The Skills Framework for the Information Age: Engaging Stakeholders in Curriculum Design

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ABSTRACT

This paper reports on a research project, examining the role of the Skills Framework for the Information Age (SFIA) in Information and Communications Technology (ICT) curriculum design and management. A goal was to investigate how SFIA informs a top-down approach to curriculum design, beginning with a set of skills that define a particular career role. A further goal was to evaluate the extent to which SFIA facilitates stakeholder interaction, such that academic programs can better identify industry needs while preparing graduates for the intended career role. The paper also evaluates the extent to which SFIA informs the identification of authentic forms of assessment and the skills and levels of autonomy and responsibility required by entry-level and Masters graduate ICT positions. Processes and practices for ICT curriculum design and management are recommended based on findings arising from this research. Although this research was conducted in an Australian context, findings suggest that there is value in using SFIA for ICT curriculum design and management, even in those jurisdictions where it is not required for accreditation or professional certification purposes.

Keywords: Advisory boards, Bloom's taxonomy, Careers, Certifications, Curriculum design and development, Computing skills

1. INTRODUCTION

The Skills Framework for the Information Age (SFIA) is a two-dimensional framework consisting of skills on one axis and seven levels of responsibility on the other that identify a broad set of technical and generic skills practiced by ICT professionals (SFIA Foundation, 2015a). While there is currently very limited documented usage of SFIA within an American context, the framework has been used extensively within the Australasian and British private and public sectors to: manage organizational ICT skill profiles and job design, define job families and position descriptions, structure staffing, promotion, and remuneration decisions. ICT professionals are encouraged to use SFIA to manage their career progression and professional development, which can be achieved using a variety of online tools and mobile applications (Australian Computer Society (ACS), 2016a; SFIA Foundation, 2015b).

SFIA further serves as the basis of national professional certification schemes in the United Kingdom, New Zealand, Australia, and Canada (ACS, 2013a; British Computer Society (BCS), 2016; Canadian Information Processing Society (CIPS), 2016; Institute of IT Professionals (ITTP), 2016), and for the international accreditation of regional

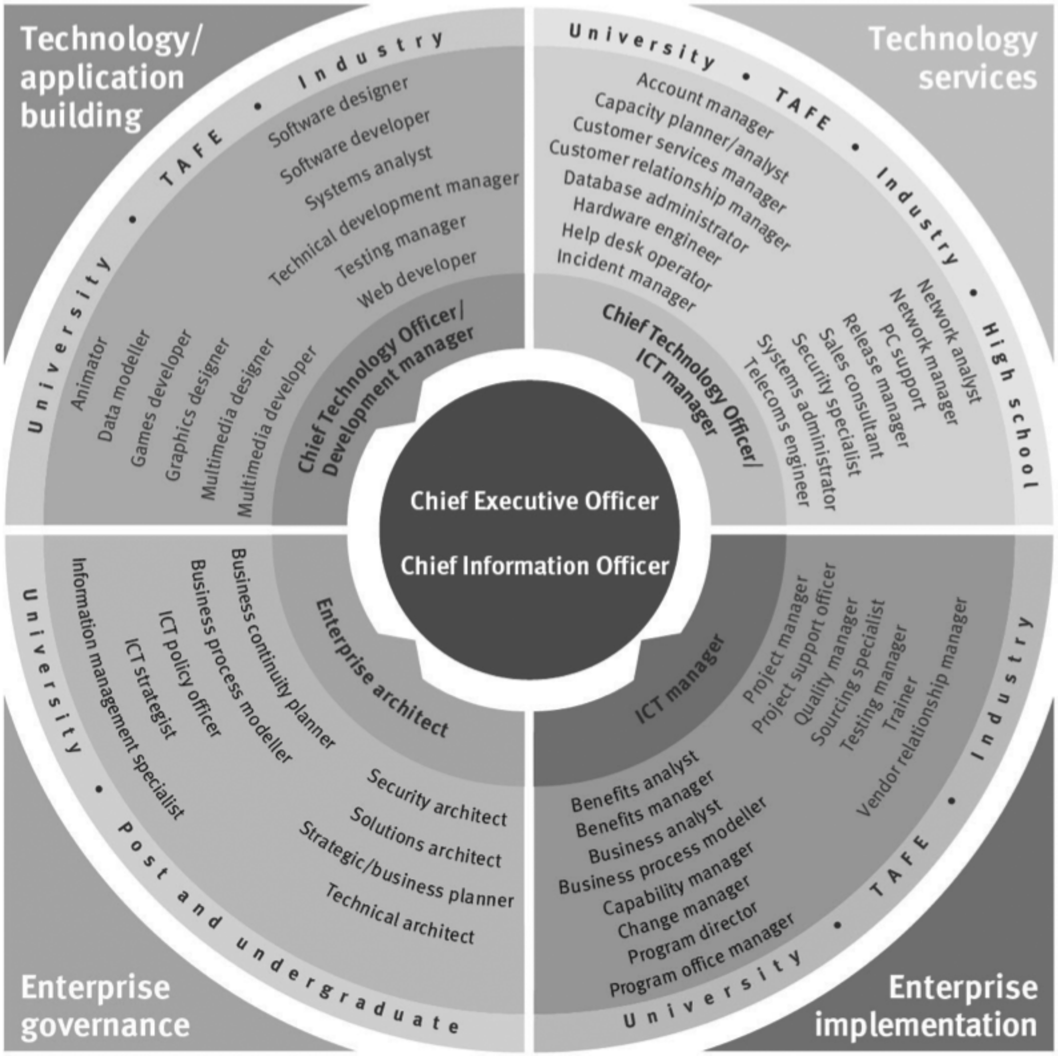

Figure 1. SFIA based position descriptions defined by the Queensland Government Chief Information Office, used with permission (Queensland Government Chief Information Office, 2013)

professional certification schemes by the International Federation for Information Processing (IFIP) as part of their International Professional Practice Partnership (IP3) (International Federation for Information Processing (IFIP), 2016; International Professional Practice Partnership (IP3), 2016; Johnson, 2010).

