes it harder for employers to fill their vacancies, it is often attributed to the failure of the education system to provide such basic skills (Cappelli 2015)<sup>7</sup>. This is the **skills gap** – where employers’ views are that basic skills are just not there among job seekers.

*“Be warned. Europe is at risk. The pipeline that generates future talent in ICT – a key discipline and industry of the 21<sup>st</sup> century – is deficient. The potential to use ICT in primary and secondary education on a much larger scale and integrated with the curriculum remains largely untapped.”*

*European Commission: The Grand Coalition for Digital Jobs: The e-Skills Manifesto 2014*

In the UK the Tech Partnership is a network of employers who collaborate to create the appropriate skills for the digital economy. The Tech Partnership is recognised by the UK Government as the Industrial Partnership for the Digital Economy. In its 2015 Employer Insights: skills survey<sup>8</sup>, the Tech Partnership highlighted how the ICT sector uses higher education as a proxy for admission to jobs within the sector – even for junior posts. See Figure 1.

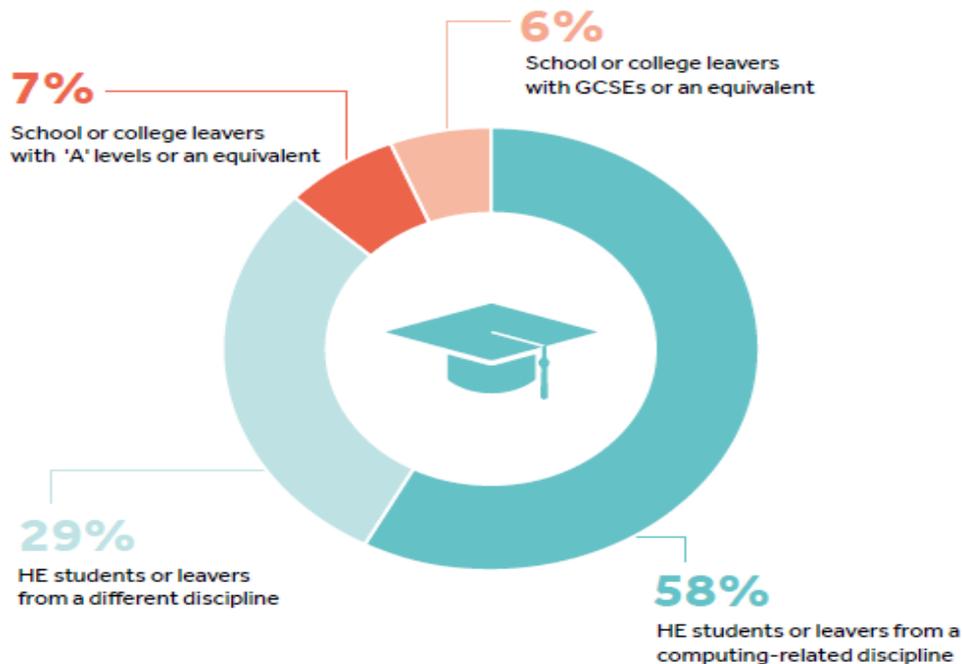
In its investigation into the skills for IT specialists, the Tech Partnership found that the biggest barrier to employing leavers from full time education was the lack of technical skills and appropriate qualifications.

<sup>7</sup> See Cappelli, P H, ILR Review, 68 (2), March 2015.

<sup>8</sup> [https://www.thetechpartnership.com/globalassets/pdfs/research-2015/tec\\_employer\\_skill\\_survey\\_web.pdf](https://www.thetechpartnership.com/globalassets/pdfs/research-2015/tec_employer_skill_survey_web.pdf)



**Figure 1: Recruits from full time education to junior technical specialist roles by level of study in the UK**



Source: The Tech Partnership Employer Insights research

In its research into the competences of over 2000 ICT professionals, the Council of European Professional Informatics Societies (CEPIS) found that Europe lacks young IT talent<sup>9</sup>. Fewer than 16% of professionals they assessed were under 30 years of age and the average age of the ICT professional in Europe is 42. Indeed as ICT increasingly pervades society and the economy, the demand for IT personnel is growing fast, outpacing the current supply of qualified professionals and producing chronic shortages in the computing industry. The low numbers of students choosing computing as a career is exacerbating the situation. Immediate action is needed to better integrate Computer Science in the school system and change the perception of computing among young people.

<sup>9</sup> <http://www.cepis.org/index.jsp?p=641&n=825>



Another complaint on the lack of skills relates to job-related skills missing for specific occupations, for example the ICT sector is regularly facing a **skills shortage** in IT specialists and the engineering sector a **skills shortage** in engineers. This appears to be a particular problem in the skills and qualifications required to work in the science, technology engineering and mathematics (STEM) sectors.

