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# Analysis of accreditation approaches in the Computing sector

Institute of Coding – Work Package 1.1 – Deliverable 1.1.1

David S Bowers, Oli Howson  
The Open University, Milton Keynes, UK

[David.Bowers@open.ac.uk](mailto:David.Bowers@open.ac.uk), [Oli.Howson@open.ac.uk](mailto:Oli.Howson@open.ac.uk)

## Abstract

This report for the Institute of Coding explores the extant accreditation regimes for Computing in the UK. It seeks to clarify the relationships between the main frameworks and standards, and how these map to some of the issues identified in the Shadbolt review.

Three primary perspectives are identified: academic, technical and competencies. Following an analysis of their key features, this report concludes by suggesting how they might be combined to help address some of the common issues with new graduates identified by Shadbolt.

## Table of Contents

<b>Abstract</b> .....	<b>1</b>
<b>1. Introduction</b> .....	<b>3</b>
<b>1.1. Aims</b> .....	<b>3</b>
<b>1.2. The meaning of accreditation</b> .....	<b>3</b>
<b>1.3. Issues with accreditation</b> .....	<b>3</b>
<b>2. Overarching Requirements</b> .....	<b>6</b>
<b>2.1. Subject Benchmark Statements</b> .....	<b>6</b>
<b>2.2. Credit</b> .....	<b>6</b>
<b>2.3. Levels</b> .....	<b>7</b>
2.3.1. NQF and the higher education levels .....	7
2.3.2. Vocational Qualifications.....	8
2.3.3. Apprenticeships.....	9
2.3.4. Skills Frameworks .....	9
2.3.5. Vendor certifications .....	10
2.3.6. Summary .....	11
<b>2.4. PSRB accreditation requirements</b> .....	<b>11</b>
<b>3. Discussion</b> .....	<b>13</b>
<b>3.1. Where are the gaps?</b> .....	<b>13</b>
<b>3.2. Understanding the tensions</b> .....	<b>14</b>
3.2.1 Theory vs practice .....	14
3.2.2 Genericity vs specificity .....	15
<b>3.3. Outcomes</b> .....	<b>16</b>
3.3.1 Competence vs knowledge .....	16
3.3.2 Specific vs generic.....	16

3.3.3.	Training vs education .....	17
3.3.4.	Employability vs academic .....	17
3.3.5.	Curriculum input vs demonstrable outputs .....	17
<b>4.</b>	<b>Conclusions .....</b>	<b>19</b>
	<b>Acknowledgements .....</b>	<b>19</b>
	<b>Appendix i: Summary tables for FHEQ, FQHEIS, Computing SBS and BCS accreditation .....</b>	<b>20</b>
<b>1.1</b>	<b>QAA Quality Code part A.....</b>	<b>20</b>
<b>1.2</b>	<b>Bachelor's degrees.....</b>	<b>21</b>
	Descriptor for a higher education qualification at level 6 on the FHEQ: bachelor's degree with honours .....	21
	Descriptor for a higher education qualification at SCQF level 10 on the FQHEIS: bachelor's degree with honours in Scotland .....	22
<b>1.3</b>	<b>Master's degree.....</b>	<b>23</b>
	Descriptor for a higher education qualification at level 7 on the FHEQ and SCQF level 11 on the FQHEIS: master's degree.....	23
<b>1.4</b>	<b>Higher Education credit framework for England.....</b>	<b>24</b>
<b>1.5</b>	<b>The framework for qualifications of higher education institutions in Scotland .....</b>	<b>25</b>
<b>1.6</b>	<b>QAA Computing Subject Benchmark Statement (Bachelor's) .....</b>	<b>26</b>
	Benchmark.....	26
	Skills .....	27
<b>1.7</b>	<b>BCS Accreditation Criteria .....</b>	<b>29</b>
	Undergraduate core .....	29
	Additional requirements for CITP .....	30
	Additional requirements for CEng .....	30
	<b>Appendix ii: Current landscape.....</b>	<b>31</b>
<b>2.1.</b>	<b>Qualification frameworks.....</b>	<b>31</b>
<b>2.2.</b>	<b>PSRB accreditation.....</b>	<b>32</b>
<b>2.3.</b>	<b>Industry and Vendor accreditation .....</b>	<b>33</b>
<b>2.4.</b>	<b>Bodies of knowledge.....</b>	<b>38</b>
<b>2.5.</b>	<b>Degree apprenticeships.....</b>	<b>40</b>
<b>2.6.</b>	<b>Skills/competency frameworks .....</b>	<b>41</b>
<b>2.7.</b>	<b>The international dimension .....</b>	<b>46</b>
2.7.1.	Degrees.....	46
2.7.2.	Accreditation .....	46
2.7.3.	Skills frameworks.....	47

## 1. Introduction

### 1.1. Aims

This deliverable for the Institute of Coding (IoC) aims to provide background to support the development of the IoC Accreditation Standard. To do this, it seeks to:

- describe and distinguish the various accreditation, qualification and skills frameworks relevant to degrees in coding/computing/cybersecurity/digital skills
- relate the frameworks to relevant bodies of knowledge
- explore some challenges of mapping between them
- elucidate the issues from both academic and industrial perspectives

### 1.2. The meaning of accreditation

Academic Accreditation in the UK usually means confirmation by a Professional, Statutory or Regulatory Body (PSRB) that a particular degree satisfies some or all of the educational requirements required for that PSRB to award a specific professional status – such as Chartered Engineer (CEng) or Chartered Information Technology Professional (CITP). Professional status, in turn, usually implies meeting requirements of regulating body, as well as post-nominals.

For the broad area of Computing, there are two relevant PSRBs – British Computer Society (BCS) and Institute of Engineering and Technology (IET) – both of which can award CITP and CEng. In recent years, other PSRBs have emerged for more specialist areas – such as the Institute of Information Security Professionals (IISP), accrediting against National Cyber Security Centre Cyber Security Body of Knowledge (NCSC CyBoK), for students on a pathway to chartered membership of IISP.

Yet others, such as Tech Partnership Degrees (TPD), have reinterpreted the term “accreditation” simply to mean that they believe that a qualification conforms to their particular take on curriculum content. But TPD is neither a degree-awarding body nor a PSRB. TPD degrees and degree apprenticeships are awarded by HEIs, conforming to TPD requirements. Furthermore, there is no recognised professional status associated with the completion of a TPD degree or apprenticeship, although graduates may well have enhanced employment prospects. So, TPD accreditation is simply an endorsement that a degree (apprenticeship) awarded by a particular higher education institution (HEI) meets the syllabus requirements set out by TPD and is approved by their industry standards committees.

### 1.3. Issues with accreditation

There has been a long-standing perception that there are “problems” with the accreditation of computing degrees, with accompanying folklore that computer science graduates, even from accredited courses, are somehow unready for employment. There has been continuing evidence in the survey of Destinations of Leavers of Higher Education (DLHE) that computing graduates appear to have poorer employment prospects than graduates in other subject areas, with an unemployment rate of 10.6% cited for graduates in 2016/17, the highest figure for any subject area in the DLHE survey for that year<sup>1</sup>. This issue, and the question of how accreditation contributes to employability, were probed in depth in the Shadbolt Review<sup>2</sup>.

The Executive Summary of the Shadbolt Review starts by laying to rest any notion that there are problems with *all* Computer Science graduates, or *only* with Computer Science graduates:

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<sup>1</sup> Destinations of Leavers from Higher Education 2016/17, HESA, July 2019, available at <https://www.hesa.ac.uk/news/19-07-2018/DLHE-publication-201617> (accessed 03 June 2019)

<sup>2</sup> Shadbolt Review of Computer Sciences Degree Accreditation and Graduate Employability, Department for Business, Innovation & Skills and Higher Education Funding Council for England, May 2016, available from [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/518575/ind-16-5-shadbolt-review-computer-science-graduate-employability.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/518575/ind-16-5-shadbolt-review-computer-science-graduate-employability.pdf) (accessed 03 June 2019)

*In many areas, the performance of Computer Sciences graduates from English HEIs is outstanding, and the majority of graduates go on to fulfil important and rewarding jobs. The review recognises that there is much that is good about Computer Sciences as an academic discipline and its graduates. [...] Although we have uncovered some challenges around employment outcomes for a number of graduates, it is significant that Computer Sciences as a discipline is not alone.*

*Shadbolt (2016) ¶ 2.1*

The executive summary continues by emphasising that the problem appears to be one of misalignment between the supply (of graduates) and the demand (for graduates)

*The relatively high unemployment rates of Computer Sciences graduates which for the purposes of this review includes all courses within the Computer Sciences subject heading, is at odds with significant demand from employers and the needs of the burgeoning digital economy. The review considers evidence that the supply of Computer Sciences graduates, and the needs of employers appears in some way misaligned, uncovers a complex interrelationship between supply and demand, and puts forward recommendations for how this might be addressed.*

*Shadbolt (2016) ¶ 2.2*

In the body of the report, Shadbolt sets out the “problem” thus:

*While many employers find that Computer Sciences graduates are well prepared for work, there continues to be a bloc of opinion that suggests that more could be done to improve graduates’ skills and work readiness. [...] There are a number of commonly reported issues, with graduates lacking work experience and commercial awareness, a lack of soft skills and insufficient technical knowledge among those most often quoted.*

*Shadbolt (2016) ¶ 2.9*

*[...] lack of a coherent employer voice on what makes an employable Computer Sciences graduate. In addition to variations across industrial sectors and types of role, the needs of start-ups and SMEs should be taken into account as much as the requirements of large organisations. Small and micro businesses are increasingly at the heart of the digital revolution, and it is vital that the needs of these types of businesses are appropriately fed into the Computer Sciences graduate employment picture.*

*Shadbolt (2016) ¶ 2.11*

*It would benefit all stakeholders, including graduates, if employment outcomes, and employability, were to become a more central part of accrediting a degree programme.*

*Shadbolt (2016) ¶ 2.14*

And, Shadbolt's recommendations include the following:

*HE providers and employers should consider how new models of provision [...] may provide opportunities for students to develop work readiness skills alongside their academic studies. Employers should work with HE providers to support them in incorporating these opportunities into degree programmes. Employers should also recognise their role in providing training to graduates to enable them to develop professionally and to adapt their skills to the specific needs of a particular employer or industry.*

*Shadbolt (2016) Recommendation 4*

*SMEs should be supported to ensure that their requirements for Computer Sciences graduate skills are captured and adequately reflected.*

*Shadbolt (2016) Recommendation 7*

*Accreditation of courses should be focussed on outputs. Accrediting bodies should work to increase awareness and value of accreditation so that it is valued by HE providers, students and employers.*

*Shadbolt (2016) Recommendation 9*

Having noted above that the approach of Tech Partnership Degrees to the specification and “accreditation” of Degree Apprentices departs from the traditional concept of accreditation, it represents, nevertheless, a worthy attempt to address some of the issues identified by Shadbolt, and to implement some of the recommendations in his report.

The IoC's development of a standard is an alternative approach to addressing the issues raised by Shadbolt.

## 2. Overarching Requirements

The Framework for Higher Education Qualifications of Degree-Awarding Bodies in England, Wales and Northern Ireland (FHEQ), and The Framework for Qualifications of Higher Education Institutions in Scotland (FQHEIS) are set out in [Part A of the UK Quality Code for Higher Education](#).

Although the frameworks, and the overall Quality Assurance Agency for Higher Education (QAA) Quality Code, are not of themselves statutory requirements, degree awarding bodies such as Universities are expected to set and maintain academic standards that are consistent with the reference points in the Quality Code, and with FHEQ and FQHEIS in particular.

Since some degree awarding bodies may not use a credit structure, and some may use European Credit Transfer Scheme (ECTS) credits rather than Credit Accumulation and Transfer Scheme (CATS) credits, FHEQ does not specify the credit volume required for a particular qualification. Rather, it specifies outcomes statements for each kind of qualification; a separate HE credit framework<sup>3</sup> is published for England. All three aspects – level, credit volume and output characteristics – are included in FQHEIS.

QAA have verified the alignment of both FQHEIS<sup>4</sup> and FHEQ<sup>5</sup> with the Framework for Qualifications of the European Higher Education Area (QF-EHEA). Thus, qualifications aligned to either FQHEIS or FHEQ are compatible with QF-EHEA.

### 2.1. Subject Benchmark Statements

The two frameworks for Higher Education qualifications, FHEQ and FQHEIS, are necessarily generic, and apply to degrees in any subject. The contextual information about what should be included in a particular degree is contained in the relevant Subject Benchmark Statement, which is also published by QAA.

The Computing Subject Benchmark Statement, for Bachelor's degrees, both summarises standards of graduate achievement (the “benchmark”, for threshold, typical and excellent students) and sets out the skills they should demonstrate, under the headings of cognitive skills, practical skills and generic skills for employability.

Given the breadth of the computing field, the subject benchmark statement (SBS) is gloriously non-specific. Although it does suggest that note should be taken of the (considerably more prescriptive and detailed) Association for Computing Machinery (ACM) Bodies of Knowledge when designing a curriculum, the SBS itself is deliberately flexible. The summary lists of the Computing SBS are reproduced in the Appendix, for reference.

### 2.2. Credit

Credit is a measure of (total) study time, including directed learning, self-study, revision and assessment. There are two fundamental applications of credit: to calculate how “big” a particular qualification is, and to allow students to transfer (completed) credit for prior learning from a different institution.