Indeed, the reach of SFIA has extended beyond its original European roots as evidenced by Rodprayoon (2015), who examined SFIA's role in underpinning Thailand's ICT standards for entry into the Association of Southeast Asian Nations (ASEAN) economic community and to assist in the development of a skilled Thai labor force to meet its "Smart Thailand 2020" agenda. Rodprayoon states:

> the SFIA Framework is the skills framework underlying most international ICT certification programs being implemented around the world by the Society's kindred partners. It also provides a standard benchmark to ensure true international recognition of a country's certification program.

SFIA is also used by the ACS in conjunction with the accreditation of Australian higher education programs in ICT (ACS, 2016b, 2016c). The ACS recommends the use of SFIA to define career roles in curriculum design and management (ACS, 2012, 2016b), as do other educational and professional organizations in Great Britain, Canada, Sri Lanka, Chile and Malaysia.

However, there are relatively few examples to inform the processes and practices of academic institutions regarding the best way to do this. That is, there are limited examples to demonstrate how SFIA informs a top-down approach to curriculum design, or facilitates stakeholder interaction. Addressing this limitation in the existing literature is the principal contribution of this paper.

2. BACKGROUND

SFIA Version 6 defines 97 skills in six categories: Strategy and Architecture, Business Change, Solution Development and Implementation, Service Management, Procurement and Management Support and Client Interface (SFIA Foundation, 2015a). Generic definitions also characterize the extent to which an ICT professional works with autonomy, influences others, engages in complex work, and possesses basic business skills. Specific SFIA descriptors provide details for each technical skill, and specify up to seven levels of increasing responsibility: follow, assist, apply, enable, ensure/advise, initiate/influence, and set strategy/inspire/mobilize. It is worth noting that SFIA Levels of Responsibility are not dissimilar to Bloom's Taxonomy (Bloom, Kratwohl, and Masia, 1956), commonly used to describe levels of cognition in educational design. In its revised form (Anderson and Krathwohl, 2001), Bloom's Cognition Levels are: remembering, understanding, applying, analyzing, evaluating, and creating.

In the context of ICT curriculum design, Bloom's Taxonomy has been used to define cognitive levels for a variety of educational activities in information systems, computer science, and software engineering. These include a range of programming tasks (Thompson et al., 2008) and software inspection and reading strategies (McMeekin et al., 2009). Bloom's Taxonomy has also been used to identify cognition levels in ICT curriculum management (Oliver et al., 2004), and to identify advanced subjects that require high cognitive levels for accreditation purposes (ACS, 2016b).

The Australian Computer Society recommends using both SFIA and Bloom's Taxonomy as part of a holistic approach to curriculum design and management (ACS, 2012, 2015, 2016b) for ICT programs including those in information systems, information technology, computer science, and software engineering. In particular, a top-down approach is recommended, beginning with the identification of intended career roles and the SFIA skills these roles require.

An example of a SFIA-based process to implement the ACS recommendation was implemented at the University of Tasmania over a two year period that concluded in 2014 (Herbert, de Salas, et al., 2013). The use of SFIA was motivated by a desire to create a new Bachelor of Information Communication Technology with industry relevance and broad appeal to prospective students (Herbert et al., 2014). The process involved extensive dialog with a range of internal and external stakeholders and was informed by externally referenced curricula and position descriptions from industry (Herbert, Dermoudy, et al., 2013). This included over 50 SFIA-based position descriptions defined by the Queensland Government Chief Information Office (QGCIO). These positions descriptions are shown in Figure 1 and are listed on the QGCIO web site, where they are linked to specific SFIA skills and SFIA Levels of Responsibility (Queensland Government Chief Information Office, 2013).

In the case of the University of Tasmania, SFIA was used to underpin the design of a new Bachelor degree course from the top-down. There is anecdotal evidence to suggest that most academic uses of SFIA, however, have been related to institutional quality management processes, or the requirements of regulatory and accreditation bodies. This includes formal curriculum mapping processes in which graduate attributes and professional competencies have been mapped to learning outcomes and assessments (Oliver, 2013; Oliver et al., 2007), or in conjunction with applications for accreditation that map course structure and curriculum to professional competencies and discipline-based bodies of knowledge (ACS, 2016b; Engineers Australia, 2013).

Standing alongside skills in the SFIA framework, the ACS ICT Profession Core Body of Knowledge (CBOK) was designed to reflect knowledge areas shared by all ICT professionals, regardless of their specific ICT discipline or area of technical specialization (ACS, 2012). The ACS ICT Profession Core Body of Knowledge was mapped to a range of international computing curricula and complements discipline specific bodies of knowledge (ACS, 2012). For example, the Software Engineering Body of Knowledge (SWEBOK) (Bourque and Fairley, 2014) has been mapped to the course structure of higher education programs in software engineering, and has served as the basis for benchmarking software engineering programs across institutions (Pyster et al., 2009). SWEBOK knowledge areas are also mapped to skills in the SFIA framework (von Konsky, Hay, & Hart, 2008), although the latter provided an added dimension with respect to the level of autonomy and responsibility with which skills are practiced.

As an industry-based framework, SFIA has the potential to inform the design of authentic forms of assessment and learning experiences that prepare students for professional practice. It has been suggested, for example, that a noun-verb analysis of SFIA skill descriptors can inform the design of learning activities (verbs) and the resulting artifacts (nouns) (von Konsky, Jones, and Miller, 2013). It has been argued that SFIA provides a basis for students to reflect on their attainment of skills and mentorship by industry representatives (Jones, 2012; Jones et al., 2010; Jones and Granger, 2011; Jones and Miller, 2012). SFIA also facilitates the visualization of career progression from academic study into professional practice as an emerging professional develops news skills and assumes additional responsibility within an organization (von Konsky, Jones, and Miller, 2014).

