Institute of Coding: Accreditation Standard

Theme 1 - University Learners - Work Package 1.1

Co-leads:

- Chris Sharp, IBM
- David Bowers, Open University

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> DRAFT PROPOSAL 2.4
>
> This is an evolving document and should not be used to implement any programme or curricula

1. Background

1.1 Context

The proposed standard must be:

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a. Fit for purpose for whole project especially themes 1, 2 and 3
b. Fit for all IoC partners
c. Fit for broad industry
d. Takes into account existing standards
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1.2. Requirements

An initial discussion in the online meeting on 9th April identified a number of requirements within the context above.

1. Some overarching targets are givens:

    a. FHEQ (Framework for Higher Education Qualifications) outcomes statement

        i. equivalents for Scotland/Wales/Northern Ireland?

    b. QAA (Quality Assurance Agency) subject benchmark statement

    c. (for degree apprenticeships) Institute for Apprentices (IfA) endorsement.

2. The standard needs to specify both technical and "soft" skills.

    a. The focus should be on work readiness rather than employability

3. Must meet the needs of, and be endorsed by, industry

    a. Should be able to recognise both industry-created and academic content.

    b. Should allow interoperability between HEIs and industry

    c. In particular, must support needs of SMEs

4. Must be flexible
    a. Given that there will be several curricula, a core standard with extensions may be appropriate.
        - The core might include such as coding, group work, lifecycle, soft skills.
    b. (For theme 2) – needs to support degree apprenticeships as well as degrees (L6 & L7).
    c. (for theme 3) – would be good if it were possible to specify chunks smaller than a complete degree – perhaps using some sort of "layering" or "component" model.
    d. Should link to other accreditations
        i. e.g., BCS, IET
        ii. Will be different from Tech Partnership Degrees (TPD) standards for degree apprenticeships.

Industry involvement in the development and adoption of the standard is crucial. This will require ongoing involvement of individuals from a wide range of employers from across the sector, constituting a broadly-based industrial panel.

1.3. Constraints

Development will require industrial participation in discussions and workshops.

If the standard is to be used for Degree Apprenticeships (DAs), then it needs to address a distinct space from those standards already in operation, primarily those developed/under development by Tech Partnership and ONS.

No standard is of value if it is neither accepted by the sector nor implementable. The eventual operation of the standard is outwith the discussion in this paper.

The IoC is not (yet) authorised to accredit anything – at best, it might offer a "kite mark" endorsement. Only professional bodies, such as BCS are currently able to accredit against a standard.

1.4. Opportunities

In developing the new standard, we could choose to work with existing accreditation bodies (BCS, TPD, GCHQ), and/or with other bodies such as SFIA who manage a user-defined skills framework for the sector.

In order to distinguish the IoC standard from other standards, such as those managed by TPD, we might align it to professional qualifications, such as CITP, or CIISP.

Early informal discussions with both BCS and SFIA indicate that they are willing – indeed, keen! – to collaborate with IoC

1.5. Discussion

The separation of the standard from the curricula (workstreams 1.2, 1.3 and themes 2/3) mean that the standard itself needs to be very flexible and adaptable. This is best achieved by abstraction.

There is a marked contrast between standards such as the BCS accreditation criteria and the TPD DA standards: the former has relatively few generic requirements that can be contextualised for a particular degree, whereas the latter is essentially a long conjunctive list of requirements. Indeed, in the latter, there is no application of MoSCow (must/should/could/won't) – all requirements and sub-requirements are given equal weight.

One of the key requirements is that the standard must meet industry needs. Although foundational knowledge and principles are important, the key focus is to be on what [graduates] will be able to do. That is, it will focus on skills and outcomes, rather than on curriculum and inputs.

And, crucially, the definition of skills and outputs needs to be recognised and accepted by industry.

It may be appropriate for the standard to suggest "staged" outputs – particularly in the context of degree apprenticeships – to ensure that those following a standard are "billable" early in their studies.

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)

Note that these are the fundamental drivers for the IoC, not some nebulous concept of "employability".

Furthermore, "employability" needs to be at the heart of the IoC standard – it is not something that can be retro-fitted to an academic curriculum based on an encyclopaedic Body of Knowledge.

2.3. Bodies of Knowledge

Academics and professional bodies have lots of experience of developing bodies of knowledge (BoKs).

Typically, they draw upon (their own) existing courses, frameworks from external bodies such as Turing Institute or the National Cyber Security Centre (NCSC). Significant reference points also include existing bodies of knowledge such as those published by ACM/IEEE. However, it should be noted that these tend to focus very much on academic content, rather than on practice.