**Figure 2: Percentage increase in first degrees 2000-2012** <sup>10</sup>

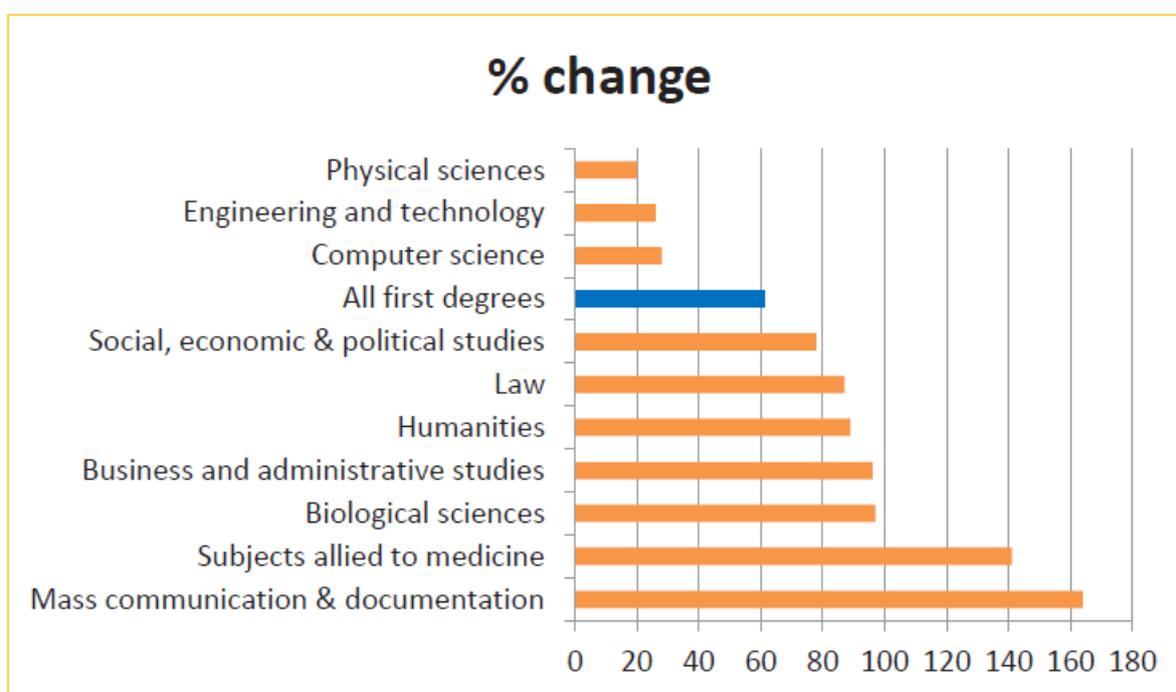


Figure 2 shows the participation rates in Higher Education in the UK grew more than 80% in some disciplines but by less than 25% in other disciplines. When the data was investigated further by The Edge Foundation, it was shown that 62% of degrees awarded in Mass Communication were awarded for Media Studies. Nursing accounts for 49% of degrees in the category Subjects allied to medicine. In the Biological sciences only 14% were for Biology. The Edge Foundation found that, above all, it is

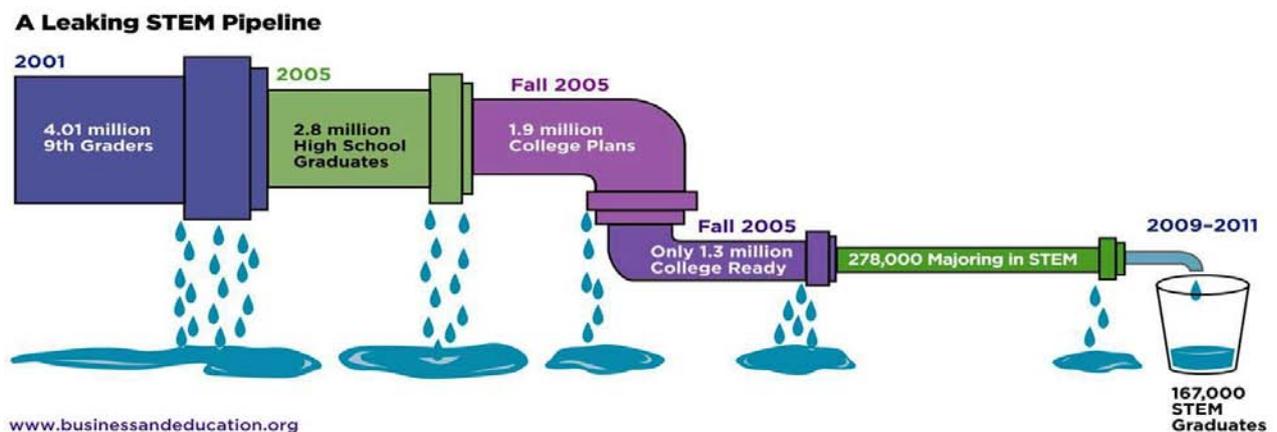
<sup>10</sup> Department for Business, Innovation & Skills and Office for National Statistics, Participation rates in Higher Education, 24 April 2013



striking that Engineering, Technology, Computer Science and Physical Sciences all grew by less than a quarter when the growth rate for all first degrees was 60%.<sup>11</sup>

The shortage of skills in STEM subjects has been exercising, and continues to exercise policy makers in the European Union nations for years. More recently the issue of a shortage of skilled workers (or qualified workers) for STEM sectors is being addressed in the United States where the emphasis is increasingly on getting school pupils interested in the STEM subjects. Previous forecasts in the US claimed a requirement for 400,000 scientists by 2010, Figure 2 shows the scale of the problem facing all the STEM sectors. This resonates with the findings and recommendations of both the House of Lords Select Committee and Europe's e-Skills Manifesto, that there is a need for a "talent pipeline" of digital skills from primary school, secondary school, vocational education and training, university and into employment.

**Figure 3:**



Source: NCES Digest of Education Statistics; Science & Engineering Indicators 2008

Both the CEPIS and Tech Partnerships' surveys revealed that IT firms reported gaps in the interpersonal skills and client interactions skills of IT specialists. The Tech Partnership found that 88% of those reporting such skills gaps of their employees. So skills gaps, shortages and mismatches in the IT sector not only include those computer science and programming skills but it also includes the "softer" skills of customer care, project management and staff development skills.