Despite this potential, the extent to which academic institutions have adopted SFIA for ICT curriculum design and management is largely unknown, with relatively few examples documented and analyzed in the scholarly literature. Similarly, SFIA's potential to promote interaction between academic institutions and their industry counterparts to collaboratively develop programs that prepare students for professional practice has not been rigorously investigated. This shortcoming in the literature has led to the investigation described in this paper, which addressed the following research questions:

- **Research Question 1:** Does SFIA contribute to stakeholder interaction and communication in a manner likely to inform the design and management of ICT curriculum?

- **Research Question 2:** Does the SFIA framework and its common nomenclature and reference model contribute to a shared understanding of skills required by early career ICT professionals as they progress from formal education into professional practice?

Outcomes arising from this research have resulted in:

- Characterizing the uptake of SFIA in Australian higher education
- SFIA-based resources to support ICT curriculum design and management
- Recommended approaches for academic institutions to collaborate with Industry Advisory Boards to design and manage ICT programs that prepare students for initial professional practice

3. METHODOLOGY

This research consisted of qualitative data collection through structured SFIA-based activities and feedback from participants in nationwide focus groups. As shown in Table 1, these were conducted in four Australian capital cities, with a deliberate mix of university ICT academics and representatives from the ICT industry. Some cities also included ICT professional society representatives, and one city included a representative from the government ICT sector. A total of 45 participants provided their informed consent to participate. Of these, 42% (n=19) were representatives from the ICT industry, 38% (n=17) were ICT academics from the higher education sector, 18% (n=8) were representatives of an ICT professional society, and 2% (n=1) were ICT professionals from the government sector.

Multiple focus groups were used to facilitate research that included data from these stakeholders, who were generally selected to be senior representatives from the far-reaching geographical locations studied. It was intended that multiple focus groups would result in the opportunity to produce rich "data and insights that would be less accessible without the interaction found in [an expert] group" (Morgan, 1988, p. 12). Focus groups were deemed to be an appropriate methodological approach for collecting and analyzing primary data, which covered a full range of perceptions and experiences from multiple participants across the Australian higher education landscape, either from an academic perspective or an industry employer perception.

Each focus group began in a similar fashion, with a detailed explanation of the purpose of the focus group meeting and the way in which it would be conducted. Participants were asked to characterize their prior level of involvement with SFIA and identify the extent of SFIA use within their respective organizations during a facilitated group discussion. A brief overview of the SFIA framework was then presented. All participants representing the mix of stakeholders then interacted in two SFIA-based activities.

The first activity provided a SFIA skillset for a hypothetical masters-level subject in Green IT. The SFIA skillset used in this activity is given in Table 2, which uses a check to indicate the levels of responsibility for which each skill is defined in the SFIA framework. The table demonstrates that not all skills are defined at all levels. As part of Activity 1, each group was asked to identify an appropriate SFIA level based on SFIA skill descriptors and to use these to consider forms of authentic assessment.

	City Number				Total
	1	2	3	4	
Industry representative	3	7	6	3	19
Academic	0	8	7	2	17
Professional Society	0	2	5	1	8
Government representative	1	0	0	0	1
Total	4	17	18	6	45

Table 1. Participant breakdown by role and city.

SFIA Skill and 4 Letter Code	Defined SFIA Levels						
	1	2	3	4	5	6	7
Emerging technology monitoring (EMRG)				☐	☐	☐	
Methods and tools (METL)				☐	☐	☐	
Business Process Improvement (BPRE)					☐	☐	☐
Enterprise and business architecture improvement (STPL)					☐	☐	☐
Sustainability management for IT (SUMI)					☐	☐	
Conformance Review (CORE)			☐	☐	☐	☐	

Table 2. Skillset showing defined SFIA levels for a hypothetical subject in Green IT used in Activity 1.

In the second activity, smaller breakout groups of between three and eight participants mapped SFIA skills and levels to a supplied position description. This was an actual position description for a Junior Software Developer selected by the researchers and considered characteristic of many entry-level ICT positions in Australia. The position required candidates with broad ICT knowledge and skills (e.g. an understanding of agile methodologies, an ability to engage quickly with new technologies, and demonstrate a passion for programming), professional skills (e.g. teamwork, communication, proactive attitude), and knowledge of specific ICT technologies (e.g. Java, JavaScript, JQuery, CSS, MySQL, Git, and specified operating systems). The position description made no mention of SFIA or SFIA skills. Breakout groups were asked to map SFIA skills and levels to the position description and report back to the other groups, justifying the levels at which they had mapped the entry-level job description.

Interaction during the focus group was recorded and subsequently transcribed. The transcripts underwent a thematic analysis so as to inform the researchers' response to elements of the research questions. Each of the three researchers reviewed the transcripts and developed themes individually. A further iteration produced a single validated set of themes arising from the activities. Names appearing in the results section of this paper have been randomly assigned to protect the identity of participants.

This study has Human Research Ethical approval from the lead author's institution (approval no: CBSFac6-2013), which was endorsed by the partner institutions participating in this research.

4. RESULTS

Thematic analysis of Focus Group transcripts identified several broad themes. Each theme provides insights into the potential role of SFIA in curriculum design and management. Identified themes are:

- **Defining ICT career roles –** The focus groups identified good examples in which experienced industry professionals described how SFIA has been used to define position descriptions and career roles in industry. In a higher education context, intentions to use SFIA to define the career roles developed by academic programs were largely aspirational in nature. Examples in which SFIA had been mapped to Bloom's Taxonomy and other frameworks were evident but appeared to be largely driven by specific institutional, accreditation and regulatory requirements.
- **Cognition, experience, and authentic learning –** Focus group participants were generally able to identify the requisite SFIA skills associated with a position description. There was evidence that SFIA descriptors were used successfully by participants to discuss and identify SFIA levels of responsibility. However, levels associated with greater autonomy and responsibility, such as those that might be associated with masters-level study, required participants to make assumptions about the prior experience and qualifications of students. There was general agreement that practicums, internships, industry-based projects and placements were important contributors to developing higher SFIA levels. However, there was speculation that other factors such as personal attributes, prior experience, and the quality of project work might lead to a cohort of Masters level graduates who do not necessarily operate at the same SFIA levels upon graduation.
- **Soft skills in the ICT curriculum –** A common perception of academic participants was that SFIA focuses on technical skills at the expense of soft skills. However, industry professionals experienced with SFIA recounted examples of how soft skills are defined in situ in the context of technical skills. It was observed that some breakout groups made the connection between SFIA technical skills and their implicit soft skills. However, less experienced groups often struggled to develop shared meaning and understanding regarding this implicit connection.
- **Processes and Related Frameworks -** Participants were interested in the relationship between SFIA and other frameworks such as Bloom's Taxonomy and the Australian Qualifications Framework (AQF) (AQF, 2016). While several academic participants reported that they had mapped these, it was apparent that there were few references to such mappings that had been widely disseminated to demonstrate this relationship.
- **Closing the loop on curriculum design and management –** Participants identified case studies as an effective means to assess attainment of skills in the Green IT activity. Skills in that set are primarily associated with SFIA Business Change and Strategy and Architecture categories such as the Emerging Technology Monitoring (EMRG) skill. Electronic portfolios in which students collect evidence of the attainment of SFIA skills and reflect on personal development as an ICT professional were identified as a sub-theme during multiple focus group session discussions.

These themes are expanded below and supported by illustrative quotes as appropriate.

4.1 Defining ICT Career Roles

Focus group participants represented a broad range of prior experience with respect to using SFIA. While most were relatively new to the framework, a few had significant experience using SFIA to define career roles in government and industry. For example, one participant recounted his experience using SFIA to define ICT career roles in the government sector:

> …in the early days we were involved with the State Government to implement the SFIA descriptions into role descriptions… All the [State Government] ICT job descriptions are now linked to SFIA. So I'm a big supporter of SFIA.

Another described how his consulting firm uses SFIA to assist clients with organizational change management:

> We use it as a fundamental tool when we're doing strategic advice in terms of reorganizing organizations so we can make sure that capability is developed in the right place and structured accordingly.

Several participants from higher education institutions also described their prior experience using SFIA. This included a university Chief Information Officer (CIO) who uses SFIA to manage roles within his institution's IT support services. Several senior academics had used SFIA to define ICT career roles as they mapped curriculum to the SFIA framework. Other academics described how SFIA skills associated with subjects they taught informed their teaching and assessment practices. However, those academics generally did not consider this in the context of a holistic skillset intended to characterize career roles for degree programs as a whole. In the main, SFIA use in curriculum design and management tended to be more aspirational in nature.

For an academic from the Vocational Education and Training (VET) sector, this aspiration was based on the recognition of SFIA's potential to differentiate between graduates of different ICT programs:

> I'm in charge of the IT degrees at [a Technical and Further Education (TAFE) institute] where we have some very vertically specialized degrees in networking, security and virtualization and in order to distinguish our students from IT students it might be useful to use this framework to give proper skill level labeling to the graduates that we produce.

Despite the limited SFIA expertise of many participants, structured activities conducted during focus group workshops demonstrated the potential of SFIA to facilitate dialogue amongst stakeholders about ICT career roles. For example, in Activity 2, participants were generally able to identify SFIA skills associated with an entry-level software development position as posted in a recent online job posting.

The Junior Software Developer position description used in the activity called for candidates with a tertiary qualification in computing and with some prior development experience. Bullet points in the position description expanded on this, listing key technologies and concepts required for the position. These included agile development along with various programming and database technologies. The position also required candidates to have testing skills, particularly in the area of unit and automated testing. Potential candidates also needed to demonstrate capability in the use of automation to reduce risk and promote processes for continuous improvement within the organization. More generally, successful candidates would support existing product functionality in addition to developing new features.

The position description made no reference to SFIA or SFIA skills. Nonetheless, breakout groups were tasked with identifying appropriate SFIA skills and levels based on SFIA descriptors. "We had a great discussion," recounted one participant, describing the analysis conducted by his breakout group. Referring to specific SFIA skills, sometimes using the four letter SFIA code for a given skill, he reported:

> Fundamentally, it was a programming and support role. We came out with the following … [skills]. There was DTAN, which was data analysis to support the Requirements Analysis and continuous improvement process [(REQM)], closely, at number two. Closely and behind that was Design [(DESN)]and supported by TEST as well, Application Support and maintenance [(ASUP)] around the ability to support any of the existing features in a platform environment, Database Design, which is DBDS, particularly because it states it needs experience with relational database, Programming [(PROG)] is a fundamental skill with an application programmer, and programming was a [Level] three...

4.2 Cognition, Experience, and Authentic Learning

Good examples in which breakout groups referred to SFIA descriptors to identify appropriate SFIA levels in conjunction with Activity 2 were observed. Consider the following exchange between members of a breakout group, considering what level would be appropriate for the SFIA Testing (TEST) skill in conjunction with the Junior Software Developer position (all names have been changed to anonymize the identity of the participants).

Tom began by reading the descriptors for each TEST level. "Well I don't think it's coordinating, managing testing", he stated, referring to verbs in the TEST Level 5 descriptor. "Is it accepting responsibility of creation for test cases?" he asked, referring to the TEST Level 4 descriptor. After a long pause he concluded "Probably not."

On the basis of the descriptors, Greg agreed that it was not TEST Levels 5 or 4 and suggested that TEST should be at Level 3. "I think at the end probably a level three, because requirements and specifications are different," he said, justifying classification at TEST Level 3 based on keywords in the SFIA descriptor: "defines test conditions."

Jake was initially concerned that TEST Level 3 might be too high for a Junior Software Developer, however, given that a junior position usually works under direct supervision. "Design test cases and test scripts under own direction is level three", he said. "As a junior developer do you want them doing that themselves or do you want them still being supervised?"

