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Representation of future-focused teaching capabilities in selection criteria used to recruit Australian engineering academics

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ABSTRACT

CONTEXT

To better prepare graduates for the demands of professional practice, approaches to engineering education need to continuously evolve. The recent "Engineering 2035 Project" commissioned by the Australian Council of Engineering Deans explored this within the Australian context, with the goal of setting a direction for change within the sector (Burnett et al., 2021). One aspect of the project identified future-focused teaching capabilities required of educators to deliver on the vision.

PURPOSE

The study focuses on the research question: *How are teaching capabilities represented in current Australian engineering academic recruitment?*

APPROACH

Publicly available engineering academic job advertisements posted between July 2021 and February 2022 were collected. The final data set comprised 52 job advertisements from 21 institutions, and consisted of 593 individual selection criteria. The job advertisements were then reviewed through the lens of the seven future-focused teaching capabilities from the Engineering 2035 Project using a two-stage coding process. Stage 1 took a general approach whereby a selection criterion was coded as aligning to a teaching capability if it was explicitly required, or if it could assumed that the capability would be a prerequisite to demonstrating the criterion. Stage 2 focused on identifying where the capabilities were explicitly referenced in a teaching context for each selection criterion.

OUTCOMES

The analysis demonstrated that current university recruitment strategies are not well aligned with the future-focused teaching capabilities highlighted by the Engineering 2035 Project. Many capabilities were overwhelmingly expressed in selection criteria only through general statements or in relation to research, rather than in teaching-specific contexts. This finding implies that current practices are leaving a significant gap in the recruitment of staff with strong skills in translating knowledge of the engineering profession into educational practice.

CONCLUSIONS

Overall, the findings of the study suggest that dramatic structural and systematic changes are needed in how engineering academics are recruited. In particular, universities need to rethink how they craft and prioritise selection criteria if they are to effectively recruit engineering academics with the future-focused teaching capabilities necessary to deliver the envisioned high-quality engineering graduates of the future.

KEYWORDS

Engineering academics, engineering education, future vision, Engineering 2035 Project

Introduction

Numerous factors are transforming professional engineering practice, including technological advances, globalisation trends, and the changing nature of work (Crosthwaite, 2019; Felder et al., 2011). Meanwhile in the higher education sector, trends are continuing around increased technology usage, rising student enrolments, and the diversification of student backgrounds (Borrego & Henderson, 2014; Reidsema et al., 2013). In response, engineering education approaches must progress to better engage and inspire students with varied needs and interests, while also ensuring students develop competencies aligned to industry needs (Crosthwaite, 2019).

Given the fundamental role that teaching quality plays in driving student outcomes (Felder et al., 2011; Norton et al., 2013), persistent concerns about the quality of instruction within present-day engineering programs do not bode well for meeting the evolving expectations of graduate engineers. For example, in Australia, just 49.7% of graduates perceived that they experienced “good teaching” in their undergraduate engineering degrees through the 2018 Quality Indicators in Learning and Teaching national survey (ACED, 2019). This was well below the average for all undergraduate fields of 62.9%, and reflected an enduring trend of underperformance (ACED, 2019). Although self-motivated and academically confident students may be able to “make up for mediocre teaching with their own efforts”, the ever-growing cohort of students from non-traditional backgrounds are more reliant on quality teaching for their success (Norton et al., 2013, p. 6). Dissatisfaction with teaching also drives many well-qualified students to withdraw from engineering degrees (Felder et al., 2011), with this attrition restricting capacity to meet the mounting demand for qualified engineers in the workforce (Kaspura, 2019).

Although the skills of engineering educators are recognised as critical to student success (Borrego & Henderson, 2014; Felder et al., 2011; Norton et al., 2013), a growing body of evidence shows that universities put limited value on the teaching proficiency of their academic staff (Dart et al., 2021; Dobele & Rundle-Theile, 2015; Norton et al., 2013). Instead, universities tend to reward academics’ research achievements through internal promotion, job security, and professional autonomy (Dobele & Rundle-Theile, 2015; Norton et al., 2013). This forms a major barrier to educational excellence and inhibits educator motivation to reform practices (Reidsema et al., 2021). Unfortunately, the teaching-research value discrepancy also pervades recruitment processes, where it has been observed that universities are “placing an increasing emphasis on demonstration of research capability and potential in hiring decisions” (Pitt & Mewburn, 2016, p. 89).

