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Pedagogies for employability: understanding the needs of STEM students through a new approach to employability development

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ABSTRACT

Labour market trends and the economic impacts of COVID-19 are elevating the importance of knowledge as a factor of production whilst concurrently eroding traditional forms of employment. Mindful of the implications for higher education, this study approached employability development as 'the ability to find, create and sustain meaningful work across the career lifespan'. The study was grounded in social cognitive theory and adopted a metacognitive approach to employability. Data were generated through an online self-assessment completed by 12,576 students enrolled with Australian universities. Data from science, technology, engineering and mathematics (STEM) students were compared with those from students in non-STEM fields. STEM students differed in several key employability traits. The paper highlights the need to promote more nuanced occupational literacy about the future of work alongside awareness that STEM skills and capabilities are valued across multiple sectors and roles. Opportunities and challenges for embedding a pedagogy for employability are discussed.

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Introduction

If contemporary higher education graduates are to *earn* a living, they will need to know how to *think* a living (Bennett, 2019a). This is likely to demand an unprecedented level of metacognition and self-regulated behaviour with which to create a living beyond a single economic sector or career and across the career lifespan. It follows that higher education pedagogies for the fourth industrial age require metacognitive development that engages learners' whole self in the consideration of their future.

The objective of this study was to explore how science, technology, engineering, mathematics (STEM) students perceive their future careers and employability compared with students in non-STEM fields of study, and to suggest how a pedagogy of employability might be implemented at scale. The article begins with an overview of STEM and

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the future of work, followed by an exploration of the more general issues which might inform a pedagogy for employability. Following this, we outline the theoretical framework and procedures. We conclude by reporting and discussing the findings, their implications, and the opportunities and challenges for embedding a pedagogy for employability.

STEM and the future of work

STEM has been criticised as an umbrella term which acts as a 'synonym for a diverse group of skills and academic fields' (Siekmann, 2016, n. p). However, the term has proven to be a useful tool for focussed thinking about career aspirations (Archer, DeWitt, & Dillon, 2014) and it has been vital to contentions that the sciences make a disproportionate contribution to the economy (Palmer, Burke, & Aubusson, 2017).

Over the past 40 years, growing interest in scientific and technology-related professions has been fuelled by scientific advancement, theories of human capital development and the growth of the knowledge economy. Interest in STEM has also been reactive, buoyed by concerns about an ageing population, the climate and the global economy (Steele, Brew, & Beatty, 2012).

The promotion of STEM engagement among children and young adults is interlinked with the future of work (Payton & Knight, 2018). Much of the literature engages with discussions of that future, positing the STEM workforce as an advent of the fourth industrial age. There is also significant emphasis on the importance of preparing STEM higher education students for graduate life (Camilli & Hira, 2019; Deming & Noray, 2018). The nature of STEM work, however, is often narrowly defined within the boundaries of limited industries. Moreover, attrition from the STEM workforce remains a persistent challenge as articulated by Palmer, Tolson, Young, & Campbell, 2015, p. 104).

> . . . many STEM graduates do not persist in the STEM workforce over the longer term. The stock-and-flow of STEM workers is often referred to as the 'STEM pipeline', and the metaphor is extended to the 'leaky pipeline' in describing the significant reduction that occurs over time in the proportion of STEM graduates working in STEM occupations.

In reality, retention and attrition rates are difficult to assess because over one-third of contemporary STEM positions belong to non-STEM occupations and one-sixth of the jobs advertised in non-STEM occupations are in fact STEM roles (Grinis, 2016). The 'growing prevalence of STEM skill requirements across a broader array of jobs and occupations' (Healy, Nicholson, & Gahan, 2017, p. 50) indicates that a pedagogy for employability in STEM should operate beyond discipline silos and prepare students for diverse careers.

A pedagogy for employability

The challenge of developing student employability in an equitable and responsive way is one of the most pressing challenges facing contemporary higher education (Campbell, Cooper, Rueckert, & Smith, 2019; Rees, 2019). Given that a commitment to employability implies 'a preparedness to rethink curriculum, pedagogy and assessment' (Yorke, 2010, p. 10), it is also one of the most complex challenges.

Pegg, Waldock, Hendy-Isaac, and Lawton (2012, p. 45) assert that a pedagogy for employability

> should inform the entire curriculum, with each programme of study designed to ensure that the learning, teaching and assessment activities with which students engage will help enable and develop creative, confident, articulate graduates.