A further discussion ensued, and TEST Level 2 and 3 descriptors were compared. In the end, the group selected TEST Level 3, given that a junior developer would generally have a role in reviewing and defining test cases for test-driven agile development.

Agreeing on intended SFIA levels for a masters-level subject in Green IT was observed to be less obvious during Activity 1. In part, this difficulty was because SFIA skills shown in Table 2 are constrained to relatively high levels of autonomy and responsibility. Some were of the view that high SFIA levels can only be achieved as a result of individual experience, and that it is difficult to teach to this level in a formal setting. Many found defining SFIA levels to be dependent both on prior experience and current professional roles, both of which could vary quite reasonably from student to student.

> Jack: I struggled with anything in the top categories because it uses the words, 'direct', 'lead'.
>
> Ted: That's right. You couldn't get a Master's [at Level 6 (Initiate, Influence)] unless they had previous experience.
>
> Jack: Well I mean a person that graduates or does a 5 [Ensure, Advise] and then gets into a workforce could start delivering at a 6, no argument, once they've got the influence... But I can't imagine you being able to teach to a 6. That's all.

Another breakout group reported that their solution was to assume the minimum level appropriate for the cohort as a whole. A group representative reported that their method was to "first go through the levels, and we went 5, 5, 6, 5, 6, 5 [for the skills in Table 2]." He continued: "We took the position that we'd look at the minimum, not the ideal, and then go through each one of them."

It was further observed that setting minimum SFIA levels in a Master's program would depend on entry requirements with respect to prior qualifications and discipline, and whether students had significant work experience prior to commencing postgraduate study. Moreover, participants indicated that the ICT profession would benefit from more rigorous expectations regarding practicums and real experience.

The importance of authentic learning opportunities, industry-based projects and placements was a common point discussed within all focus groups. “The case studies, I like the idea of the case studies… Helping students to get work ready,” noted a participant.

> The other one is actual placements. You can say they’re in industry, and they get dropped into a team that’s working on level six. … You can get graduates coming out because of the particular placement and experience in a project at the higher level. They’ve got say level six experience when they graduate, and [others] nominally level three.

“I think one of the biggest things we can do as a professional,” reflected another participant, “is to have that professional year [placement from] which you get confidence that when we’re talking to someone they know not just the theory and what they’ve been taught, but that they’re able to apply it in a broader context.”

A senior academic involved in institutional reviews of programs across a broad range of disciplines reported that in her experience, some disciplines do a better job at work integrated learning that some ICT disciplines.

> In Health, in almost all of the courses, there’s a placement, there’s working to credit learning, there’s professional practice, there’s a practicum, there’s field work. When you go across to Engineering they’ve got that to the high end of Engineering.

She reported that this was often not the case in courses like Information Systems and Computer Science. She further suggested that these programs could do a better job at working with the ICT industry to provide work integrated learning opportunities for students. This view is consistent with data from the Australian Survey of Academic Engagement (AUSSE) (Radloff and Coates, 2010). The AUSSE data show that ICT students participate in practicums and industry placements to a significantly lesser extent that students studying in other disciplines.

4.3 Professional Skills in the ICT Curriculum

A common theme arising during Focus Groups was a perceived lack of emphasis in the SFIA framework on professional skills such as communication, teamwork, and lifelong learning. For example, an academic with extensive experience mapping SFIA to the curriculum at her institution expressed concern about a lack of an explicit emphasis on soft skills:

> My concern is that very little emphasis is made in SFIA on the generic [soft] skills… and that’s the thing that keeps coming out from industry is that they want the whole person, not just the technical, but all those other things and I don’t think that’s teased out enough here [in the SFIA standard].

However, during Activity 1, another participant observed that lifelong learning skills are an underlying component common to SFIA skills in the supplied Green IT skillset, noting that these are:

> ...largely around the individual’s ability to be able to gather research, collate, synthesize and build an effective framework to assess the value of a piece of software technology or whatever in Green IT…

He provided further insight by noting that the Activity 1 skills should be taken as holistic skillset, rather than as a collection of independent and unrelated skills, based on soft skills that connect the underlying theme of the skillset:

> …whilst heavily dependent each of these capabilities, it’s not really represented in the co-dependency between any one of those individual capabilities. You’re looking at them individually, but they’re actually very closely linked.

Several focus groups discussed soft skills that were implicit components of SFIA technical skills. Examples cited by participants experienced with SFIA were principally those skills and categories that require interacting and communicating with stakeholders. Specific examples discussed during focus groups include the Project Management (PRMG) skill in the Business Change SFIA category and Governance (GOVN) in the Strategy and Architecture SFIA category. One participant also observed that soft skills were at the heart of the Client Interface SFIA category. “The client interface is soft skills and it’s the most important job,” he said, “because if you don’t sell you don’t produce.”

As a specific example, consider the following exchange in which a breakout group identified the Application Support (ASUP) skill as a component of the Activity 2 position description, having implicitly linked communication and teamwork skills to application support. Tom begins the interaction by reading directly from the position description.

> Tom: The role will have a passion for working and collaborating with people.’ That doesn’t sound like a junior developer to me.
> Jake: It’s a junior?
> Tom: Yes.
> Greg: It’s becoming one of the key things... You have to be able to work with other human beings.
> Tom: Oh, right. Okay.
> Greg: Yeah. Otherwise they won’t hire you, if you can’t interact.
> Jake: So probably Application Support [(ASUP)]?
> Tom: Yes, I think so.
> Jake: Which is in the Services Management [SFIA category].

Groups that were less experienced with SFIA, however, sometimes struggled to develop a shared understanding regarding the relationship between SFIA technical skills and the implicit soft skills. This was evident in a lengthy exchange between an industry representative named Karen and other members of her breakout group. Karen mapped skills from the Business Change category to the supplied position description used during Activity 2 as being of principal importance to the role. Karen nominated skills from the SFIA Business Change category because of their implicit relationship to communication and teamwork and an inferred relationship to agile methodologies mentioned in the position description.