Furthermore, BoKs tend to aim to be universal, inclusive, exhaustive, complete, exhausting etc. With the possible (but unlikely) exception of really focussed BoKs like CyBok, addressing the whole of a BoK within a single degree programme would probably be extremely challenging.

BoKs should be reference points, from which curricula are drawn, rather than templates for curricula.

2.4. Accreditation standards

An accreditation standard is a statement of what all (accredited) graduates should achieve.

For a degree, a standard must deliver the explicit outcomes included in both the Framework for Higher Education Qualifications (FHEQ) outcomes statement and the Quality Assurance Agency (QAA) subject benchmark statement.

In computing, the QAA SBS specifies a set of generic skills, and requires that the design of a curriculum should refer to the ACM BoK.

There is no direct 1-1 mapping from a BoK to a realistic Standard; any resulting "standard" would be a large, constraining, conjunctive "tick list" (like the Tech Partnership Degrees DTS degree apprenticeships.) If a BoK is used as a standard, then if a graduate fails to achieve any one item in the BoK, then they should fail their degree – which is neither realistic nor helpful, in the context of the IoC's aims.

Rather than focus purely on (yet another) BoK, it is proposed that the focus be changed from *knowledge* to **competence**.

2.5. Competence

Competence is more than being able to get correct answers to problems, or write correct code, or complete any other kind of university exercise. It's more than just practice, in a "protected" university environment in which nobody can get hurt.

Competence is about being able to apply knowledge and skills successfully in new environments, **without** the safety net of it "just being a university exercise"

Competence is about being able to "fly solo", when it matters.

Competence is about what graduates can be let loose to do for clients...without close supervision.

2.6. The IoC standard – principles

SFIA is an industry focussed competence framework, maintained and updated by its users (primarily industry). We propose using SFIA as an abstraction layer – defining the standard in terms of competences in SFIA skills.

Bodies of Knowledge will then be used to decide what must be in a curriculum to deliver (focussed) competence.

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 only to develop competence corresponding to **one** SFIA skill at (SFIA) Level 3 ("Apply").

3. High-level proposal

In order to address requirements (ii) and (iii), an appropriate model could be to use the SFIA framework as the abstraction framework, which will then support requirement (iv).

By working closely with BCS, we should ensure that the resulting standard will meet the accreditation requirements for CITP (requirement v). This would allow the "occupation" for any degree apprenticeships to be "IT professional", which is distinct from "digital and technology solutions professional" (i.(c)).

3.1. SFIA

3.1.1. (content from SFIA website)

SFIA [1], the Skills Framework for the Information Age, describes skills required by professionals in roles involving information and communications technology. Since [its formal inception in] 2000, SFIA 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 SFIA Framework remains relevant and useful because it is simple and generic and is updated through a consultation activity where its extensive global user base comes together to collaborate on initiating, drafting and reviewing updates to the Framework. SFIA gives individuals and organisations a common language to define skill, abilities and expertise in a consistent way. It provides a common reference model in a two-dimensional framework consisting of skills on one axis and seven levels of responsibility on the other. It describes professional skills at various levels of competence. It also describes generic levels of responsibility, in terms of Autonomy, Influence, Complexity, Business Skills, Knowledge and Security.

3.1.2. commentary

SFIA is updated by its user community – primarily employers. It is directly relevant to industry needs. From version 7 (2018), the update process will be

continual, and demand based – so, if users find a new skill has emerged, or is needed at a lower / higher level than is currently specified, it is possible to add to the framework.

The current release of SFIA version 7 describes 102 skills. A typical job – or occupation – will usually be covered by two or three skills, usually at the same or similar levels.

One key distinction between SFIA and the conjunctive lists of current DA standards is that the description of a skill gives exemplars that would demonstrate competence in that skill at a particular level. The exemplars are usually fairly generic, so that there is flexibility in how they might be interpreted in a particular environment. Furthermore, a given individual may not be performing all of the suggested activities – that does not mean they are not competent. SFIA is *not* a conjunctive checklist.

The generic skills, defined by level rather than skill, cover many of the competencies required for accreditations such as FHEQ and QAA, as well as for the professional accreditation offered by BCS. New graduates would typically work at SFIA levels 2 or 3 ("assist" or "apply"), but will usually have the underpinning knowledge to enable them to progress rapidly to higher levels. For graduates who have had relevant work experience, the starting level should certainly be level 3. Graduates' knowledge will also probably underpin at least some level 4 skill(s).

