

A COMPARATIVE SCIENTOMETRIC ANALYSIS OF DIVERSITY, EQUITY, AND INCLUSION (DEI) PUBLICATIONS IN EUROPEAN JOURNAL OF ENGINEERING EDUCATION AND JOURNAL OF ENGINEERING EDUCATION

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ABSTRACT

It remains the case that the engineering profession fails to reflect the diversity of people impacted by its work, and issues of diversity, equity and inclusion (DEI) continue to be a key area of interest within engineering education research (EER). In this work we aim to understand the focus of DEI within engineering education: we applied a scientometric content analysis to EJEE and JEE articles published in 2023. Three authors independently screened each publication (using the title and abstract) for inclusion in the subsequent analysis and synthesis stage. The abstract of each paper was then evaluated to determine the primary DEI issue(s) covered. Findings

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indicate that DEI is currently a major focus for US scholars with 42% of the 71 publications in JEE addressing DEI in some form. Articles studying underrepresented racial groups (43% of DEI articles identified) made up the largest part of these publications while 23% considered gender related under-representation. In the case of EJEE there were fewer DEI related papers overall in 2023: 15% of the 86 publications addressed DEI in some form. Of these publications 77% referred to gender related under-representation, which suggests that this area of DEI is currently the most studied by EJEE-published researchers

1 INTRODUCTION

Issues of diversity, equity and inclusion (DEI) have long been discussed within engineering education and practice, with the rationale for work in the area including a variety of arguments based on social justice to economics. Terms such as inclusion, diversity, equity, and equality, while commonly used within engineering education, tend to be used interchangeably and their meaning both evolves over time, and varies significantly across context and institution. Such changes and variation have implications for the areas in which efforts towards DEI, are focused, as well as our ability to learn from good practice and monitor progress. One way in which to gauge the areas of DEI that are of current interest is by understanding the common issues researched. This work therefore describes an analysis of papers published within the Journal of Engineering Education (JEE) and the European Journal of Engineering Education (EJEE) in 2023, to determine the DEI issues studied.

Scientometric methods have been used to understand the engineering education research (EER) publication landscape previously. For example, when mapping global trends in engineering education research, Jesiek et al. (2011) analysed the categories of research published in a range of journals and conferences between 2005 and 2008 and found that Diversity, classified as including Gender, Masculinity, Minority, Race, Underrepresentation and Women, appeared as 13th in a ranking of the most studied areas (the first three places in their ranking were occupied by Learning, Assessment and Educational Technology respectively). Previous EER in this area includes a content analysis of gender-related research published in JEE over a fourteen year period (1998-2012) whereby scientometric and other classification categories were developed and applied (Pawley, Schimpf, & Nelson, 2016). Articles primarily focused on quantitative studies of undergraduate students in university settings and applied a variety of theories. More recently, in their bibliometric review of papers published within JEE over a 53 period (1969-2021), encompassing 1251 articles, Qiu and Natarajarathinam (2022) identified diversity and inclusion as a major theme that was covered in 106 papers. Topics were found to include gender, student characteristics affecting enrollment and retention, value system and personal identity, and race and ethnicity, among others.

More recently, in a 'Statement on Diversity and Inclusiveness', the American Society for Engineering Education (ASEE) claims that "diversity and inclusiveness is essential to... innovations that drive the development of creative solutions in addressing the world's challenges". Similarly, in the ASEE & SEFI (French: Société Européenne pour la Formation des Ingénieurs, English: European Society for Engineering Education) Joint Statement on Diversity, Equity, and Inclusion (2020), the organisations claim that "engineers have not consistently made informed judgements that consider equitably the far-reaching societal impacts of engineering solutions" and that "history has shown that new technologies benefiting one part of society sometimes have less fortunate impacts on other segments" saying that "these unintended consequences partially result from an engineering profession with a limited diversity of lived experiences" (p.1). In a Position Paper on Diversity, Equality and Inclusiveness in Engineering Education (SEFI, 2018), SEFI states that "recognizing and supporting diverse individuals is more than a moral or ethical obligation. It is also the logical choice to improve the practice of engineering and its impact on society".