The lack of recognition for quality teaching was reflected in the recent “Engineering 2035 Project” commissioned by the Australian Council of Engineering Deans (ACED). The project sought to identify “significant drivers of change in professional engineering roles and anticipate the impacts…[on] graduates of professional engineering programs in the year 2035” (Crosthwaite, 2019, p. 2). While the project highlighted teaching capabilities required of engineering educators to deliver on the future vision, it was noted that the selection criteria used to recruit academics was a “major inhibitor to educational excellence and capacity to reform” (Crosthwaite, 2019, p. 54). Although previous research has examined engineering educator capabilities and teaching skill development (e.g. Borrego and Henderson (2014); Felder et al. (2011); Reidsema et al. (2013)), no studies have deeply assessed how engineering academic recruiting practices align (or misalign) with expectations. To address the gap, the present study focuses on the research question: *How are teaching capabilities represented in current Australian engineering academic recruitment?* This forms a preliminary step in understanding how the processes by which academics are appointed may be revised, such that skill sets better align with the anticipated needs for delivering high-quality educational outcomes.

Background

Engineering educator workforce context

Traditionally, academics have been employed to both teach and research within their technical discipline (Norton et al., 2013). However, research-skewed reward and recognition structures mean that the types of academics who succeed within the university environment are often not suited to shaping the next generation of engineers (Aparicio & Ruiz-Teran, 2007). This is because research-focused academics frequently lack real-world experience, pursue research directions that are of little interest to practicing engineers, and seek to develop students for research careers rather than for success in industry (Aparicio & Ruiz-Teran, 2007). The heightened value placed on research also disincentivises academics from improving their teaching quality (Borrego & Streveler, 2015), with time taken away from research reported as the most significant barrier to Australian engineering academics innovating within their educator role (Reidsema et al., 2021). While traditional teaching-research academics tend to fill educational leadership roles (such as those related to curriculum design and subject coordination), the majority of teaching in Australian universities is actually delivered by casual academics (Norton et al., 2013). This group of educators hired on precarious short-term appointments typically support subject delivery through facilitating tutorials and practicals for smaller groups of students.

Future vision for Australian engineering education

The Engineering 2035 Project captured the views of key stakeholders on their envisioned future state of engineering education and professional practice (Crosthwaite, 2019). Themes emerged for how educational approaches needed to change to better prepare engineering graduates for the demands of industry. These included increasing collaboration with industry for teaching activities, improving opportunities for students to engage in authentic learning experiences (including working in multidisciplinary teams to solve open-ended problems), incorporating a more humanised and societal focus within engineering programs, and changing curriculum and pedagogies to emphasise development of professional skills alongside technical skills (Crosthwaite, 2019).

In order to deliver on the aforementioned changes to engineering education practice, the Engineering 2035 Project explored developments needed within the engineering educator workforce (Crosthwaite, 2019; Reidsema et al., 2021). Subsequently, seven future-focused teaching capabilities were identified (Reidsema et al., 2021). As stated in the project's summary report of Burnett et al. (2021, p. 14), these were:

1. Change in teaching practice
2. Integrating real-world situations in teaching
3. Using digital technologies to model engineering problems
4. Increasing industry collaboration
5. Integrating human/social dimensions within technical contexts
6. Using e-learning
7. Professional development as an engineer educator

This list was used as the basis for investigating how teaching capabilities were represented in engineering academic recruitment within the present study.

