2. Rationale for a new accreditation standard

2.1 Aim

The Institute of Coding aims to, "create a new way to develop the digital skills you'll need at work and beyond."

The purpose of IoC workstream 1.1 is to codesign with industry a new standard for "digital" graduates.

As the latest, post-Shadbolt, venture seeking to address the "digital skills gap", the focus is on digital skills for the workplace, rather than on knowledge and learning for their own sake.

2.2. Digital skills for the workplace

The primary requirements of employers include –

- graduates must be billable (competent)
- graduates must be adaptable (underpinning knowledge for cognate skill areas)
- graduates must be effective problem solvers (which is fundamentally what university education is about)

These are the fundamental drivers for the IoC, not some add-on concept of "employability". Competence, adaptability and problem solving are at the heart of the IoC standard – they are not simply to be retro-fitted to an academic curriculum based on an encyclopaedic Body of Knowledge (BoK).

BoKs are reference points, ***from*** which curricula are drawn, rather than templates ***for*** curricula. Foundational knowledge and principles remain important, but the key focus for the IoC standard is on what graduates will be able to do. That is, it focuses on skills and outcomes, rather than on curriculum and inputs; and hence

on ***competence*** (as described in a skills framework) rather than on knowledge (derived from a BoK).

2.3. Accreditation standards

An accreditation standard is a statement of what all (accredited) graduates should achieve. It describes a minimum level of achievement.

The IoC Accreditation Standard set out in this document ensures that graduates will meet the requirements of both the Framework for Higher Education Qualifications (FHEQ) outcomes statement and the Quality Assurance Agency (QAA) subject benchmark statement.

Furthermore, graduates from a programme meeting the IoC Accreditation Standard should also meet the educational requirements for BCS Accreditation for at least CITP. The focus on competence rather than knowledge means that graduates may also have gained some of the experience required for chartered status.

2.4. The development of competence

Competence lies at one end of a spectrum that starts with knowledge (knowing how to do something), progresses through capability (being able to something in a controlled environment) to competence. This maps more appropriately to Simpson's Hierarchy [1] rather than to Bloom's Taxonomy [2], the latter being the more usual reference for the design of academic assessment. The two are compared with the competence spectrum, and with each other, in table 1.

Item	"Competence" spectrum	Simpson's Hierarchy	Bloom's Taxonomy
1			**Remember**: recall facts and basic concepts
	Recognition: understand what the problem is	**Perception**: responds to cues in real world	
2	**Knowledge**: knowing how to deal with it	**Set**: ready to apply a known sequence of steps	**Understand**: describe ideas or concepts
3	**Capability**: have done it at least once	**Guided Response**: imitation and practice	**Apply**: relate information to new situations
4	**Not incompetent**: doesn't repeat mistakes	**Mechanism**: learned responses with confidence and proficiency	
			Analyse: draw connections amongst ideas
5			**Evaluate**: justify a stand or decision
	Competent: reproducible, reliable, creative	**Explicit** Overt Response: quick, accurate and coordinated performance	

Table 1: Mapping between competence hierarchy, Simpson's hierarchy and Bloom's taxonomy

The descriptions for the competence spectrum seek to echo some of the concerns expressed by employers for why some computing graduates are not "competent", and what it might mean if they were. They draw also on Miller's

pyramid (1990) [3], proposed originally for the assessment of clinical competence, and from the descriptions of nursing competence described by Herman and Kenyon (1987) [4]. These abstractions bear remarkable similarity to the levels of Simpson's hierarchy, rather than to those of Bloom.

Note that there is considerable similarity between the characterisations for Simpson's Hierarchy and Bloom's (revised) taxonomy across the first three levels, although the former is fundamentally "practical", and the latter "theoretical". Indeed, the first level of Bloom seems entirely abstract, which is why it is shown on a separate row of table 1. However, there may be a (weak) argument that perception and recognition are based, at least to some extent, on memory and on association of facts.

For the next two levels, despite attempts to assert that "analyse" in Bloom's taxonomy might actually mean to analyse the failure of a machine, for example – something which is eminently practical – the fourth and fifth level of Bloom are essentially knowledge-focussed, that is, theoretical, and do little to capture practical application; indeed, in many ways, they just enhance "capability" without delivering "competence". Simpson, for these two levels, is essentially practical – about doing things, and doing them successfully; this practical emphasis is reflected directly both in Miller and in Herman and Kenyon.

Given that employers apparently want graduates to be able to do things, rather than just reason about them, the practical emphasis expressed in Simpson's hierarchy seems more appropriate for the IoC standard – against which outcomes will be measured - than the purely cognitive perspective of Bloom.

This goal may pose challenges for traditional degree programmes, which may currently include few opportunities for students actually to practise their skills in the real world.

But a focus on competence – rather than just capability, however advanced – is entirely in keeping with the goals for the IoC.