The starting point is that one year of full-time study on an undergraduate course is taken to be 1200 hours of effort. There are essentially two relevant credit frameworks: the CATS and the ECTS. The only difference between these frameworks is a simple factor of two: one year of full-time undergraduate

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<sup>3</sup> Higher education credit framework for England, QAA (2008), available from <https://www.qaa.ac.uk/docs/qaa/quality-code/academic-credit-framework.pdf> (accessed 03 June 2019)

<sup>4</sup> Verification of Compatibility of the FQHEIS with the FQ-EHEA: Report of the Scottish Working Group: <https://www.qaa.ac.uk/docs/qaa/quality-code/verification-of-compatibility-scottish-fqhe.pdf> (accessed 03 June 2019)

<sup>5</sup> QAA (2009) Verification of the Compatibility of the FHEQ with the FQ-EHEA: <https://www.qaa.ac.uk/docs/qaa/quality-code/verification-of-the-compatibility-of-fheq-with-fq-ehea.pdf> (accessed 03.06.19)

study is set at 120 CATS credits, or 60 ECTS credits; so a (CATS) credit corresponds to 10 hours of effort.

A credit value, and level (discussed in the next section) can then be assigned to each module, course or chunk within a degree programme. Credits are awarded for completion of study, including some form of summative assessment. Typically, within a University degree, the smallest component would be 10, or very occasionally 5, CATS credits, with a common maxima of 30, 40 or 60, or for some placement years, 120. Whatever the chunks are called, they tend to be indivisible – that is, students either pass the whole chunk, being awarded the relevant number of credits, or they fail the whole chunk, with no credits awarded.

It is important to note that the full time study year of 1200 hours is for an undergraduate course: for a Master's course, the norm is 1800 hours, or 180 CATS credits.

With the increasing popularity of small chunks of online learning, often presented as Massive Open Online Courses (MOOCs), the lower limit of 10 credits for a chunk of learning is becoming blurred. A MOOC may have an expected study time of only a few hours, so, if a credit value is associated with a MOOC, it may be only 1 or 2 credits. However, the processes by which such credit values – and levels – are associated with MOOCs is not always transparent.

It should also be noted that the study hours for a module/chunk/whatever are the total over the term/semester or year. This contrasts directly with the USA system of defining module “size” in terms of the teaching hours per week over a semester. The equivalence is not direct (e.g.,  $N$  teaching hours per week \* number of weeks), as this does not take into account self-study, reflection, revision and assessment.

### 2.3. Levels

One of the greatest sources of confusion is the multiplicity of qualification and skills frameworks, each of which has several levels. Unfortunately, the numbering varies between frameworks, as does the purpose of the framework itself.

**Figure 1** shows the approximate alignment between the principal frameworks relevant to accreditation in England. There are some differences in Scotland, Wales and Northern Ireland, but the principles of the discussion that follows remain the same.

At the centre of the diagram is the (English) National Qualification Framework (NQF). To the right, the informal numbering of levels used internally by some universities, corresponding to 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> years of study. The correspondence to the three cycles of the Bologna process (QF-EHEA) is shown on the far right. To the left of the NQF are the levels of the Skills Framework for the Information Age (SFIA). SFIA is fundamentally different from the educational levels on the right of the diagram, but there is some scope for aligning where, on the SFIA framework, it might be reasonable for new graduates/diplomates/school leavers to start working.

#### 2.3.1. NQF and the higher education levels

These three frameworks attempt to align “educational” qualifications, such as those pursued in school, college or university, exemplars of which are shown to the right of the NQF levels. For example, a Bachelor's degree is at level 6 on the NQF, and is usually awarded on completion of the first, second and third years of study at a University. Completion of these three years of study corresponds to the first cycle of the Bologna process in the European Higher Education Area (EHEA).



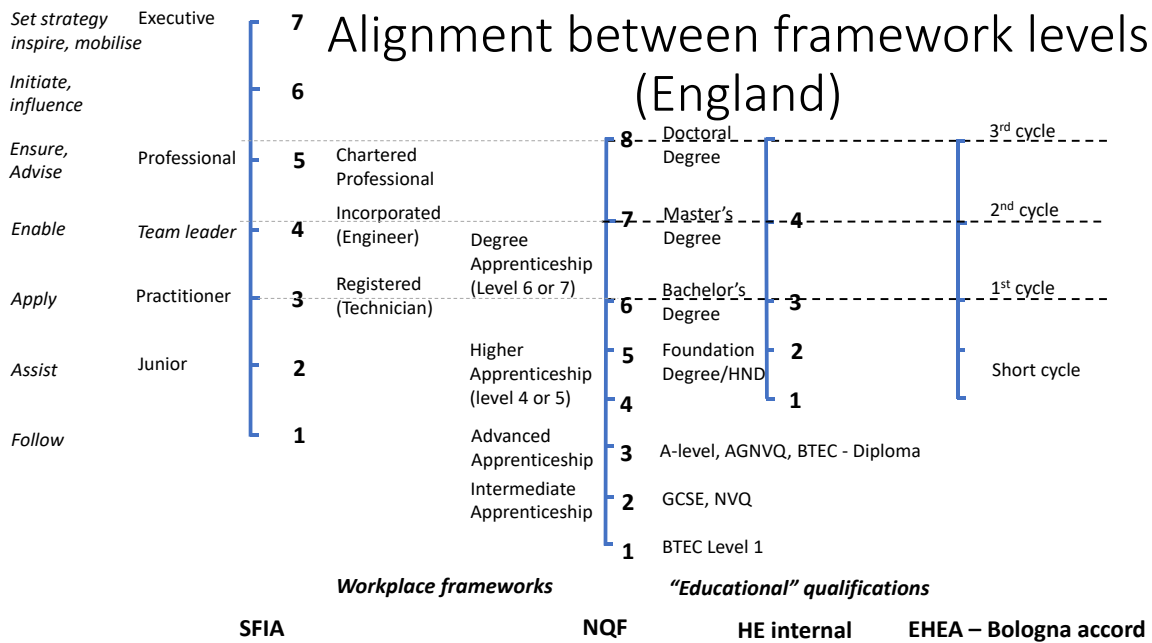


Figure 1: Alignment between qualification framework levels (England)

In some universities, the “1-2-3” numbering of the years of study is used also to denote the level of study, so students study “level 3” modules in their third year. This may also be extended to master’s study – corresponding to year 4 – although, depending on the university, the “level” of Masters’ modules may be denoted 4, 6 or 8 (or even just “M”). Of course, none of these labels correspond either to the NQF or to the Bologna cycles; they are purely internal.

Most universities who use these “internal” levels do acknowledge the correspondence between their internal levels and NQF levels, so that “internal” level 1 should, formally, be referred to as (NQF) Level 4. However, when discussing levels of study in the context of the broader picture, the fact that “HE level 3” corresponds to NQF level 6, and to the end of the Bologna first cycle, introduces scope for significant confusion. “Level 3” is not a unique identifier.

A final comment about the levels on the right of figure 1 is that they all refer to periods of continuous, usually time-limited, education, such as a two-year A-level course or a three-year degree programme. Starting with years 10 -11 in school (and year labelling is another can of worms that could be explored!), the NQF covers General Certificates of Secondary Education (GCSEs and low-level vocational qualifications such as Business and Technology Education Council (BTEC) first certificates. Post-16 qualifications are at NQF level 3, and include A-levels, Advanced General National Vocational Qualifications (AGNVQs) and BTEC National diplomas. T-levels are expected to sit at this level also. Levels 4 and 5 of the NQF may correspond to Higher National certificates and diplomas, often taught in Further Education (FE) colleges, or the first two years of University education. Levels 6, 7 and 8 correspond primarily to university-level education – namely Bachelor’s, Master’s and Doctoral degrees.

### 2.3.2. Vocational Qualifications

The NQF is used not only to describe the level of “educational” qualifications, but serves the same purpose also for both vocational qualifications and apprenticeships. National Vocational Qualifications (NVQs) are available at levels 1 to 5 on the NQF, but are not time-limited.

Vocational qualifications are fundamentally practical rather than theoretical. They may be part of the initial training for a job, or they may be set in a context of continual professional development (CPD). For example, across the UK, the majority of domiciliary care workers are expected to achieve NVQ

level 2 within a year or so of starting work – regardless of their age. Similarly, those handling food in settings such as restaurants are legally required to achieve a Level 2 food Hygiene Certificate. Although there may be a small amount of classroom teaching, the assessment of a vocational qualification is based primarily on the ability of candidates to perform the duties that are part of their job. At the lower levels, this may be assessed by observation; at higher levels, by discussion of a portfolio of evidence. However, for some common qualifications – including food hygiene! – there appears also to be the possibility of sitting an online exam.

Although the NQF attempts to express the difficulty of each qualification through the level to which it is aligned, there is no assertion of the volume of study. In many cases, the alignment to the NQF relies on an assessment of achievement, independent of the journey the learner has undertaken. For example, a level 3 Food Hygiene qualification – for somebody supervising food handling and developing food safety management systems – the formal study time is apparently of the order of 10-12 hours, with only a minimal expectation of any period of experience. This qualification is positioned on the NQF alongside A-levels and BTEC National Diplomas, which may require a couple of years of full-time study.

### 2.3.3. Apprenticeships

The final set of qualifications set alongside the NQF are apprenticeships. By definition, these are work-based, but may include an educational qualification. For example, an advanced apprenticeship (Level 3) may include an NVQ or a diploma; a higher apprenticeship (Level 5) a Higher certificate, diploma or a foundation degree, and a degree apprenticeship (level 6 or 7) either a Bachelor's or Master's degree, as appropriate.

As with other qualifications, the NQF is agnostic about the study time required. Where there is a formal qualification embedded, the duration of the apprenticeship is likely to be determined by the study time for that qualification – so, for example, 3 or 4 years for a Degree Apprenticeship, depending on study intensity.

### 2.3.4. Skills Frameworks

The levels of the SFIA framework, shown on the left of figure 1, do not correspond to time-limited educational experiences, but rather to the development of skills and competences over a lifetime career. The key characteristics of the different levels relate to the responsibility and autonomy of an individual, as demonstrated in their application of one or more skills. The levels are described by short phrases, shown at the extreme left of figure 1, ranging from “follow” (for a new trainee) at SFIA level 1 to “set strategy, inspire, mobilise” for a C-level executive (e.g., chief information officer, chief executive officer etc.) at SFIA level 7.

Alternative descriptions of the levels are shown immediately to the left of the scale. Levels 1 and 2 are essentially “juniors” or “trainees” (we will avoid the term “apprentice”, to minimise confusion with the apprenticeship levels defined against the NQF). Level 3 in SFIA – those who are competent to *apply* their skills – can be thought of as “practitioners”; and higher levels might include “team leaders”, “managers” and “executives”.

It is worth noting that the relevant PSRBs, including BCS and IET, map their various registrations to the levels of competence and autonomy described in the SFIA framework; so chartered status is mapped to SFIA Level 5, Incorporated status to SFIA Level 4 and Registered level to SFIA level 3.

Although the lower SFIA levels are shared also by the IT National Occupational Standards (NOS), developed by e-skills/TechPartnership, the SFIA framework is careful not to imply any automatic progression through the levels on the basis of time served, whereas the NOS give indicative timings for progression between levels. Whilst these timings may be reasonable for many practitioners, it should be

emphasised that time served is not, of itself, sufficient to guarantee the requisite skill level, and even less the levels of responsibility and autonomy.

Having noted that the primary purpose of the NQF is to express the level of difficulty associated with a particular (taught) qualification, whereas the SFIA framework is concerned with the development of skills throughout a working lifetime, it should be clear that there is no a priori reason for there to be any direct alignment between the two.

However, it is broadly accepted within the SFIA community that a new graduate, with a relevant degree (NQF Level 6) could be expected to be working at SFIA level 3.

Considering only the knowledge required to underpin the relevant SFIA skills, it might be argued that a Masters degree (NQF Level 7) might provide some requisite knowledge between SFIA Level 4 and Level 5, and a doctoral degree might correspond to a subset of the knowledge required somewhere between SFIA Levels 5 and Level 6. However, these are woefully inadequate alignments, as the emphasis of the SFIA framework is on competence and autonomy, not mere knowledge.

### 2.3.5. Vendor certifications

The IT sector is replete with vendors offering certifications (usually only in their own technologies) at a range of levels, as summarized in Table 1. BCS L&D is included in this list, not because it is a vendor of specific technologies, but because the BCS certifications seem to be playing in the same market as those from various vendors.

Table 1 Summary of selected Vendor certification levels

Vendor	Certification levels
<a href="#">Microsoft</a>	Fundamentals, Associate, Expert; some preparatory courses labelled as level 1(00) to 4(00).
<a href="#">Oracle</a>	Junior Associate, Associate, Professional, Master, Specialist, Expert
<a href="#">Cisco</a>	Entry, Associate, Professional, Expert, Architect
<a href="#">BCS L&amp;D</a>	Foundation, Intermediate, Practitioner, Higher
<a href="#">Axelos</a>	Foundation, Intermediate, Expert, Master
<a href="#">Amazon AWS</a>	Foundational, Associate, Professional; Specialty
<a href="#">IBM</a>	“entry level” to “advanced”
<a href="#">APM</a>	Foundation, Management, Professional
<a href="#">LPI</a>	Administrator, Engineer, Professional

Although some designations – such as Associate and Professional – are offered by several vendors, there is little clarity about how any of these levels map either between vendors or to other frameworks. Explicit mapping to either NQF or its Scottish equivalent is scarce and may not always be consistent. Given that the driving force for most of these certifications is to support the use of a particular vendor’s technology, the “levelness” seems to be determined primarily by the extent of a candidate’s prior and post knowledge, with respect to that technology, rather than against any broader scheme.

