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Interventions for Improving Employability Skills of International Postgraduate Engineering Students: A Scoping Review

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ABSTRACT

CONTEXT

Professional skilled migration to countries like Australia, New Zealand, USA, Canada and UK, has been a major driver for international students pursuing a postgraduate coursework degree in engineering. While the demand for engineers across the globe is increasing, relevant in-field professional employment outcomes for international students remain low. This is a serious concern for example, in Australia, where the overseas students on average accounted for over 72% of all postgraduate coursework enrolments in Engineering from 2017 and 2022.

PURPOSE OR GOAL

Our analysis of 2016 and 2021 census respondents with an international (non-Australian) citizenship aged between 25-30, who held an engineering coursework master's degree as their highest qualification revealed concerning employment trends. These trends highlight a multifaceted challenge in the context of designing curricula for postgraduate engineering coursework programs and preparing international students for professional engineering practice.

APPROACH OR METHODOLOGY/METHODS

To identify targeted interventions that evidence impact of employability outcomes, we undertook a scoping review of articles published in peer reviewed journals. Within the literature we looked for empirical evidence of strategies that improved the employability skills of international students studying engineering coursework degree programs to understand, 'What works? To produce what outcomes? For whom? And under what circumstances?

ACTUAL OR ANTICIPATED OUTCOMES

Despite ongoing calls to improve the employability skills of international students studying engineering postgraduate degrees in countries like Australia, New Zealand, USA, Canada and UK, empirical studies on effective learning interventions are limited. Frequent policy change surrounding international students in these host countries is a critical challenge for higher education institutions and employers alike. In our scoping review, we found a large number of advocacy papers with only a small number of studies providing empirical evidence of the impact of interventions.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

The findings from this study highlights an urgent need for more research to understand difficulties that international postgraduate coursework engineering students from different backgrounds face in countries like Australia, New Zealand, USA, Canada and UK.

KEYWORDS

International students, postgraduate coursework engineering degrees, scoping review.

Introduction

In countries like Australia, New Zealand, USA, Canada and UK professional skilled migration has been a significant motivator for international students seeking to pursue a postgraduate coursework degree in engineering. A growing demand for post-study employment opportunities has emerged as a critical issue and major challenge in many host countries (Gribble, Rahimi and Blackmore, 2017).

Engineers Australia's 'Statistical Overview of the Engineering Profession' reported information in relation to overseas-born qualified engineers in the Australian workforce. Engineers born overseas comprise 62.7% of the qualified engineer population in Australia. The number of overseas qualified engineers working in engineering occupations has increased by 36% in 2021 census when compared with the 2016 census, growing at twice the rate when compared with the previous five years leading up to the 2016 census. Overseas-born engineers contributed to 70% of the growth in the engineering labour force for the period 2016 – 2021 (Briggs, 2023).

While the demand for engineers is increasing, relevant in-field professional employment outcomes for international students (overseas students on a student visa) with an Australian postgraduate engineering qualification remain low. Briggs (2023) reported that among those engineers that come to Australia to study a postgraduate engineering degree and remain in Australia at least 50% work in non-engineering fields (see Figure 1). He highlighted that year of arrival of overseas-qualified engineers in Australia has a bearing on their occupational outcome.

