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Adopting an integrated inclusion practice: Preliminary findings and reflections

Jeremy Lindeck[a,*], Scott Daniel[a], Karen Whelan[b], Leandra Rhodes-Dicker[c], Tania Machet[a], Eva Cheng[a], Nick Brown[c], Timothy Boye[a], and Tanvi Bhatia[a]

[a]University of Technology Sydney
[b]Queensland University of Technology
[c]RMIT University
[*]Corresponding author: jeremy.lindeck@uts.edu.au

CONTEXT
For the engineering profession to tackle global challenges, it needs engineering teams with diverse backgrounds and life experiences. However, the engineering profession in Australia lacks inclusion, and does not reflect Australian society. This paper reviews the adoption of an integrated inclusion practice developed at three Australian universities and presents preliminary findings of fostering inclusion and belonging in engineering students in first-year classrooms. The paper reports research progress from an AAEE grant awarded in 2021.

PURPOSE
This project aims to cultivate an inclusive learning experience for engineering students, and to enable the development of students' inclusion competencies. This will involve an iterative cycle of contextualising, delivering, reflecting, and improving a combined approach to an integrated inclusion practice. This paper reports reflections and findings from the first iteration of this approach.

APPROACH
Previous approaches to fostering inclusivity focused on activities or directions unrelated to the content or context of the unit of study. These activities frequently addressed inclusion as a single event rather than an ongoing process. The onus of change was placed on the underrepresented minorities. We believe inclusion needs to involve everyone through a whole-of-program approach, with a shared direction throughout the teaching team. The inclusion program involves the development of inclusive teaching environments and teaching activities.

OUTCOMES
Surveys show that students see inclusive work environments as an important part of the engineering profession. However, they may not feel confident in creating an inclusive environment. It is interesting to note that many students do not identify as part of the engineering or IT professions.

SUMMARY
Inclusion involves the creation of an atmosphere where diversity is expected, rather than one off activities aimed at promoting inclusion. Approaches to inclusion continue to be centred around attracting participants from diverse groups. Instead, the culture of the engineering workplace needs to positively reinforce the inclusion of everyone.

KEYWORDS
Inclusion, belonging, diversity

Introduction

To tackle global challenges, the engineering profession in Australia requires teams with diverse backgrounds and life experiences. However, there is an ongoing lack of diversity in the Australian engineering sector (Dobson, 2018). In addition, a lack of a sense of belonging stifles higher-order skills such as creativity and problem-solving required to meet these challenges (Maslow, 1954). As engineering educators, there is a need to create inclusive learning environments and to develop students' inclusion capabilities (i.e., the skills and motivations for students to be inclusive in their own engineering practice).

This need motivates our ongoing project of integrating inclusion into teaching practice. Building on early work presented at AAEE in Brown, Pearson, and Rosenqvist (2020), and with support from an AAEE grant awarded in 2021, our project intentionally teaches inclusion competencies. Initially, we are investigating large-enrolment first-year introduction units of study at our respective institutions. We hope to expand this scope of application further in future.

Drawing on inclusive practice research, theories of change, and practice theory, combined with reflective teaching practices, we propose the Integrated Inclusion Practice Loop depicted in Figure 1. The background and development of this approach to inclusive practice and teaching is explored in Machet et al. (2022).

Having reported on how integrated inclusion practices were devised, contextualised and then delivered in different institutions (stages 1, 2 and 3 in Figure 1) (Machet et al., 2022), this paper covers reflections on the delivery of the devised practice (stages 4 and 5 in Figure 1). This reflection has three components: first, at the unit of study level, then across our three institutions, and finally reflections on how our work relates to diversity and inclusion in Australian engineering by referencing and comparing the recent Engineers Australia (EA) diversity report (Romanis, 2022) to earlier reports. These reflections will be informed by preliminary findings from a student survey administered in the first semester in 2022. The survey investigates students' perceptions of belonging and inclusion in engineering practice.