We contend that a pedagogy for employability is a pedagogy of metacognition in which learners actively engage in the exploration of explicit learning goals and in dialogue about learning processes and learners' cognitive styles (Cullen & Harris, 2009; Evans, 2018). This suggests a critical, responsive pedagogy in which the theoretical underpinnings of learning and teaching, and its application in future life and work, are explicitly articulated and supportive of the learning purpose (Evans, Muijs, & Tomlinson, 2015; Jackson & Bridgstock, 2020). A pedagogy for employability, then, should explicitly develop learners' disciplinary and broader metacognitive understanding not as an outcome of higher education but as an integral component of student engagement and retention (see Evans & Kozhevnikov, 2013; Kift, 2019). The rationale for this broader view is set out in the following section.

Theoretical framework

The study was grounded in social cognitive theory (SCT) (Bandura, 1986, 1993, 1997), which sees learning as a cognitive act which occurs in a social context and involves dynamic interactions between person, context and behaviour. SCT proposes that interpersonal and intrapersonal variables such as outcome expectations and personal goals play an important role in guiding behaviour. Bandura (1986) asserts that people's actions reflect their values. It follows that students will be more motivated to achieve when they perceive their goals to be aligned with the outcomes that are important to them (Bandura, 1986).

The extension to career theory was made by Lent, Brown, and Hackett (1994), whose social cognitive career theory (SCCT) emphasises that career- and study-related exploration and decision making are influenced by motivation, self-efficacy and discipline interest. SCCT highlights both feedback and feed-forward mechanisms together with intra- and inter-personal and temporal dimensions. This development occurs within the metacognitive frame through which people make sense of cognitive processes and determine how thoughts and feelings are processed.

Metacognition was first presented by Flavell (1979) as the knowledge and regulation of cognition. Pintrich (2002) observes that few students come to higher education with metacognitive understanding; rather, it needs to be explicitly taught. Pintrich's (2002) three broad areas of metacognitive understanding are widely adopted. A fourth and crucial area is that of self-regulation (see Yorke, 2005), which can be described as learners who 'are metacognitively, motivationally, and behaviourally active participants in their own learning process' (Zimmerman, 1989, p. 329). Metacognition is essential for knowledge transfer: the application of prior experience and knowledge for learning or problem solving in a new situation. The last of Mayer and Wittrock (1996) four views of knowledge transfer, 'metacognitive control of general and specific skills', neatly illustrates the alignment of learning transfer and employability.

Taking into account labour market change and the need for metacognition and self-regulation, learners' attainment of employability could be summarised in the following points. Adapted from Pintrich (2002), Yorke (2005), and Yorke and Knight (2007) USEM model, the dot points illustrate the contextual considerations which underpin the measure used in this study and which might also underpin a pedagogy for employability.

- Understanding of and beyond the discipline, demonstrated with a curated and developmental body of evidence;
- Skilful practices which can be applied in multiple contexts;
- Efficacy beliefs and other personal qualities and attributes, reviewed regularly and benchmarked in relation to self, others, community and broader global contexts;
- Metacognition:
    - General strategies for learning, thinking and problem-solving (strategy understanding);
    - Differentiation in task difficulty which can require different cognitive strategies (procedural understanding);
    - Awareness of how to learn and accomplish tasks (strategy understanding);
    - Self-regulation of learning, behaviour and motivation (declarative understanding) informed by understanding individual learning styles, capabilities and areas of developmental need.

Study design

The researchers employed a design-centric approach informed by Goodyear's (2015) 'design for learning' model and adapted by Bennett (2019b) to the context of employability development (Figure 1). The challenges outlined in the following section were identified, and solutions proposed, using this design-centric approach.

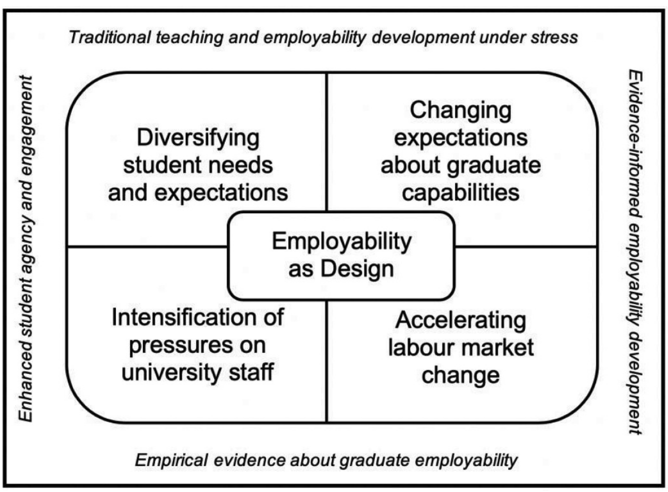

Figure 1. Employability as design (Bennett, 2019a, p. 51).