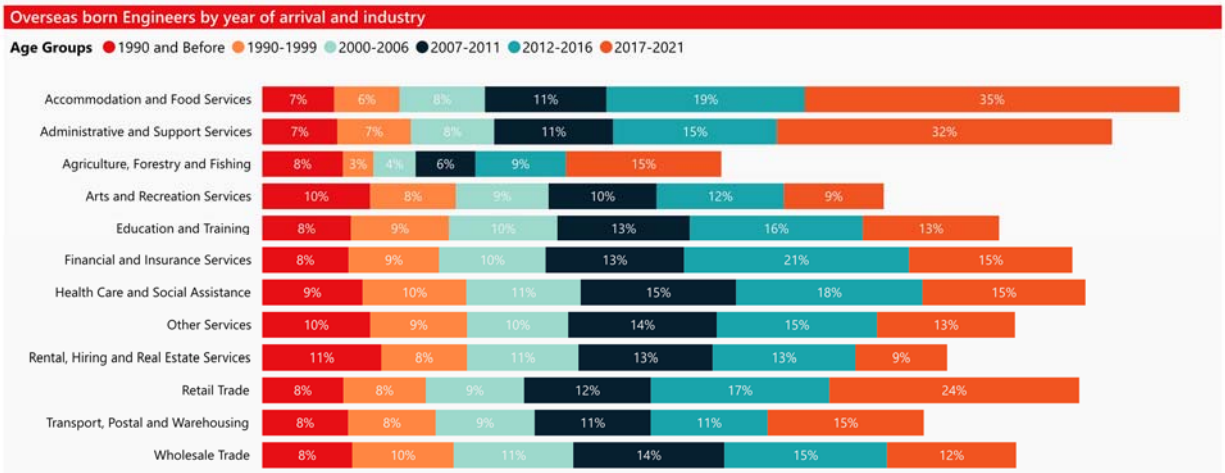

Figure 1: Proportion of overseas qualified engineers working in non-engineering roles (Briggs, 2023).

Census data are a potential source of information regarding graduate outcomes, including for international students. Using both 2001 and 2006 census data, Trevelyan and Tilli (2010) observed a significant differential between Australian-born and foreign-born engineering graduates (including master graduates) regarding the likelihood of working in an engineering-related occupation, and the likelihood of working in any occupation. Using 2011 census data, Buddelmeyer, van de Ven and Zakirova (2013) showed that graduate labour market engagement was correlated with time of arrival in Australia – employment rates were lower for recent international arrivals, somewhat higher for those resident for more than five years, and highest for those born in Australia.

Overseas students, on average, accounted for over 72% of all postgraduate coursework enrolments (see Table 1 below) in Engineering and Related Technologies in Australia Universities and non-University Higher Education providers between 2017 and 2022 (Department of Education, 2024). Krishnan et al. (2020) analysed the 2016 census data and noted that respondents with an international (non-Australian) citizenship aged between 25-30 (most likely recent graduates), who held an engineering coursework master's degree as their highest qualification suggests that engineering graduates who completed a postgraduate engineering

coursework degree as an international student in Australia are less likely to be working in engineering related jobs when compared to those of their Australian peers, and to all recent engineering bachelor graduates in Australia. This finding is consistent with our subsequent analysis of the 2021 census data using the same method. This employment outcome for international students, who have completed a postgraduate engineering qualification in Australia, is a serious concern. It highlights a multifaceted challenge in the context of designing curricula for postgraduate engineering coursework programs and preparing international students for professional engineering practice.

Table 1: Student enrolment patterns in Australian Higher Education (Department of Education, 2024)

Enrolment data	2017	2018	2019	2020	2021	2022
Total enrolments (all areas)	1513383	1562520	1609798	1622867	1602573	1551411
Total overseas student enrolments (all areas)	431562	480110	523748	489348	440661	448728
Overseas student enrolments in PG Coursework programs (all areas)	163229	193376	218031	200382	167366	164434
Total enrolments in Engineering and Related Technologies	111980	116528	118687	114666	109562	106390
Total overseas student enrolments in Engineering and Related Technologies	48612	53605	56031	50628	43147	40081
Total PG enrolments in Engineering and Related Technologies	23005	25906	27135	24664	20554	18125
Overseas PG enrolments in coursework Engineering and Related Technologies	16473	19785	21167	18232	13866	11855

International students are an important aspect of university education and finances for Schools of Engineering in Australian Universities (Kaspura, 2017). The Australian Council of Engineering Deans noted in 2018 that recent overall growth in university engineering enrolments is due almost exclusively to international coursework master students (Australian Council of Engineering Deans, 2018). Yet, research on employability skills development or its impact on employment outcomes of international coursework postgraduate engineering students is rare.

Winberg et al. (2020) identified several studies that focus on employability skills development in engineering education. However, research studies that focus on international coursework postgraduate students are typically small, general in nature (Beagon et al., 2019; Campbell et al., 2021; Froyd et al., 2012; Jollands et al., 2012; Mitchell et al., 2021; Winberg et al., 2020). A more recent study by Engineers Australia focused on barriers to employment for migrant engineers (Romanis, 2021). This study identified that many overseas-born engineers struggle to find work in the engineering sector. Those who find employment in-field are likely to be underemployed in junior level roles than their skills and experience warrant. While this study surveyed 817 migrant engineers, it stopped short of isolating international coursework postgraduate students or the barriers that are specific to them.

To identify targeted interventions that evidence impact of employability outcomes, we undertook a scoping review of the engineering education literature. Within the literature we looked for empirical evidence of strategies that improved the employability skills of international students

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studying engineering coursework degree programs to understand, ‘What works? To produce what outcomes? For whom? And under what circumstances? In this paper we present our findings and unpack the evidence presented in the studies we identified through our research.