> I would put in business change because they include all the soft skills like skills management and relationship management, and it definitely says ... [in the position description] working with peers and agile methodologies, so that means communication and teamwork.

From the Business Change category, Karen went on to map Relationship Management (RLMT) at Level 4 (Enable) in the Activity 2 exercise. She had made an implicit connection between RLMT and communication and teamwork. An academic named Rich disagreed with this mapping. Rich's rejoinder was primarily focused on relationship management and the level at which a new graduate would be able to practice it, not on the more implicit aspects of communication and teamwork that Karen was trying to coax from within the SFIA descriptors.

> Rich: Can I take this opportunity … to disagree with Karen on that? That level of skill, Karen, is at Level 4. In other words, you're asking a junior developer to be able to enable business change, enable business relationships.
>
> Karen: …If you're going to work in agile, you need to be able to do it at Level 4 because you've got to put your opinions forward.

George, initially supportive of Karen's suggestion to include Relationship Management (RMLT) because of the implied connection with communication skills, later changed his mind after a more thorough reading of the descriptor. A lengthy discussion ensued, in which the importance of the Programming (PROG) skill was discussed relative to soft skills like communication, teamwork, and lifelong learning, all either implicit or mentioned in situ in SFIA in the context of other technical skills.

Referring to the colors used in the SFIA documentation to designate specific SFIA categories, an academic named Chuck attempted to sum up the group's discussion by suggesting that another category might be useful to adequately capture soft skills in the SFIA standard:

> But just in my head, if there was another section, if there were 100 categories, and the top [category], a different colored one, was soft skills, communication ability, ability to get on in a team, attitude, then every employer would tick all of them as the most important.

4.4 Processes and Related Frameworks

Some Focus Groups discussed the extent to which SFIA levels are compatible with Bloom's Taxonomy. The later framework classifies the level of cognition associated with learning, and is often included in curriculum mapping exercises, and for accreditation purposes to identify advanced subjects.

Bloom's Taxonomy places the simple recall of knowledge at the low end (Bloom's Level 1), comprehension and application in the middle range (Bloom's Levels 2 and 3), and analysis, synthesis, and evaluation at the higher end of the cognition scale (Bloom's Levels 4, 5, 6).

Consider the following exchange in which the relationship between SFIA levels and Bloom's Taxonomy was explored during the focus group:

> George: When we develop our outcomes, we have to map them across Bloom's taxonomy. What's the relationship between this and Bloom's taxonomy?
>
> Samantha: It's actually, it fits quite nicely. [SFIA] Level 3 for example, 'apply'.
>
> George: Yeah, [Bloom's] Level 4.
>
> Samantha: Exactly. No, the verbs fit quite nicely in terms of descriptors.

During another focus group session, a senior academic described her experience with mapping verbs associated with SFIA levels to Bloom's Taxonomy, the Australian Quality Framework (AQF), and the ACS Core Body of Knowledge (CBOK) associated with regulatory and accreditation requirements:

> I actually have mapped both the generic skills across Bloom's, SFIA and the AQF and across the [ACS CBOK] knowledge… they integrate with 'synthesize'. That is the top of Boom's and that's your connection across. So I have mapped it and there was only one Bloom's word that existed that was not in any of the other frameworks but that's looking at it at a very micro level.

However, such experience at mapping across frameworks was not widespread amongst focus group participants. This observation supports prior anecdotal evidence that SFIA mapping is generally associated with addressing regulatory and accreditation requirements.

4.5 Closing the Loop on Curriculum Design and Management

In Activity 1, participants worked in small breakout groups to identify the SFIA levels associated with each skill in the set listed in Table 2. They were also tasked with identifying appropriate assessment strategies for each skill. While most groups spent the bulk of their time discussing what SFIA level would be appropriate for students at various levels of study, some groups were able to progress to defining assessment tasks.

"We thought that the best way to assess this was through progressively difficult case studies," reported a representative from one breakout group. He continued by suggesting that

> you would give the student a relatively simple case study and ask them to explore business improvement for that particular situation and also recommend frameworks or technology platforms to solve and which option they would use and why.

Another group reported that identifying appropriate assessments for the skillset was “pretty self-explanatory.” They noted that SFIA skill descriptors are very specific and stipulated what must be done to demonstrate skill attainment. The group interpreted skill descriptors for assessment purposes as follows:

> So for example, EMRG [Emerging Technology Monitoring] at Level 5 [Ensure/Advise], the tool for assessment would be probably a project that would comprise market research requirements, definition, something that’s domain specific, and would also include presentation skills to be able to communicate and sell what they’ve found.

The assessment they defined recognized that Emerging Technology Monitoring (EMRG) requires understanding new technologies and an ability to evaluate the impact of these on the business, make recommendations, and communicate these to stakeholders. This example provides a further instance in which communication skills are defined *in situ* within the context of a technical skill descriptor.

It should be noted that some groups struggled to see how a student would demonstrate EMRG Level 5 (ensure/advise), since this assessment would not necessarily be conducted in the context of an actual business. It was noted that the EMRG level 4 (enable) descriptor speaks to ensuring and advising within one’s sphere of influence. This could be a sphere of influence at home, or in the wider context of a student group, a university environment, or an internship or work placement. In contrast, EMRG level 5 (ensure/advise) extends this sphere to encompass briefings to “staff and management” for emerging technologies within one’s area of expertise. “Management” tends to suggest someone more senior than yourself, whereas “staff” tends to suggest one’s peer group. As such it was deemed reasonable in an academic setting to re-conceptualize the EMRG level 5 (ensure/advise) descriptor to encompass presentation to peers and written presentations that are assessed by academics in the hypothetical role of manager or senior corporate executive.

A similar case study approach involving requirements gathering and analysis, higher order thinking skills requiring evaluation and synthesis, and professional skills such as communication were common to other assessments defined by the group and based on the SFIA descriptors for other skills in the set.