<sup>11</sup> The Edge Foundation, The Skills Mismatch March 2014



**Figure 4: Skills Shortage, Skills Mismatch and Skills Gaps**

<b>Skill Shortage</b>	<b>Demand for a particular type of skill exceeds the supply of people with that skill.</b>
<b>Qualification Mismatch</b>	The level of qualification is different from that required to perform the job adequately.
<b>Over – (Under-) qualification</b>	The level of qualification is higher (lower) than required to perform the job adequately.
<b>Skills Gap</b>	The type or level of skills is different from that required to perform the job adequately.
<b>Over-(Under-) Skilling</b>	The level of skill is higher (lower) than that required to perform the job

Sources: Cedefop, 2010; OECD, 2011.

The reliance of the UK ICT sector on recruiting employees from higher education coupled with the ageing nature of specialists in the sector presents the sector and the economy with major challenges. The onus is on policy makers throughout Europe to ensure the climate exists for the preparation of school pupils and jobseekers for the digital workforce. This requires a collaborative effort between all the stakeholders from Government, parents, learners, teachers and lecturers, careers advisers, employees and employers.

The implications of skills and qualifications mismatches for policy delivered in Europe and in nation states ranges from the school curriculum for ICT all the way through to continuous professional development of those already in the ICT workforce. It is crucial that efforts are focused on the mobile applications development skills required by employers for the world of work, however, the qualifications and the curriculum offered in schools and colleges are important to ensure the future skills needs for mobile applications developers are delivered. The importance of ICT education in schools and colleges (including mobile applications development) is twofold;

- The right training and qualifications provide a progression pathway to work in the ICT sector; and
- The ubiquitous and constantly changing nature of ICT is increasingly important to all other sectors and employment within them.



Digital technology challenges traditional methods of delivering education, meaning schools and teachers will have to adapt. New models of learning - such as increased online learning and employer-designed short courses - need to keep pace with evolving technology and digital change. Changing demands from firms, consumers, students and communities mean that apprenticeships, vocational qualifications and degrees need to deliver more general - and also specific - digital capabilities. Adults need more opportunities to learn throughout their lives to adjust to a world changing in ways as yet unknown. Education needs a greater emphasis on providing every citizen with adaptable digital skills.

The European Council conclusions of 25 October 2013<sup>12</sup> urge “a higher degree of integration of digital skills in education, from the earliest stages of school to higher education, vocational education and training and lifelong learning”. Success has been variable in Member States’ efforts to update school curricula and ICT infrastructure in line with the rapid pace of technical innovation and the evolving needs of industry and society. In the Erasmus+ Appskills project, D3.1.1, capture of the extensive data on the skills required for apps creation used open, structured interviews along with existing data from the industry to identify, in a comprehensive grid along with a graphic mind map of all the skills which are required for effective apps development which could be used to inform future curricula for VET in ICT in the European Union.

While some countries have overhauled their curricula with the purpose of embedding ICT use and media literacy within all segments of the learning process, most Member States have not yet gone so far. For example, the introduction of the new computing curriculum in England in September 2014 (whereby children throughout primary and secondary education will be taught how to code) was broadly welcomed by the House of Lords Select Committee, stating the belief that it would not only have a positive impact on STEM take-up at further and higher education, but would increase digital capability among the general population. However, they identified serious challenges to be faced when implementing the new curriculum, not least the fact that many teachers are not confident or equipped to deliver it. Teachers will require significant

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<sup>12</sup> European Council 169-13, Para 11(b) General Secretariat of Council 24-25 October 2013



engagement with industry to see and learn the latest technologies in action and effectively pass such knowledge on to young people. The Select Committee concludes that the government needs to take responsibility for leading the UK through the seismic changes brought about by changing technologies.

Multi-stakeholder partnerships are crucial to the development and provision of education and training offers corresponding to the needs of the ICT labour market. Many Member States have attempted to channel graduates and jobseekers towards particular ICT jobs for which there is strong demand, and some aim to provide students and workers with alternative channels of educational achievement, with improved means for “on-the-job” and “just-in-time learning”. Coder Dojo, for example, has been set up as a grassroots movement that organises programming sessions (“Dojos”) for school children of all ages, at first set up in Ireland and now operating in 29 countries around the world<sup>13</sup>.

Education and training, including VET, make a substantial contribution to several EU strategies and initiatives, including the Europe 2020 Strategy, the Digital Single Market initiative, the European Agenda on Security and the Investment Plan for Europe. As underlined in the 2015 European Employment Guidelines<sup>14</sup>, education and training systems should improve their effectiveness and efficiency to raise the skill level of the workforce and address skills mismatches, to better anticipate and meet the rapidly changing needs of labour markets while respecting the competence of Member States for their education and training systems. This is particularly important in an increasingly digital society. Products from the Appskills project are designed to contribute to the effectiveness of VET for apps development skills.

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<sup>13</sup> e-Skills for jobs in Europe: Measuring Progress and Moving Ahead.

<sup>14</sup> [http://ec.europa.eu/europe2020/pdf/europe2020\\_guidelines\\_part2\\_en.pdf](http://ec.europa.eu/europe2020/pdf/europe2020_guidelines_part2_en.pdf)



## 5. Bridging the Apps Gap

The Apple iPhone was launched in 2007. The App Store was launched in 2008. The iPad was launched in 2010, followed by the iCloud in 2011. The pace of change, the pervasiveness and the impact of the technology have been nothing short of astounding, leading some commentators to describe the phenomenon as “the digital revolution” or “the Third Industrial Revolution”.<sup>15</sup>

Of the 5.7 million mobile applications developers working in the world, Europe has 1.3 million. The number of available mobile applications has grown from 250,000 apps early in 2010 to 3 million apps by the end of 2014<sup>16</sup>. Vision Mobile’s European App Economy Report forecasts that developers in Europe are facing stiff and increasing competition from Asia but they are maintaining their global standing for the moment. While mobile applications development currently focuses on income generation for the companies employing developers, more and more applications are being developed for Public Services, indeed, this may well be an untapped market.

