

Whose voices are being heard? A review of diversity and inclusion research in the *Australasian Journal of Engineering Education*

Ashlee Pearson^a & Matheus S. Xavier^b

The University of Melbourne, Faculty of Engineering and Information Technology, Teaching and Learning Laboratory^a
The University of Melbourne, Department of Electrical and Electronic Engineering^b
Corresponding Author Email: ashlee.pearson@unimelb.edu.au

ABSTRACT

CONTEXT

In 2022, Engineers Australia released a new diversity and inclusion position statement that explicitly references marginalised groups in engineering beyond women. The 2022 position statement calls for the diversity and inclusion work in engineering to also include LGBTIQ+ and Indigenous engineers. Other groups known to be historically marginalised in engineering, such as disabled and chronically ill people, however, have received far less consideration. As research often reflects whose voices are being heard and are often used to inform policy and strategic directions, it begs the question, whose voices are being heard in research into diversity and inclusion in the Australian engineering education context?

PURPOSE OR GOAL

The aim of this work is to categorise the diversity and inclusion research published in the *Australasian Journal of Engineering Education (AJEE)* to date through an intersectional lens of power to establish whose voices are being heard and whose voices have been silent in the literature so far. This work also aims to categorise the types of studies undertaken in this space, and understand any past and current trends, challenges, and initiatives.

APPROACH

A rapid review of papers published in *AJEE* has been conducted. The search string “‘inclusion’ OR ‘diversity’ AND ‘*Australasian Journal of Engineering Education*’” returned 202 responses that were screened and categorised inductively for pre-identified fields of interest.

ACTUAL OUTCOMES

This paper summarises the current state of *AJEE* regarding:

- Number of papers, origins of papers (e.g., institutions, countries) and citations;
- Demographics studied, including groups of focus (minorities) and progression points (pre-university, university, post-university);
- Focus of the studies, including what is being investigated/understood/reported, and to what extent;
- Methods and theoretical frameworks being used.

CONCLUSIONS

This work demonstrates that, although nearly 10 marginalised groups have been discussed within *AJEE* articles, one voice has received far more representation: women. In contrast, groups such as LGBTIQ+ have been silent. The results also show that, despite large increase of university enrolments and student profiles that are far more diverse than that of previous decades, studies of diversity and inclusion within *AJEE* have not followed the same trend.

KEYWORDS

Diversity, inclusion, minority groups, engineering education

Introduction

In 2022 Engineers Australia, the peak governing body for engineering in Australia, released a new position statement that included a call for diversity and inclusion works in engineering to include focus on LGBTIQ+ and Indigenous engineers (Engineers Australia, 2022). This call from Engineers Australia follows the establishment of the Indigenous Engineers Group in 2017 (Engineers Australia, 2017) and the InterEngineering group (for LGBTIQ+ engineers) in late 2020 (Engineers Australia, 2020). This call parallels movements in the tertiary sector, where many institutions have recently launched (or re-launched) action plans, strategies or frameworks around inclusion of diverse peoples (RMIT University, n.d., RMIT University, 2016, The University of Sydney, 2019). For example, this year the author's institution, The University of Melbourne, has launched an Indigenous strategy (The University of Melbourne, 2023c), LGBTIQ+ inclusion action plan (The University of Melbourne, 2023b), and a disability inclusion action plan (The University of Melbourne, 2023a).

This shift to considering more diverse voices also mirrors conversations in engineering education literature. Many have called for a shift to considering diversity in engineering more expansively (Brown, Cheng and Whelan, 2021; O'Shea et al., 2016; Brown, Pearson and Rosenqvist, 2020). Some scholars have critiqued the field as having understudied certain groups experiences in engineering and engineering education including transgender and gender diverse students (Haverkamp et al., 2021; Cech & Rothwell, 2018), students with disabilities and chronic illnesses (Blaser & Ladner, 2020) as well as students experiencing financial hardship (Strutz, Orr & Ohland, 2012). There are many more groups in society and consequently engineering experiencing marginalisation including English proficiency, housing status, mental health status and citizenship status (Vanderwoerd, 2016, Center for Teaching, Learning and Mentoring, 2022).