Mapping SFIA to the ICT curriculum and its assessments contributes to the authenticity of assessments designed in this fashion. Moreover, focus groups observed that this approach has the potential to empower students to reflect on their own development and progression as an ICT professional. An academic with an Information Systems background and currently tasked with an institution-wide curriculum-mapping project envisioned a significant role for SFIA as an outcome of such an exercise:

> So if we were to say that SFIA was mapped against a curriculum, not only can we evidence it, students can make judgments about their own standard…so it’s not just, ‘I did a report about a business and I met a grade distinction,’ or whatever. They can now evidence against whatever the SFIA attributes are… It could be anything from a portfolio that you contribute through evidence, but it could also be other things that the student forms their own understanding about and then they develop their own artifacts.

Similar scenarios were discussed during other focus groups. For example, it was suggested that electronic portfolios should enable students to collect and reflect on evidence of SFIA skills arising from both their curricular and co-curricular activities:

> Every time you do something what if you evaluate it against those [SFIA skills]? ‘I did this exercise or I did this assessment, in our project this week we did these sort of things’… so that in the end they can map their education experience, their extra-curricular activities, their work integrated learning activities, et cetera, all against an electronic portfolio that is designed for them to report against that.

Moreover, recent trends were discussed in which ICT professionals were being placed into positions based on evidence available in their electronic portfolios. This includes evidence of technical skills, as well as communication and critical thinking skills. One participant reported:

> …HR consultants are starting to use them. They actually prefer them in terms of quick snaps, to be able to determine whether somebody actually can do what they want. And again, similarly, are they well written, are they dynamic, do they actually prove something?

Strategically, it was suggested that electronic portfolios should be designed, built and deployed based on common standards, and that electronic portfolio use should be encouraged by professional societies. A goal of such an approach was to encourage ICT professionals to continue to collect and reflect on evidence of ongoing development as a professional over the course of their entire career, beginning with their formal academic studies.

5. DISCUSSION

The focus group outcomes contribute to addressing the two research questions investigated in this project.

> **Research Question 1:** Does SFIA contribute to stakeholder interaction and communication in a manner

likely to inform the design and management of ICT curriculum?

An analysis of focus group transcripts shows that SFIA guided the interaction between academics and ICT industry representatives as they collaborated on focus group activities. This included the identification of specific SFIA skills and levels of responsibility for an entry-level ICT role. Although there were initial disagreements in several breakout groups, SFIA descriptors enabled groups to reach consensus using a standardized framework. Similarly, SFIA descriptors informed discussions regarding appropriate assessments in the Green IT activity. These typically included case studies and an environmental scan of new technologies and an analysis of their impact on an organization. Impact was communicated to "stakeholders" through role-playing activities or class presentations to peers and tutors. In that sense, proposed assessments were closely linked to SFIA skill descriptors. The latter uses verbs like "identify" and "monitor", related to environmental scans in proposed assessments, "evaluate", related to the analysis of new technologies and their impact on an organization, and "briefing" and "promotion", related to proposed role-playing activities and class presentations.

In addition to being linked to SFIA, these forms of assessment can be categorized by their Bloom's Taxonomy Level of Cognition. For example, the *application* of knowledge is demonstrated as students identify new technologies based on course topics and areas of personal specialization. Students also demonstrate higher order *analysis* skills as the impact of new technologies is evaluated.

While a SFIA-Bloom's mapping has been documented (Australian Health Informatics Education Council, 2011), this mapping has not been widely disseminated or subjected to wide peer review. In their mapping, Bloom's Cognition Level 6 (Creating) is mapped to SFIA Level 7 (Set strategy, inspire, mobilize). Bloom's Cognition Level 5 (Evaluating) is mapped to SFIA Level 6 (Initiate, influence). Focus group data demonstrate the view that Bloom's Cognition Levels 6 and 7 may best be developed through professional practice at a senior level, and that it is difficult to teach to those levels consistently across an entire student cohort. Moreover, the generic descriptor for SFIA level 5 (Ensure, advise) characterizes ICT professionals that demonstrate "creativity and innovation in applying solutions for the benefit of the customer/stakeholder." Together, these observations suggest that SFIA level 5 may be better mapped to Bloom's Level 6 (Creating). Moreover, in the absence of a widely disseminated reference point, there is anecdotal evidence to suggest that individual institutions undertake their own SFIA-Bloom's mapping exercise on an as-needed basis. The need for further analysis of the SFIA-Bloom's relationship is indicated, with rigorous peer review and wide dissemination.

This research has shown that SFIA is an incomplete framework for curriculum design and management purposes. While experienced study participants were able to identify implicit examples of soft skills like communication and teamwork in the SFIA skill descriptors, most had difficulty making this conceptual connection. This is despite communication and teamwork being necessary attributes to complete the role-play and presentation assessments identified by some groups during the Green IT.

It is important to note, however, that SFIA is a competency framework. Its principal use is as a reference model to distinguish between the levels of responsibility at which specific ICT skills are practiced. It was not designed to explicitly capture generic professional skills or attributes like teamwork, communication, life-long learning, complex problem solving, and innovation abilities. As such, SFIA is an incomplete framework for the specification of an academic program, as demonstrated by this research.

That said, SFIA is often used in conjunction with other frameworks to provide context, or to include other appropriate dimensions of a given career role or application.

For example, the Queensland Government Chief Information Office defines all ICT positions using SFIA in conjunction with the Queensland Public Service (QPS) Capability and Leadership Framework (CLF) (Queensland Public Service Commission, 2008). The latter framework characterizes workplace capabilities and behaviors related to communication, drive, integrity, workplace relationships, and an individual's ability to support or shape strategy.