Method

Data Collection

Our research question seeks to understand how teaching capabilities are represented in Australian engineering academic recruitment. To address this, we focused on the selection criteria of publicly available engineering academic job advertisements posted between July 2021 and February 2022. Where possible, job advertisements were collected by directly subscribing to job alert emails from the recruitment websites of ACED member institutions (ACED, n.d.). If search criteria could be specified in the alert, alerts were filtered to academic jobs with the keyword "engineering". Given some universities' recruitment websites did not offer alert functionality, alerts for job aggregator websites of Seek, LinkedIn Jobs, and TimesHE Jobs were also deployed. These searches utilised the keyword filters of "lecturer", "academic", "professor", and "engineering". The widespread nature of the job aggregator websites often meant that job advertisements were captured several times.

Job advertisements were regularly downloaded over the collection period with duplicates removed. They were then screened with those retained meeting the following criteria: (1) role included a teaching component, (2) job advertised by an ACED institution with an engineering program accredited by Engineers Australia; and (3) included a position description with selection criteria. It was found that for the few casual job advertisements initially collected in the sample, detailed position descriptions were not provided. Therefore, casual roles were excluded from the study. The selection criteria as well as metadata from each advertisement were extracted and collated. The final data set comprised 52 job advertisements from 21 institutions and consisted of 593 individual selection criteria. Table 1 summarises the breakdown by academic level, contract type, and institution location.

Table 1: Characteristics of 52 job advertisements meeting screening criteria. Note that where advertisements were listed as potentially being offered at multiple position levels (such as Lecturer or Senior Lecturer), the role has been counted against each level.

Characteristic		Count	Percentage
Position Level	Associate Lecturer (A)	3	5%
	Lecturer (B)	29	44%
	Senior Lecturer (C)	16	24%
	Associate Professor (D)	12	18%
	Professor (E)	6	9%
Contract Type	Ongoing	38	73%
	Fixed Term	4	8%
	Not Specified	10	19%
Institution Location	Australian Capital Territory	1	2%
	New South Wales	16	31%
	Queensland	5	10%
	South Australia	3	6%
	Tasmania	2	4%
	Victoria	21	40%
	Western Australia	4	8%

Data Analysis

The seven future-focused teaching capabilities arising from the Engineering 2035 Project (introduced above) were chosen to frame the data analysis given the currency and relevance to the research question. However, the capabilities as communicated in Burnett et al. (2021) and Reidsema et al. (2021) (which are said to be based on the original report of Crosthwaite (2019)) comprise only short, general definitions of each capability. Consequently, they lacked the detail necessary to suitably interrogate whether each aspect is represented in job advertisement selection criteria. Therefore, the descriptor for each capability was extended based on a literature review (primarily informed by Crosthwaite (2019)) and interviews with educators to those shown in Table 2. The development and refinement process will be reported in a forthcoming article.

In this article we focus on assessing how the selection criteria from each job advertisement align with the future-focused teaching capabilities as described in Table 2. This involved a two-stage coding process. Stage 1 took a general approach whereby a selection criterion was coded as aligning to a future-focused teaching capability if it was explicitly required, or if it could assumed that the capability would be a prerequisite to demonstrating the criterion. For example, many selection criteria called for academics to have excellent communication skills, which was assumed a necessary precursor to developing these skills in students (C5). Similarly, several selection criteria asked for academics to have industry connections, which was assumed related to academics' ability to incorporate collaborations with industry into their teaching (C4). Stage 2 coding focused on identifying where the future-focused teaching capabilities were explicitly referenced in a teaching context for each selection criterion. Thus, in the examples where academics were asked for communication skills or industry connections without an educational focus, the selection criteria were not coded to future-focused teaching capabilities at Stage 2. The coding process was undertaken independently by two researchers. Conflicting codes (which occurred on less than 2% of the ~4400 selection criteria/capability combinations) were resolved through discussion until consensus was reached.