Research into the experiences of marginalised groups is often used to inform policy and strategic directions, as well as evidence-based change called for in university strategies, action plans and frameworks. As such, it is important to understand whose voices are being heard through engineering education literature and whose voices are currently silent. This paper aims to understand within a sample of literature which marginalised groups voices are being represented and how these voices are being listened to and presented. It will do this through categorising the diversity and inclusion research published in the *Australasian Journal of Engineering Education (AJEE)* to date by marginalised group of focus and type of study, working to understand trends.

Methods

A rapid review was conducted of papers published in the *Australasian Journal of Engineering Education (AJEE)*. A rapid review, as described by Booth and Grant (2009), allows for an assessment of current state of knowledge around a policy or practice issue, here diversity and inclusion in engineering and engineering education. Rapid reviews leverage the strengths of systematic review methods to 'search and critically appraise existing research' in a way that limits the scope for either depth or breadth of the literature being considered (Booth and Grant, 2009). Here, we have chosen to limit scope to AJEE or breadth of the review. The limitation of rapid reviews is that, by design, they limit the scope of search leading to a potential for bias to be introduced (Booth and Grant, 2009). In this work, for example, the limited AJEE database and the single reviewer in the initial screening step may lead to subjective judgment, missing a few relevant studies and data extraction errors. Nevertheless, as this study aims to understand trends in whose voices are being listened to and through what methods, we feel this is an appropriate method to capture a snapshot to inform further works using more in-depth methodologies.

Consequently, a search of the Taylor and Francis database was conducted on 7 November 2023 using the search string:

“inclusion’ OR ‘diversity’ AND ‘Australasian Journal of Engineering Education’”

This returned 202 responses. The abstracts of these responses were screened by Pearson for a pre-agreed upon criteria (focuses on a marginalised community) to meet (Y), not meet (N) or require further review (R). Those requiring a further review were reviewed by Xavier in line with the same criteria. If papers were left requiring review, that is, had been rated R by both reviewers, the authors planned to discuss the papers to settle the categorisation. The end of the review process left 27 papers included in the scope of this study, as shown in Figure 1. Details of these papers were documented against fields of interest including group of focus, year the study was undertaken, sample size, citation count, cohort of study, focus of study, method, theoretical framework, country and state of study. While completing this step, 2 papers were removed due to not specifically analysing any marginalised groups, leaving the final number of papers in this analysis as 25.

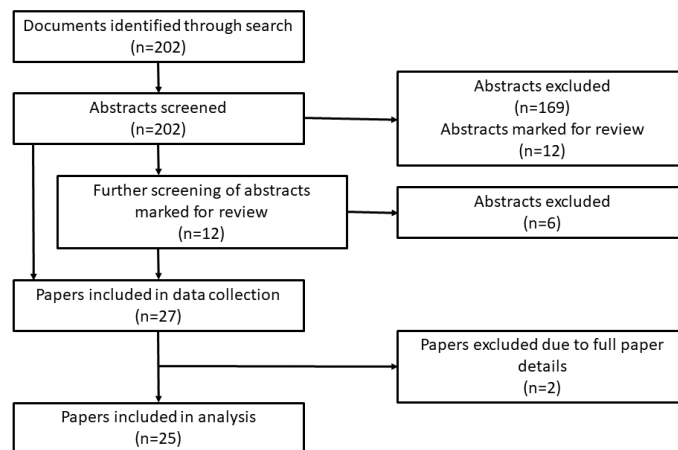
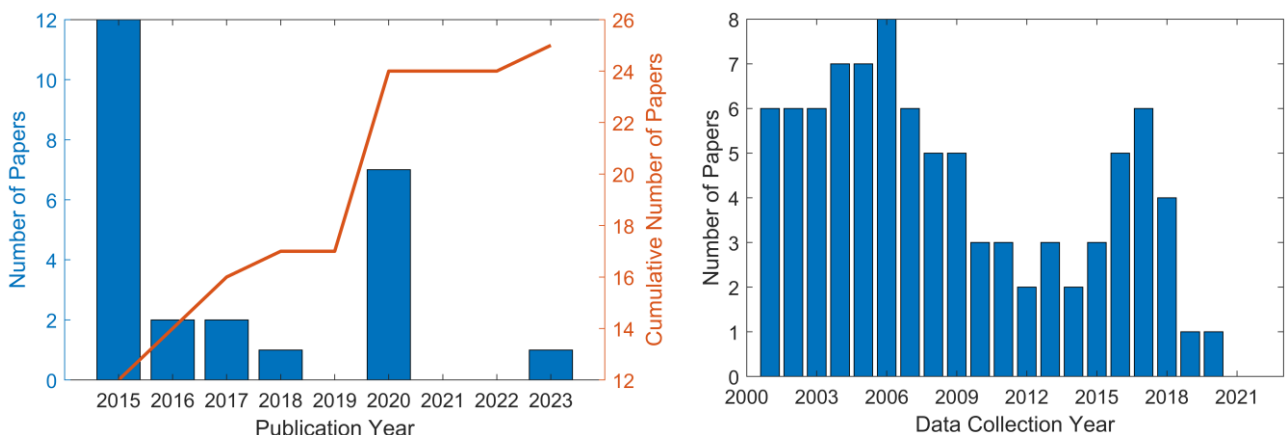


