Empowering Graduate Success with Career-Driven Modular Curriculum

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Abstract
Graduates entering an ever-more-competitive job market are often unaware of the skills and values they offer employers. The challenge is more significant with emerging job roles requiring certifications, multidisciplinary skills, specialist knowledge, even entry-level positions. We seek to empower our graduates and maximise their career prospects. New research has enabled us to harness the power of artificial intelligence for a custom-designed course planning and recommendation system for students based on the skills their desired jobs require. We named these curriculum delivery models JobFit and ModuLearn.

Keywords: Employability, Graduate Success, Skills, Skill Development, Learning Management

Introduction

Current graduates enter highly competitive national and international job markets, requiring job-ready knowledge with a demanding set of skills (Morrell & Morrell, 2014). Scientists examined various approaches that human resources use to find candidates (Harris, 2017), involving a high level of algorithmic processing and automation using text mining. The most common filtering method is finding and extracting desired features/keywords from CVs. Thus, when applying for positions with many candidates, it is essential to understand and describe applicant skills matching the employer's needs.

Employers distinguish between two skill types: "hard skills" and "soft skills." Hard skills represent the job-related specialised knowledge and abilities to perform the job effectively. Soft skills represent personal qualities and traits. While research shows that soft skills often have a more significant impact on career success (Heckman & Kautz, 2012), candidate filtering and selection mainly focus on hard skills. With this approach, graduates face an issue where they often do not understand and cannot express their skill set to potential employers.

However, the current curriculum approach informs students on subjects and their content rather than which skills they develop upon completion of a given subject (Kumpas-Lenk, Eisenschmidt, & Veispak, 2018). Then, a key issue is mapping acquired academic knowledge to industry-required skills (Shankararaman & Gottipati, 2016). Likewise, this process is opaque to the industry, relying on references and connections between academics and industry professionals to 'translate' what students can achieve.

Not only does understanding skills and abilities pose a challenge, but it is also often challenging to acquire the desired skills in the relatively short period that students spend in higher education. In undergraduate university degrees, the structure of the first few semesters is often pre-defined with core subjects. Students have a more significant opportunity to explore different knowledge pathways in the second year, leaving only one or two semesters to focus their knowledge on the desired skill set. This problem is even more significant in shorter courses, such as two-semesters long diplomas.

As a result, curriculum designers face issues trying to address the job-ready student needs with the traditional approach (Misni, Mahmood, & Jamil, 2020). Analysing the curriculum of higher education institutions, we can often spot overlaps in capabilities and skills delivered. While partially the reason is pathway (prerequisite) issues, we spot a different trend. Trying to maintain an advantage over competitors, institutions introduce new subjects at a fast pace, leading to an incoherent curriculum, particularly concerning current/future industry and employment needs. Consequently, the lack of understanding of what is needed and ad-hoc additions have led to programs that do not provide a clear pathway and relevance to work roles.

However, higher education institutions can work with industry to co-develop technologies that can support this mapping and simultaneously help graduates market their knowledge. If we can achieve this, the whole system benefits: students will find academic and extra-curricular pathways that deliver the critical job skills that their dream jobs require (Knight & Yorke, 2002). Further, curriculum designers will intuitively interact with the "job-ready" approach by assessing how well the curriculum covers specific skill requirements.

This is now possible. With rapid changes in computing and engineering technology, the curriculum development process can be more agile and future-focused rather than reactive. In this paper, we scope and describe a prototype of a technological solution, “JobFit” and “ModuLearn”. The “JobFit” harvests data from employer adverts, define the requisite skills, map to academic subjects, and – considering user preferences and career aspirations - construct educational study pathways. The ”ModuLearn” framework proposes a modular decomposition of academic content delivery, increasing the variety of studied content and facilitating the curation of targeted pathways of study.

JobFit Model

The JobFit model proposes explicit annotation of learning components (e.g. subject, units, modules) with the information on hard and soft skills they deliver. For hard skills in Science, Technology, Engineering and Mathematics (STEM) areas, we propose to use the definition of skills from the popular Skills for Information Age (SFIA) framework (https://sfia-online.org/en). The SFIA framework version 8 defines 121 skills, mainly focusing on technology and business. For example, “Acceptance Testing” or “Business Modelling” are skills from SFIA. Furthermore, each skill can reach seven different levels of responsibility. Level 1 - “Follow” restricts the knowledge to following instructions under supervision in the given knowledge area. Level 3 - “Apply” defines the capability to apply the knowledge to new problems and challenges. Level 7 - “Set strategy, inspire, mobilise” concerns managers, visionaries and thought leaders capable of defining organisational as well international procedures, policies and standards.