In the European Union, developers of mobile applications took in €17.5 billion in revenue in 2013 and it is forecast that that figure will increase to €63 billion by 2018<sup>17</sup>. The European Union workforce developing mobile applications is forecast to grow from 1 million in 2013 to 2.8 million in 2018 and if additional support and marketing staff are included the total number of people working in this area in 2018 could be around 4.8 million.

The Tech Partnership in the UK identifies the technologies of cyber security systems, mobile computing, cloud computing and big data analytics as having increasing importance in the IT sector and has labelled these as “strategic technologies”. These technologies have high importance for the development of mobile applications currently and will prove crucial for the future direction of mobile technology in general.

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<sup>15</sup> <http://www.economist.com/news/special-report/21621156-first-two-industrial-revolutions-inflicted-plenty-pain-ultimately-benefited>

<sup>16</sup> European App Economy 2015; Vision Mobile. [vmob.me/EUApp15](http://vmob.me/EUApp15)

<sup>17</sup> Eurapp: Sizing the EU App Economy, European Commission, DG Communications Networks, Content & Technology, prepared by NUI Galway, Insight and Giacom Research 2014.



**Figure 5 : Adoption of Strategic Technologies**

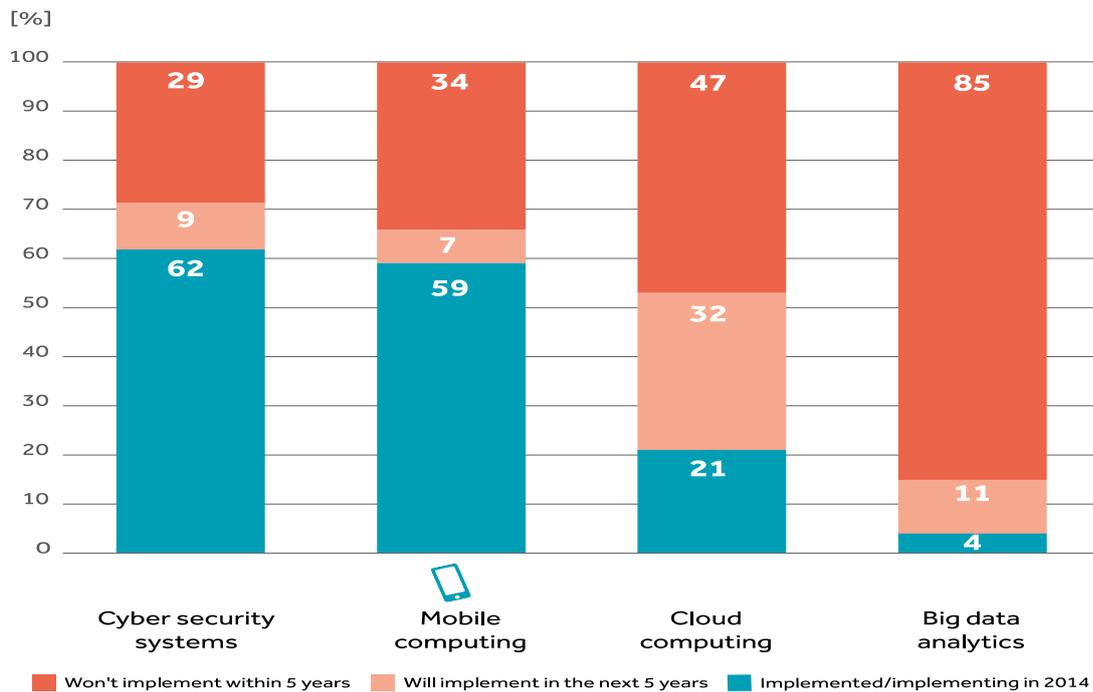


Figure 5 above shows that around six out of ten UK businesses have implemented or are in the process of implementing cyber security systems and mobile computing while only one in five are using cloud computing and less than one in twenty currently exploits big data analytics.

The strategic technologies are presented as particularly important for IT specialists. However the relentless pace of change and the reliance of more and more non-IT specialist on computing in their everyday work means the strategic technologies will have an increased importance. This places a greater importance on ensuring that skills gaps in the strategic technologies are addressed.