As seen at Figure 1, the interactions within and between context, discipline, pedagogical approach, learners, and teachers are important considerations for the design and evaluation of pedagogy (see also Evans & Waring, 2015). However, the difficulties of accumulating local evidence for pedagogical decision-making have been voiced for some time. The UK's Enhancing Student Employability Co-ordination Team, for example, asserted in 2007 the need for programme leaders seeking to enhance student employability

> … to have some appreciation, *inter alia*, of the degree to which students have a robust sense of self-efficacy and of the degree to which students report the programme to provide experiences that are associated with making strong claims to being employable in graduate jobs (p. 158) [and] to consider how findings about students in general might stand in relation to these particular students (Yorke & Knight, 2007, p. 169).

Student-derived data is a primary source of university intelligence and an arbiter of national quality assessment (Williams, 2014). However, survey fatigue among students (Klemenčič & Chirikov, 2015; Porter, 2004) can lead to careless or inaccurate responses and questionable or 'minimal validity' (Porter, 2011, p. 45). Student surveys are also inherently biased due to the 'underrepresentation of disengaged, non-traditional and minority students' (Klemenčič and Chirikov (2015, p. 372).

One of the reasons for survey fatigue among students is that they rarely see survey results and rarely derive (or are made aware of) any direct benefit from the findings. To create a 'net gain' for students, the researchers employed the online employABILITY self-assessment tool (Bennett, 2019a) through which students created personalised employability profiles and gained access to developmental resources.

Materials and methods

Survey instrument

The validated employABILITY measure (Bennett, 2019a) integrates principles of Bandura's (1986, 1993) social cognitive theory (SCT) and Lent et al.'s (1994) social cognitive career theory (SCCT) into a formative self-measure of perceived employability. The measure encompasses the core principles of metacognition, learner agency, reflexivity and self-regulation. As a pedagogical tool, the measure was designed to underpin learners' employability development by enhancing their metacognitive ability to operate as capable, self-regulated learners who might 'invoke systematic and regular methods of learning to improve performance, and … adapt to changing contexts' (Cassidy, 2011, p. 991).

The reliability for each construct (employability trait) within the measure has been previously estimated using Cronbach's alpha coefficient (Cronbach, 1951), with a reliability measure of.70 considered acceptable (Nunnally, 1978). All constructs had alphas over 0.70, indicating acceptable internal consistency (Bennett & Ananthram, In review). These results provide confidence for further statistical analysis using the measure. Demographic details comprise current work status; age in years; sex; location; highest completed level of education; and institution.

From a social cognitive perspective, self-regulated learning can be attributed to reciprocal causation between personal processes including goal-related behaviour and academic self-efficacy; the learning environment and associated task demands; and the accumulation of individual outcomes over time (see Cassidy, 2011, p. 991). With this in mind, for this study we focussed on six constructs or employability traits within the tool: goal-directed behaviour, career identity and commitment, ability and willingness to learn, perceived program relevance, career exploration and awareness, and occupational mobility. We elicited students' views about their accumulation of individual outcomes over time using two text-based questions.

Procedures

Participating students created a formative, personalised profile report on their perceived employability using the online employABILITY self-reflection tool. Each student report contained a personalised profile, scaffolded activities and embedded links to developmental resources, enabling students to further their employability thinking and increase their developmental agency. Within the tool, students responded to Likert-style items to assess their confidence in relation to self-management, career decision-making, self-esteem, academic self-efficacy, identity construction, the citizen-self, emotional intelligence, and perceived learner and graduate attributes. Students could also respond to optional open questions relating to their work and study backgrounds, career intentions, choice of major and their feedback about their current courses (programs).

Ethical approvals were obtained before the study commenced (approval number HRE2017-0125). The self-assessment tool was most often set as a required reading task and it formed part of the curriculum; however, the tool is freely available online and some students completed it independently. When implemented within the curriculum, analysis of students' aggregated responses informed targeted interventions within the same study period. These included, for example, a session with a careers practitioner or a targeted discussion with teachers (Bennett, Knight, & Rowley, 2020). Students received an information sheet and an assurance of anonymity, and they completed a consent form. Students chose whether or not to include their online tool responses in the research dataset; this decision did not affect their access to the tool and associated resources.

Sample and recruitment

The study objective was to explore how STEM students perceive their future careers and employability compared with students in non-STEM fields of study, and to suggest how a pedagogy of employability might be implemented at scale. STEM was defined as the Australian fields of education *Natural and Physical Sciences, Information Technology*, and *Engineering and Related Technologies* (including Architecture and Building) – see Table 1. We acknowledge that there has been extensive debate over the rationale behind using STEM as an umbrella term. The most common challenge is to argue for the inclusion of medicine in a broader 'STEMM'. To address this, we included and compared responses from students in the field of health and medicine.

The researchers recruited students enrolled in STEM and non-STEM disciplines and their responses were aligned with one of 12 broad fields of study. Invitations were issued via university networks, professional associations, career services, and through networks such as the Deans of Science and ICT and Deputy Vice-Chancellors. Table 1 shows the

Table 1. Student respondents: sample frequencies by field of study (1–12) and gender.