Indeed, anecdotally, some years ago, when the authors’ University was seeking to map one vendor’s “Associate” certification to HE levels, it made a determination of “around HE Level 2” (NQF Level 5). Simultaneously, the vendor was itself seeking to demonstrate that the same Associate certification mapped to Level 3 of the NQF, so that it could legitimately be taught in sixth forms and FE colleges. When this disparity was raised with the vendor, they suggested, first, that they believed that the certification in question could happily be mapped simultaneously to both NQF levels, and then that they were simply trying to get their certification into schools – but that they weren’t really interested in any objective assessment of their “levelness”.

### 2.3.6. Summary

To summarise, it is important to be aware which framework is being referenced when citing a level. Level 3 in the NQF corresponds to A-levels, National Diplomas and Advance Apprenticeships. Level 3 may refer to the final year of study within an undergraduate degree programme. Good graduates with a relevant degree (including plenty of real experience) may be able to work at Level 3 in the SFIA framework. But the Third cycle (“level 3”) of the Bologna process actually refers to a PhD!

Furthermore, the SFIA framework, and other skills frameworks including ECF and the IISP skills framework, are designed to capture career-long skills acquisition, whereas the NQF is (largely) concerned with progression through incremental taught qualifications. Thus, it is unreasonable to expect there to be any direct correspondence between the levels in skills frameworks (such as SFIA) and a formal qualifications framework (such as NQF).

A final comment is that this discussion can be adapted readily to be based on, for example, FHEQIS for Scottish qualifications. This is left as an exercise for the reader.

### 2.4. PSRB accreditation requirements

For many academic subjects, given the relevant qualification framework (FHEQ or FQHEIS) and an appropriate SBS, it can be left up to an individual University to assure itself that a particular degree satisfies the relevant requirements of framework, credit volume and level and SBS.

One of the advantages of formal accreditation by a Professional Body such as BCS, the Chartered Institute for IT, is that it provides external scrutiny of the composition of a degree and can confirm – or otherwise – that it is consistent with both the relevant qualification framework and the SBS.

Until the latest revision of the Computing SBS, in 2016, the accreditation criteria set by BCS and the content of the SBS were quite closely aligned – not least because BCS, as the relevant PSRB, had been involved in the development of previous versions of the Computing SBS.

Nevertheless, it is possible to trace the majority of facets of both the FHEQ outcomes statements and the SBS benchmark and skills in the BCS accreditation criteria, reproduced for reference in the Appendix.

Accreditation by BCS ensures recognition of accredited degrees by other signatories to the [Seoul Accord](#). Degrees accredited by BCS on behalf of the Engineering Council (ECUK) – that is, as meeting part or all of the educational requirements for CEng – are also recognised by signatories to the [Washington Accord](#). Finally, BCS accredited degrees are eligible (following payment of a fee) for the Euro-Inf quality label.

It might well be noted that, if all of the accreditation requirements for CITP were to be given appropriate weight when designing, and assessing, a particular degree programme, many employers’ concerns discovered by the Shadbolt review might be addressed. There would seem to be little to argue about with the criteria themselves; but perhaps instead with the emphasis placed on them either by universities, the accreditation process or even the students themselves. One recurring example might be team-working skills: employers want them, and accreditation requires them to have been developed. In some programmes, they are integrated well, but despite this, many students seem to dislike/de-emphasise (or even hate!) them.

Of course, a traditional degree programme is time-constrained – usually to the equivalent of three years of full-time study. It may just not be possible to include everything that would be “nice”. Indeed, there is an inevitable trade-off in the design of a programme between breadth and depth, which can lead to patchy coverage of and variable emphasis on important accreditation outcomes.

Perhaps the key point is made in Shadbolt's recommendation 9: that accreditation should focus on outputs; in particular on outputs that demonstrate the accreditation criteria.

### 3. Discussion

The obvious comment to make about the accreditation space for Computing is that it is crowded and complicated.

Fundamentally, there are three complementary perspectives: academic (represented by NQF/FHEQ/FQ-EHEA); skills (SFIA/NOS/specialist); and vendor training (focussed application of skills) There is some blurring of the distinctions because NVQs and Apprenticeships are aligned to the NQF rather than to a skills framework, even though they are fundamentally practical rather than academic.

#### 3.1. Where are the gaps?

Shadbolt noted that many computing graduates are valued and sought by employers; so the question really is, where are the gaps, rather than what is wrong with the current approaches.

The issues identified by Shadbolt as being most commonly reported were a lack of work experience, commercial awareness, soft skills and specific technical knowledge. Although these all appear to some extent in the current accreditation criteria, the emphases are different. For example, FHEQ makes no reference to commercial awareness, perhaps because that is seen as context for a particular subject; but the Computing SBS goes only as far as:

contextual awareness: the ability to understand and meet the needs of individuals, business and the community, and to understand how workplaces and organisations are governed.

*Computing SBS, Generic skills (vi)*

This could be interpreted as a largely theoretical or abstract requirement – “understanding”, in an abstract, Bloom-esque, manner, rather than having a deep, practical grasp of the issues.

In the BCS accreditation criteria that we find:

- Knowledge and understanding of the commercial and economic context of the development, use and maintenance of information systems
- Evaluate systems in terms of general quality attributes and possible trade-offs presented within the given problem
- ..., identify constraints, understand customer and user needs, identify and manage cost drivers, ...
- Apply the principles, methods and tools of systems design to develop information systems that meet business needs

*BCS Accreditation criteria – core, CITP, CEng*

Which would seem to cover several aspects of commercial awareness, but not all.

In the SFIA skills framework, the generic description for level 3 – the level a new graduate should expect to be working - includes:

- (Influence) Understands and collaborates on the analysis of user/customer needs and represents this in their work.
- (Knowledge) Has an appreciation of the wider business context.
- (Business skills) Appreciates how own role relates to other roles and to the business of the employer or client.

Again, these descriptors may not include explicit “commercial awareness”; but the aspects mentioned may be closer to what employers are seeking than the primarily technocentric requirements of the accreditation criteria, and perhaps spell out what is actually intended by the statement in the Computing SBS.

Similar comparisons can be drawn for the other three “deficiencies” Shadbolt identifies as being cited most often. The question is one of perspective. The SBS and accreditation criteria are fundamentally academic, so they say little about work experience, or, indeed, about application of detailed technical knowledge. Vendor certification, on the other hand, tends to be strong on the practical aspects of doing things with particular technologies, but is sometimes light on underlying theory – the very thing that CS graduates are in demand for: understanding “why” rather than just “how”. And skills frameworks, such as SFIA, focus on skills acquired and refined by doing things in the real world – underpinned by relevant knowledge, but developed through work experience.

### 3.2. Understanding the tensions

This section of this report raises more questions than asserts answers, in the hope that they may stimulate discussion across the IoC consortium.

#### 3.2.1 Theory vs practice

This is perhaps the sharpest division.

Focus on Bloom’s Taxonomy<sup>6</sup> in the academic environment may not have been helpful. The taxonomy was devised by a committee of educators, and the domain most used in assessment is that attributed to Bloom (as rapporteur) – the cognitive domain, which is entirely knowledge-focussed. The taxonomy is perhaps too often interpreted as:

- Knowledge – remembering principles and facts [P&F]
- Comprehension – understanding what the P&F mean, and how they can be expressed as techniques
- Application – of the techniques to classroom exercises of appropriate complexity and challenge
- Analysis – of a set of theoretical (classroom-based) problems, to choose an appropriate technique for application
- Synthesis – combination of multiple techniques for complex problems
- Evaluation – of the outcomes of the (theoretical) application of techniques to (theoretical) classroom exercises.

This kind of focus might lead to the notion that “competence” means being able to argue cogently about principles, rather than actually being able to do anything.

But employers seem to be seeking competence in *doing* things. Perhaps, rather than Bloom’s cognitive domain of learning, it would be appropriate to consider the psychomotor domain, reported by Simpson<sup>7</sup>, in order to understand the development of competence. Although developed initially in the context of primarily physical skills, it seems highly relevant to any practical discipline. The hierarchy can be summarised as follows:

- Perception - responds to cues in real world

<sup>6</sup> Bloom’s Taxonomy, e.g., [https://en.wikipedia.org/wiki/Bloom's\\_taxonomy](https://en.wikipedia.org/wiki/Bloom's_taxonomy) (accessed 04 6 19)

<sup>7</sup> Simpson, Elizabeth (1972). "Educational objectives in the psychomotor domain". Washington, D.C.: Gryphon House: 25–30. Scanned PDF available at <https://files.eric.ed.gov/fulltext/ED010368.pdf> (accessed 04.6.19)

- Set - knows and applies a sequence of steps
- Guided response - imitation and practice
- Mechanism - learned responses with confidence and proficiency
- Explicit overt response - quick, accurate and coordinated performance

Of course, the division is not one-sided. Colleagues have doubtless encountered the timeless question of whether or not maths (in any form) is a relevant business skill, with the implication that universities should be spending their time teaching their students something more “useful”. Sometimes, this argument extends to computational thinking and, by extension, to data structures and algorithms. But would it be wise to exclude such topics from computing curricula in favour of something – anything! – “more relevant”?

The real question is, “Who actually knows best?” Was Eric Schmidt correct when he argued publicly<sup>8</sup> that every child needs to learn to program? Even if they are never going to touch a computer again after leaving school? And, if everyone needs to learn to program, putting it on a par with mathematics and English, how can mathematics not be “relevant” to business?

### 3.2.2 Genericity vs specificity

In this debate, two separate issues are often conflated. The first, concerning vendor/platform neutrality vs. knowledge or experience contextualised by a particular product is the most relevant. The second – distinguishing between principles and practice – is really just a re-expression of the theory vs practice division explored in the previous section; it will not be discussed further here.

So, this debate is essentially about whether graduates should be familiar with the latest versions of every specific technology that they have encountered. So, for example, is Oracle SQL a distinct skill from DB2 SQL? Is imperative programming in Python different from programming in, say, JavaScript? Or Java from C#? Many commercial training courses seem to imply that they are – focussing on very narrow questions of how to achieve something in a particular package.

And what about versions? Is Python 3 really that different from Python 2? Or are different generations of a particular vendor’s flavour of SQL really distinct?

This debate is one which is depressingly persistent, and which can result in academics having to justify, or even excuse, the content of their courses. The response, of course, is that, having understood the principles of programming, databases, machine learning, cybersecurity or whatever in one context, it is having learned those principles that will enable graduates to move quickly from one specific implementation to another. Perhaps a more concerted effort to communicate this (shared) aim of higher education – to develop a grounding in principles that will enable the graduate to adapt and continue learning – would be beneficial to both industry and to universities?

It is notable that all of the accreditation and skills frameworks are completely agnostic about specific technologies. The requirements are completely generic. This is for the reason given above: it is principles that matter in education. Of course, they need to be instantiated to be properly understood – learning to “speak” SQL requires real interaction with a real dbms. But, within reason, it probably doesn’t matter which dbms, provided due effort is made to cover any deficiencies in the particular implementation of SQL used.

The SFIA skills framework has much more detail than any of the accreditation frameworks. It is intended to capture the kinds of things that one might do as a software developer, a project manager, or a

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<sup>8</sup> <https://gigaom.com/2011/08/29/eric-schmidt-challenges-teachers-get-with-the-program/> (accessed 03.6.19)



database manager. But it is still vehemently vendor-neutral. Otherwise, it would immediately exclude those employers who happened not to use whichever software it mentioned.

Of course, as with the debate over theory versus practice, the debate is not one-sided: it isn't just about employers failing to grasp the essential beauty of principles in comparison with tawdry implementation. One of the authors of this report recalls a meeting with an employer – or, strictly, someone responsible for interviewing, selecting and then managing new graduates. His complaint was that the graduates might know all sorts of marvellous modern approaches, techniques and so on, but when faced with the task of maintaining a piece of legacy code, all they were prepared to consider was rewriting it completely in their favourite “modern” language – whether or not it would then be compatible with the remainder of the system. Perhaps it is not just employers who need to be convinced of the reasons for learning principles?

### 3.3. Outcomes

Shadbolt identified a small number of gaps and misalignments, not accreditation processes that are completely unfit for purpose.

However, having considered some of the common debates surrounding the “gaps” between what is taught in Universities and what is needed by employers, it might be argued that universities (still) teach predominantly principles and theory, whereas what is needed by employers is practical competence. Of course, many universities are already making significant efforts to address this mismatch, but assessment practices that are developed solely through the lens of Bloom’s cognitive dimension may militate against rewarding practical competence.

Apart from the eternal imperative for clear communication of what any particular course delivers, and what its graduates will be equipped to do, there may be scope for revisiting the existing accreditation frameworks, standards and statements, seeking to ensure that courses really do deliver what graduates will need in their careers.

This raises questions about how achievement might be assessed, and how those achievements might be recognized.

#### 3.3.1 Competence vs knowledge

Knowing how to do something (in theory...) is not the same as being able to do it in practice, effectively. Nor should be assumed that *assessment* of the ability to do something in practice should be approached in the same way as the ability to argue about its merits and demerits. Both are important, but they need to be assessed differently.

It is no surprise that, when Simpson was seeking to develop her psycho-motor domain of the learning taxonomy, she found “no special interest” for it amongst those who developed the cognitive and affective domains. It just wasn't seen as “relevant” to education - even though it was seen as highly relevant for, “industrial education, agriculture, home economics, business education, music, art and physical education”. (Simpson 1976, p2)

There could be an argument that assessment of some achievements from the perspective of Simpson’s hierarchy, rather than Bloom’s, might help in addressing this aspect of the “skills gap”.

#### 3.3.2. Specific vs generic

If skills frameworks such as SFIA describe the sorts of competences that are sought by employers, how might they be recognised?

Many technical training courses are recognised by certificates and, increasingly, by e-badges. Whilst this seems eminently appropriate for those who have mastered the intricacies of a particular piece of software, approach or method, might there be scope for more “generic” badges?