**Figure 6: Incidence /scale of skills gaps by strategic technology**

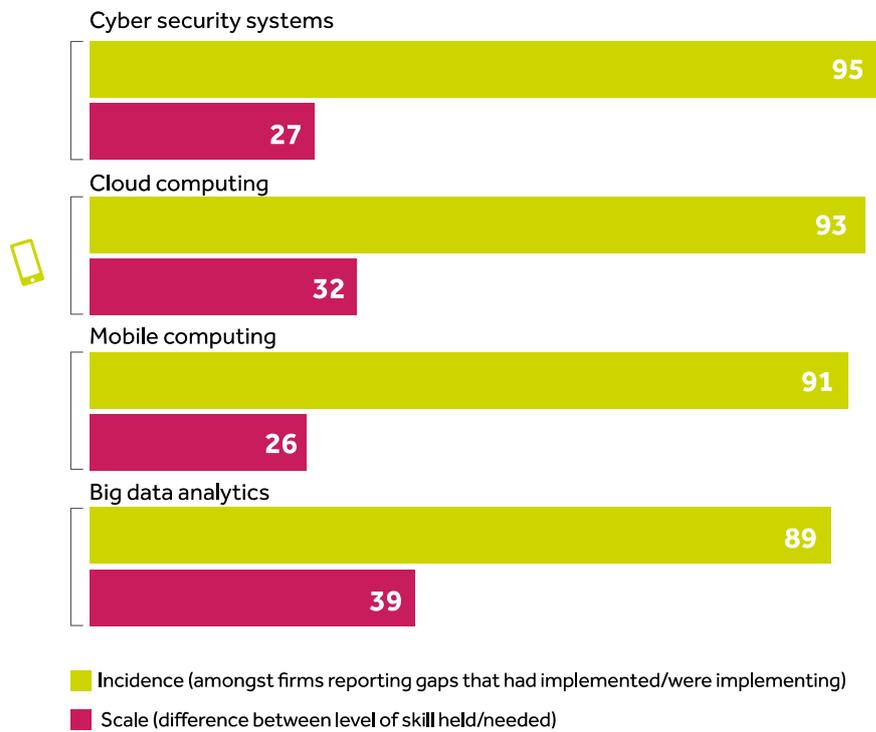


Figure 6 highlights that of the four strategic technologies, data analytics was least often associated with skills gaps among the technical specialists. However, when gaps were apparent, the extent of the mismatch between skills held and the skills needed was considered to be the largest at 39%

The following job description for an applications developer highlights the skills and competences required to develop mobile applications.<sup>18</sup>

***Applications developers translate software requirements into workable programming code and maintain and develop programs for use in business.***

***Most will specialise in a specific development field, such as mobile phone applications, accounting software, office suites or graphics software, and will have in-depth knowledge of at least one computer language.***

<sup>18</sup> Taken from [http://www.prospects.ac.uk/applications\\_developer\\_job\\_description.htm](http://www.prospects.ac.uk/applications_developer_job_description.htm)



***Applications, or 'apps', can be written for a particular system, such as IOS, Windows or Android, or across numerous platforms, including computers and mobile devices.***

***Job titles and specific duties may vary between organisations but the role usually involves writing specifications and designing, building, testing, implementing and sometimes supporting applications using programming languages and development tools.***

***Applications developers work in a range of business sectors, including finance and the public sector. They often work as part of a team with other IT professionals, such as software engineers and systems analysts, and write programs according to their specifications.***

***They may also work on generic products or for individual clients providing bespoke solutions.***

***The work of an applications developer differs from a systems developer in that systems software allows a computer to actually run. Users interface with the applications software, which is served by the systems software.***

Potential mobile applications developers will be expected to have a good level of technical knowledge and many employers, particularly software houses, will expect a degree in a relevant subject, such as:

- business/management;
- computer science/software engineering;
- information systems;
- mathematics;
- physical/mathematical/applied science.

Sometimes employers will waive the need for a degree if the job candidate can show relevant experience and will offer conversion courses for candidates at degree level.



Increasingly employers are also seeking candidates with software vendor certification as a way of demonstrating competence. Product vendors and software firms offer certification as a means of recognising that individuals have the relevant skills and knowledge to work with particular languages, applications and operating systems.

Relevant training and certification routes for applications developers include:

- Microsoft Certified Professional Developer;
- Oracle Certified Associate/Professional/Master, Java;
- SAP;
- Intel;
- Oracle PL/SQL Developer Certified Associate/Professional;
- Objective C/Linux/HTML 5/JavaScript/C++/C#

This is not an exhaustive list of skills that are required for developers of mobile applications, nor will a single mobile applications developer require all of these skills. It is illustrative of the extent of investigation into the skills of mobile applications developers that was highlighted in a previous report from the AppSkil project<sup>19</sup>. This data will be increasingly important as the AppSkil Project moves forward and seeks to develop education and training interventions to address the issues faced by mobile applications developers.

In an interview with Wharton University of Pennsylvania in June 2012 Peter Cappelli said:

*“There’s this belief that we don’t have enough STEM graduates — science, technology, engineering, math. Some engineering jobs are in hot supply now, but five years ago they weren’t... So if you’re entering one of these engineering fields, you’re really making a bet about whether it happens to be hot the year you go on the job market. If it’s not, you’ve got the same problem as everybody else, and you’ve got the additional problem that those skills go out of date very quickly, especially IT degrees. So, the idea that you’re going to have a career as a computer programmer, for example, is probably not true because your skills become obsolete. You’re pushed out, and you’ve got to figure out how to get retooled. It’s very difficult for math majors and*

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<sup>19</sup> Appskil Project – 55471, WP3, Task 3.1, 11th July 2015



*science majors to get jobs in math or in science. If you look here at Penn, for example, most of our students with those majors end up doing consulting and investment banking. So it's not the case that the industry is clamoring for math majors and biology majors and they just can't find them — that's not what's going on."*

Increasingly, it is not just programming and technical mobile applications skills that employers want from effective mobile applications developers. Cappelli argues that it is **experience** that is important to employers. This reinforces the need for the IT industry to engage with education (at all levels) to ensure skills such as:

- Strategic thinking;
- Quality assurance - of products for usefulness and impact (user interface for example);
- Understanding the customer;
- Entrepreneurial skills;
- Marketing; and
- Business planning

should all be part of the curriculum for IT courses.