Field of study and code	Male	Female	All
Natural and Physical Sciences (code = 1)	169	263	432
Information Technology (code = 2)	1367	303	1670
Engineering and Related Technologies (code = 3)	533	109	642
STEM (1 + 2 + 3)	2069	675	2744
Architecture and Building (code = 4)	364	219	583
Agriculture, Environmental and Related Studies (code = 5)	29	27	56
Health (code = 6)	645	1835	2480
STEMM (1 + 2 + 3 + 6)	2714	2510	5224
Education (code = 7)	164	734	898
Management and Commerce (code = 8)	1686	1966	3652
Society and Culture (code = 9)	436	906	1342
Creative Arts (code = 10)	299	478	777
Food, Hospitality and Personal Services (code = 11)	3	13	16
Mixed Fields (code = 12)	8	20	28
Non-STEM (4 + 5 + 6 + 7 + 8 + 9 + 10 + 11 + 12)	3634	6198	9832
Non-STEMM (4 + 5 + 7 + 8 + 9 + 10 + 11 + 12)	2989	4363	7352
All	5703	6873	12576

entire population of 12,576 STEM and non-STEM students, grouped into fields of study. STEM students represented around 22% of the total sample; within the STEM sample, 75% identified as male students and 25% as female.

Analysis

Analysis of quantitative data

Shown at Appendix 1, we analysed six sub-scales within the employABILITY instrument: goal-directed behaviour, career identity and commitment, ability and willingness to learn, perceived program relevance, career exploration and awareness, and occupational mobility.

To facilitate a concise empirical investigation with students from STEM, non-STEM, STEMM, non-STEMM and health, a single score was generated for each of the six predictors using factor analysis. Factor analysis is a purely mathematical procedure that calculates the correlations between a set of variables and generates the weighted composite of those variables – the 'factor' – that maximises the total variation captured in the data. Factor analysis is a method of summarising the variation in a number of variables by generating weighted composites of the individual variables. As an example, 'ability and willingness to learn' is measured using a 7-item scale with each item requiring a response ranging from 1 (strongly disagree) to 6 (strongly agree). Many of these items will be highly correlated with one another: people who agree (disagree) that they can identify personal weaknesses are also likely to agree (disagree) that they can articulate their personal strengths. Hence, much of the information from one of those items can be inferred from the other.

The factor analysis, which is a form of principal component analysis (pca), was performed using STATA's 'pca' command. The weights from the factor analyses were then used to calculate a score for each of the six employability traits for each individual based upon their survey response. For ease of interpretation, the factor scores for each of the six traits were standardised to have a mean of zero and a standard deviation of 1 across the full sample of students.

Analysis of qualitative data

The team analysed STEM students' responses to two open questions:

(1) Beyond your studies, what are you doing to prepare for graduate life and work?

Use this space to write anything you think we need to know about students and higher education.

The questions yielded 1,188 and 2,400 responses respectively and ranged from a few words to several sentences of text. Two researchers independently coded the data (Mays & Pope, 2000). Coding was compared and refined until agreement was reached; inter-rater reliability met the cut-off point of 80 (Miles & Huberman, 1994).

Analysis using NVIVO software began with word frequency analyses (Wilkinson, 2011), producing word clouds using the 'with stemmed words' (e.g. talking to talk) setting to include different presentations of the same stem word. Next, the researchers corrected for multiple meanings of the same word (Weber, 1990) or different meanings of a similar word (e.g. work and works).

Analysis was also iterative in that the researchers went back and forth between the question, the complete response in which it was contained, and observational notes. This enabled the analysis to evolve from first-order themes to broader categories and dimensions, following Gioia, Corley, and Hamilton (2013). The iterative approach enabled us to move away from the descriptive formulation of first-order codes within NVIVO, where the words of the students were used, to a higher level of abstraction where meaningful themes were created (Locke, 2001). Finally, we returned to the literature and explored connections between themes and concepts that were conceptually meaningful to align the proposed themes with previous research and to determine whether we had missed any key constructs.

Results

Table 2 shows the mean factor scores of employability for STEM, Non-STEM, STEMM and Non-STEMM students. The results indicate that, STEM students display stronger goal directed behaviour, reflecting greater confidence in achieving their goals, accomplishing tasks and meeting deadlines compared to Non-STEM students. The difference in the means between the two samples is significant at the 5% level ($p = 0.013$).[1]

STEM students' greater confidence in problem solving and decision making by accessing information from various sources using the internet also contribute to a higher score on goal directed behaviour. STEM students also show significantly higher mean factor scores for occupational mobility, career exploration and awareness, and ability and willingness to learn. Their high occupational agility score indicates STEM students feel better equipped to handle disappointments and negative feelings if their first choice of occupation should not work, and to prepare themselves for second best or alternative career options. The career exploration factor score is associated with confidence in identifying and picking the best-fitting career options for their skills, values and personal preferences, and to acquire knowledge to guide those decisions. STEM students' higher mean score on the willingness to learn factor reflects that STEM students are, on average, more confident than other students in their ability to acquire and

Table 2. Comparison of factor score means, whole sample.