Experience at SFIA Level 5 is the normal benchmark required to attain Chartered status, which one would expect normally to be achieved a few years after graduation. This level might be appropriate for post-experience Master's programmes.

A final point – which could be very helpful – is that one of the activities in the current SFIA update is to map certifications, curricula and bodies of knowledge explicitly to the SFIA framework.

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1. https://www.sfia-online.org/en/reference-guide

A SFIA-based standard

An initial proposal for an IoC standard might be:

> A graduate from an IoC honours degree should have demonstrated competence in **at least one** skill at **Level 3**, and should have the knowledge to underpin **at least one** SFIA skill at **Level 4**, and **at least 2** other relevant skills at level 3.
>
> They should be able to demonstrate **all** of the generic skills for **Level 3**.

For a graduate from a degree apprenticeship (where there is significant relevant work experience), this might be adapted to:

> A graduate from an IoC degree apprenticeship should be able to demonstrate competence in at least one SFIA skill at level 4, in one additional skill at level 3, and at have the knowledge to underpin least 2 more relevant skills at level 3.

They should be able to demonstrate all of the generic skills for level 4.

Note that the **numbers of skills**, and the definition of **which ones would be relevant**, are open to discussion.

For example, it might be that the target for competence should be Level 4, rather than three, but that may be unrealistic in the absence of significant workbased experience (such as a placement year, or WB learning integrated into a Degree Apprenticeship).

The "generic skills" for levels 3 are reproduced in Appendix 1, as are a selection of skill descriptors which might be relevant for data analytics and cyber-security curricula.

This model could be readily adapted for Master's level degrees and apprenticeships, and also for sub-degree chunks (e.g, for theme 3).

In addition, "layering" would be possible, so that, for example, level 1 of an IoC degree might be required to underpin skills at SFIA level 1 or 2. Alternatively, for Theme 3, and appropriate IoC accreditation might focus on a single SFIA skill at

level 3 or 4, or perhaps three or four skills at level 2 (depending on the domain requirements).

Commentary

The skills listed in Appendix 1 are, at this stage, exemplars – there is no intention that this should be the prescriptive list for the data analytics standard to be developed by IoC.

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 "generic" skills provide a core which seems to correspond both to IfA requirements, FHEQ and QAA benchmark statements and also to BCS CITP accreditation requirements.
- The abstraction mechanism allows those working on different curricula to select appropriate skills;
- 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 – i.e., useful to an employer – rather than on curriculum input
- 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 other standards.
- BCS and IET are core partners in the SFIA Foundation.

Final comments

The generic skills cover virtually all of the explicit requirements in the QAA subject benchmark statement (SBS), FHEQ and also those specified by IfA for apprenticeships.

Requiring underpinning knowledge for additional SFIA skills completes FHEQ/QAA requirements.

Crucially:

> Competence in 1 skill => billable
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> Underpinning knowledge for additional skills => adaptability
>
> Generic skills => employability
>
> Non-specificity of standard => flexibility

Generic Skills

From SFIA Version 7

Generic Attributes

Level 3

Autonomy

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.

Influence

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.

Complexity

Performs a range of work, sometimes complex and non-routine, in a variety of environments. Applies methodical approach to issue definition and resolution. Knowledge

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.

Business skills

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.

SFIA skills that could be relevant for any curriculum

Portfolio, programme and project support PROF The provision of support and guidance on portfolio, programme and project management processes, procedures, tools and techniques. Support includes definition of portfolios, programmes, and projects; advice on the development, production and maintenance of business cases; time, resource, cost and exception plans, and the use of related software tools. Tracking and reporting of programme/project progress and performance are also covered, as is the capability to facilitate all aspects of portfolio/ programme/ project meetings, workshops and documentation.

Level 4

Takes responsibility for the provision of support services to projects. Uses and recommends project control solutions for planning, scheduling and tracking projects. Sets up and provides detailed guidance on project management software, procedures, processes, tools and techniques. Supports programme or project control boards, project assurance teams and quality review meetings. Provides basic guidance on individual project proposals. May be involved in

aspects of supporting a programme by providing a cross programme view on risk, change, quality, finance or configuration management.

Level 3

Uses recommended portfolio, programme and project control solutions for planning, scheduling and tracking. Sets up project files, compiles and distributes reports. Provides administrative services to project boards, project assurance teams and quality review meetings. Provides guidance on project management software, procedures, processes, tools and techniques.