The competences - skills, knowledge and attitudes – for mobile applications developers is explored further and set out in the mind map in the Appskil report WP 3.1.<sup>20</sup> The mind map presented below at Figure 7 graphically encapsulates the extensive data gathering and analysis stage of WP3.1 which was further evaluated and validated in WP3.1.2 using a study with a wide sample of participants interviewed to study and conclude the competences of most importance to apps creators.

Further, in the Appskil report 3.3.1, Existing Skills Supply, which set out to document and analyse the business and technical skills required in mobile apps creation development. This was achieved through an extensive survey and desk-top research the results of which conclude that mobile apps developers, in the majority, possess almost all the necessary technical skills. In terms of non-technical skills, IPR, resource

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<sup>20</sup> Appskil Project – 55471, WP3, Task 3.1 Mind map, 11th July 2015



planning, social media and sales are amongst the less represented. Significantly, participants in the desk-top research ranked business related skills as essential to the future of apps development and creation.

The emergence of softer skills as perceived gaps in the competency of potential applications developers is reinforced within the findings of the Competences Analysis Validation report (WP 3, Task 3.3, Deliverable 3.3.1). The findings, while drawn from a limited sample size, which has significant bias from one geographic region, provides a microcosmic insight in its identification of softer cross cutting skills as having greater importance than current or future technical deficiencies.

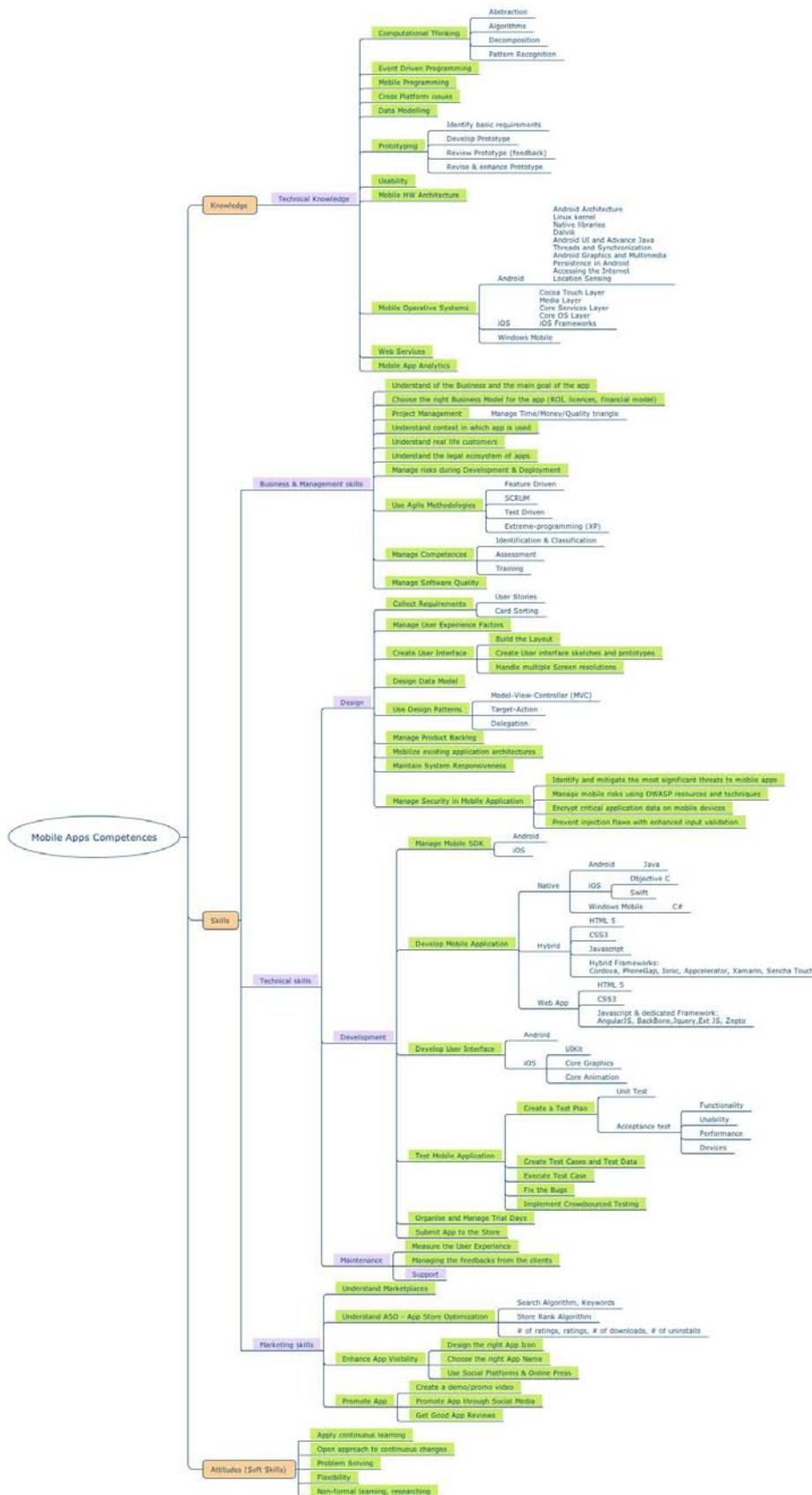


Figure 7 – Mobile Apps Competences – Appskills WP3.1.1



## 6. Conclusions

As the scheduled work packages underpinning the AppSkil Project mature and interact to form a seamless coherent assessment of:

- The knowledge and skills required for applications development – WP 3.1;
- Analysis of existing mobile app qualifications including accreditation – WP 3.2; and
- Existing curricula requirements - WP 3.3

the scope and remit of the project is required to pause, self reflect and challenge the rational within the project. The objective assessments of the work packages indicate that the value proposition to investigate, support and make recommendations for the establishment of a European ICT Sector Skills Alliance has not been investigated sufficiently to progress this matter at this juncture.