	Means, employability factor score				T-test for equivalence of means				
	STEM	Non-STEM	STEMM	Non-STEMM	STEM v. non-STEM			STEMM v. non-STEMM	
Field of study code	1	2	3	4	All	1–2	p	3–4	p
Goal directed behaviour (RL2)	.042	−.011	.047	−.031	.000	.053	.01	.0782	.000
Career identity and commitment (CL1)	−.049	.013	.053	−.035	.000	−.062	.004	.088	.000
Ability and willingness to learn (CL4)	.057	−.015	.053	−.036	.000	.072	.001	.089	.000
Perceived program relevance (CL5)	−.024	.006	.092	−.061	.000	−.031	.154	.153	.000
Career exploration and awareness (OL1)	.073	−.020	.066	−.044	.000	.093	.000	.110	.000
Occupational mobility (OL2)	.1327	−.035	.049	−.033	.000	.168	.000	.082	.000

$p < 0.01$ is considered as highly significant (1% LOS), $p < 0.05$ is considered as moderately significant (5% LOS), $p < 0.1$ is considered as weakly significant (10% LOS).

enhance new knowledge, skills and abilities to keep themselves updated, and to prepare themselves for their careers using the right kind of training and development opportunities.

Hence STEM students appear to stand out in a number of employability constructs. However, STEM students display low career identity and commitment. They tend not to identify strongly as a professional working in their discipline and are more open to changing professions and to working in different disciplines. STEM students also score lower on perceived program relevance, indicating a sense that their studies are less directly applicable to the workplace relative to other students. The difference in means between STEM and non-STEM students for perceived program relevance is not statistically significant. In summary, students studying in STEM fields appear acutely aware of the need to be flexible, to update their skills and to be prepared for career changes.

Comparing STEMM (STEM + health) students with non-STEMM students, we find that STEMM students show significantly higher mean factor scores in all the employability constructs (level of significance 1%). This indicates that STEMM students are more confident in achieving their goals and in identifying themselves as professionals in their careers. They have more understanding about the relevance of their program of study, show more willingness and ability to learn and can better explore their career options. STEMM students are also more confident that they can manage future uncertainties: they report more confidence in being able to handle disappointments and negative feelings if they can't achieve their dream careers and they are ready to go for alternative career paths if things go wrong.

However, this comparison hides some important differences between the employability perceptions of students studying in STEM fields and those in health and medicine. Table 3 provides a direct comparison of the means of the employability factors scores for STEM and health students. There are no statistically significant differences between the two groups for goal directed behaviour, ability and willingness to learn, or career exploration. However, health students display stronger career identification and commitment as well as higher perceived program relevance (significant at the 1% level) compared with STEM students. Health students strongly identify as professionals in their

Table 3. Comparison of factor score means, STEM and health students.

	Means, employability factor score			T-test for equivalence of means	
	STEM	Health	All	STEM v. health	
Field of study code	1	2		1–2	p
Goal directed behaviour	.042	.052	.047	−.010	.711
Career identity and commitment	−.049	.166	.053	−.215	.000
Ability and willingness to learn	.057	.050	.053	.007	.800
Perceived program relevance	−.024	.221	.092	−.245	.000
Career exploration and awareness	.073	.058	.066	.016	.569
Occupational mobility	.133	−.044	.049	.177	.000

$p < 0.01$ is considered as highly significant (1% LOS), $p < 0.05$ is considered as moderately significant (5% LOS), $p < 0.1$ is considered as weakly significant (10% LOS). There were 10 survey items for Goal directed behaviour (RL2); however for this analysis we retained only 7 items, deleting the last 3 items due to an insufficient response rate.

disciplines and show more confidence in the relevance of the skills and abilities they are learning for their careers and lives. They score significantly lower than STEM students on occupational agility.

It appears to be the case, then, that some of the defining characteristics of STEM students, in terms of their employability and career perceptions, do not apply to health students. While STEM students display high occupational agility and awareness of the likelihood that their first choice of occupation may not work out, health students strongly identify with a chosen profession and career and see their studies as directly applicable to that career. They display low occupational mobility and they are less confident in choosing alternative career options or second-best alternatives if things go wrong. This can be understood in a way that many health courses are direct entry pathways into specific health occupations: for example, doctors, nurses, physiotherapists and other health professionals. STEM students appear highly aware that they face a less certain occupational future and they are willing to prepare and respond accordingly. Given these sharp contrasts, there seems little justification in a 'STEMM' grouping of health and STEM students from the perspective of a pedagogy for employability.