Figure 1: Screening process demonstrating the number of papers at each step.

Results and Discussion

In Table 1, we summarise the 25 papers found in the Taylor and Francis’ database as published in *AJEE*. As shown in Figure 2(a), these papers were primarily published between 2015 (when *AJEE* shifted to online publishing) to 2018, making them over 5 years old. Figure 2(b) shows the years studied for the 20 papers which explicitly included data collection years. On average, papers have employed data collected over 6 years. In addition, the years of 2001 to 2007 have received higher interest, which further highlights the need for literature reflecting more current practices and experiences.



(a) Number of papers by publication date.

(b) Number of papers by date of data collection.

Figure 2: Trends in the number of publications related to inclusion and diversity in *AJEE* by year.

Table 1: Overview of papers included in the scope of the analysis of this rapid review.

Reference	Location	Marginalised Community of Focus	Cohort of Study		Focus of Study	Theoretical Framework	Data Collection	Years Data Collected
(Biggio, Vázquez & García, 2015)	Argentina	Women, Secondary Education	University Students	1 st Year	Assess differences in task completion		Standardised test	
(Calvo, Markauskaite & Trigwell, 2010)	Australia (NSW)	Women	University Students	Undergraduate	Understand students' learning experience		Student evaluations	2001 - 2007
(Danowitz & Beddoes, 2022)	USA	Intersectional	University Students	Undergraduate, Postgraduate	Understand the mental health of students at the conclusion of the first semester in COVID-19		Surveys	2020
(Docherty et al., 2020)	New Zealand	Women	Secondary education, University students	Undergraduate	Comparison of enrolments based on secondary education	Critical theory	Student demographic data	2005 - 2017
(Dowling, 2011)	Australia (QLD)	Mature students with work experience	University Students	Undergraduate, Postgraduate	Describing inclusive curriculum design		Student enrolment data, surveys	2004 - 2011
(Freitas & DeBoer, 2020)	Jordan	Refugee/ displaced persons	Tertiary learners		Describing the design and understanding the experience of a bespoke curriculum design		Student work	2017 - 2019
(Godfrey, 2009)	New Zealand	Women	University Students, Graduates	1 st Year, Final year, 1 st year graduate	Describing the experiences of culture in engineering education	Schein's model for cultural analysis	Surveys, semi-structured interviews, field notes, documentary analysis	1997 - 2001
(Hollis & Goldfinch, 2017)	Australia (NSW)	Indigenous knowledges	Graduates	Recent graduates	Exploring the exposure of all engineers to Indigenous knowledges in early career works		Surveys	2015
(Lloyd & Szymakowski, 2017)	Australia (VIC & WA)	Women	University Students	1 st Year	Effect of curriculum design choice on engagement	Kanter's tokenism theory	Classroom observations, surveys	2016 - 2017
(Male & MacNish, 2015)	Australia (WA)	Women	University Students	1 st Year	Understanding perceptions of industry by students	Possible selves	Interviews	2013
(Manakul, 2007)	Japan	English as an additional language (EAL/ESL)	University Students	Postgraduate	Describing perceptions of curriculum		Surveys, interviews, focus groups	2003 - 2006
(McCall et al, 2020)	USA	Disability	University Students	Undergraduate	Exploring experiences in engineering education	Grounded theory	Semi-structured interviews	