Table 2: Extended descriptions of future-focused teaching capabilities proposed in Burnett et al. (2021, p. 14)

#	Description
C1	Continuously improve teaching approaches based on evidence drawn from a range of sources, including educational research, student and peer feedback, assessment outcomes, and observed cohort needs.
C2	Engage students in experiences authentic to professional engineering practice, including collaboration with complementary disciplines to solve complex open-ended problems incorporating uncertainty.
C3	Use contemporary digital technologies to interpret, manipulate, and communicate data related to engineering problems.
C4	Embed collaborations with industry and community organisations in teaching.
C5	Integrate the human and social dimensions of engineering in learning designs to develop students' professional skills, including communication, ethical decision-making, cultural competence, inclusiveness, and entrepreneurship.
C6	Incorporate educational technologies into teaching to effectively engage students in blended and online modes of delivery.
C7	Engage in and gain recognition for ongoing professional development as an engineering educator, while supporting the professional learning of others such as through mentoring and dissemination of effective practice.

Results

Results of the two-stage coding process are presented in Figure 1. This shows that there is a disconnect between the priorities of universities in recruitment and the future-focused teaching capabilities outlined in the 2035 report, given the limited coverage of the capabilities (even implicitly) across the advertised positions.

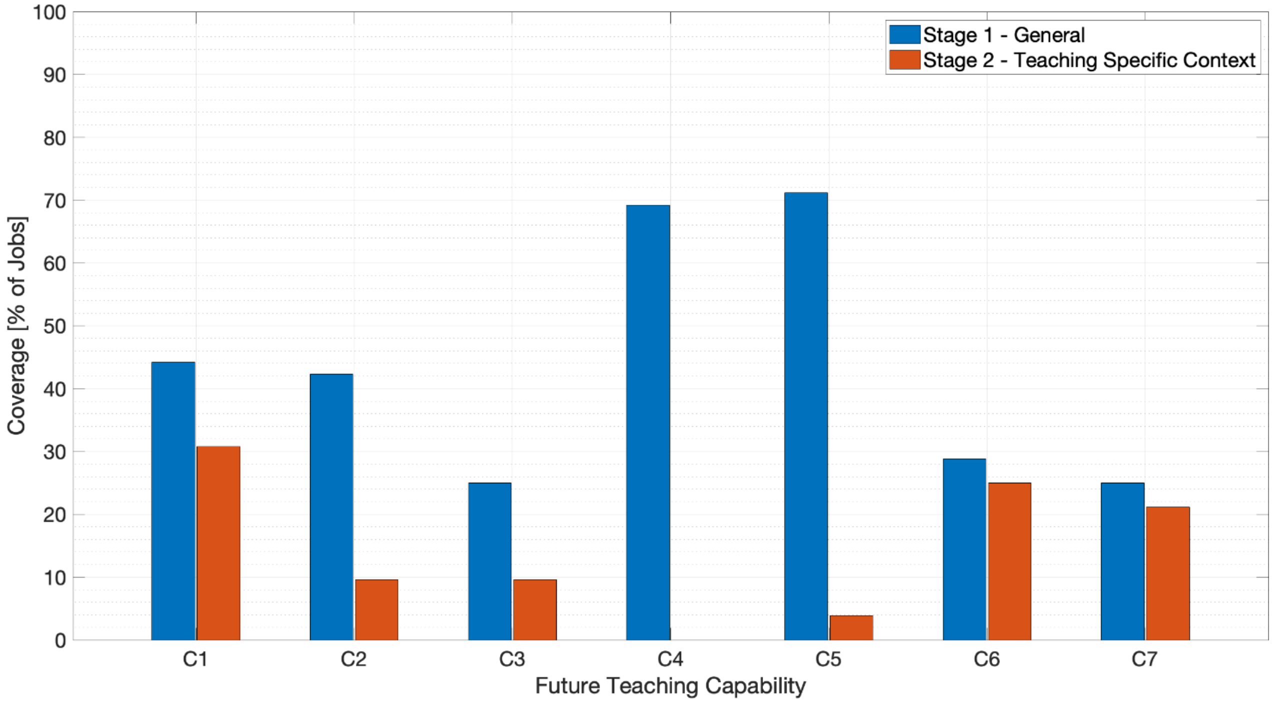

Figure 1: Coverage of the future-focused teaching capabilities (summarised in Table 2) across job advertisements when assessed generally (Stage 1) and in a teaching-specific context (Stage 2)