What are the career concerns of STEM students?

To ensure that students had an opportunity to express views on matters which were not otherwise covered in the tool, students were invited to 'Use this space to write whatever you think we need to know about students and higher education'. The question elicited 1,188 responses from STEM students; 91% of these respondents studied full time and 59% were female. Using the process described earlier, the research team extracted all responses with a link to students' concerns about career, employability and work.

Three themes emerged. The first of these was a perceived lack of transition learning: learning to support the transition from student to professional, including the transition into industry placements. One mature student reflected on her earlier experiences and her observations of younger peers:

> I think students could use more support in job applications. A lot of this was not available when I was younger and I could not understand what roles were available to me or how to achieve these when I was younger. (1st year, female, information technology student)

The second theme was wellbeing, with students reporting considerable stress in relation to achieving high grades, managing their workloads and positioning themselves for a successful transition to graduate work. The following student observed the need for failure to be discussed and acknowledged:

> I think something that people need to know is it is okay to fail, but the stress that comes with it should be taken into account, and this goes to students of all age groups. (1st year, male, information systems student)

The third prevalent theme relates to financial pressure, the extent of students' paid work and the impact of that work on their studies.

> Students these days are under more financial stress than anything else. Some, like me, live out of home and work 40+ hours a week while doing full time study. Me and many others work as hard as we can at both, to better our futures, but sometimes we need more help than we may put forward. (1st year, male, architecture student)

Shown at Figure 2, the most commonly used word was students (602 mentions) with 'education' the next most prevalent word at 235 mentions. The student narratives illustrate that students place themselves, rather than the external world of work, at the centre of their thinking.

Figure 2. Weighted word cloud (frequency) for the career concerns of STEM students.

What, if anything, are STEM students doing to enhance their employability?

Employability development requires a partnership between student, institution and industry. To ascertain their own efforts, students were asked about their self-directed learning with the question ‘Beyond your studies, what are you doing to prepare for graduate life and work?’

The researchers analysed the responses of 2,400 STEM students using the process described earlier. Illustrated at Figure 3, the overwhelming focus of students’ employability efforts related to gaining experience through discipline-relevant paid work, volunteering and career exploration. Constraints to these undertakings came in the form of insufficient time, insufficient professional networks, insufficient knowledge of the employability development opportunities (EDOs) on offer, and insufficient awareness of STEM industries and potential career pathways.

Asked about the activities they were undertaking to enhance their employability, students tended to write about study, work and volunteering. Less than 10% of students mentioned the development of skills and less than five per cent mentioned extra-curricular learning. Some students gave specific examples of their employability development efforts:

> I am currently working in a field that increases my future employability level. (1st year female mathematics student)

Figure 3. Beyond your studies, what are you doing to prepare for graduate life and work? Weighted word cloud (frequencies) of student responses (n = 2,400).

In summary, students appeared to be aware of the fierce competition for work in many STEM industries. They perceived there to be a lack of support to make the transition from student to professional, including the transition into industry placements. Students reported considerable stress in relation to achieving high grades, managing their workloads and positioning themselves for a successful transition to graduate work. Related to this, many students noted the need to make a living and the impact of work commitment on their studies.

There was little mention made by students of pursuing a formal program of development, following a defined career development strategy or taking advantage of existing careers development opportunities. This adds weight to the earlier finding that students are relying on their studies to make them career ready. The results might also indicate that students fail to realise the broad career development value of embedded, extracurricular and co-curricular activities, or of their paid and unpaid work. Rather, as Jackson and Bridgstock report (2020), students might narrowly relate these activities to gaining experience and skills. Constraints to career-related development related to insufficient time and professional networks; insufficient awareness of available EDOs; and insufficient knowledge of STEM industries and career pathways. STEM and STEMM student cohorts emerged as more confident in their ability to cope with disappointment and reorient their careers than non-STEM and non-STEMM students respectively.

Discussion

Limitations

Every study has limitations. Our study engaged a broad population of STEM students across multiple universities, but they were all enrolled with Australian universities. We accept that students' self-report might differ in other jurisdictions. We also note that we had a single data collection and do not yet have the ability to analyse students' changes in thinking over time or relate their responses to educational or labour market outcomes. Given these limitations we do not seek to generalise the findings to all disciplines or contexts. However, in this final section we draw on our research and the research of others to highlight some of the opportunities and challenges relating to implementing a pedagogy for employability.