(Melles, 2008)	Australia (VIC)	English as an additional language	University Students	Postgraduate	Describing the design and understanding the experience of a bespoke curriculum design		Questionnaire	2002 - 2003
(Mills, 2011)	Australia (SA)	Women	University Students, Graduates	Final Year	Published literature overview		Published literature	1983 - 2009
(Neal et al., 2011)	Australia (NSW)	Women and International	University Students	1 st Year	Understand students' learning experience		Student performance data, student evaluations	2006 - 2009
(Polmear, Chau & Simmons, 2021)	USA	Women and racial/ethnic minorities	University Students	Undergraduate	Understand students' learning experience	Intersectional approach	Surveys	2016 - 2017
(Smith, Mazzurco & Compston, 2018)	Australia (ACT & VIC)	Female and rural backgrounds	University Students	Undergraduate	Describing the design and understanding the experience of a bespoke curriculum design		Student enrolment data, surveys	2007 - 2018
(Sorby, 2007)	USA	Women	University Students	1 st Year	Describing inclusive curriculum design		Student performance and retention data	1993 - 2002
(Sorby, Duffy & Loney, 2020)	USA	Female	University Students	3 rd Year	Assess differences in task completion		Standardised test	
(Stappenbelt & Barrett-Lennard, 2008)	Australia (WA)	English as an additional language	University Students	1 st Year	Assessing differences in performance between groups		Student performance data	2001 - 2007
(Trevelyan & Tilli, 2010)	Australia	Migrants	Graduates		Comparison of employment and occupational profiles		Census data	2001 - 2006
(Vrcelj & Krishnan, 2008)	Australia (NSW)	Women/ Females	University Students	Undergraduate, Postgraduate	Understanding perceptions of industry and further education by students'		Surveys, focus groups	
(Ward et al., 2015)	Australia (TAS)	Women in physics, Men in biology	Primary education students	Grade 6	Describing the design and understanding the experience of a bespoke curriculum design		Surveys	
(Wilson & Wilson, 2020)	Australia (ACT)	Female, Military status, Mature aged	University Students	1 st Year	Understand students' learning experience		Surveys, observations (in and out of class)	2016 - 2018
(Wilson et al., 2020)	New Zealand	Female, Maori and International	University Students	1 st Year	Describing the design and understanding the experience of a bespoke curriculum design		Student performance data	2018

Nine marginalised groups of interest were focused on explicitly including rural backgrounds, disabilities, refugee, mature age, Indigenous, migrants, racial minorities, English as an additional (or second) language (EAL/ESL) and women. Here, the terms refugee and EAL/ESL are used to mirror the language used in the papers included in this work. Many of the papers that focus on women often conflated and collected data on 'females' in focusing on women. We have chosen to represent this using the language of the group of interest in the paper. Additionally, a paper chose to take an intersectional approach to groups of interest. As shown in Figure 3(a), two thirds of the papers included in the scope of this work (16) focused on women. While it is promising that there is diversity in the marginalised groups studied, few works focused on other marginalised groups. Further, no studies worked to understand the experiences of LGBTIQ+ engineering students. To inform policy and education reforms focusing on diverse groups other than women, further research is needed, including working to understand if the publication trends in *AJEE* are representative of all diversity and inclusion work in engineering and engineering education.