For example, might a graduate who has achieved the knowledge, understanding and experience described in a SFIA skill (which is entirely vendor-neutral) be awarded a “badge” for that competence? Could such a generic badge then be supplemented by a vendor-specific badge, which could inform a potential employer of the context through which the competence was developed?

### 3.3.3. Training vs education

Universities have long maintained that they educate, rather than train. They teach principles, for the reasons set out above. Sometimes, they also emphasise the differences between their education and the training provided by vendors.

Universities might claim that training courses may teach people how to do something, but that they often fall short on the “why”, “when” and “so what”, which universities would claim is their forte. Indeed, these three aspects are evident in the (academic) accreditation criteria applied by BCS.

Without delving into the validity of any claims about how much or how little vendor training courses might address the “why”, “when” and “so what” questions, employers seem to want graduates to be able to *do* things. Could such abilities be developed in graduates by incorporating vendor training courses within degree programmes? If so, would the inherent narrow focus of many training courses need to be balanced by explicit de-contextualisation – i.e., reduction to principles?

### 3.3.4. Employability vs academic

Most universities have engaged heavily with the “employability” agenda in recent years. However, Shadbolt’s findings seem to suggest that this has not been entirely successful.

Some might argue that this is a consequence of “employability” being portrayed as an add-on to the curriculum, and not really part of the core knowledge that graduates will need. Yet one of Shadbolt’s findings is that employers lament the lack of “soft skills”.

As with commercial awareness, discussed above, the existing accreditation criteria, benchmark statements and so on, explicitly cover the soft skills – somewhat better than they set out commercial awareness, as it happens. However, if these skills are seen as mere supplements to the core domain knowledge, it is not surprising that not all students prioritise them – as noted in section 2.4 for the example of team-working skills. There are many excellent attempts by qualification designers to get students working in teams, but too often the student perception is of unnecessary hurdles or distractions.

Again, there may be something in the way that these skills are assessed. Reflection may be appropriate from an academic perspective, but these are actually practical skills. They are captured explicitly in the SFIA framework, in terms of influence, communication and team working, but only under the last two headings in the other frameworks and standards.

### 3.3.5. Curriculum input vs demonstrable outputs

A final thought about outputs is that outputs are not the same as inputs.

Indeed, even if particular topics are taught and assessed, using an appropriate perspective, not all graduates will have attained competence in all aspects of the syllabus.

Apart from anything else, most Universities have a passmark of 40%, and their assessment is based on sampling.

So considerable care needs to be taken when deriving the expected output competences from a particular curriculum. Virtually no graduate will emerge competent in every single aspect of that curriculum. And, of course, there is the question of what “competent” actually means, as explored in section [3.3.1](#).

It would seem to be much safer to focus on a smaller number of high-level outcomes, abstracted from the curriculum. Even then, there will be cases where individuals do not achieve the expected threshold in all of the outcomes. Universities need to be honest about this, perhaps providing explicit recognition of which outcomes have been achieved. And, accrediting bodies need to be realistic about what can be achieved.

A final point might be that it is infeasible just to keep adding additional content, required outcomes, or whatever to existing curricula. The learning time associated with a particular course is necessarily finite, and quite limited, in comparison with the breadth of the subject area. Not only is there the standard trade-off between breadth and depth; but so also there has to be a trade-off between application and principles.

## 4. Conclusions

Having completed a survey of the various accreditation frameworks available in the computing sector in England, and what each brings, and then explored where the issues and potential gaps lie, it is appropriate now to suggest how the different resources might be combined to address the issues identified by Shadbolt. The approach is to focus on what needs to be achieved, and to identify which approach or frameworks might be the most appropriate tool for different facets of the overall goal.

For example, there could be value in including vendor training in an academic curriculum, either to introduce contexts, or to illustrate concepts, but certainly to provide some concrete skills.

From the discussions earlier in this report, it seems that the following approaches of frameworks might be appropriate.

- To recognise mastery of underpinning knowledge – the generic HE frameworks and academic credit
- To generate immediately usable skills – vendor training
- To assess evidence of competence – that is, having *applied* skills developed through training, based on underpinning principles – mapping against a skills framework such as SFIA.

It has been argued also that Bloom's categorisation of learning and assessment activities does not lend itself to assessing practical competence.

It is worth noting that constructing a curriculum, or standard, in this way would still almost certainly meet the criteria for BCS accreditation, as well as satisfying the requirements of FHEQ/FQHEIS and the computing subject benchmark statement. But, because the way the curriculum would be constructed would be slightly different, it should also address the most common issues identified by Shadbolt.

A final comment is that this modified approach may not be appropriate for all students. As Shadbolt comments, employers find that many computer science graduates are [already] well prepared for work. The suggestions and discussions in this report are intended to help address the gaps identified for the minority.

## Acknowledgements

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## Appendix i: Summary tables for FHEQ, FQHEIS, Computing SBS and BCS accreditation

### 1.1 QAA Quality Code part A

The Frameworks for Higher Education Qualifications of UK Degree-Awarding Bodies<sup>9</sup>

Typical HE qualifications

Table 2: Typical qualifications at levels of the Frameworks for Higher Education Qualifications of UK

Typical higher education qualifications awarded by degree-awarding bodies within each level	FHEQ	FQHEIS	Corresponding QF-EHEA cycle
	FHEQ level <sup>a</sup>	SCQF level <sup>b</sup>	
Doctoral degrees (eg, PhD/DPhil, EdD, DBA, DCLinPsy) <sup>c</sup>	8	12	Third cycle (end of cycle) qualifications
Master's degrees (eg, MPhil, MLitt, MRes, MA, MSc)	7	11	Second cycle (end of cycle) qualifications
Integrated master's degrees (eg, MEng, MChem, MPhys, MPharm) <sup>d</sup>			
Primary qualifications (or first degrees) in medicine, dentistry and veterinary science (eg, MB ChB, MB BS, BM BS <sup>e</sup> ; BDS; BVSc, BVMS) <sup>f</sup>			
Postgraduate diplomas			
Postgraduate Certificate in Education (PGCE) <sup>g</sup> /Postgraduate Diploma in Education (PGDE) <sup>h</sup>			
Postgraduate certificates	6	10	First cycle (end of cycle) qualifications
Bachelor's degrees with honours (eg BA/BSc Hons)			
Bachelor's degrees			
Professional Graduate Certificate in Education (PGCE) in England, Wales and Northern Ireland <sup>g</sup>			
Graduate diplomas			
Graduate certificates <sup>i</sup>	5	9	Short cycle (within or linked to the first cycle) qualifications
Foundation degrees (eg, FdA, FdSc)		NA	
Diplomas of Higher Education (DipHE)		8	
Higher National Diplomas (HND) awarded by degree-awarding bodies in England, Wales and Northern Ireland under licence from Pearson <sup>l</sup>	4	NA	
Higher National Certificates (HNC) awarded by degree-awarding bodies in England, Wales and Northern Ireland under licence from Pearson <sup>l</sup>		NA	
Certificates of Higher Education (CertHE)		7	

<sup>9</sup> QAA (2014) The Frameworks for HE Qualifications of UK Degree-Awarding Bodies: <https://www.qaa.ac.uk/docs/qaa/quality-code/qualifications-frameworks.pdf> (accessed 03.6.19)

## 1.2 Bachelor's degrees

Descriptor for a higher education qualification at level 6 on the FHEQ: bachelor's degree with honours

The descriptor provided for this level of the FHEQ is for any bachelor's degree with honours which should meet the descriptor in full. This qualification descriptor should also be used as a reference point for other qualifications at level 6 of the FHEQ, including bachelor's degrees, and graduate diplomas.

Bachelor's degrees with honours are awarded to students who have demonstrated:

- a systematic understanding of key aspects of their field of study, including acquisition of coherent and detailed knowledge, at least some of which is at, or informed by, the forefront of defined aspects of a discipline
- an ability to deploy accurately established techniques of analysis and enquiry within a discipline
- conceptual understanding that enables the student:
  - to devise and sustain arguments, and/or to solve problems, using ideas and techniques, some of which are at the forefront of a discipline
  - to describe and comment upon particular aspects of current research, or equivalent advanced scholarship, in the discipline
- an appreciation of the uncertainty, ambiguity and limits of knowledge
- the ability to manage their own learning, and to make use of scholarly reviews and primary sources (for example, refereed research articles and/or original materials appropriate to the discipline).

Typically, holders of the qualification will be able to:

- apply the methods and techniques that they have learned to review, consolidate, extend and apply their knowledge and understanding, and to initiate and carry out projects
- critically evaluate arguments, assumptions, abstract concepts and data (that may be incomplete), to make judgements, and to frame appropriate questions to achieve a solution - or identify a range of solutions - to a problem
- communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.

And holders will have:

- the qualities and transferable skills necessary for employment requiring:
  - the exercise of initiative and personal responsibility
  - decision-making in complex and unpredictable contexts
  - the learning ability needed to undertake appropriate further training of a professional or equivalent nature.

Descriptor for a higher education qualification at SCQF level 10 on the FQHEIS: bachelor's degree with honours in Scotland

### General

The bachelor's degree with honours in Scotland is typically offered through the equivalent of four years of full-time higher education. It is awarded mainly as either a Bachelor of Science (BSc Hons), or a Bachelor of Arts (BA Hons). All honours degrees will exhibit a balance of breadth and depth as will be clear from the definitive records for individual programmes. Many honours degrees will have a specific vocational focus, and in some cases will carry recognition by the appropriate professional or statutory body. In a small number of universities, in some faculties, this qualification is titled 'MA (Hons)' (see paragraph 4.17.6). The honours degree is the recognised 'normal' entry requirement to postgraduate study and to many professions across the UK.

Honours degrees are awarded to students who have demonstrated:

- A systematic, extensive and comparative knowledge and understanding of the subject(s) as a whole and its links to related subject(s). A detailed knowledge of a few specialisms and developments, some of which are at, or informed by, the forefront of the subject.
- A critical understanding of the established theories, principles and concepts, and of a number of advanced and emerging issues at the forefront of the subject(s).
- A critical understanding of the uncertainty and limits of knowledge and how it is developed, and an ability to deploy established techniques of analysis and enquiry within the subject.
- A comprehensive knowledge and familiarity with essential and advanced materials, techniques and skills including some at the forefront of the subject.
- Skills in identifying information needs, and in the systematic gathering, analysis and interpretation of ideas, concepts and qualitative and quantitative data and information from a range of evaluated sources including current research, scholarly, and/or professional literature.

Typically, holders of the honours degree will be able to:

- use their knowledge, understanding and skills in the systematic and critical assessment of a wide range of concepts, ideas, and data (that may be incomplete), and in both identifying and analysing complex problems and issues; demonstrating some originality and creativity in formulating, evaluating and applying evidence-based solutions and arguments;
- communicate the results of their study and other work accurately and reliably using the full repertoire of the principal concepts and constructs of the subject(s);
- systematically identify and address their own learning needs both in current and in new areas, making use of research, development and professional materials as appropriate, including those related to the forefront of developments;
- apply their subject-related and transferable skills in contexts of a professional or equivalent nature where there is a requirement for:
  - the exercise of personal responsibility and initiative
  - decision-making in complex and unpredictable contexts
  - the ability to undertake further developments of a professional or equivalent nature.

### 1.3 Master's degree

Descriptor for a higher education qualification at level 7 on the FHEQ and SCQF level 11 on the FQHEIS: master's degree

The descriptor provided for this level of the frameworks is for any master's degree which should meet the descriptor in full. This qualification descriptor should also be used as a reference point for other qualifications at level 7/ SCQF level 11 on the FQHEIS, including postgraduate certificates and postgraduate diplomas.

Master's degrees are awarded to students who have demonstrated:

|| a systematic understanding of knowledge, and a critical awareness of current problems and/or new insights, much of which is at, or informed by, the forefront of their academic discipline, field of study or area of professional practice

|| a comprehensive understanding of techniques applicable to their own research or advanced scholarship

|| originality in the application of knowledge, together with a practical understanding of how established techniques of research and enquiry are used to create and interpret knowledge in the discipline

|| conceptual understanding that enables the student:

- to evaluate critically current research and advanced scholarship in the discipline
- to evaluate methodologies and develop critiques of them and, where appropriate, to propose new hypotheses.

Typically, holders of the qualification will be able to:

|| deal with complex issues both systematically and creatively, make sound judgements in the absence of complete data, and communicate their conclusions clearly to specialist and non-specialist audiences

|| demonstrate self-direction and originality in tackling and solving problems, and act autonomously in planning and implementing tasks at a professional or equivalent level

|| continue to advance their knowledge and understanding, and to develop new skills to a high level.

And holders will have:

|| the qualities and transferable skills necessary for employment requiring:

- the exercise of initiative and personal responsibility
- decision-making in complex and unpredictable situations
- the independent learning ability required for continuing professional development.