In Stage 1 coding, the capability related to integrating the human and social dimensions of engineering into learning designs (C5) was the most frequently represented in job advertisements. Many selection criteria called for high levels of interpersonal and communication skills in academics, such as:

> *"High quality interpersonal skills, with excellent written and verbal communication skills."*

> *"High level communication skills and ability to network effectively and interact with a diverse range of students and staff."*

However, this same capability was present in just two job advertisements when the teaching-specific context was considered in Stage 2. Of these, neither specifically reflected the facilitation of the professional skills in students:

> *"Demonstrated capacity to work effectively with and to negotiate sensitively with students especially on issues related to effective learning."*

> *"Strong leadership contributions and personal qualities that influence the development and maintenance of a positive academic environment which is conducive to high levels of engagement and standards of achievement for both staff and students."*

There is a growing body of research showing that programs with a social impact focus (such as the Engineers Without Borders Challenge) lead to an improvement in student outcomes, especially in professional skills and engineering mindsets (Daniel & Mann, 2017). However, these social and human-centred considerations are often an afterthought in curriculum design, rather than embedded cohesively across a program (Crosthwaite, 2019). This lack of cohesion reinforces a traditional focus on purely technical aspects of engineering (Male et al., 2011) and needs to be addressed by revisiting engineering education approaches. Recruiting academics with the skills to lead this shift in how curriculum is conceived will subsequently be important.

A similar trend was evident for how the capability related to embedding collaborations with industry in teaching (C4) was represented in job advertisements. When advertisements discussed the need for collaboration with industry, it was always described in a general sense, or for the purpose of research or funding. Typical examples include:

> *"Ability to build effective networks with colleagues and generate alternative funding projects through effective liaison with industry and government."*

> *"The ability to prepare and win competitive research grants and/or research contracts with industry."*

Likewise, using digital technologies to solve engineering problems (C3) was most often referenced in relation to a role's research direction rather than in an educational capacity, such as:

> *"Experience with direct numerical simulation of pore-scale flow in porous media."*

> *"Deep knowledge of programming, artificial intelligence, and machine learning methods."*

This is consistent with previous research which has found that universities are placing a heavy emphasis on academics' research capabilities during recruitment processes (Norton et al., 2013; Pitt & Mewburn, 2016). This research focus also persists for academics operating within institutions as research track record is the key driver for recognition, especially through promotion (Crosthwaite, 2019; Dobele & Rundle-Theile, 2015; Reidsema et al., 2021).

Just under half of all roles included selection criteria associated with the continuous improvement of teaching approaches (C1). Those that discussed the required skills in a teaching-specific context used language like "*reflective approach to teaching delivery*", "*strong understanding of pedagogical theory*", and, "*outcomes for students that will improve or innovate in response to feedback*." Encouraging academics to consistently review their teaching using a range of data is recognised as a critical step in getting academics to apply evidence-based teaching practices (Borrego & Henderson, 2014).

Approximately 40% of roles described skills at least implicitly related to engaging students in experiences authentic to professional engineering practice (C2). This was typically expressed through selection criteria that asked for applicants to demonstrate an understanding of the profession through their previous work with industry or from first-hand experience as a professional engineer, such as:

> *"A history of working in industry or with industry, delivering quality outcomes, a demonstrable knowledge of current best practices in Software Engineering, Cloud, Systems and Security, and a demonstrated ability to stay abreast of and adapt to new trends in the industry."*

Where there was a reference to the educational context for this capability, it was usually in relation to supporting "*work-integrated learning*" as the authentic experience. Thus, other contexts in which authentic experiences could be embedded, such as through problem-based learning or multi-disciplinary design projects (Hadgraft & Kolmos, 2020), were neglected. Authentic learning experiences provide students opportunities to increase confidence and enthusiasm to solve complex engineering problems (Foong & Guthrie, 2006), while increasing their employability, professional communication, and project management skills (Hogan, 2012). However, recruiting for these skills only through a research or industry experience lens leaves a significant gap in translating knowledge of the profession into educational practice.