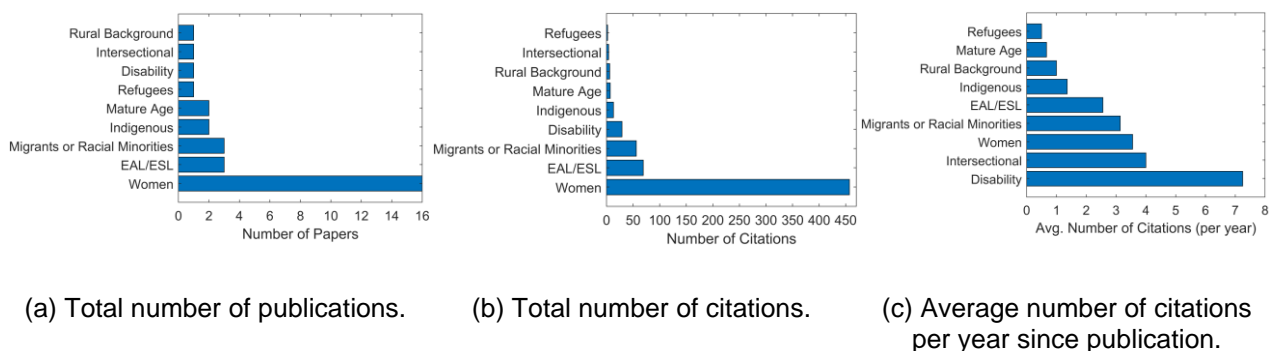


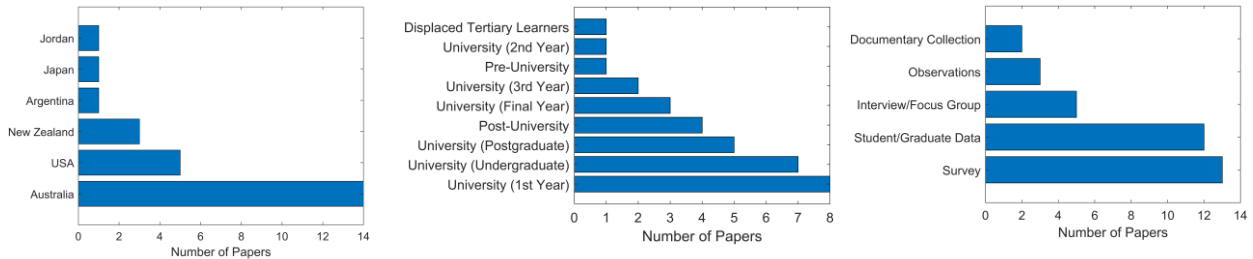
Figure 3: Analysis of *AJEE* publications for each group of focus.

Using the number of citations as an indicator of impact (using GoogleScholar as of November 2023), papers focusing on women significantly outperform papers focusing on any other minority group of interest, as shown in Figure 3(b). When normalised for the average number of citations per year since publication, this gap is significantly reduced, with papers focusing on disabled and intersectional groups outperforming others, as shown in Figure 3(c). These results indicate that, despite the prevalence of papers and citations for women in engineering, studies of these two minority groups are having a greater penetrance in discourse. Moreover, the papers associated with these groups have been published in the last 5 years, demonstrating an increased interest in the unique experiences, challenges, and opportunities within less represented groups.

Most papers reported studies in Australia, followed by USA and New Zealand, as shown in Figure 4(a). Papers primarily focused on undergraduate students, and where further specified, first year undergraduate, see Figure 4(b). Additionally, as shown in Figure 4(c), most works have employed surveys as the primary method, although a range of quantitative data have also been frequently reported, including student performance, enrolment numbers, demographics, and census data.

As described in Table 1, these methods are utilised to investigate a variety of lines of inquiry, including assess differences in task completion and performance between groups, compare employment and occupational profiles, compare enrolment based on secondary education, describe curriculum design, understand students' perceptions and experience of curriculum, understand the effect of curriculum design choices on engagement, exploring students experiences in engineering education generally, review published literature, understand students' mental health, understand students' perceptions of industry and explore graduates' exposure to Indigenous knowledges in their early career. Nearly 60% of the papers discussed here focused on curriculum

design or reporting numerical data such as overall performance or demographical statistics instead of diving into engineering culture and understanding the unique experiences and challenges associated with the reported marginalised groups. As we have only started to understand the experiences of diverse groups, further qualitative information can provide valuable information to improve inclusion of underrepresented groups.



(a) Number of papers by country. (b) Number of papers by study level. (c) Number of papers by method.

Figure 4: Analysis of AJEE publications by country, study level and method.

Conclusion

In this work, a rapid review was performed to assess the current state of diversity and inclusion articles published by *AJEE*. Although nearly 10 marginalised groups have been reported, most works focused on a single group: women. In contrast, minority groups such as disabled, mature age and Indigenous people or individuals from rural backgrounds and refugees are far less represented. Further, minority groups such as LGBTIQ+ have been neglected. The results also demonstrate that studies are skewed toward undergraduate students, particularly within the first year, and surveys are the most reported method. Finally, it is concerning that, despite the increasing diversity within engineering students and graduates, studies focusing on diversity and inclusion within *AJEE* have not received any further attention, especially over the last few years, which clearly highlights the need for more research to understand and support the unique experiences of minority groups in engineering.

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