## 1.4 Higher Education credit framework for England

Table 3: [Credit values typically associated with programmes leading to HE qualifications in England](#)

	1	2	3	4	5
HE qualifications as set out in the FHEQ	FHEQ level	Minimum credits*	Minimum credits at the level of the qualification	FQ-EHEA cycles	ECTS credit ranges from the FQ-EHEA
PhD/DPhil	8	Not typically credit-rated		Third cycle (end of cycle) qualifications	Not typically credit-rated
Professional doctorates (only if credit based) (eg EdD, DBA, DCLinPsy)**		540	360		
Research master's degrees (eg MPhil, MLitt)	7	Not typically credit-rated		Second cycle (end of cycle) qualifications	The minimum requirement is 60 ECTS credits; however a range of 90-120 ECTS credits is more typical at second cycle level
Taught MPhil		360	240		
Taught master's degrees (eg MA, MSc, MRes)		180	150		
Integrated master's degrees (eg MEng, MChem, MPhys, MPharm)***		480	120		
Postgraduate diplomas		120	90		
Postgraduate Certificate in Education (PGCE)		60	40		
Postgraduate certificates		60	40		
Bachelor's degrees with honours (eg BA/BSc Hons)	6	360	90	First cycle (end of cycle) qualifications	180-240 ECTS credits
Bachelor's degrees		300	60		
Professional Graduate Certificate in Education (PGCE)****		60*****	40		
Graduate diplomas		80	80		
Graduate certificates		40	40		
Foundation Degrees (eg FdA, FdSc)	5	240	90	Short cycle (within or linked to the first cycle) qualifications	approximately 120 ECTS credits
Diplomas of Higher Education (DipHE)		240	90		
Higher National Diplomas (HND)		240	90		
Higher National Certificates (HNC)*****	4	150	120		
Certificates of Higher Education (Cert HE)		120	90		

1.5 The framework for qualifications of higher education institutions in Scotland<sup>10</sup>

Table 4: Credit definitions of the main qualifications of higher education institutions in Scotland

Level	Typical qualifications and their credit definitions	
SCQF 12	PhD/DPhil <i>Not credit rated*</i>	Other doctoral degrees <i>At least 540 credits with a minimum of 420 credits at SCQF Level 12</i>
SCQF 11	MPhil	<i>Either not credit rated*</i>  <i>or at least 300 credits with a minimum of 270 credits at SCQF Level 11</i>
	Master's degree	<i>At least 180 credits with a minimum of 150 credits at SCQF Level 11</i>
	Integrated master's degree (following an integrated programme from undergraduate to master's level study)	<i>At least 600 credits with a minimum of 120 credits at SCQF Level 11</i>
	Postgraduate diploma	<i>At least 120 credits with a minimum of 90 credits at SCQF Level 11</i>
	Postgraduate certificate	<i>At least 60 credits with a minimum of 40 credits at SCQF Level 11</i>
SCQF 10	Honours degree** <i>At least 480 credits with a minimum of 90 credits at SCQF Level 9 and a minimum of 90 credits at SCQF Level 10</i>	
SCQF 9	Ordinary degree** <i>At least 360 credits with a minimum of 60 at SCQF Level 9 (***)</i>	
	Graduate diploma <i>Minimum of 120 credits at SCQF Level 9 or above</i>	
	Graduate certificate <i>Minimum of 60 credits at SCQF Level 9 or above</i>	
SCQF 8	Diploma of Higher Education <i>At least 240 credits with a minimum of 90 at SCQF Level 8 or above</i>	
SCQF 7	Certificate of Higher Education <i>At least 120 credits with a minimum of 90 at SCQF Level 7 or above</i>	

<sup>10</sup> QAA (2014) The Framework for Qualifications of Higher Education Institutions in Scotland: <https://www.qaa.ac.uk/docs/qaa/quality-code/fqheis-june-2014.pdf> (accessed 03.06.19)

## 1.6 QAA Computing Subject Benchmark Statement (Bachelor's)<sup>11</sup>

### Benchmark

#### Threshold

- i. demonstrate a requisite understanding of the main body of knowledge for their programme of study
- ii. understand and apply essential concepts, principles and practices of the subject in the context of well-defined scenarios, showing judgement in the selection and application of tools and techniques
- iii. produce work involving problem identification, the analysis, design and development of a system with accompanying documentation, recognising the important relationships between these stages and showing problem solving and evaluation skills drawing on supporting evidence
- iv. produce small well-constructed programmes to solve well-specified problems
- v. demonstrate generic skills, an ability to work under guidance and as a team member.
- vi. identify appropriate practices within a professional, legal and ethical framework and understand the need for continuing professional development.

#### Typical

- i. demonstrate a sound understanding of the main areas of the body of knowledge within their programme of study, with an ability to exercise critical judgement
- ii. critically analyse and apply essential concepts, principles and practices of the subject in the context of loosely defined scenarios, showing effective judgement in the selection and use of tools and techniques
- iii. produce work involving problem identification, the analysis, the design or the development of a system, with appropriate documentation, recognising the important relationships between these
- iv. the work will show problem solving and evaluation skills, draw upon supporting evidence and demonstrate a good understanding of the need for a high quality solution
- v. demonstrate generic skills with an ability to show organised work both as an individual and as a team member and with minimum guidance
- vi. apply appropriate practices within a professional, legal and ethical framework and identify mechanisms for continuing professional development and lifelong learning.

#### Excellent students:

- i. will be able to contribute significantly to the analysis, design or the development of systems that are complex, recognising the important relationships between these
- ii. will be creative and innovative in their application of the principles covered in the curriculum
- iii. will be able to exercise critical evaluation and review of both their own work and the work of others.
- iv. will be able to demonstrate team leadership skills.

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<sup>11</sup> BCS (2016) Subject Benchmark Statement: Computing: <https://www.qaa.ac.uk/docs/qaa/subject-benchmark-statements/sbs-computing-16.pdf> (accessed 03.6.19)

## Skills

### Computing-related cognitive skills:

- i. Computational thinking including its relevance to everyday life.
- ii. An understanding of the scientific method and its applications to problem solving in this area.
- iii. Knowledge and understanding: demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to Computing and computer applications as appropriate to the programme of study.
- iv. Modelling: use such knowledge and understanding in the modelling and design of computer-based systems for the purposes of comprehension, communication, prediction and the understanding of trade-offs.
- v. Requirements, practical constraints and computer-based systems (and this includes computer systems, information, security, embedded, and distributed systems) in their context: recognise and analyse criteria and specifications appropriate to specific problems, and plan strategies for their solutions.
- vi. Critical evaluation and testing: analyse the extent to which a computer-based system meets the criteria defined for its current use and future development.
- vii. Methods and tools: deploy appropriate theory, practices and tools for the specification, design, implementation and evaluation of computer-based systems.
- viii. Professional considerations: recognise the professional, economic, social, environmental, moral and ethical issues involved in the sustainable exploitation of computer technology and be guided by the adoption of appropriate professional, ethical and legal practices.

### Computing-related practical skills:

- i. The ability to specify, design and construct reliable, secure and usable computer-based systems.
- ii. The ability to evaluate systems in terms of quality attributes and possible trade-offs presented within the given problem.
- iii. The ability to plan and manage projects to deliver computing systems within constraints of requirements, timescale and budget.
- iv. The ability to recognise any risks and safety aspects that may be involved in the deployment of computing systems within a given context.
- v. The ability to deploy effectively the tools used for the construction and documentation of computer applications, with particular emphasis on understanding the whole process involved in the effective deployment of computers to solve practical problems.
- vi. The ability to critically evaluate and analyse complex problems, including those with incomplete information, and devise appropriate solutions, within the constraints of a budget.

### Generic skills for employability:

- i. Students are expected to develop a wide range of generic skills to ensure they become effective in the workplace, to the benefit of themselves, their employer and the wider economy. Students who develop generic skills, and are able to evidence and demonstrate such skills, will gain significant advantage when seeking employment. It is the responsibility of higher education providers to provide every student the opportunity to acquire and evidence generic skills; it is the responsibility of the student to make the most of that opportunity.
- ii. Intellectual skills: critical thinking; making a case; numeracy and literacy; information literacy. The ability to construct well argued and grammatically correct documents. The ability to locate and retrieve relevant ideas, and ensure these are correctly and accurately referenced and attributed.

- iii. Self-management: self-awareness and reflection; goal setting and action planning; independence and adaptability; acting on initiative; innovation and creativity. The ability to work unsupervised, plan effectively and meet deadlines, and respond readily to changing situations and priorities.
- iv. Interaction: reflection and communication: the ability to succinctly present rational and reasoned arguments that address a given problem or opportunity, to a range of audiences (orally, electronically or in writing).
- v. Team working and management: the ability to recognise and make best use of the skills and knowledge of individuals to collaborate. To be able to identify problems and desired outcomes and negotiate to mutually acceptable conclusions. To understand the role of a leader in setting direction and taking responsibility for actions and decisions.
- vi. Contextual awareness: the ability to understand and meet the needs of individuals, business and the community, and to understand how workplaces and organisations are governed.
- vii. Sustainability: recognising factors in environmental and societal contexts relating to the opportunities and challenges created by computing systems across a range of human activities.

## 1.7 BCS Accreditation Criteria<sup>12</sup>

### Undergraduate core

Graduates have been assessed on the following abilities

#### *Computing-related cognitive abilities*

- Knowledge and understanding of essential facts, concepts, principles and theories relating to computing and computer applications as appropriate to the programme of study
- The use of such knowledge and understanding in the modelling and design of computer-based systems for the purposes of comprehension, communication, prediction and the understanding of trade-offs
- Recognise and analyse criteria and specifications appropriate to specific problems and plan strategies for their solution
- Analyse the extent to which a computer based-system meets the criteria defined for its current use and future development
- Deploy appropriate theory, practices and tools for the specification, design, implementation and evaluation of computer-based systems
- Recognise the legal, social, ethical and professional issues involved in the exploitation of computer technology and be guided by the adoption of appropriate professional, ethical and legal practices
- Knowledge and understanding of the commercial and economic context of the development, use and maintenance of information systems
- Knowledge and understanding of the management techniques which may be used to achieve objectives within a computing context
- Knowledge and understanding of information security issues in relation to the design, development and the use of information systems

#### *Computer-related practical abilities*

- Specify, design or construct computer-based systems
- Evaluate systems in terms of general quality attributes and possible trade-offs presented within the given problem
- Recognise any risks or safety aspects that may be involved in the operation of computing and information systems within a given context
- Deploy effectively the tools used for the construction and documentation of computer applications, with particular emphasis on understanding the whole process involved in the effective deployment of computers to solve practical problems

#### *Transferable skills*

- An ability to work as a member of a development team recognising the different roles within a team and different ways of organising teams
- Development of transferable skills that will be of value in a wide range of situations; these include: problem solving, working with others, effective information management and information retrieval skills, numeracy in both understanding and presenting cases involving a quantitative dimension, communication skills in electronic as well as written and oral form to a range of audiences and planning self-learning and improving performance as the foundation for on-going professional development

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<sup>12</sup> BCS (2018) Course Accreditation Guidelines <https://www.bcs.org/media/1209/accreditation-guidelines.pdf> (accessed 03.06.19)

#### Additional requirements for CITP

Graduates from all accredited CITP undergraduate and generalist masters programmes should have been assessed on the following abilities:

##### *Computer-related cognitive abilities*

- Knowledge and understanding of the methods and issues involved in deploying systems to meet business goals
- Knowledge and understanding of methods, techniques and tools for information modelling, management and security
- Knowledge and understanding of systems architecture and related technologies for developing information systems
- Knowledge and understanding of mathematical and/or statistical principles appropriate to the nature of the programme

##### *Computing-related practical abilities*

- Use appropriate theoretical and practical processes to specify and deploy, verify and maintain information systems, including working with technical uncertainty
- Define a problem, research its background, understand the social context, identify constraints, understand customer and user needs, identify and manage cost drivers, ensure fitness for purpose and manage the design process and evaluate outcomes
- Apply the principles, methods and tools of systems design to develop information systems that meet business needs

#### Additional requirements for CEng

Graduates from all accredited CITP undergraduate and generalist masters programmes should have been assessed on the following abilities:

##### *Computer-related cognitive abilities*

- knowledge and understanding of the use of engineering principles in the creation, use, support and decommissioning of information systems for the solution of practical problems, founded on appropriate scientific and technological disciplines
- knowledge and understanding of mathematical and statistical principles necessary to underpin their programme of study and the ability to apply mathematical and statistical methods, tools and notations proficiently in the analysis and solution to problems
- knowledge and understanding of the principles of computational modelling used for the comprehension of engineering phenomena

##### *Computing-related practical abilities*

- use appropriate theoretical and practical processes to specify, design, implement, verify and maintain computer-based systems, including working with technical uncertainty
- Define a problem, research its background, understand the social context, identify constraints, understand customer and user needs, identify and manage cost drivers, ensure fitness for purpose and manage the design process and evaluate outcomes
- apply the principles of appropriate supporting engineering and scientific disciplines

## Appendix ii: Current landscape

### 2.1. Qualification frameworks

The qualification frameworks offer an essential structure within which comparable qualifications can be built. They can be recognised both nationally and internationally and those operating within them are generally aware of where their particular qualifications fit within the relevant framework.

Where the frameworks fall down is in cross-framework comparability. In some cases, there is a need to compare levels with different numbers or names but comparative levels of rigour. However, in other cases there are levels which are not directly comparable, where one level in a framework may cover one and a half levels in another. This causes problems both for comprehension and for the moving of credit across frameworks.