Despite such efforts, the lack of diversity within engineering continues to exist, with our ability to monitor changes in demographics being impacted by our changing and varying understanding of diverse characteristics. Such differences in semantics have been highlighted in the work of Pineda and Mishra (2023) who made use of computer-assisted content analysis to explore the extent to which the term 'diversity' appears to be global and universal within 2378 publications. Their findings reveal that diversity discourses are dominant within the USA and Canada, UK and Ireland and Europe, but not Asia, Africa, the Middle East and Latin America. They found academic literature on diversity to have emerged in the mid-1970s in both the USA and Canada, primarily in relation to race and gender, this extending to other English-speaking countries by the mid-2000s, with inclusion, gender, ethnicity and cultural diversity being referenced. Within Europe, diversity appeared later in the decade, often framed as inclusion and gender. They concluded that the interpretation was influenced by the local socio-political settings and that the semantics of diversity had not become global or universal. They subsequently proposed the use of new methods that allow and support the ability to view different regions simultaneously.

Given these differences in interpretation, it is encouraging that ASEE & SEFI call for a commitment to “deepen and broaden our understanding of inequities, so that we are prepared to take action to transform our institutions, universities, and the whole of the engineering community” (p. 2) within their Joint Statement on Diversity, Equity, and Inclusion (2020). The organisations claim that “steady gains have been made” in terms of “decreasing imbalance for white women” but acknowledge that progress is needed with respect to “all segments of our society, including minoritized races, immigrant populations, disabled persons, and economically marginalized groups”. claim that it is “our engineering duty that no one is disadvantaged or receives less favourable treatment because of age, disability, neurodiversity, gender, gender identity and expression, sexual orientation, race, ethnicity, religion or belief, socio-economic status, national status, pregnancy and maternity, marriage and civil partnership, or any other minority status” (p. 3)

In keeping with such commitments, it is interesting to note that (what was) the SEFI *Gender and Diversity* Special Interest Group (SIG), changed their name to *Diversity, Equity and Inclusion* saying that they “embrace a broad understanding of diversity, equity and inclusion and work to better represent all SEFI members and the wider engineering education community. It is our experience that definitions of diversity, equity and inclusion vary considerably between different contexts and institutions, and that many initiatives have been primarily concerned with widening the participation of women in engineering”.

As pointed out by Meija and Martin (2023) the fact that researchers use the same terms, whilst defining them and measuring them in different ways, makes it difficult to discuss DEI work meaningfully. Considerations for these broad understandings are of significance in terms of our ability to learn from best practice and make use of research findings within our own context, but also in supporting our ability to monitor progress and inform strategy and policy in the area. It is subsequently of interest to investigate and compare the focus of DEI research within engineering education. Consistent with this aim, here we present initial findings of a study involving the analysis of EJEE and JEE articles published in 2023 in terms of the primary DEI issue(s) covered.

This study aims to determine the current DEI issues under focus in two leading journals in the EER field. It poses the research question:

- what are the DEI topics addressed in the European Journal of Engineering Education and the Journal of Engineering Education in 2023?

2 METHODOLOGY

Adopting a scientometric content analysis approach (Hassan & Mathiassen, 2009), a list of all publications (including articles, editorials and erratum) in EJEE and JEE during 2023 were downloaded from the Scopus web interface. There were 86 EJEE publications and 71 JEE publications in 2023. We limit this work to the main EER journals, namely JEE, and EJEE which, as Jesiek et al. (2011) observe, have committed to publishing and disseminating high quality EER work, are highly cited journals. They are published by the American and European Societies for Engineering Education respectively, both of whom collaborated on the ASEE & SEFI Joint Statement on Diversity, Equity, and Inclusion (2020). We therefore chose JEE as a representative of US and EJEE of European EER journals. Furthermore, both journals specifically refer to EER in their scope.

Publications were vetted for inclusion in two main stages. The purpose of the first stage was to restrict the list to only those that discussed at least one DEI issue (Direito et al., 2021). The second stage focused on classifying the included papers into specific DEI categories that would subsequently be used for statistical analysis. First, three authors independently screened each publication (using the title and abstract) for inclusion in the subsequent analysis and synthesis stage. Publications were tagged by the author for inclusion included using a binary yes/no inclusion criteria; publications that explicitly referred to any DEI issue within the title and/or abstract were tagged as 'yes'. Following this, the authors met to compare their evaluations and any disagreements were resolved during discussion in which a consensus as to whether each article was to be included or excluded, was reached. Following this, the authors then evaluated each abstract together to inductively determine the primary DEI issue(s) covered, and allocated publications to these categories.