Higher education's focus on student success and graduate employability is ubiquitous, driven by the assumption that highly skilled workers benefit both individuals and the State. However, employability is influenced by a range of human, social, identity and psychological capitals as well as socio-economic factors and aspects of disadvantage beyond the control of a program or institution (Mackaway & Winchester-Seeto, 2018; Tomlinson, 2017). These capitals also limit students' ability to understand which employability capabilities are important and how they might be so.

In the case of STEM, graduates who work in other industries bring essential and high-level skills to the labour market, thereby enhancing and enriching the broader economy (Payton & Knight, 2018). This signals the need to communicate to students that whilst the link between qualifications and STEM employment is weakening, the relevance of disciplinary STEM skills has not diminished. This is particularly important for students of ICT, for whom the future and nature of work is particularly uncertain.

From a career development perspective, it is crucial that students don't feel under pressure to change themselves in order to 'become' STEM (Macdonald, 2014); rather, students need support to explore their self- and STEM identities in line with their interests and aspirations. This position supports the holistic and mindful development of self-awareness (Hooley & Barham, 2015). A pedagogy for employability in STEM would logically therefore include but extend beyond discipline skills, knowledge and practices. In the final sections we consider the implications of our work for implementing a pedagogy for employability, starting with the engagement of faculty and students and ending with consideration of equitable approaches.

Our findings are indicative that STEM students do have an awareness of the challenges associated with forging a career in STEM or, at least, a career as a STEM graduate. Reflecting much of the literature on STEM careers, students are cognisant of the need to be prepared to work in a variety of sectors and positions, and to be flexible in their career choices. They appreciate the importance of continuous learning and upgrading of skills, and of contextualized, workplace-based experience over the specific content of their current courses. However, the fact that they have greater metacognition around employability than the average student in other fields, does not mean they are *sufficiently* prepared, and qualitative responses indicate a need for greater professional development support in the transition from university to work.

Engaging faculty

The study findings confirm the need for a systematic, evidence-based and accessible approach to employability development located within the core curriculum. And yet time-poor and increasingly hourly-paid academic staff have insufficient time, resources or expertise to include what they see as yet another thing in an already over-crowded curriculum. Yorke and Knight (2007, p. 160) assert that 'pedagogic practices may be enhanced through research bearing upon efficacy beliefs and self-theories'. However, Leat and Lin (2003, p. 387) warn that 'teachers find enacting a pedagogy for metacognition and transfer difficult'. Although research insights are potentially valuable, 'teachers will not take up research-based ideas if they are presented as general principles, which leaves them with the task of translating them into practice – they are too busy' (Leat & Lin, 2003, p. 387). We agree that the busy-ness of teachers is a growing concern in higher education, where increasing casualisation, heavy workloads and the persistent privileging of research can impede pedagogical reform.

Turning to possible solutions, Black and Wiliam (1998, p. 384) suggest that teachers might be supported with 'a variety of living examples of implementation, by teachers with whom they can identify and from whom they can both derive conviction and confidence'. A pedagogy for employability might be scaffolded by carefully designed resources, embedded within the core curriculum (Bennett, 2019c; Rees, 2019) and delivered in partnership with careers practitioners and other student support services (Campbell et al., 2019). The pedagogy should also be processual with a focus on the developmental process (Holmes, 2013) and designed to assure a 'holistic, end-to-end curriculum design for employability' (Kift, 2019, p. 155). These features would enable the integration of discipline and broader career learning and also ensure equitable access across a diverse student body (Bennett, In press).

The survey results show that the development of such pedagogies need to be tailored to the needs of students by individual fields of study, as well as to other student characteristics. Given the diversity and fluidity of both the student body and the labour market, there is great potential in a design-led approach for the creation and renewal of a pedagogy for employability. Effective design practices demand greater investment in the planning stage in order to bring together multiple portfolios such as teaching, careers services and educational designers. As Goodyear (2015, p. 2) argues, however, there are both educational and economic benefits to such an approach in that it can help to improve the quality of higher education while negotiating funding constraints and assisting 'teachers and teaching teams to cope with intensifying pressures on the quality of their work'.

Despite the similarities between STEM students and students in the Health field in some respects, such as in willingness to learn and goal directed behaviour, they have different perceptions of the linkages between their current courses and future careers. In stark contrast to STEM students, Health students strongly identify with careers for which their current programs have direct relevance. Hence from the perspective of developing employability pedagogies, we argue for maintaining a focus on STEM that is separate from the 'M' of the medical fields.

Engaging students

Metacognition is at the core of higher education and at the core of students' development as workers able to manage their work and learning in a self-regulated manner. Yorke (2005, p. 224) makes the same point, citing employers' 'desire for graduate recruits to be able to reflect critically on practice and to operate with a high level of autonomy'. As the responsibility for career progression and learning shifts from employers to workers in the fourth industrial age (Potgierter, 2012, p. 2) and beyond the 2020 pandemic, students need to develop the metacognitive capability to make informed decisions about their learning and careers. As Leat and Kinninment expound (2000), pedagogies which enable effective (and we would add explicit) instruction help students to draw on their experiences and knowledge in order to select relevant information, build internal and external connections, and enhance their performance.