While SFIA works well for STEM skills, for all other sectors (e.g. health, social sciences), we use the aggregated skillsets extracted from job advertisements by the commercial data provider Burning Glass (https://www.burning-glass.com). While the Burning Glass skill definition is not as comprehensive as the SFIA, it provides the possibility to discover available job offers in world markets. On the other hand, SFIA defines comprehensive, multi-level skills but only maps to often outdated job definition datasets, such as Australian Public Service, listing 149 career pathway roles (https://sfia-online.org/en/tools-and-resources/standard-industry-skills-profiles/australian-public-service). Table 1 compares the two skills providers.

	SFIA (version 8)	**Burning Glass**
Number of Skills	121	Hundreds
Industry Sectors	STEM, Business (partially)	Any
Skill Description	Comprehensive (7 levels)	Limited to None
Job Mapping	Job roles in a few datasets	Thousands of live jobs
Implementation	Easy	Very Difficult
Requires Post-Processing	No	Yes (aggregations)
Price	Free (Corporate User License)	$100.000 +

Table 1: Comparison of SFIA and Burning Glass

But, the idea of using skills to assess the quality of the curriculum is not novel. University of Auckland (Putt, 2020), or the University of Tasmania (Herbert, Lewis, & Salas, 2013), used

SFIA to analyse their degrees and assess their strengths and weaknesses in relation to job-market opportunities. Using the analysis results, they proposed degree changes and discontinued or introduced new units.

Consequently, the JobFit model proposes to embed the skills information into learning outcomes of learning components, assuring their continuous updates. The skill-based approach supports both curriculum designers and students. For curriculum designers, it delivers quantifiable measures to assess the curriculum structure and support for jobs or roles. For students, it facilitates the what-if analysis of their study pathways with relation to employability requirements of their desired job roles. Moreover, embedding skills into the curriculum facilitate accreditation of study programs, where accrediting bodies use skill analysis (e.g. Australian Computer Society). Also, if this approach becomes widely adopted, it will facilitate student transfers among institutions and study programs.

JobFit Framework

The primary functionality of the JobFit Framework is to automatically assess and aggregate the embedded skill information of a defined study pathway and compare it with the requirements of a selected job role or a job category. This provides a quantifiable approach to assess the "compatibility" of the pathway with the selected job. Figure 1 shows the compatibility assessment screen of the JobFit framework.

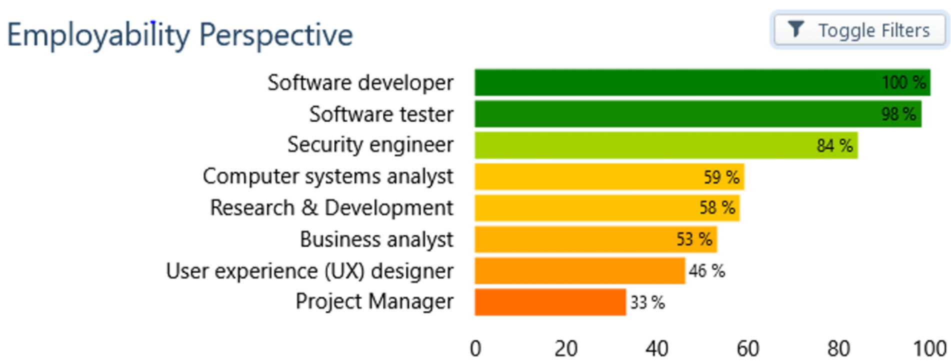

Figure 1: Compatibility Assessment of the JobFit Framework

The JobFit framework supports students and curriculum designers in making the best-informed study or curriculum decisions. For this purpose, we designed state-of-the-art artificial intelligence planning, monitoring, recommendation methods and support systems. The framework curates information differently with respect to who interacts with it:

Prospective Students

1. Explore careers supported by institution study programs.
2. Based on career selection and/or knowledge area preferences, explore diverse study pathways and choose the best matching course and program.