Editorials were included as they were considered to reflect emerging and significant areas of interest within the context. They have, alongside review papers, been separated from research papers in terms of analysis (see Table 3, Table 4). Abstracts in which DEI was not mentioned as a primary aim or focus of the research, but in which elements of DEI were mentioned or reported in the findings were included on the basis that they demonstrated an understanding of the impact of diverse characteristics on research outcomes. However, results are again presented separately (Table 2 and Table 6). Papers focused on belonging were also included to reflect the (often lesser used) term DEIB (Diversity, Equity, Inclusion, and Belonging), which originated in organisations in the 1960s and which recognises sense of belonging as associated with inclusion. Finally, abstracts which referred to 'mental health' were included as they were considered to relate more directly to ableism and disability as opposed to those who broadly referenced wellbeing.

The full-text of each paper was not evaluated, as it was outside the intended scope of this paper. We thus acknowledge that our analysis may have excluded papers that discuss diverse characteristics, for example within the findings, without this being mentioned in the abstract. The findings reflect the focus of journal articles published within 2 journals during a year one period and the degree to which they reflect wider trends is thus limited. We also recognise that published work only reflects a small amount of DEI work conducted within engineering education, and the validity of our findings are thus limited by the extent to which trends in published articles reflect the situation more widely.

3 RESULTS

Papers were assigned an individual ID (e.g. EJEE-3, JEE-18) based on the row in the spreadsheet exported from Scopus. e.g. EJEE-15 refers to the publication on the fifteenth row of the exported spreadsheet. The results below are presented first showing the results from EJEE, then the results from JEE.

3.1 European Journal of Engineering Education

There were 86 EJEE publications in our sample from 2023. A total of 9.3% of the publications primarily focused on addressing at least one specific DEI issue, with 7.0% focusing on gender related issues, 1.2% focused on belonging or inclusion, and 1.2% focused on diversity of nationality (Table 1). There were also another 6.8% of the publications which did not primarily focus on DEI issues, but included metrics or information related to DEI in the results or findings (Table 2).

Table 1. EJEE Articles which primarily focused on a DEI issue(s)

DEI Issue	%	Publications
Gender	7.0%	EJEE-02 Rokooei (2023) EJEE-09 Vellamo (2023) EJEE-11 Maji, Mitra, and Asthana (2023) EJEE-23 Chan, Rottmann, Reeve, Moore, Maljkovic, and Radebe (2023) EJEE-28 Qadhi, Du, Chaaban, Al-Thani, and Floyd (2023) EJEE-52 Moloney and Ahern (2023)
Belonging/Inclusion	1.2%	EJEE-38 Holmegaard, Madsen, and Nielsen (2023)
Diversity of Nationality	1.2%	EJEE-30 Bergman, Negretti, and Apelgren (2023)

Table 2. EJEE Articles which primarily focused on other issues, but included DEI in the results or findings

DEI Issue	%	Publications
Gender	4.6%	EJEE-22 Lockhart, and Rambo-Hernandez (2023) EJEE-37 Apostolellis, Taggart, and Schwartz (2023) EJEE-55 Behera, Alves de Sousa, Oleksik, Dong, and Fritzen (2023) EJEE-64 Chédru and Delhoume (2023)
Access/Participation	1.2%	EJEE-73 Wint (2023)

3.2 Journal of Engineering Education

There were 71 JEE publications in our sample from 2023. A total of 30 (42%) publications primarily focused on addressing at least one specific DEI issue (Tables 3, 4, 5), with marginalised racial groups (18.3% total - articles 14.1%, review 1.4%, editorial 1.4%) gender (7.0% total - articles 7.0%), belonging (4.2% total - articles 4.2%) and mental health (4.2% total - articles 2.8%, review 1.4%) being the largest categories. Smaller categories included diversity of nationality, disability, historical marginalised groups only having 1.2% each. There were also another 5.6% of the publications which did not primarily focus on DEI issues, but included metrics or information related to DEI in the results or findings (Table 6). Overall, 43% of the 30 articles identified, were dealing with under-represented racial groups while 23% gender-related under-representation.