Students' engagement in explicit employability development creates cognitive links and enhances their ability to negotiate the graduate labour market. This study finds that lack of engagement in co-curricular (extra-curricular) EDOs is the result of time pressures as students struggle to balance work, study and other commitments. Insufficient time impacts both time dedicated to study and time dedicated to discipline-relevant work, including placements. Seen in Pitman, Roberts, Bennett and Richardson's (2019, p. 48) study of graduate outcomes for disadvantaged students, this is particularly problematic for students with disadvantage: 'undertaking paid work in the final year of study was the single most important factor in predicting whether a graduate would be working between four and six months after graduation'. Further, Morrison (2014) finds that students from low socio-economic backgrounds tend to view their degrees as providing specialist knowledge rather than knowledge and skills which might be transferred to multiple settings. This suggests that disadvantaged students are more likely to need help to create the less-obvious links between study and career.

Billett (2015) describes students as ‘time-jealous’ in that they need to make strategic decisions about how to spend their limited time. We suspect that the impact of insufficient time is exacerbated for the students who are unable to make strategic decisions because they do not have sufficient information. A pedagogy for employability might therefore make explicit the relevance of each learning task and EDO to students’ future lives and work. This includes existing tasks such as team-based assessments, giving and receiving feedback and engaging in critical reflection, all of which might be re-branded as employability ‘touchpoints’ (Bennett, 2019a).

Concluding comments

We conclude by emphasising that for employability development and expert career guidance to be equally available to all students, they should be aligned with disciplinary knowledge, skills and practices and delivered within the core curriculum. By adopting a design-centric approach we were able to amass student data in a way that was beneficial for students and which will help us to respond to their learning and developmental needs. We were also able to minimise the challenges of time, resources and expertise among teachers by scaffolding employability development within the existing curriculum. In the longer term, we hope that the data will inform both pedagogical practice and curricular renewal such that a pedagogy for employability is accepted as an essential component of our core business.

Notes

1. That is to say, there would be only a 1.3% chance of observing a difference in the means of this magnitude just by random sampling variability if thetwo groups in fact had the same mean. Hence we can reject the null hypothesis of equivalence of means with some confidence.
2. The employABILITY measure (Bennett, 2019a) can be accessed in full at www.developingemployability.edu.au

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Further information

More information on the measure, research and resources can be found at the student and educator sites or by contacting the lead author. Educator site: https://developingemployability.edu.au/

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Appendix 1. EmployABILITY sub-scales utilised in the study.[2]

Subscale	Items (count)	Original source	Indicators of employability	Likert scale
Goal-directed behaviour	10	Coetzee (2014) *GSAS* factor 6, *goal directed behaviour* (GDB, 10 items).	GDB: Tendency to be proactive and strategic in order to meet goals and deadlines.	1-strongly disagree to 6- strongly agree
Career identity and commitment	8	Constructs: career commitment (CC, 4 items); reconsideration of commitment (RC, 4 items). Adapted from the *identification with- and reconsideration of commitment* dimensions in Mancini et al.'s (2015) *professional identity status questionnaire (PISQ-5d)*.	CC: Being proud and happy about becoming a professional in the discipline (identification and affirmation). RC: Considering alternative study or career pathways when a current commitment is unsatisfactory (reconsideration of commitment).	1-not at all to 5-very much
Ability and willingness to learn	7	Coetzee (2014) *GSAS* factor 3, *continuous learning orientation* (7 items).	AWL: Commitment and ability to maintain career-related knowledge, skills and abilities.	1-strongly disagree to 6- strongly agree
Perceived program relevance	4	Three items adapted from Smith, Ferns and Russell's (2014) *employability* scale (integrate theory & practice, 3 items); 4th item new.	PPR: Ability to recognise the relevance of learning tasks and integrate theory and practice into workplace settings.	1-very poor to 5-very good
Career exploration and awareness	8	From Lent, Ezeofor, Morrison, Penn and Ireland's (2016) *career exploration and decision self-efficacy* scale *(CEDSE)*. Factor 1: *brief decisional self-efficacy* (CEA: 8 items).	CEA: Ability to understand and match self-qualities with career and study options.	1-no confidence at all to 10-complete confidence
Occupational mobility	4	From Lent, Ezeofor, Morrison, Penn, and Ireland's (2016) *CEDSE*. Factor 2: *decisional coping efficacy*. (OM: 4 items).	OM: Ability to cope with career-related decisional obstacles and post-decisional regrets.	As above