Further, extending the objective exercise to the requirement to identify a training programme and inform the design of curricula for certified qualifications predicated upon skills gaps and mismatches highlighted within the afore referenced reports requires careful consideration. The empirical evidence does not support the initial perception of the existence of “technical” skills gaps vis a vis mobile applications development; rather the gap in skills is identified as being within the “business skills” and “softer skills” competencies identified by respondents and reflected in the research reports.

The implications of skills and qualifications mismatches for policy delivered in Europe and in nation states ranges from the school curriculum for ICT all the way through to continuous professional development of those already in the ICT workforce. At this macro level the findings of WP3, Task 3.3, Deliverable 3.3.1 highlight the youthfulness of the industry; demographic and educational composition of the labour employed; speed of technological change and expansion of accessibility identify a



dynamic environment. The regional variations in the language development utilised emphasises the diversity of access which current curricula facilitates. The high level assessment of current curricula for technological knowledge aligns with employer and respondents requirements.

The reliance of the ICT sector on recruiting employees from higher education coupled with the ageing nature of specialists in the sector presents the sector and the economy with major and urgent challenges. The onus is on policy makers throughout Europe to ensure the climate exists for the preparation of school pupils and jobseekers for the digital workforce. Therefore, the requirement for primary and secondary curricula, which is beyond the scope of this project, emerges as a responsibility for all member states in order to provide the flow of an appropriately equipped work force for the app sector.

It is crucial that efforts are focused on the mobile applications development skills required by employers for the world of work, however, the qualifications and the curriculum offered in schools and colleges are important to ensure the future skills needs for applications development are delivered. The curriculum at each level should include the softer skills required to operate effectively as a mobile applications developer. This is underlined by the previous outcomes from Appskills WP3. WP3.3, Existing Skills Supply, for example surveyed the existing educational and training curricula in the consortium's countries to determine the expected skills supply of individuals entering the mobile applications workforce. The results showed that most of the developers surveyed possess the technical skills required for their jobs and developers indicated that there is a need for non-technical skills such as IPR, resource planning, social media and sales while their employers indicated that non-technical competences are essential.

As reported in WP3, Task 3.3, Deliverable 3.3.1 (page 12) the non technical skills of business expertise, business development, intellectual property and project management exist as competencies on a global scale. The Competences Analysis Validation Report (WP3, Task 3.4, Deliverable 3.1.2) emphasises this in assessment



of technical and marketing knowledge when compared to business, management, marketing and technical skills.

The wide range of competences has been identified and WP3.2.1 concludes that ‘the wave of ICT innovation is driving demand for new ICT skills and abilities and the sector need people who can design, develop and deploy new applications and services for mobile devices. The report (WP3.2.1) highlights a wide range of qualifications and certificates dedicated to mobile, ranging from Level 3 in the EQF or above and including vocational and work-related qualifications’.

The work of the Appskills Project to date has identified the knowledge, skills and attitudes required for mobile applications creators (see WP3.1.1 Mobile Applications Competences – reproduced at Figure 7, p26 of this report). Extensive validation of the relevant competences was carried out and reported fully on in Appskills WP3.1.2. The full set of competences and skills identified as the most important for the applications training curriculum can be summarised as:

- Technical Knowledge;
- Business and Management Skills;
- Technical Skill – Design, Development and Maintenance;
- Marketing Skills; and
- Soft Skills

In detail, the final list of required competences for creating applications is:

Technical Knowledge: *Computational Thinking (Abstraction, Algorithms, Decomposition and Pattern Recognition); Event Driven Programming; Mobile Programming; Cross Platform Issues; Data Modelling; Prototyping (Identify Basic Requirements; Develop Prototype; Review Prototype - feedback; Revise & Enhance prototype); Usability; Mobile HW Architecture; Mobile Operating Systems – along with their associated items; Web Services and Mobile App Analytics.*



Business & Management: *Understand the Business and the Main goal of the App; Choose the Right Business Mode; Project Management (manage time, money and quality); Understand the Context in which app is used; Understand Real Life Customers; Understand the Legal Ecosystem of apps; Manage Risks during Development & Deployment; Use Agile Methodologies & associated items; Manage Competences (Identification & Classification; Assessment and Training) and Manage Software Quality.*

Technical Skill – Design, Development and Maintenance: *Collect Requirements (User Stories and Card Sorting); Manage user Experience Factors; Create User Interface (includes Build the Layout; create UI Sketches and Prototypes and Handle Multiple Screen Resolutions); Design Data Model; Use Design Patterns and associated items; Manage Product Backlog; Mobilise Existing Application Architectures; Maintain System Responsiveness; Manage Security in mobile Application (including Identify & Mitigate threats to Mobile Apps; Manage Risk using OWASP Resources and Techniques; Encrypt Critical App Data on Mobile Devices and Prevent injection Flaws with Enhanced Input Validation); Manage Mobile SDK; Develop Mobile Application; Develop UI; Test Mobile App; Organise and Manage Trials; Submit App to Store; measure User Experience; Manage feedback from Clients and Support.*

Marketing Skills: *Understand App Store Optimisation and associated items; Enhance App Visibility – Design the Right App Icon/Name and use Online Press; Promote App (Create a Demo/Video; Promote App through Social Media and Get Good App Reviews).*