Project management PRMG

The management of projects, typically (but not exclusively) involving the development and implementation of business processes to meet identified business needs, acquiring and utilising the necessary resources and skills, within agreed parameters of cost, timescales, and quality. The adoption and adaptation of project management methodologies based on the context of the project and selecting appropriately from predictive (plan-driven) approaches or adaptive (iterative/agile) approaches.

Level 4

Defines, documents and carries out small projects or sub-projects (typically less than six months, with limited budget, limited interdependency with other projects, and no significant strategic impact), alone or with a small team, actively participating in all phases. Identifies, assesses and manages risks to the success of the project. Applies appropriate project management methods and tools whether predictive (plan-driven) approaches or adaptive (iterative/agile) approaches. Agrees project approach with stakeholders, and prepares realistic plans (including quality, risk and communications plans) and tracks activities against the project schedule, managing stakeholder involvement as appropriate. Monitors costs, timescales and resources used, and takes action where these deviate from agreed tolerances. Ensures that own projects are formally closed and, where appropriate, subsequently reviewed, and that lessons learned are recorded.

Data Analytic Skills

SFIA skills that could be relevant for Data Analytics

Analytics INAN

The application of mathematics, statistics, predictive modeling and machine-learning techniques to discover meaningful patterns and knowledge in recorded data. Analysis of data with high volumes, velocities and variety (numbers, symbols, text, sound and image). Development of forward-looking, predictive, real-time, model-based insights to create value and drive effective decision-making. The identification, validation and exploitation of internal and external data sets generated from a diverse range of processes.

Level 3

Undertakes analytical activities and delivers analysis outputs, in accordance with customer needs and conforming to agreed standards..

Data management DATM

The management of practices and processes to ensure the security, quality, integrity, safety and availability of all forms of data and data structures that make up the organisation's information. The management of data and information in all its forms and the analysis of information structure (including logical analysis of taxonomies, data and metadata). The development of innovative ways of managing the information assets of the organisation.

Level 3

Applies ethical and robust techniques in the transformation of data from one format/medium to another, in line with organisational policies and procedures and being sensitive to risks around the use of information.

Methods and tools METL

The definition, tailoring, implementation, assessment, measurement, automation and improvement of methods and tools to support planning, development, testing, operation, management and maintenance of systems. Ensuring methods and tools are adopted and used effectively throughout the organisation.

Level 3

Provides support on the use of existing methods and tools. Configures methods and tools within a known context. Creates and updates the documentation of methods and tools.

Database design DBDS

The specification, design and maintenance of mechanisms for storage of and access to data in support of business information needs. Design of the physical data layer, addressing enterprise data resource needs and local stored data structures. Definition of physical or virtual data warehouse structures required to support business intelligence and data analytics services.

Level 3

Develops appropriate physical database or data warehouse design elements, within set policies, to meet business change or development project data requirements. Interprets installation standards to meet project needs and produces database or data warehouse component specifications.

Database administration DBAD

The installation, configuration, upgrade, administration, monitoring and maintenance of databases. Providing support for operational databases in production use and for internal or interim purposes such as iterative developments and testing. Improving the performance of databases and the tools and processes for database administration (including automation).

Level 3

Uses database management system software and tools to collect agreed performance statistics. Carries out agreed database maintenance and administration tasks.

Cybersecurity Skills

Information security SCTY

The selection, design, justification, implementation and operation of controls and management strategies to maintain the security, confidentiality, integrity, availability, accountability and relevant compliance of information systems with legislation, regulation and relevant standards.

Level 3

Communicates information security risks and issues to business managers and others. Performs basic risk assessments for small information systems. Contributes to vulnerability assessments. Applies and maintains specific security controls as required by organisational policy and local risk assessments. Investigates suspected attacks. Responds to security breaches in line with security policy and records the incidents and action taken.

Information governance IRMG

The overall governance of how all types of information, structured and unstructured, whether produced internally or externally, are used to support decision-making, business processes and digital services. Encompasses development and promotion of the strategy and policies covering the design of information structures and taxonomies, the setting of policies for the sourcing and maintenance of the data content, and the development of policies, procedures, working practices and training to promote compliance with legislation regulating all aspects of holding, use and disclosure of data.

Level 4

Ensures implementation of information and records management policies and standard practice. Ensures effective controls are in place for internal delegation, audit and control relating to information and records management. Assesses and manages risks around the use of information. Provides reports on the

consolidated status of information controls to inform effective decision making. Recommends remediation actions as required. Ensures that information is presented effectively.