Table 3. JEE Editorials which primarily focused on a DEI issue

DEI Issue	%	Publications
Marginalized Racial Groups	2.8%	JEE-08 Secules (2023) JEE-12 Paige, and Morton (2023)
Diversity of Nationality	1.4%	JEE-14 Xu, Wei, and Cao (2023)

Table 4. JEE Review Papers which primarily focused on a DEI issue

DEI Issue	%	Publications
Marginalized Racial Groups	1.4	JEE-39 Reeping, Lee, and London (2023)
DEI (generally)	1.4	JEE-53 Andrews, and Boklage (2023)
Mental Health	1.4	JEE-71 Asghar, Minichiello, and Ahmed (2023)

Table 5. JEE Articles which primarily focused on a DEI issue(s)

DEI Issue	%	Publications
Gender	7.0	JEE-21 Patrick, Andrews, Riegler-Crumb, Kendall, Bachman, and Subbian (2023) JEE-24 Davis, Nolen, Cheon, Moise, and Hamilton (2023) JEE-25 Garriott, Pinedo, Hunt, Navarro, Flores, Desjarlais, Diaz et al (2023) JEE-37 Halkiyo, and Hailu (2023) JEE-59 Chen, Usher, Roeder, Johnson, Kennedy, and Mamaril (2023)
Marginalized Racial Groups	14.1	JEE-21 Patrick, Andrews, Riegler-Crumb, Kendall, Bachman, and Subbian (2023) JEE-24 Davis, Nolen, Cheon, Moise, and Hamilton (2023) JEE-25 Garriott, Pinedo, Hunt, Navarro, Flores, Desjarlais, Diaz et al (2023) JEE-37 Halkiyo, and Hailu (2023) JEE-39 Reeping, Lee, and London (2023) JEE-47 Coley, and Thomas (2023) JEE-52 Henderson, Junqueira, Benjamin, Hines, Alarcón, Davis, and Cavazos (2023) JEE-61 Taylor Jr, Mastrogiovanni, Lakin, and Davis (2023) JEE-66 Fleming, Coloyan, Patrick, Grote, Denton, Knight, Lee, Borrego, and Murzi (2023)

		JEE-68 Fletcher, Jefferson, Boyd, Park, and Crumpton-Young (2023)
Belonging	4.2	JEE-21 Patrick, Andrews, Riegle-Crumb, Kendall, Bachman, and Subbian (2023) JEE-63 Buckley, Robinson, Tretter, Biesecker, Hammond, and Thompson (2023) JEE-68 Fletcher, Jefferson, Boyd, Park, and Crumpton-Young (2023)
Mental Health	2.8	JEE-23 Wright, Wilson, Hammer, Hargis, Miller, and Usher (2023) JEE-71 Asghar, Minichiello, and Ahmed (2023)
Disability	1.4	JEE-67 Cech (2023)
Historically Excluded/ Marginalised Groups	1.4	JEE-06 Lee, Hall, Josiam, and Pee (2023)
DEI (generally)	1.4	JEE-53 Andrews, and Boklage (2023)

Table 6. JEE Articles which primarily focused on other issues, but included DEI in the results or findings

DEI Issue	%	Publications
Gender	2.8	JEE-16 Rocker Yoel, and Dori (2023) JEE-31 Beagon, and Bowe (2023)
Marginalized Racial Groups	1.4	JEE-27 Misra, Kardam, VanAntwerp, and Wilson (2023)
Belonging	1.4	JEE-27 Misra, Kardam, VanAntwerp, and Wilson (2023)

DISCUSSION

Given that the researchers whose work is published in JEE are predominantly US-based (Williams, Wankat & Neto 2018), our findings suggest that DEI is currently a major focus for US scholars with 30 of the 71 (42%) publications addressing DEI in some form. Underrepresented racial groups (43% of DEI articles identified) made up the largest part of these publications while 23% considered gender related under-representation. Other DEI contexts appearing in JEE included belonging, disability, mental health and diversity of nationality.

In the case of EJEE there were fewer DEI related papers overall in 2023: 15% of the 86 publications addressed DEI in some form. Of these publications 77% referred to gender related under-representation, which suggests that this area of DEI is currently the most studied by EJEE-published researchers. While authors in EJEE predominantly are Europe-based, they also include researchers from the US and other international contexts (Williams, Wankat & Neto 2018). Other DEI contexts appearing in EJEE included diversity of nationality and belonging.

The methodology presented here can be readily adapted to analyse a larger sample of journal articles and the authors plan to do this in future work.

CONCLUSION

While DEI issues were 13th in the ranking of the most studied areas in EER in the period 2003-2008 (Jesiek et al., 2011), they have become a high-priority area in recent years with race and gender issues being the most addressed in JEE publications and gender the most in EJEE. These findings will be helpful to inform the work of groups like the SEFI Special Interest Groups on Diversity, Equity and Inclusion and on Ethics as well as the ASEE ASEE Commission on Diversity, Equity and Inclusion.

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