2.5. Reference to skills framework

Since competence is described in skills frameworks rather than BoKs, it is appropriate to express the IoC standard, which focusses on competence, in terms of a relevant skills framework.

As noted in Bowers and Howson (2019) [5], for the computing profession, the most appropriate skills framework is the Skills Framework for the Information Age, SFIA [6], now in version 7.

2.5.1 The SFIA Framework

SFIA is industry focussed, maintained and updated regularly by its user community (primarily employers). It has become the de facto global IT skills Framework, used in nearly 200 countries by organisations and individuals to characterise and manage their skills.

The underlying SFIA model is a two-dimensional matrix consisting of skills on one axis and seven levels of responsibility on the other. SFIA (v7) describes 102 skills. Cells in the matrix correspond to individual professional skills at various levels of competence. A typical job – or occupation – usually comprises about three skills, usually at the same or similar levels.

2.5.2 Choice of levels

SFIA characterises the seven levels of responsibility in terms of Autonomy, Influence, Complexity, Knowledge and Business Skills. As discussed by Bowers and Howson [7], (good) new graduates should normally be able to work at SFIA Level 3 – the "Apply" level, corresponding to being a competent practitioner. The responsibility characteristics defined for SFIA level 3 meet virtually all of the generic skills stipulated by both FHEQ and the QAA SBS for Computing, and the majority required for CITP. Competence at SFIA Level 3 is therefore the target for the IoC standard for Bachelor's degrees.

In contrast, experience at SFIA Level 5 ("ensure") is the normal benchmark required to attain Chartered status, which one would expect normally to be achieved a few years after graduation. Although this level might be achieved on

some post-experience Master's programmes, competence at Level 4 ("enable") is more appropriate for the IoC Master's standard.

2.6 The IoC standards - principles

2.6.1 Competence requirements

The IoC standards are defined in terms of competences in SFIA skills. The description of a SFIA skill gives *exemplar* activities that would demonstrate competence in that skill at a particular level. The exemplars are generic, so that there is flexibility in how they should be interpreted in a particular environment.

Furthermore, even if a given individual is not performing all of the suggested activities, that does not mean they are not competent. SFIA is **not** a conjunctive checklist; the target for competence should be between 50 and 85% of the tasks specified for any skill.

2.6.2 Using BoKs

Bodies of Knowledge should be drawn upon to design curricula to develop (focussed) competence.

2.6.3 Number of competence skills

The only place that most undergraduate students (without the benefit of a placement / internship etc.) will be able to demonstrate competence is likely to be in their final year (capstone) project. In that context, it is probable that there will be scope for the majority of students to develop competence corresponding to only **one** SFIA skill at (SFIA) Level 3.

Similar arguments apply for taught Masters' students. Although projects at Masters level may be more substantial than those for undergraduates, so also are the responsibility characteristics for SFIA Level 4. Hence, in the absence of a substantial placement, Master’s students should be required to develop competence in only **one** SFIA skill at Level 4.

2.7 Commentary

The principal advantages of adopting a standard based on SFIA include:

- Use of the SFIA framework provides an abstraction mechanism that can assure comparable standards across different curricula;
- The SFIA responsibility characteristics provide a core which corresponds to the generic skills in IfA requirements, FHEQ and QAA benchmark statements.
- Underpinning knowledge for additional SFIA skills addresses the FHEQ/QAA requirements for breadth of knowledge.
- LSEPI and sustainability as explicit additional requirements ensure coverage of BCS CITP accreditation requirements.
- Those developing different curricula can select skills appropriate to their focus and context;
- SFIA is not prescriptive about how competence is developed - it allows providers to choose how to deliver that competence, and for competence to be developed by different providers within a single qualification;
- SFIA is widely recognised across industry – both in the UK and internationally.
- SFIA focusses on what it means to be competent – that is, on particular expertise that is useful in employment, rather than on the curriculum studied to gain that expertise.
- Given that the focus is on exemplars to demonstrate competence, so that different individuals (students/apprenticeships) may have strengths in different aspects of a skill, this approach avoids the "conjunctive shopping list" approach of some other standards.
- BCS and IET are core partners in the SFIA Foundation.

2.8 Final comments

Although the IoC standards are based on the SFIA framework, they are not simply that framework.

The standards specify the number and level of skills required by an IoC graduate, together with the range of additional underpinning knowledge.

The standards are designed explicitly to meet the stated aims, and do so as follows:

- Competence in 1 skill => productive, able to operate in a live environment, billable etc.
- Underpinning knowledge for additional skills => adaptability, breadth of knowledge
- SFIA responsibility characteristics => employability
- Non-specificity of standard => flexibility

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5. David S Bowers, Oli Howson (2019) "Analysis of accreditation approaches in the Computing sector", The Institute of Coding
6. https://www.sfia-online.org/en/reference-guide
7. ibid