Methodology

This research study utilises a scoping review, a structured methodology, which is similar to a systematic review to scope a body of literature, identify and clarify a concept and investigate research opportunities. Scoping reviews can be advantageous over a systematic review when the practice is heterogenous, evidence is unclear and more specific questions must be posed to retrieve and synthesise evidence relevant to a particular question (or questions) to inform practice, policy or further research (Munn et al., 2018; Suri, 2018).

The following three quality criteria were adhered to enhance rigor in this scoping review

- Purposeful selection to maintain conceptual coherence
- Informed subjectivity and reflexivity to minimize potential unintended biases
- Audience-appropriate transparency to facilitate transferability of findings.

The research question we sought to answer was: What strategies improve the employability skills of international students studying postgraduate engineering coursework programs?

We identified relevant peer-refereed journal articles indexed within the following databases: SCOPUS, ERIC, Compendex, Web of Science and EBSCOHost. Building on the logic that most rigorous empirical research is likely to get published in peer-refereed journals, we excluded conference papers and dissertations.

The following Boolean search query was conducted to identify relevant studies for this research: (engineering education) AND (international student) AND (employability skills OR professional practice skills OR professional skills OR professional capabilities OR professional attributes OR personal attributes OR work-readiness OR graduate capabilities OR graduate competencies) AND (Australia OR Canada OR New Zealand OR UK OR USA). The search query was modified with alternative keywords, truncations and limiters to capture studies published between 2010 and 2023.

The initial search resulted in a total of 251 published articles (24 from Scopus, 138 from ERIC, 7 from Compendex, 21 from Web of science and 61 from EBSCOHost) from the following journals: 1) Engineering Education, 2) Chemical Engineering Education, 3) Advances in Engineering Education, 4) Journal of Engineering Education, 5) Studies in Engineering Education, 6) European Journal of Engineering Education, 7) Computer Applications in Engineering Education, 8) International Journal of Engineering Education, 9) Australasian Journal of Engineering Education, 10) Journal of Pre-College Engineering Education Research, 11) International Journal of Continuing Engineering Education and Life-Long Learning. A separate search was undertaken to identify published Articles from 12) International Journal of Work Integrated Learning as that journal was not indexed in any of the databases searched.

Following the initial elimination of duplicate records, the second part of the review involved systematically applying the inclusion and exclusion criteria. A review tool called Covidence was used for voting an article in or out. The authors individually reviewed each article and voted to include studies that related to and international coursework students in Australia, New Zealand, USA, Canada and UK. Studies conducted outside of these jurisdictions, for example Danaher et al. (2019); Daniels (2011); Kaushal (2016), were excluded. We also eliminated studies that did not discuss employability skills development and checked for reviewer bias. We used the definition of employability provided by Yorke (2006, p. 8) to maintain consistency during the selection process:

> *“a set of achievements – skills, understandings and personal attributed – that makes graduates more likely to gain employment and be successful in their chosen occupations, which benefits themselves, the workforce, the community and the economy.”*

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Research studies that had an inward focus, on student academic performance, course evaluation or process improvements, rather than an outward focus were excluded (Andrade et al., 2020; Blicblau et al., 2016; Greetham & Ippolito, 2018; Lieb, 2016; Milke et al., 2015; O'Leary, 2017). Also excluded were studies that were merely opinion pieces with no empirical evidence, for example (Saviz et al., 2012), and those that focused on international study exchange (Papadopoulou, 2020) or international students pursuing an undergraduate engineering qualification (Palmer et al., 2015).

Findings

In this section, we present our findings and synthesise all the available evidence along with our critique. While several studies among the 251 articles initially located focused on employability skills development for engineering students, the selection and elimination process resulted in the identification of 11 empirical studies that were specifically related to international coursework students. Eight of the 11 studies were conducted in Australia, two in the USA and one in Canada. The varied focus of the studies selected are presented in Table 2 below. The analysis that follows unpacks key messages and applicable challenges.