<b>FHEQ/HQHEIS</b>	UK Quality Code for Higher Education Part A: Setting and Maintaining Academic Standards, QAA, 2014 <a href="https://www.qaa.ac.uk/docs/qaa/quality-code/qualifications-frameworks.pdf">https://www.qaa.ac.uk/docs/qaa/quality-code/qualifications-frameworks.pdf</a> (accessed 04 June 2019)
The HFEQ are frameworks for Higher Education Qualifications for UK Degree-awarding bodies. The same standards are applied across all four countries and any UK education delivered internationally. Part A (covered here) is responsible for setting and maintaining academic standards. This is of import to the IoC accreditation framework to ensure that qualifications accredited are comparable in terms of level both nationally and internationally. The UK frameworks align with the framework for qualifications of the European higher education area (QF-EHEA).	
<b>NQF</b>	What qualification levels mean <a href="https://www.gov.uk/what-different-qualification-levels-mean/list-of-qualification-levels">https://www.gov.uk/what-different-qualification-levels-mean/list-of-qualification-levels</a> (accessed 04 June 2019)
The National Qualification Framework defines the levels used within education and learning within England, Wales and Northern Ireland. There are a range of 9 levels from Entry level (pre-GCSE) through 8 which are doctoral awards or equivalent.	
<b>CATS</b>	Facilitating Credit Based Links in Higher Education <a href="https://www.qaa.ac.uk/docs/qaa/quality-code/facilitating-credit-based-links-in-higher-education-guidelines-to-support-colleges-and-higher-education-institutions.pdf?sfvrsn=25b3f981_14">https://www.qaa.ac.uk/docs/qaa/quality-code/facilitating-credit-based-links-in-higher-education-guidelines-to-support-colleges-and-higher-education-institutions.pdf?sfvrsn=25b3f981_14</a> (accessed 04 June 2019)
The Scottish Advisory Committee on Credit and Access have published guidance on transference of credits between Higher National Qualifications (HNQs) and degrees. The guidelines seek to inform learners of the opportunities afforded by credit transfer and hence enable them to make beneficial informed decisions.	



## 2.2. PSRB accreditation

The Professional, Statutory and Regulatory Bodies accreditation allows national (and international) recognition of particular degree and post-graduate courses which are deemed to fully meet the expectations of the body, giving students further recognition which can be shown when applying for employment. These are awarded at programme (rather than individual) level following an accreditation process between the body and the higher education institution.

<b>BCS</b>	Guidelines on Course Accreditation <a href="https://www.bcs.org/media/1209/accreditation-guidelines.pdf">https://www.bcs.org/media/1209/accreditation-guidelines.pdf</a> (accessed 04 June 2019)
<p>The British Computer Society have a Royal Charter which includes the responsibility to develop and maintain standards for the educational foundation appropriate to people wishing to follow a career in information systems. BCS believe preparation requires both a sound theoretical understanding and practical experience; they also generally only consider accreditation for large programmes. Accreditation is based on meeting the QAA Computing benchmark<sup>13</sup>. Programmes of study can be considered for accreditation for Chartered IT Professional (CITP), Chartered Engineer (CEng) or Incorporated Engineer (IEng) and where students follow a degree apprenticeship/foundation degree with a programmed of work-based learning or industrial placement modules where the placement is assessed as part of the overall programme of study, Registered IT Technician status can be considered for accreditation. IEng accreditation criteria fit broadly under the SFIA level 3 framework, for example “Has a sound generic, domain and specialist knowledge necessary to perform effectively in the organisation typically gained from recognised bodies of knowledge and organisational information. Demonstrates effective application of knowledge. Has an appreciation of the wider business context. Takes action to develop own knowledge.” (SFIA 7, pg20) links to the core requirements for accreditation of honours programmes (BCS: Guidelines on course accreditation, pg10) and requirements for IEng (pg 12). The integrated masters programme may be considered for CITP and full CEng accreditation with the project requirements (team-based, major 30-credit project work at level 6 or above) correlating with SFIA Level 4 complexity (SFIA 7, pg21).</p> <p>Undergraduate, integrated masters and postgraduate masters programmes all are expected to involve an individual project. Written guidance on all aspects of the project should be provided. This clearly fits within the SFIA level 3 autonomy framework, as learners are expected to work under guidance with a clear framework of accountability. At undergraduate level a learner does not necessarily exercise substantial personal autonomy so may not fit within the level 4 framework although this may not be the case at higher levels.</p>	

<sup>13</sup> QAA Computing Benchmark, [https://www.qaa.ac.uk/docs/qaa/subject-benchmark-statements/sbs-computing-16.pdf?sfvrsn=26e1f781\\_12](https://www.qaa.ac.uk/docs/qaa/subject-benchmark-statements/sbs-computing-16.pdf?sfvrsn=26e1f781_12) Accessed on 04 June 2019.

<b>IET</b>	<p>Guide to Academic Accreditation for Higher Education Institutions  <a href="https://www.theiet.org/media/1755/iet_academic_accreditation_brochure.pdf">https://www.theiet.org/media/1755/iet_academic_accreditation_brochure.pdf</a> (accessed 04 June 2019)</p> <p>Academic Accreditation Information Pack  <a href="https://www.theiet.org/media/1772/accreditation-information-pack-online-2018-19.pdf">https://www.theiet.org/media/1772/accreditation-information-pack-online-2018-19.pdf</a> (accessed 04 June 2019)</p>
<p>The Institution of Engineering and Technology accredits courses from level 5 to level 8 (Foundation degree to professional doctorate with IEng, CEng, and partial status. To be accredited programmes must:</p> <ul style="list-style-type: none"> <li>• Fulfil AHEP learning outcomes and align with the title of the qualification,</li> <li>• Fulfil AHEP output standards (Science and mathematics, Engineering analysis, Economic, legal, social, ethical and environmental context, design, engineering practice and additional general skills),</li> <li>• Evidence robust assessment standards, procedures and regulations,</li> <li>• Include a major project which should integrate and exercise the learning obtained through the programme,</li> <li>• Support students commensurate with their learning needs and with staff experienced and expert enough to deliver teaching to the required standard,</li> <li>• Have adequate learning resources and facilities to support the students' learning experience,</li> <li>• Have guaranteed quality of assessment and review and monitoring procedures which guarantee maintaining output standards.</li> </ul> <p>The guidance documents available do not enable the accreditation to be aligned accurately within the SFIA framework. However it is likely that the alignment will be analogous with the BCS accreditation discussed above.</p>	
<b>NCSC</b>	<p>NCSC Degree Certification – Call for new applicants  <a href="https://www.ncsc.gov.uk/information/ncsc-degree-certification-call-new-applicants-0">https://www.ncsc.gov.uk/information/ncsc-degree-certification-call-new-applicants-0</a> (accessed 04 June 2019)</p>
<p>The NCSC certifies degrees in Cyber Security to help set the standard for good cyber security higher education. The programme aims to address the perceived knowledge, skills and capability requirements for both research and education in cyber security.</p> <p>Courses accredited include Bachelors (three titles), Integrated Master's (three titles), Master's (four titles) and a single title of degree apprenticeship. These give students an additional form of recognition if considering a role within cyber security.</p>	

### 2.3. Industry and Vendor accreditation

Any industrial vendor can accredit courses, either internally or externally run, without recourse to guidelines or criterion. This leads to a wide variety in quality and comparability between courses. Some abide by strict internal codes (and in fact may also offer PSRB accreditation as well, such as the NCSC). Others are less rigorous, determining content, levelling and criterion internally. A range of assessments may be used, with some organisations requiring interview, evidence of experience, or rigorous examinations and others relying

purely on multiple choice assessments. With most there is a sometimes not inconsiderable cost involved which may go directly to the organisation, bringing into question the purpose for offering accreditation in the first place. Some offer digital badging which could open the accreditation up to credit transfer schemes in the future, although this is not always the case and careful consideration will be needed. Most do not attempt to align themselves with other frameworks, often having multitudes of differing levels (and names for levels) which are difficult to align and using terms like competency without offering sufficient evidence of what is meant by ‘competent’.

NCSC	Certified Cyber Professional <a href="https://www.iisp.org/iisp/Accreditation/NCSC_CCP_Scheme/iispv2/Accreditation/CCP_Info.aspx?hkey=bd7ecf54-a8d7-4abb-ba59-376c1e1103ea">https://www.iisp.org/iisp/Accreditation/NCSC_CCP_Scheme/iispv2/Accreditation/CCP_Info.aspx?hkey=bd7ecf54-a8d7-4abb-ba59-376c1e1103ea</a> (accessed 04 June 2019)
<p>The National Cyber Security Centre’s Certification for Cyber Security/IA Professionals has the purpose to “provide employers with an assured pool of certified cyber security/IA professionals for recruitment” (Pg 1). This aligns with the desire of the IoC accreditation to ensure that graduates are billable, i.e. they are usable within the workplace from day 1. The NCSC certification aligns (and is designed to align) with SFIA. A Cyber Security/IA Auditor would be aligned with SFIA level 2 and tests compliance, meets code of ethics, assists with development of audit plans and works under the supervision of a more senior auditor. Senior and lead auditors align with SFIA level 4 and 6 and have correspondingly higher levels of responsibility.</p> <p>There are a number of accredited roles, with the role of auditor being used within this example; As suggested in the draft IoC standard, NCSC certified auditors have a range of skills they are required to be aware of. Within this there are a subset of core skills and each auditor is expected to meet a role-specific core skill (Audit and review) and 3 of the remaining 5 core skills at the requisite level.</p> <p>This model follows across all of the roles defined by the NCSC, although some roles fall between the senior and lead levels of responsibility, aligning with SFIA level 6. Each skill is defined at differing levels with headlines statements (that must be met) and indicative examples of activities within the standard.</p> <p>Evidence is provided in written format with two pieces of evidence per skill, written in STAR format (situation, task, action result). This must then be backed up with a client reference.</p>	

<b>IISP</b>	<p>IISP Skills Framework  <a href="https://www.iisp.org/iisp/About%20Us/Our%20Frameworks/Our%20Skills%20Framework/iispv2/Accreditation/Our%20Skills%20Framework.aspx?hkey=e77a6f03-9498-423e-aa7b-585381290ec4">https://www.iisp.org/iisp/About Us/Our Frameworks/Our Skills Framework/iispv2/Accreditation/Our Skills Framework.aspx?hkey=e77a6f03-9498-423e-aa7b-585381290ec4</a> (accessed 04 June 2019)</p>
<p>The Institute of Information Security Professionals (IISP) framework consists of a set of ten skills areas and security disciplines labelled A-F and H-K. There are six skills levels within the framework, with level 1 (basic knowledge and following good practice) and level 2 (knowledge and understanding of basic principles) being knowledge-centric and level 3 (practitioner), level 4 (senior practitioner), level 5 (principal practitioner) and level 6 (expert/lead practitioner) being practically focussed. Each level has a set of descriptors for assessment of competencies. Each discipline has between two and seven skill groups within it, each of which has generic principles and then example skills at each level to align with the level descriptors to assess competency.</p>	
<b>BCS L&amp;D</b>	<p>BCS Certification Pathway  <a href="https://www.bcs.org/develop-your-people/develop-your-team-or-organisation/professional-certifications-for-your-team/">https://www.bcs.org/develop-your-people/develop-your-team-or-organisation/professional-certifications-for-your-team/</a> (accessed 04 June 2019)          Solution Development and Architecture Career Path  <a href="https://certifications.bcs.org/upload/pdf/solution-development.pdf">https://certifications.bcs.org/upload/pdf/solution-development.pdf</a> (accessed 04 June 2019)</p>
<p>The British Computer Society certify at four levels (foundation, intermediate, practitioner and higher level) and across a range of subject areas. Each subject area has a matrix of BCS membership levels, their linked SFIA levels, what characterises those levels in terms of what they are likely to do, their typical job titles and experience (in terms of roles and years), and the level of BCS professional certification that aligns with the given level.</p> <p>Requirements for the certifications are based on experience (in terms of years work experience in the field), examination (written multiple choice questions or oral depending on level) and prior levels of accreditation with BCS or certain equivalents.</p> <p>The BCS certification begins at a foundation level. Although at this level there is no formal experience required, it is aligned with SFIA level 3 and typical work experience in the field is 3-4 years.</p>	
<b>Vendor: Microsoft</b>	<p>Certification overview  <a href="https://www.microsoft.com/en-us/learning/certification-overview.aspx">https://www.microsoft.com/en-us/learning/certification-overview.aspx</a> (accessed 04 June 2019)</p>
<p>Microsoft offer a suite of certifications ranging from entry level (MTA, MCSA) to MCSD and MCSE. There is no direct link with SFIA levels and attaining the certification is entirely examination based. Academically it was suggested in 2007<sup>14</sup> that the MCSE was the equivalent to level 4 on NQF, although this has not been fully investigated. The information available on the Microsoft website does not suggest any form of work-based evidence is necessary to attain the certification.</p>	

<sup>14</sup> Professional Certifications mapping to the UK NQF, <https://www.certforums.com/threads/professional-certifications-mapping-to-the-uk-nqf.21840/>, accessed 04 June 2019

<b>Vendor: Oracle</b>	Oracle University <a href="https://education.oracle.com/certification">https://education.oracle.com/certification</a> (accessed 04 June 2019)
Oracle offers a range of certifications in their own cloud, hardware and software-based products. All certifications are entirely examination based, although associate and professional levels claim to recognise 1-2- and 3-4-years' experience. It does not suggest, however, whether these will count towards certification and it is more likely that they simply position the certificates within the typical career points. There is no direct link to SFIA levels and, taking the Java developer certificate as an example, there seems to be little evidence to correlate the two.	
<b>Vendor: Cisco</b>	Training and Certifications <a href="https://www.cisco.com/c/en/us/training-events/training-certifications/overview.html">https://www.cisco.com/c/en/us/training-events/training-certifications/overview.html</a> (accessed 04 June 2019)
Cisco offer a wide range of subject areas across five levels of certification from entry to architect. As with most vendor certifications, Cisco certificates do not directly link with SFIA levels. All certificates are exam based although some of the highest involve a verbal defence of a project proposal while others may involve practical assessments.	
<b>Vendor: Amazon AWS</b>	AWS Certification <a href="https://aws.amazon.com/certification/">https://aws.amazon.com/certification/</a> (accessed 04 June 2019)
Amazon offers four learning paths, Cloud Practitioner, Architect, Developer and Operations. Within each path there are four levels of certification, Foundational, Associate, Professional and Speciality. Some of these are available in different role-based flavours (eg Solutions Architect, Developer, SysOps Administrator). Although there is no requirement of evidence, Amazon suggests six months, one year, two years and two-five years of experience of incrementing depth as the four levels progress. While there are no direct SFIA links, the time experience would suggest levels 1-4 may be applicable.	
<b>Vendor: IBM</b>	IBM Certifications <a href="https://www.ibm.com/certify/certs.html">https://www.ibm.com/certify/certs.html</a> (accessed 04 June 2019)
IBM offer a range of nearly 200 certifications. Each certificate is applicable to a single IBM product or family (often separated by product version) and is levelled with differing titles. Although there are no specific requirements of experience and no realistic way to tie to SFIA levels, each certificate does have a detailed description of who the certificate is suitable for, including detailed prerequisite (recommended) skills. The certificates are all exam based.	