Surprisingly, use of educational technologies (C6) was among the least represented in job advertisements. This is despite the dramatic uptake in online learning technologies brought on by the COVID-19 pandemic (Reidsema et al., 2021). Where selection criteria asked for skills in this area, it was framed broadly rather than naming specific technologies, such as "*innovative in teaching, including online or blended delivery*." Although digital learning technologies have been utilised in engineering education programs previously, the COVID-19 driven acceleration of e-learning tools means engineering faculties now have the opportunity for further implementation and improvement of online learning approaches (Crosthwaite, 2019). However, the transition may have meant that online learning and teaching is now an unwritten expectation, and thus roles have not included an explicit reference to this form of delivery in their selection criteria.

Engaging in professional development (C7) was among the least represented capabilities. Where it was reflected in selection criteria, it was primarily connected to being recognised as a leader in the field through awards and dissemination of practice:

> *"A distinguished record of scholarly teaching excellence as evidenced through successful student outcomes, demonstrated impact on student learning, recognition through awards/prizes and innovation."*
>
> *"…a record of contribution to scholarship in teaching"*
>
> *"Demonstrated ability to lead improvement of academic standards, including implementing best practice teaching strategies and dissemination of innovative practices"*

Consistent with the standard that a doctoral qualification is the expectation for an academic role rather than a teaching-focused qualification (Norton et al., 2013; Pitt & Mewburn, 2016), very few jobs asked for formal educational training. Examples of the few selection criteria addressing this include:

> *"Completion of the Essentials of Learning and Teaching or possess (or eligible to apply for) appropriate HEA fellowship (if the appointed candidate does not meet this requirement at time of appointment, they will be supported to complete this as a requirement to fulfil their probation)."*
>
> *"Evidence of and/or preparedness to undertake professional development of teaching practice.*

Professional development activities empower and engage educators to reflect on their teaching practice, and can increase uptake of evidence-based approaches (Borrego & Henderson, 2014). Developing proactive educators who continuously seek and are supported through professional teaching development is key to ensuring effective learning environments and positive outcomes for students (Borrego & Henderson, 2014). This will be critical to meeting the future vision for engineering education (Reidsema et al., 2021).

Conclusion

This study sought to assess the representation of teaching capabilities within the selection criteria of engineering academic job advertisements. The analysis demonstrated that current university recruitment strategies are not well aligned with the future-focused teaching capabilities highlighted by the Engineering 2035 Project. Many capabilities were overwhelmingly expressed in selection criteria only through general statements or in relation to research, rather than in teaching-specific contexts. This is consistent with previous studies which have shown universities value teaching less than research (Dart et al., 2021; Dobele & Rundle-Theile, 2015; Norton et al., 2013). This finding implies that current practices are leaving a significant gap in the recruitment of staff with strong skills in translating knowledge of the engineering profession into educational practice, which is noted as critical to achieving the future vision for Australian engineering education (Crosthwaite, 2019). Fewer than half of the job advertisements included selection criteria related to continuously improving teaching and using educational technologies. This is despite these skills becoming more important as students come to increasingly expect educational experiences tailored to their individual needs and interests, and delivered online (Crosthwaite, 2019). Finally, only a handful of job advertisements asked for evidence of professional development. This is interesting given that continued professional development is a requirement of chartered engineers (Engineers Australia, 2022), but is clearly not widely valued by universities for their engineering educator workforce.

Overall, the findings of the study suggest that dramatic structural and systematic changes are needed in how engineering academics are recruited. In particular, universities need to rethink how they craft and prioritise selection criteria if they are to effectively recruit for the future-focused teaching capabilities necessary to deliver the envisioned high-quality engineering graduates. A limitation of this work is that it focuses exclusively on the selection criteria in job advertisements, which may not be totally reflective of the skills recruited for. This is because individuals bring their own biases to the process, and thus those sitting on selection panels may influence recruitment directions. Future work should seek to explore the experiences of frontline academics to understand whether the findings can be triangulated.

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