Soft Skills: *Apply Continuous Learning; Open Approach to Continuous Changes; Problem Solving; Flexibility and Non-formal Learning and Researching.*

## **Mismatches**

While the list above has been identified by the Appskills project as the final list of competences for applications creators, within the list there are areas, identified from the various work packages of the project to date, where there are mismatches that need to be addressed in the development of future Appskills products, including:



Technical Knowledge: *Linkages of applications to cyber security, cloud computing and wider or 'big' data analytics; Quality Assurance Skills; Social Media; Technical Reporting; Programming Basics (Java, C++ and C#).*

Business & Management: *Understand the strategic direction of the business; Leadership; Communications; Legislative Knowledge; IPR; Business Planning; Project Management (including Agile Methodologies); Resource Planning and Financial management; Develop a culture of innovation; Ensure value for money to the business the application is to be applied to; Decision-making and Problem Solving; Entrepreneurial skills; Identifying Commercial Partnerships; Managing Risk; Contract Management and Customer Care.*

Technical Skill – Design, Development and Maintenance: *User Feedback; Technical Reporting; Testing, Usability and Debugging; Graphics for User Interface; Animation; Creativity; Tracking; Database Building; IPR (Patent Protection); Technical Support.*

Marketing Skills: *Evidence-based promotion of applications; Promotional Skills; Social Media Skills; Creativity; SEO Apps Store Optimisation; Product Tracking and Promotion.*

Soft Skills: *Commitment to continuous improvement including self-improvement; Presentation Skills; Sales Skills.*

Developing training courses and qualifications that address the issues highlighted in this report and the previous Appskills reports will require active and genuine engagement with a range of stakeholders to be effective. In order for the AppSkill project to develop relevant and effective solutions and recommendations for the introduction of qualifications and curricula based on the identified competences, including the identified gaps, that contribute to enhancing the developing of mobile applications in the European Union, due recognition of the differences in approaches of nation states is required as identified in the learning outcomes of WP3.2, 'all countries organise their education in their way – knowledge parts often different from



the skills parts – but all qualifications belong inseparably together’. Any interventions suggested by the AppSkill project are required to add value to what is already available.

**Table 1: Mobile Applications - Appskills Identified Mismatches Overview**

	Final Competences – Full List	Appskills Identified Mismatches
<b>Technical Knowledge</b>	<i>Computational Thinking (Abstraction, Algorithms, Decomposition and Pattern Recognition); Event Driven Programming; Mobile Programming; Cross Platform Issues; Data Modelling; Prototyping (Identify Basic Requirements; Develop Prototype; Review Prototype - feedback; Revise &amp; Enhance prototype); Usability; Mobile HW Architecture; Mobile Operating Systems – along with their associated items; Web Services and Mobile App Analytics.</i>	<i>Linkages of applications to cyber security, cloud computing and wider or 'big' data analytics; Quality Assurance Skills; Social Media; Technical Reporting; Programming Basics (Java, C++ and C#).</i>
<b>Business &amp; Management</b>	<i>Understand the Business and the Main goal of the App; Choose the Right Business Mode; Project Management (manage time, money and quality); Understand the Context in which app is used; Understand Real Life Customers; Understand the Legal Ecosystem of apps; Manage Risks during Development &amp; Deployment; Use Agile Methodologies &amp; associated items; Manage Competences (Identification &amp; Classification; Assessment and Training) and Manage Software Quality.</i>	<i>Understand the strategic direction of the business; Leadership; Communications; Legislative Knowledge; IPR; Business Planning; Project Management (including Agile Methodologies); Resource Planning and Financial management; Develop a culture of innovation; Ensure value for money to the business the application is to be applied to; Decision-making and Problem Solving; Entrepreneurial skills; Identifying Commercial Partnerships; Managing Risk; Contract Management and Customer Care.</i>
<b>Technical Skill – Design, Development and Maintenance</b>	<i>Collect Requirements (User Stories and Card Sorting); Manage user Experience Factors; Create User Interface (includes Build the Layout; create UI Sketches and Prototypes and Handle Multiple Screen Resolutions); Design Data Model; Use Design Patterns and associated items; Manage Product Backlog; Mobilise Existing Application Architectures; Maintain System Responsiveness; Manage Security in mobile Application (including Identify &amp; Mitigate threats to Mobile Apps; Manage Risk using OWASP Resources and Techniques; Encrypt Critical App Data on Mobile Devices and Prevent injection Flaws with Enhanced Input Validation); Manage Mobile SDK; Develop Mobile Application; Develop UI; Test Mobile App; Organise and Manage Trials; Submit App to Store; measure User Experience; Manage feedback from Clients and Support.</i>	<i>User Feedback; Technical Reporting; Testing, Usability and Debugging; Graphics for User Interface; Animation; Creativity; Tracking; Database Building; IPR (Patent Protection); Technical Support.</i>
<b>Marketing Skills</b>	<i>Understand App Store Optimisation and associated items; Enhance App Visibility – Design the Right App Icon/Name and use Online Press; Promote App (Create a Demo/Video; Promote App through Social Media and Get Good App Reviews).</i>	<i>Evidence-based promotion of applications; Promotional Skills; Social Media Skills; Creativity; SEO Apps Store Optimisation; Product Tracking and Promotion.</i>
<b>Soft Skills</b>	<i>Apply Continuous Learning; Open Approach to Continuous Changes; Problem Solving; Flexibility and Non-formal Learning and Researching.</i>	<i>Commitment to continuous improvement including self-improvement; Presentation Skills; Sales Skills.</i>



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