<b>Vendor: Citrix</b>	Citrix Education <a href="http://training.citrix.com/cms/index.php/certification/">http://training.citrix.com/cms/index.php/certification/</a> (accessed 04 June 2019)
Citrix offers fewer strands of certification than many vendors, with only one strand (Networking) covering four levels (Certified, Associate, Professional, Expert). Although Citrix's strapline <sup>15</sup> "You're an expert. Now prove it." Suggests experience (and hence competency) is central, for the initial assessment candidates can only attain certificates through examination. For recertification there is an opportunity to attend instructor-led training rather than sitting an examination. However there appears to be no opportunity to use evidence of competency as part of the certification.	
<b>Vendor: VMWare</b>	Certification <a href="https://www.vmware.com/education-services/certification.html">https://www.vmware.com/education-services/certification.html</a> (accessed 04 June 2019)
VMWare offer certifications in six strands (data centre virtualization, network virtualization, cloud management and automation, desktop and mobility, digital business transformation and digital workspace) and four levels (associate, professional, advanced professional and design expert). VMWare certificates are exam based, although each one begins with the step "Gain experience with ...". It is unclear whether this experience is validated or verified in any way; there is no direct SFIA links although it is possible there is further information not yet seen within the required experience which would allow us to place the certificates within the SFIA framework.	
<b>Vendor: Axelos</b>	Axelos Certifications <a href="https://www.axelos.com/certifications">https://www.axelos.com/certifications</a> (accessed 04 June 2019)
Axelos provide certification for a range of technologies. While some, such as the Prince 2 2017 certifications, cover three levels and are examination based, others do not; The ITIL certification for example covers five levels with the highest (Master) level requiring the candidates to explain and justify real world decisions within ITIL which suggests higher levels of competency being checked. With the added requirements it may be possible, with sufficient time and information, to align some or all of the certificates with SFIA levels.	
<b>Vendor: Association for Project Management</b>	APM Qualifications and Training <a href="https://www.apm.org.uk/qualifications-and-training/">https://www.apm.org.uk/qualifications-and-training/</a> (accessed 04 June 2019)
APM offer a suite of qualifications at fundamental, management and professional levels. The fundamental and management levels are aligned with the Scottish Credit and Qualifications Framework at level 6 and 7 (7 being the equivalent to a CertHE in England). APM makes no claims to alignment with SFIA competencies. Modules are examination based but the courses are advertised as building employability and status rather than having an onus on building competency within the area of development.	

<sup>15</sup> Citrix Education, <http://training.citrix.com/cms/index.php/certification/> , accessed on 04 June 2019.

<b>Vendor: Project Management Institute</b>	Certifications <a href="https://www.pmi.org/certifications">https://www.pmi.org/certifications</a> (accessed 04 June 2019)
PMI offer certifications with attendant digital badges. There are a total of eight certifications available, the lower-level ones being incremental, with the higher level certificates branching out into specialisms. All certifications have prerequisites of both academic attainment and professional practise. A professional registry is kept and maintenance of the certification is required. Although no alignment with SFIA is offered, the courses suggest that they are competency based and with sufficient detail of the courses offered, alignment should be feasible.	

<b>Vendor: Linux Professional Institute</b>	LPI: Our Certifications <a href="https://www.lpi.org/our-certifications/summary-of-certifications">https://www.lpi.org/our-certifications/summary-of-certifications</a> (accessed 04 June 2019)
LPI seek to develop a global standard in Linux administration. The certifications consist of two stand-alone certificates and five levelled certificates, with the top three being specialised. There is no direct comparison to SFIA competencies and the assessments are entirely dependent on examination results rather than being able to demonstrate any experience or competencies over time.	

#### 2.4. Bodies of knowledge

Bodies of knowledge have been produced, often by academic organisations, in order to bring together what is known about a particular subject domain. In some cases these are used as a corpus of what should be known to be (academically) competent within the domain, in others the intent is to bring as much focussed knowledge together as possible to allow others to make use of the knowledge in their own working.

<b>Quality Assurance Agency</b>	Undergraduate: <a href="https://www.qaa.ac.uk/docs/qaa/subject-benchmark-statements/sbs-computing-16.pdf?sfvrsn=26e1f781_12">https://www.qaa.ac.uk/docs/qaa/subject-benchmark-statements/sbs-computing-16.pdf?sfvrsn=26e1f781_12</a> (accessed 04 June 2019) Postgraduate: <a href="https://www.qaa.ac.uk/docs/qaa/subject-benchmark-statements/sbs-masters-degree-computing.pdf?sfvrsn=c490f681_16">https://www.qaa.ac.uk/docs/qaa/subject-benchmark-statements/sbs-masters-degree-computing.pdf?sfvrsn=c490f681_16</a> (accessed 04 June 2019)
The QAA has released subject benchmarks for Computing degrees at both undergraduate and postgraduate levels. These benchmarks show “what graduates might reasonably be expected to know, do and understand at the end of their studies”.	
The undergraduate benchmark specifically states that graduates “should have a fundamental ability to adapt and gain additional specific competences after completion of their University learning”. The criterion is laid down with threshold, typical and excellent levels being defined by benchmark standards. Graduates are not required within the benchmark to demonstrate competency outside of the learning environment.	

The postgraduate benchmark suggests a programme *should* seek to “involve acquiring resources to ensure the success of some technically sound endeavour; this may include a company start-up or placing a well-argued resource request before an industrial concern, a research council or some such organisation” which is a move towards demonstrating real-world competencies. However, this is not a hard-and-fast requirement. Once again threshold levels are defined although higher levels are not.

<b>Association for Computing Machinery/IEEE - Cybersecurity Curricula</b>	<p>Cyber Security Curricula 2017  <a href="https://www.acm.org/binaries/content/assets/education/curricula-recommendations/csec2017.pdf">https://www.acm.org/binaries/content/assets/education/curricula-recommendations/csec2017.pdf</a> (accessed 04 June 2019)</p> <p>Information Technology Curricula 2017  <a href="https://www.acm.org/binaries/content/assets/education/curricula-recommendations/it2017.pdf">https://www.acm.org/binaries/content/assets/education/curricula-recommendations/it2017.pdf</a> (accessed 04 June 2019)</p> <p>Computer Engineering Curricula 2016  <a href="https://www.acm.org/binaries/content/assets/education/ce2016-final-report.pdf">https://www.acm.org/binaries/content/assets/education/ce2016-final-report.pdf</a> (accessed 04 June 2019)</p> <p>Software Engineering 2014  <a href="https://www.acm.org/binaries/content/assets/education/se2014.pdf">https://www.acm.org/binaries/content/assets/education/se2014.pdf</a> (accessed 04 June 2019)</p> <p>Computer Science Curricula 2013  <a href="https://www.acm.org/binaries/content/assets/education/cs2013_web_final.pdf">https://www.acm.org/binaries/content/assets/education/cs2013_web_final.pdf</a> (accessed 04 June 2019)</p>
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The ACM/IEEE have put together a number of curricula based within the Computing field.

The 2017 cybersecurity curriculum describes a vision of proficiency and a structure within the discipline as well as building an alignment with industry needs. The curriculum is organised around eight knowledge areas within cybersecurity, each with attendant ‘essentials’ and ‘learning outcomes’, with learners being deemed as being able to demonstrate proficiency by meeting the learning outcomes which typically lie within understanding and application skills.

The 2017 IT curriculum goes to some length to describe the IT graduate. While acknowledging the existence and worth of vendor certifications the curriculum asserts that any credit-based awarding must ensure mapping to the competencies within the curriculum. Competency is seen as a central area of the curriculum; within this context competency is defined as knowledge, skills and dispositions. This is then further ratified with the professional context. What it doesn’t do, however, is define or discuss levels of competency.

The 2016 Computer Engineering curriculum contains a hierarchical structure in terms of disciplinary sub-fields rather than courses. These are then split into knowledge units which are further devolved into a set of learning outcomes which describes each knowledge unit. These knowledge areas consist of twelve key sub-fields within computer engineering, each of which has between eight and fourteen knowledge units. While the curriculum suggests easing the learner into business world through educational experiences, it does not suggest or require real-world experience as part of the learning experience.

The 2014 Software Engineering curriculum tries to define the educational knowledge all software engineering students must know and ways in which the knowledge and fundamental skills can be taught. Like the computer engineering curriculum, the software engineering



curriculum is broken into knowledge areas (sub-disciplines) of which there are ten, units (three-six), and topics (three-fourteen). No reference to a requirement for work-place based competencies are discussed.

The 2013 Computer Science curriculum consists of eighteen knowledge areas, each split into multiple knowledge units and thence learning outcomes. Although more emphasis is put on professional practice and so called ‘soft skills’ in this document than the aforementioned curricula, there is no suggestion or recommendation for work-place based learning to develop ‘real-world’ competencies. Graduates are described as having ‘fundamental competency’ in the areas described by the BoK. The curriculum goes on to describe eleven characteristics of graduates in Computer Science.

<b>Cyber Security Body of Knowledge</b>	The Cyber Security Body of Knowledge <a href="https://www.cybok.org/">https://www.cybok.org/</a> (accessed 04 June 2019)
The CyBOK is a body of knowledge being led by the University of Bristol and aims to be a guide and codification system of existing cyber security literature. Nineteen knowledge areas are being worked on, although at time of writing only five have been ratified and released, while six others are in draft form. The knowledge areas themselves consist of documents which summarise key aspects of the area, with referenced sources, summative tables, guides to common acronyms and a glossary of terms.	

## 2.5. Degree apprenticeships

Degree apprenticeships are an attempt to bring together the level of academic knowledge gained from completing a degree with the practical, real world experience found by working in industry. Degree apprenticeships allow the potential of developing true competency by the time a student graduates.

<b>Institute for Apprenticeships and Technical Education</b>	Developing and Writing an Apprenticeship Occupational Standard <a href="https://www.instituteforapprenticeships.org/developing-new-apprenticeships/developing-and-writing-an-apprenticeship-occupational-standard/">https://www.instituteforapprenticeships.org/developing-new-apprenticeships/developing-and-writing-an-apprenticeship-occupational-standard/</a> (accessed 04 June 2019) Apprenticeship Standards <a href="https://www.instituteforapprenticeships.org/apprenticeship-standards/?routes=Digital&amp;levelFrom=6">https://www.instituteforapprenticeships.org/apprenticeship-standards/?routes=Digital&amp;levelFrom=6</a> (accessed 04 June 2019) What is a quality apprenticeship? <a href="https://www.instituteforapprenticeships.org/quality/what-is-a-quality-apprenticeship/">https://www.instituteforapprenticeships.org/quality/what-is-a-quality-apprenticeship/</a> (accessed 04 June 2019)
The IfAaTE set out standards for developing apprenticeships. This includes details as to how to write the standard for the individual apprenticeship which must be ‘short, concise and clear’, ‘based on a clear occupational profile setting out duties, skills, knowledge and behaviours [of the employee]’, ‘define the full competence’ and ‘align with regulatory requirements and professional recognition’.	

There are currently twenty eight digital apprenticeship standards, with seven from level six to eight. These are mainly integrated degrees with one non-integrated degree in Artificial Intelligence – data specialist. These standards include such detail as typical job titles, levels and awards, core skills, technical knowledge and behavioural skills as well as specialism outcomes.

IfAaTE have also defined what they consider to be a quality apprenticeship, including that it should include (substantial) ‘on and off-the-job training’, and that the ‘occupational competence’ should be tested. It is acknowledged that the needs of the apprentice are to achieve ‘competence in a skilled occupation, which is transferable’. This competence is to be included in the written standard.

<b>Tech Partnership Degrees</b>	Tech Partnership Degrees: Purpose <a href="https://www.tpdegrees.com/about/tech-industry-gold-accreditation/purpose/">https://www.tpdegrees.com/about/tech-industry-gold-accreditation/purpose/</a> (accessed 04 June 2019)
Tech Partnership have the intention of accrediting degrees, degree apprenticeships and tech degrees with a gold standard where they integrate industry-relevant academic learning with the ‘technical, business and interpersonal skills’ needed in industry. Unfortunately, Tech Partnership do not publish criterion under which courses can become accredited and at time of writing have not responded to requests for a specification document. There is also no indication that Tech Partnership Gold accreditation requires any form of real-world experience as part of the accredited course (other than the apprenticeships) or any methodology of proving competency other than completing the degree course.	

<b>Skills Development Scotland</b>	Graduate Apprenticeships (Skills Development Scotland) <a href="https://www.skillsdevelopmentscotland.co.uk/what-we-do/apprenticeships/graduate-apprenticeships/">https://www.skillsdevelopmentscotland.co.uk/what-we-do/apprenticeships/graduate-apprenticeships/</a> (accessed 04 June 2019) Overview <a href="https://www.apprenticeships.scot/become-an-apprentice/graduate-apprenticeships/">https://www.apprenticeships.scot/become-an-apprentice/graduate-apprenticeships/</a> (accessed 04 June 2019)
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Skills development Scotland have implemented graduate apprenticeships to allow employees to equip themselves with higher level academic learning and industry accreditation to help them progress as professionals. Twelve courses are currently available, with five coming under the umbrella term of Computing. The apprenticeships are work-based and as such rely heavily upon developing work-based competencies which are then brought into the academic study where possible and suitable.