Existing Students

1. When choosing a new elective, perform the what-if analysis to choose the most interesting one with respect to chosen career and/or knowledge areas of interest.
2. Monitor the study progress, proactively detect problems or opportunities, plan alternative pathways.

Curriculum Developer and Curriculum Quality Officer

1. Check the compatibility of the study program with the target job roles and categories.
2. When adding or discontinuing new knowledge units, analyse the impact on compatibility.
3. Automatically generate new multi-disciplinary courses or micro-credentialing degrees from the catalogue of available knowledge units.

Figure 2 depicts the interface of the JobFit application, with tools for curriculum developers. On the left is a selected study pathway (core + major). In the middle is the career compatibility analysis. The details of the chosen pathway concerning the selected career are on the right. Under "SFIA Skills" section, on the left, green are the desired target level of the skill. On the right, are the skills obtained after completing the chosen pathway. We see that many of them did not reach the desired target level (depicted red). Underneath the SFIA Skills section, we see the analysis of skill progression and the analysis of units contributing to further skill progression.

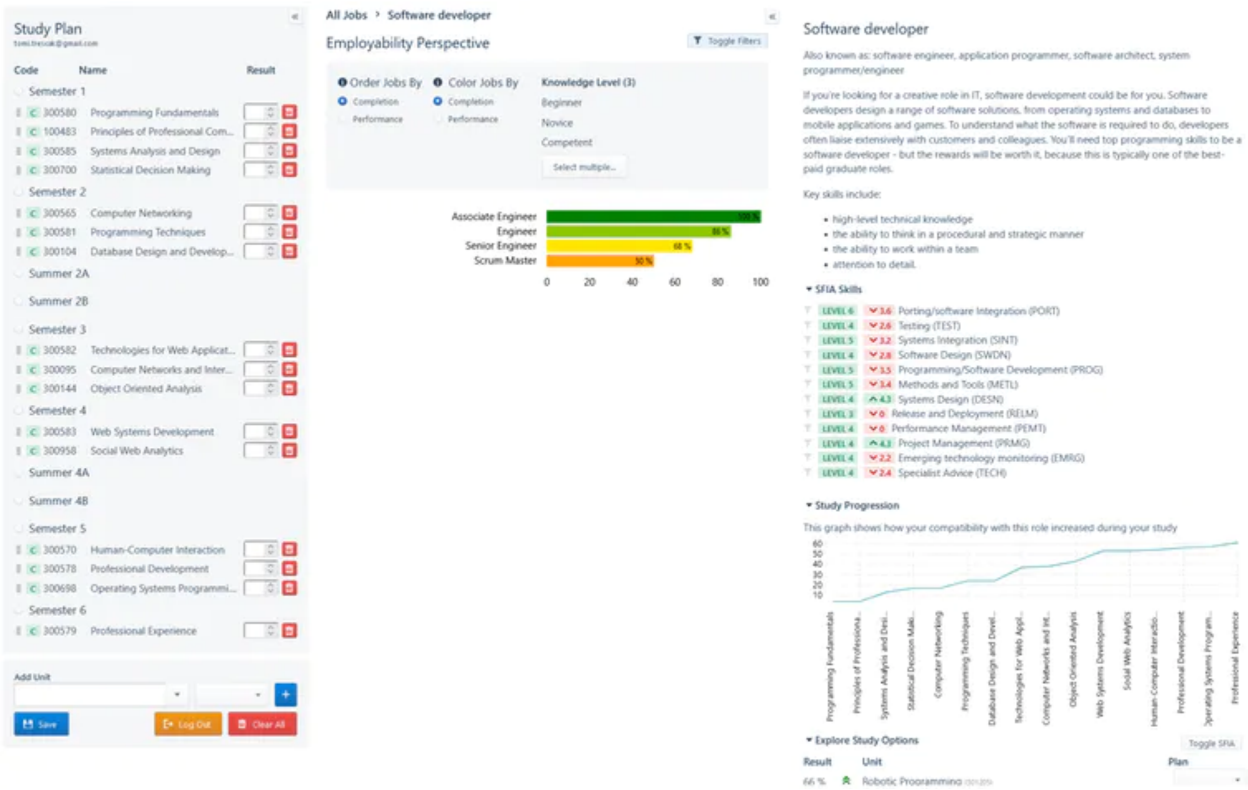

Figure 2: JobFit Framework: Curriculum Designer Tools

While JobFit Framework should deliver positive benefits, with short programs, such as diplomas or certificates with a limited number of knowledge units, the impact of the JobFit framework is limited. Even many undergraduate courses are composed of a large pool of core units, permitting only a very few electives. To increase the variety and number of options from which we can construct a pathway study, we propose the ModuLearn model. We describe the model in the next section.

ModuLearn Model

The ModuLearn introduces modules as the novel building block of the modern curriculum. Modules represent short, skill-informed learning units lasting two to four weeks. An intertwined network of modules delivers fundamental knowledge with lower commitment needs than semester-long subjects, allowing for experimentation and dynamic skill acquisition with a wider variety of skill options across multiple knowledge domains.

We base the ModuLearn model on the Charles Sturt University (CSU) Topic Tree (https://www.csu.edu.au/engineering/curriculum), delivering 1000 topics within their engineering degree. Unfortunately, the CSU topic tree solution has no technological back-end, and the tree exists only as a visualisation. There is no notion of skills, allowing to explore the knowledge acquisition in diverse pathways. As a result, students cannot perform what-if analysis and estimate the impact of their chosen plan on their career prospects.

The ModuLearn modules use the JobFit approach to define the skills module delivers. Moreover, ModuLearn uses skills to define prerequisites and completion criteria. For example, traditionally, we specify that the prerequisite to study a knowledge unit “A” you need to complete knowledge units “B” and “C”. With ModuLearn, we can specify that the prerequisite to study a knowledge unit “A” you need to have skills “a”, “b” and “c” (at a specific level). This ensures the understanding and progression of acquired skills and a more natural and dynamic approach to defining study pathways, such as obtaining similar skills through multi-disciplinary studies. Overall, modules provide various opportunities to develop a more engaging curriculum.