Penetration testing PENT

The assessment of organisational vulnerabilities through the design and execution of penetration tests that demonstrate how an adversary can either subvert the organisation's security goals or achieve specific adversarial objectives. Penetration testing may be a stand-alone activity or an aspect of acceptance testing prior to an approval to operate. The identification of deeper insights into the business risks of various vulnerabilities.

Level 4

Maintains current knowledge of malware attacks, and other cyber security threats. Creates test cases using in-depth technical analysis of risks and typical vulnerabilities. Produces test scripts, materials and test packs to test new and existing software or services. Specifies requirements for environment, data, resources and tools. Interprets, executes and documents complex test scripts using agreed methods and standards. Records and analyses actions and results. Reviews test results and modifies tests if necessary. Provides reports on progress, anomalies, risks and issues associated with the overall project. Reports on system quality and collects metrics on test cases. Provides specialist advice to support others.

Digital forensics DGFS

The collection, processing, preserving, analysis, and presentation of forensic evidence based on the totality of findings including computer-related evidence in support of security vulnerability mitigation and/or criminal, fraud, counterintelligence, or law enforcement investigations.

Level 4

Contributes to digital forensic investigations. Processes and analyses evidence in line with policy, standards and guidelines and supports production of forensics findings and reports.

Business risk management BURM

The planning and implementation of organisation-wide processes and procedures for the management of risk to the success or integrity of the business, especially those arising from the use of information technology, reduction or non-availability of energy supply or inappropriate disposal of materials, hardware or data.

Level 4

Investigates and reports on hazards and potential risk events within a specific function or business area.

Data management DATM

The management of practices and processes to ensure the security, quality, integrity, safety and availability of all forms of data and data structures that make up the organisation's information. The management of data and information in all its forms and the analysis of information structure (including logical analysis of taxonomies, data and metadata). The development of innovative ways of managing the information assets of the organisation.

Level 4

Takes responsibility for the accessibility, retrievability, security, quality, retention and ethical handling of specific subsets of data. Assesses the integrity of data from multiple sources. Provides advice on the transformation of data/information from one format or medium to another. Maintains and implements information handling procedures. Enables the availability, integrity and searchability of information through the application of formal data and metadata structures and protection measures. Manipulates specific data from information services, to satisfy defined information needs.

Hypothetical instantiation - Web App Developer

This is a worked example of a hypothetical instatiation of an IOC degree for a Web App Developer, showing the mapping of SFIA skills and model curriculum.

Curriculum

Year 1

Semester 1	Semester 2	Summer
PROG101 [1]	WEBD102 [4]	
...	COMP102 [5]	
NWSC101 [2]	PROF102 [6]	
BSYS101 [3]	CLIN102 [7]	Internship [8]

Year 2

Semester 1	Semester 2	Summer
SPMG201 [9]	ARCH202 [13]	
UCDD201 [10]	NWSC202 [14]	
DMAD201 [11]	WEBP202 [15]	
PROJ201 [12]	CLIN202 [16]	Internship [8]

Year 3

Semester 1	Semester 2	Summer
CSVC301 [17]	MOBS302 [21]	
RQMS301 [18]	LEAN302 [22]	
SYSI301 [19]	PROJ302 [23]	
PROJ301 [20]	...	

1. Introductory Programming
2. Network & Security Fundamentals
3. Business Systems & Drivers
4. Developing Web Content
5. Computational Thinking
6. Communications and Professional Practice
7. Web Content Clinic
8. Summer Internship
9. Service & Project Management
10. User Centred Design & Development
11. Data Modelling & Design
12. Yr 2 Group Project
13. Systems Architecture
14. Network & Web Security
15. Web Programming
16. Web Development Clinic
17. Cloud Based Services
18. Requirements Management
19. Systems Integration & Testing
20. Yr 3 Group Project
21. Mobile & Cross-Platform Services
22. Business Agility

23. Final Project

SFIA Skills

Level 3/4 targets

- Information Security SCTY
- Programming/software development PROG
- Requirements definition and management REQM
- Systems integration and build SINT
- Release and deployment RELM

Level 2 underpinning

- Portfolio, programme and project support PROF
- Data modelling and design DTAN
- Information content authoring INCA
- User experience design HCEV
- Solution architecture ARCH

Responsibility Characteristics

- Leadership skills & experience
- Influence / business skills
- Job experience
- Complexity/Autonomy/Business skills