Table 2: Selected studies for detailed review

No of studies	Focus of study	Authors
3	Work placement experience	Baron and Hartwig (2020); Jackson (2017); Nunes and Arthur (2013)
2	Generic skill development	Campbell (2010); Newberry et al. (2011)
2	Industry exposure	Carbone et al. (2020); Jackson (2016)
1	Professional identity development	Park et al. (2018)
1	Navigating employment opportunities	Pham (2021)
1	Recruitment practices	Blackmore and Rahimi (2019)
1	Student perceptions of engineering and engineering work	Bennett et al. (2015)

Work placement experience and Industry Exposure

The studies that focused on international student experience of work placements, internships and industry exposure through site visits highlighted that undertaking work placement was the single most important factor in predicting whether a graduate would be working between three to six months after graduation (Baron & Hartwig, 2020; Carbone et al., 2020; Jackson, 2016, 2017; Nunes & Arthur, 2013). This likelihood is most significant for international postgraduate coursework students who are less likely to be working in engineering related jobs when compared to those of their Australian peers. Empirical evidence in these studies suggested that international students appeared to be poorly equipped for the recruitment and selection process associated with employment, and employers tended to be concerned with communication and cultural differences among international students. These studies recommended a strength-based approach to employability skills development allowing students to gain experience in new cultural and professional contexts while also highlighting the value for employers in embracing and utilising cultural knowledge and experience that international students bring to the workplace environment.

Generic skill development and professional identity development

Studies that focused on generic skill development emphasised the need for exposure to professional practice and its benefits in the development of deeper understanding of professional attributes, ethical expectations and cultural norms (Campbell, 2010; Newberry et al., 2011; Park et al., 2018). A challenge highlighted in one of the studies is the relevance of "western" notion of generic skills and its applicability for international students who might return to their home countries after graduation, questioning the apparent westernisation goal implicit in the way professional attributes are defined in educational programs (Campbell, 2010). Nevertheless, the ability of students to plan their future lives and careers alongside their professional identity requires future oriented thinking and students vary significantly in this regard with some students having little notion of what the future might hold for them and others with a very rigid career identity. Difficulties encountered by international students, including differenced in culture, language, social environment and loss of personal support structures seemed to negatively impact their self-esteem resulting in more negative assessment of their skills and attributes. Generic skills such as valuing and respecting different views, being confident, showing commitment and being resilient in unfamiliar situations were identified as key generic skills that international students could benefit from for developing their professional identity.

Student perception of engineering, engineering work and navigating employment opportunities

Not surprisingly, the focus of these studies overlapped with the studies that focused on generic skills and professional identity development (Bennett et al., 2015; Pham, 2021). While the study on perception of engineering and engineering work sampled perspectives of first year students, the focus reappeared in the study that explored how international students navigated their employment once they returned to their home countries. These studies highlighted the role of social capital (networking and exposure to industry and accreditation bodies) in informing international students' professional identity, and their decisions and ability to seek and succeed in attaining employment.

Recruitment practices

Concerns surrounding the practices of employers seemed to be the key focus of this study (Blackmore & Rahimi, 2019). The study highlighted a persistent problem in relation to the mindset of several employers who favoured local candidates over international students to achieve a "good fit" for the organisation despite the rhetoric around diversity. This study highlighted the unconscious bias exercised against international students, sending a clear signal of exclusion.

Some concluding thoughts

It is important to note that all these studies explored the needs, challenges and opportunities for international students more generally. Disturbingly, none of the studies focused specifically on postgraduate coursework engineering student cohort. Also, none of the studies identified through this scoping review explicitly recommended any targeted intervention that may be beneficial to improve the employability skills of this student cohort. These findings highlight an urgent need for more research to understand difficulties that international postgraduate coursework engineering students from different backgrounds face in countries like Australia, New Zealand, USA, Canada and UK.

While these countries attract international students in large numbers, frequent government policy changes surrounding international students affect their relevant in-field post-study employment opportunities and thereby their employment destinations, weakens employer confidence in international students and presents a major challenge for higher education institutions to prepare graduates for the workforce. Nevertheless, engineering institutions in these host countries need to think about how international students that they attract can be supported to develop employability skills and competencies to find employment within the engineering sector.

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Based on the evidence that we could find, making industry placement or internship mandatory in postgraduate programs appears to increase the likelihood for in-field employment within the first six months following graduation. However, a key challenge will be around increasing the number of internship or placement opportunities available to postgraduate coursework students. A program-wide approach to Work Integrated Learning (WIL) seems more plausible, where several industry engagement opportunities should used to maximise the opportunity for international students to gain experience in new cultural and professional contexts. Ascertaining the barriers, enablers and the positive impact that various opportunities can have on international students finding in-field employment warrants further research investigation.

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