First, modules can provide prerequisite knowledge for first-year students, allowing all students from diverse backgrounds to have the same starting position. For example, we propose entry-level mathematical and science modules for first-year ICT students or students from other faculties to acquire fundamental knowledge required in applied modules.

Second, we discovered that knowledge units are missing the desired prerequisites due to study pathway issues, affecting students with insufficient starting knowledge, leading to their failure. Modules define a vast intertwined knowledge network of shorter, targetted knowledge units, connecting fundamental knowledge to applications, providing better motivation and insight. For example, we propose to deliver Linear Algebra classes (fundamental knowledge), with modules focused on Video Games Programming (applied linear algebra). Consequently, curriculum designers can explore this network to specify more targetted prerequisites (based on skills or modules), lowering failure rates.

Third, short module length and limited content facilitate keeping the content up to date and adjustments for dependants and applications. Last, with our approach, it is easy to estimate the impact of curriculum adjustments with its quantifiable skill-based assessment. For example, it informs us which careers the new applied module supports or benefits from a new fundamental knowledge module on other modules.

Conclusion

We deliver an innovative product, represented by the framework for the curriculum design, supported by innovative technological solutions. We designed a state-of-the-art planning and recommendation tool processing a large variety of modules and combining them into a meaningful study pathway based on user preferences. The system proactively monitors student progress and provides alternatives to maximise the best possible career opportunities. Students can use the system to do the “what-if” analysis and explore career options. Combined with live-job market data, we can analyse different study pathways and compare study outcomes with real job prospects, quality and quantity of offered jobs.

Curriculum designers use the system to find and bridge skill gaps and support global job markets by addressing increasing and ever-changing demand for graduate skills. Moreover, the system can automatically analyse and design micro-credential degrees according to current job market needs.

The impact of this system will be greatly enhanced if it spreads across many organisations. But, the implementation may become a hindrance for often large institutions with established structures and policies. Thus, the JobFit Framework, which is easy to integrate into the existing structures and information systems, can exist independently of ModuLearn, often requiring complex policy adjustments. Implementing ModuLearn is only encouraged as it significantly increases the impact of our solution.

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