In a similar fashion, the Australian Computer Society requires professionally accredited programs to map subjects and assessments to the ACS Core Body of Knowledge (CBOK) for the ICT Profession (ACS, 2015). The CBOK explicitly includes interpersonal communication, teamwork concepts and issues, ethical analysis and reasoning in an ICT context, and complex problem solving skills. This professional level accreditation requirement is in addition to demonstrating that graduates operate at SFIA level 3 or higher in one or more key areas related to career roles identified for each program.

Indeed, most ICT higher education programs endeavor to prepare graduates for a designated set of career roles. To that end, this study has shown that a significant contribution of SFIA in curriculum design and management is that the framework facilitates interaction and dialog between industry professionals and academics. This was seen to be particularly true with respect to differentiating between levels of responsibility and accountability for the SFIA skills that characterize a given career role. Educational design to that level of detail has the potential to ensure that graduate are prepared for entry level roles, typically at SFIA level 3, or more senior roles at higher levels. It also helps to ensure that potential students possess the required experience or skills necessary to undertake advanced study. This suggests that SFIA may have value even in those jurisdictions where it is not required for accreditation or professional certification purposes. Rather, this study indicates that SFIA can promote effective consultation and interaction to ensure that academic programs meet stakeholder needs.

Research Question 2: Does the SFIA framework and its common nomenclature and reference model contribute to a shared understanding of skills required by early career ICT professionals as they progress from formal education into professional practice?

Principal SFIA Skills	Relationship to the Data Scientist Career Role
Analytics (INAN)	Data scientists analyze data to discover and quantify patterns in information using statistics, statistical inference, regression analysis, and machine learning.
Data Analysis (DTAN)	Data Scientists manage data requirements and establish and modify data structures leading to the retrieval, transformation, and analysis of data.
Methods and Tools (METL)	Data scientists ensure appropriate methods and tools are applied to retrieve, transform, curate, visualize, and analyze data and to build related data products.
Consultancy (CNSL)	Data scientists consult with clients to recommend and implement approaches to address client business questions, leading to new insights and knowledge, informing decision making and predicting outcomes.
Research (RSCH)	Data scientists form and test hypotheses based on a statistically rigorous and repeatable methodology involving the analysis of complex data sets.
Technical Specialism (TECH)	Data scientists require specialist knowledge in a range of topics including statistics, statistical inference, high performance computing, and visualization.
Project Management (PRMG)	Data scientists manage data science projects within agreed parameters of cost timescale, and quality.
Programming / Software Development (PROG)	Data scientists write programs and integrate custom-off-the-shelf solutions to retrieve, clean, transform, and visualize data, and build predictive data products that inform business decisions.

Table 3. The Data Scientist career role description mapped to SFIA (SFIA Foundation, 2015a)

Academics and industry representatives successfully used SFIA to characterize the skills and levels of responsibility associated with a typical entry-level ICT position during focus group activities. This suggests that the skills required to prepare students for initial professional practice in given ICT roles can be characterized by SFIA-based analysis of entry-level positions associated with those roles.

The ICT Career Streams wheel (Queensland Government Chief Information Office, 2013) used by the University of Tasmania in their curriculum renewal exercise (Herbert, de Salas, et al., 2013; Herbert, Demoudy, et al. 2013; Herbert, et al., 2014) may be a good source of data to inform such an analysis. An additional source, not available at the time of the University of Tasmania curriculum development exercise, is the ACS ICT Skills White Paper (ACS, 2013b), characterizing common ICT job profiles. This white paper documents the self-reported SFIA skills deemed to be important by the ACS members in their various job roles.

It is also indicated that SFIA can be used as a vehicle to inform discussions regarding roles not included in those published position description skill sets. Consider Table 3, for example, which maps the Data Scientist career role to SFIA skills for a hypothetical Master's program. Such a role is not directly described in either the Queensland or ACS position descriptions. None-the-less, SFIA can be aligned with a data scientist career role as illustrated in Table 3, using the common nomenclature and reference model provided by SFIA. Capturing skills developed to support the intended career roles of graduates in this way is consistent with best practice as recommended by ACS (ACS, 2015, 2016b)

Based on this analysis, the following is recommended regarding the use of SFIA for ICT curriculum design and management:

- Use SFIA as a framework to engage Industry Advisory Boards when identifying the skills required by ICT graduates.
- Consult established resources that specify ICT position descriptions in terms of SFIA descriptors and levels. In those cases, where an appropriate set of position descriptions is not available, skills for the intended ICT role should still be mapped to SFIA, as in Table 3.
- Use SFIA as part of a holistic approach to ICT curriculum design and management.
- Conduct professional development training for academic staff to ensure an adequate understanding of SFIA and its relationship to professional practice in ICT.
- Use SFIA descriptors to inform the design of authentic learning activities and assessments, while taking into consideration the relationship of these to Bloom's Cognition Levels.

Additionally, opportunities exist for broader evaluation of the effectiveness of SFIA as a means to inform the curriculum consultation process with local industry, particularly in those regions or jurisdictions where SFIA is not required for accreditation or professional certification purposes, or where is it less prominently used in industry.

6. CONCLUSIONS

This study highlights the potential role of SFIA for designing and managing ICT courses and programs with industry relevance. The inclusion of industry representation in design and management was a key theme throughout this research project. In particular, this study has demonstrated that using a common reference model and nomenclature provides a framework that enables stakeholders from both industry and academia to discuss and agree on the skills required for professional practice in a given role. The positive interactions between the industry and academic stakeholders exemplifies the need for both to participate in the discussion of how best to prepare students for careers in ICT. The study has further illustrated how SFIA skill descriptors can inform the design of authentic forms of assessment within university ICT programs. However, there is a need to rigorously demonstrate the relationship to other frameworks used in educational design, such as Bloom's Taxonomy. In addition, the implicit criticism of the focus group participants regarding the framework's limited ability to address the soft skills required within ICT curricula design and development needs to be recognized, particularly in the important areas of communication and teamwork. Although other frameworks and bodies of knowledge can be added to address this, that aspect of SFIA was a framework limitation that became apparent from the research findings.

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