## 2.6. Skills/competency frameworks

Skills and competency frameworks are designed to allow a potential employer to assess and compare candidates against the roles they are expecting them to work within. This is useful for job descriptions, application processes and internal assessment. The difficulty arises when different frameworks are used in comparison, as they may have differing levels of competency, ways of judging the competency, or even differing ideas of what competency is.

<b>SFIA</b>	SFIA Foundation <a href="https://www.sfia-online.org/en">https://www.sfia-online.org/en</a> (accessed 04 June 2019)		
Forms a competency framework and reference model for the organisations within ICT, Seng and digital transformations. Primarily consists of a matrix of professional skills against seven levels of competence.			
Within the IoC proposed accreditation we are primarily concerned with three levels of responsibility:			
<b>Responsibility Level</b>	<b>3 (Apply)</b>	<b>4 (Enable)</b>	<b>5 (Ensure, Advise)</b>
<b>Autonomy</b>	Works under general direction. Uses discretion in identifying and responding to complex issues and assignments. Receives specific direction, accepts guidance and has work reviewed at agreed milestones. Determines when issues should be escalated to a higher level.	Works under general direction within a clear framework of accountability. Exercises substantial personal responsibility and autonomy. Plans own work to meet given objectives and processes.	Works under broad direction. Work is often self-initiated. Is fully responsible for meeting allocated technical and/or project/supervisory objectives. Establishes milestones and has a significant role in the assignment of tasks and/or responsibilities.
<b>Influence</b>	Interacts with and influences colleagues. Has working level contact with customers, suppliers and partners. May supervise others or make decisions which impact the work assigned to individuals or phases of projects. Understands and collaborates on the analysis of user/customer needs and represents this in their work.	Influences customers, suppliers and partners at account level. May have some responsibility for the work of others and for the allocation of resources. Participates in external activities related to own specialism. Makes decisions which influence the success of projects and team objectives. Collaborates regularly with team members, users and customers. Engages to ensure that user needs are being met throughout.	Influences organisation, customers, suppliers, partners and peers on the contribution of own specialism. Builds appropriate and effective business relationships. Makes decisions which impact the success of assigned work, i.e. results, deadlines and budget. Has significant influence over the allocation and management of resources appropriate to given assignments. Leads on user/customer collaboration throughout all stages of work. Ensures users' needs are met consistently through each work stage.
<b>Complexity</b>	Performs a range of work, sometimes complex and non-routine, in a variety of environments. Applies methodical approach to issue definition and resolution.	Work includes a broad range of complex technical or professional activities, in a variety of contexts. Investigates, defines and resolves complex issues.	Performs an extensive range and variety of complex technical and/or professional work activities. Undertakes work which requires the application of fundamental principles in a wide and often unpredictable range of contexts. Understands the relationship between own

			specialism and wider customer/organisational requirements.
<b>Knowledge</b>	Has a sound generic, domain and specialist knowledge necessary to perform effectively in the organisation typically gained from recognised bodies of knowledge and organisational information. Demonstrates effective application of knowledge. Has an appreciation of the wider business context. Takes action to develop own knowledge.	Work includes a broad range of complex technical or professional activities, in a variety of contexts. Investigates, defines and resolves complex issues.	Is fully familiar with recognised industry bodies of knowledge both generic and specific. Actively seeks out new knowledge for own personal development and the mentoring or coaching of others. Develops a wider breadth of knowledge across the industry or business. Applies knowledge to help to define the standards which others will apply.
<b>Business Skills</b>	Demonstrates effective communication skills. Plans, schedules and monitors own work (and that of others where applicable) competently within limited deadlines and according to relevant legislation, standards and procedures. Contributes fully to the work of teams. Appreciates how own role relates to other roles and to the business of the employer or client. Demonstrates an analytical and systematic approach to issue resolution. Takes the initiative in identifying and negotiating appropriate personal development opportunities. Understands how own role impacts security and demonstrates routine security practice and knowledge required for own work.	Communicates fluently, orally and in writing, and can present complex information to both technical and non-technical audiences. Plans, schedules and monitors work to meet time and quality targets. Facilitates collaboration between stakeholders who share common objectives. Selects appropriately from applicable standards, methods, tools and applications. Fully understands the importance of security to own work and the operation of the organisation. Seeks specialist security knowledge or advice when required to support own work or work of immediate colleagues.	Demonstrates leadership. Communicates effectively, both formally and informally. Facilitates collaboration between stakeholders who have diverse objectives. Analyses, designs, plans, executes and evaluates work to time, cost and quality targets. Analyses requirements and advises on scope and options for continuous operational improvement. Takes all requirements into account when making proposals. Demonstrates creativity, innovation and ethical thinking in applying solutions for the benefit of the customer/stakeholder. Advises on the available standards, methods, tools and applications relevant to own specialism and can make appropriate choices from alternatives. Maintains an awareness of developments in the industry. Takes initiative to keep skills up to date. Mentors colleagues. Assesses and evaluates risk. Proactively ensures security is appropriately addressed within their area by self and others. Engages or works with security specialists as necessary. Contributes to the security culture of the organisation.

Each skill is given a name, code and description and is then defined at each of the levels at which it is practised. If a candidate tallies with the skill at a given level then they can be considered professionally competent within that skill at the level assessed. Not all skills are covered at all levels; Analytics (INAN) is considered only applicable between levels 3 and 7 inclusive. Data Visualisation (VISL) is only applicable between levels 4 and 5 inclusive.

<b>National Occupation Standards</b>	Repository for all approved National Occupation Standards <a href="https://www.ukstandards.org.uk/EN">https://www.ukstandards.org.uk/EN</a> (accessed 04 June 2019)
National Occupation Standards (NOS) are a large collection of standards of performance which individuals must achieve when carrying out functions in the workplace. They include specifications of underpinning knowledge and understanding. The NOS cover a vast range of function, numbered in the thousands. These standards are not levelled but targeted at specific job functions and skills. They consist of both academic competency ('You need to know and understand...') and practical competency ('You must be able to...'). Unlike some standards, the NOS are specific and specified, and do not indicate any sort of variance within a skills demonstrated/knowledge held by which the standard may still be met.	

<b>European e-Competence Framework</b>	e-CF overview <a href="http://www.ecompetences.eu/e-cf-overview/">http://www.ecompetences.eu/e-cf-overview/</a> accessed 04 June 2019) e-CF 3.0 Framework Download <a href="http://www.ecompetences.eu/e-cf-3-0-download/">http://www.ecompetences.eu/e-cf-3-0-download/</a> (accessed 04 June 2019)
The e-CF is based on competencies rather than job roles. This brings it closer in line with the SFIA approach than the NOS approach detailed above. The competencies are broken into five areas (plan, build, run, enable, manage). Each of these is then broken down into between four and twelve competencies. Each competency is aligned with levels 1 to 5. Some competencies can be met across up to four levels, while some can be met at only two levels. Levels e-1 to e-5 are aligned correspondingly with EQF levels 3-8.	
Levels of competency have indicative skills examples which demand practical competency without being as prescriptive as the NOS framework. There are also knowledge competencies which, while prescriptive, could be considered somewhat vague which allows variance within the requirements.	

<b>Digital, Data and Technology Profession Capability Framework</b>	Digital, Data and Technology Profession Capability Framework – GOV.UK <a href="https://www.gov.uk/government/collections/digital-data-and-technology-profession-capability-framework">https://www.gov.uk/government/collections/digital-data-and-technology-profession-capability-framework</a> (accessed 04 June 2019) Example: Data Engineer <a href="https://www.gov.uk/government/collections/digital-data-and-technology-profession-capability-framework#data:-data-engineer">https://www.gov.uk/government/collections/digital-data-and-technology-profession-capability-framework#data:-data-engineer</a> (accessed 04 June 2019)
<p>The DDaT framework aims to describe the job roles in Digital, Data and Technology across government. This covers in the region of 17,000 civil servants. Thirty-eight individual job roles are described in the fields of data, IT operations, Product and delivery, QAT, Technical, and User centred design.</p> <p>With some variation, each job role has a role description which is generic to the role, and then tables of skill levels. These cover the different roles (eg. Data engineer, senior data engineer, lead data engineer and head of data engineering), and the essential and desirable skills they will need as well as the levels they will be needed at for each role. These levels range from awareness, through working and practitioner to expert. Within each role, there is a description of the role and then a table of each of the skills listed, along with a description of the skill, the level needed and what that means in the context of the role. These are more definitive than exemplars.</p> <p>There is no attempt to align the roles with SFIA or other similar frameworks.</p>	

<b>Success Profiles</b>	Success Profiles – GOV.UK <a href="https://www.gov.uk/government/publications/success-profiles">https://www.gov.uk/government/publications/success-profiles</a> (accessed 04 June 2019)
<p>Success Profiles is an attempt by HM Government to create a framework to attract and retain people of talent and experience. The framework is split into five elements, Behaviours, Strengths, Ability, Experience and Technical. Each of these elements has a range of definitions (eg. Strengths has 36 key terms with attendant definitions). These definitions are then mapped to behaviours (e.g. strengths has 9 behaviours such as ‘seeing the big picture’ and ‘managing a quality service’).</p> <p>There is no exemplar of levels of competency within the definitions or alignment with other frameworks. While the definitions are open rather than dictatorial, they are somewhat vague and there is no way of determining whether all or some have to be met, whether partially meeting in some cases is acceptable, or what levels of competency in the definition is needed.</p>	

<b>JNCC Data Skills Framework</b>	Data Skills Framework <a href="http://jncc.defra.gov.uk/page-7255">http://jncc.defra.gov.uk/page-7255</a> (accessed 04 June 2019)
<p>The Joint Nature Conservation Committee have attempted to create a framework that sits between data-related domains (small scale) and larger IT related skills frameworks such as SFIA.</p> <p>The framework draws out seven areas of competency, each with three levels (foundation, intermediate and advanced) to represent competency. These levels are laid out in a format with a general descriptor followed by a range of points, ‘most’ of which must be met. There is also an exemplar for applying the framework to a specific domain (in this case a Geographic Information Analyst), with the application including specific applications with applicable levels to be defined as fully competent.</p>	

## 2.7. The international dimension

### 2.7.1. Degrees

<b>Bologna</b>	The Bologna Process in higher education <a href="https://www.qaa.ac.uk/docs/qaa/quality-code/bologna-process-in-he.pdf?sfvrsn=e04cf981_14">https://www.qaa.ac.uk/docs/qaa/quality-code/bologna-process-in-he.pdf?sfvrsn=e04cf981_14</a> , accessed 05 June 2019
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The Bologna Process proposes that the European Higher Education Area is developed as a means of promoting mutual recognition of qualifications. This is with an aim to ease the mobility of staff and students across higher education within Europe. An overarching Framework for Qualifications of the European Higher Education Area (FQ-EHEA) was developed. The FHEQ in England, Wales and Northern Ireland were verified as aligning with FQ-EHEA in 2008, with FHEQ level 7 (Bachelor’s degrees) aligning with the first cycle in the Bologna process, level 7 (Master’s degrees) aligning with the second cycle and level 8 (Doctoral degrees) aligning with the third cycle.

<b>CATS and ECTS</b>	
<p>The Credit Accumulation and Transfer System is a system used within the UK to enable credit completed in one educational establishment to be transferred at another establishment with an equitable equivalence. In HE, 10 hours of learning is equated to 1 credit.</p> <p>The European Credit Transfer and Accumulation System (ECTS) is an equivalent, Europe-wide system central to the Bologna process. Two UK credits normally equal one ECTS credit, so each ECTS credit reflects 20 hours of learning.</p>	

### 2.7.2. Accreditation

<b>Seoul Accord</b>	Seoul Accord <a href="https://www.seoulaccord.org/">https://www.seoulaccord.org/</a> , accessed 04 June 2019
<p>The Seoul Accord, formed in 2008, is a multi-lateral agreement among agencies responsible for the accreditation/recognition of Computing and IT related qualifications. The BCS is the UK signatory and as such are committed to transparency of accreditation, avoidance of the perception that it is arbitrary or capricious in application of policy, promote, develop and recognise best practice within Computing and IT-related disciplines.</p>	

<b>Washington Accord</b>	Washington Accord <a href="http://www.ieagreements.org/accords/washington/">http://www.ieagreements.org/accords/washington/</a> , accessed 05 June 2019
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The Washington Accord is an international agreement between bodies responsible for accrediting engineering degree programmes. Similar to the Seoul accord and predating it by some 19 years, the Washington accord signatories are committed to development and recognition of good practice in engineering education with the aim of growing the global mutual recognition of engineering qualifications. Within the UK the Washington accord is signed by the Engineering Council United Kingdom.

### 2.7.3. Skills frameworks

<b>SFIA</b>	SFIA Foundation <a href="https://www.sfia-online.org/en">https://www.sfia-online.org/en</a> , accessed 05 June 2019
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While it was developed in the UK, SFIA is used internationally. It has been translated into 10 languages and contributors to the consultation process come from over 140 countries. Such a large international user base enables both employees and employers to compare competency levels internationally.

<b>e-CF</b>	European e-Competence Framework <a href="http://www.ecompetences.eu/">http://www.ecompetences.eu/</a> , accessed 05 June 2019
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The European e-Competence Framework is a European standard and aims to provide a reference of 40 competences applicable to the ICT workplace and understandable across Europe. This common language includes both skill and knowledge requirements for ICT professionals, professions and organisations across five proficiency levels.