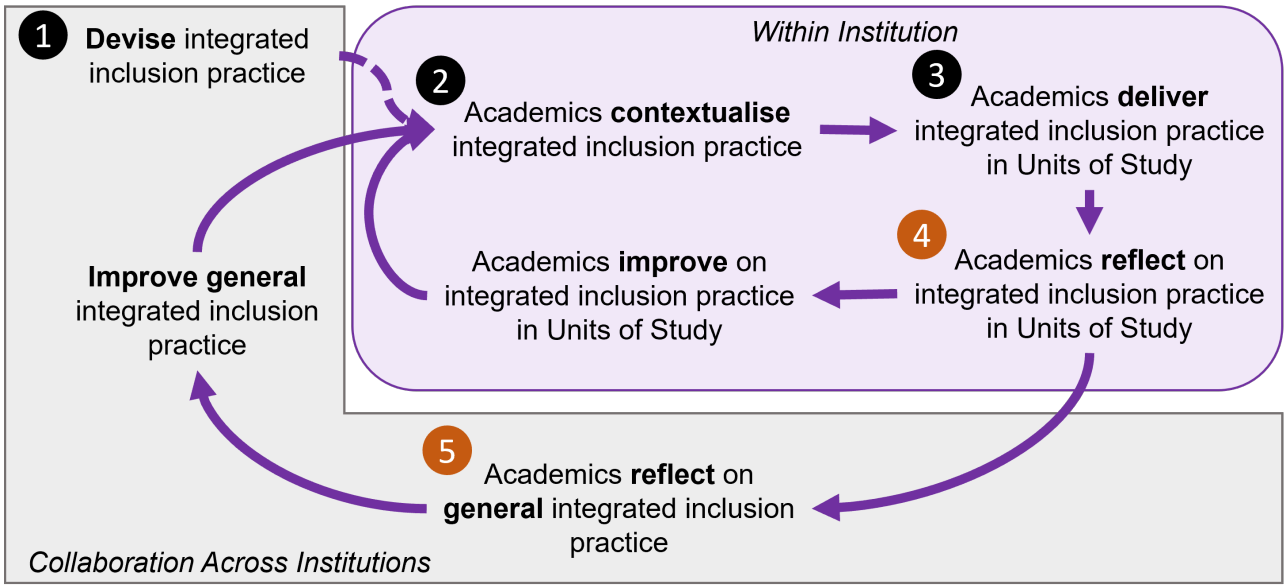

Figure 1: Integrated Inclusion Practice Loop - with stages of interest highlighted.

Pilot Project Reflections

The integrated inclusion practice loop uses reflection to strengthen individual units of study (see stages 4 in Figure 1). Reflective practices are used to allow unit coordinators to consider the impacts of their work in the context of the teaching cycle.

This section presents the research team's reflections of integrated inclusion practice and on the collaboration itself. This additional reflection captures a research output which is not often disseminated: the benefits of collaboration and strengthening of the partnership, i.e., the shared experience builds networks and shares knowledge within the team. To provide structure, the model presented by Rolfe, Freshwater, and Jasper (2001) is used.

Reflection Approach

Rolfe et al. (2001) use three prompts for the basis of reflection:

- **What?** – considers the scope of the reflection, a description of the activity and its outcomes. For example, what was students' response to the inclusion practice.
- **So What?** – draws insights from the activity and determines its relevance. For example, why these responses are important. These insights can also be linked to past experiences.
- **Now What?** – considers how you will act on what you have learnt in your reflective practice, and how your practice will change.

The reflections for each unit of study are provided, each unit of study is given a code matching those used in Machet et al. (2022). All units of study lay the foundations for first-year students in either engineering or IT. Professional concepts such as teamwork and ethics are taught alongside more technical topics, including an introduction to design processes. The units of study utilise The EWB Challenge as part of their project-based learning.

Unit of Study 1

This is a first-year engineering unit of study with approximately 1000 students a year. The learning outcomes focus on the *process* of an engineering group design project, rather than the design outcome or output. Seeing study and work cultures developing amongst students with embedded stereotypes and bias motivated the need to address building inclusive study and work culture from day one at university.

- We firstly focused on building a diverse team of tutors who bought into an inclusion philosophy and established an atmosphere designed to engage students. Materials were discussed each week and recommendations were taken and acted upon during tutors' meetings, where the coordinator's role was as much to listen as to speak. This shift to focus on building a diverse tutor team working in a collaborative and inclusive manner has enabled a united front to consistently introduce building inclusive cultures in the classroom with students across up to 20 classes a semester (i.e., tutor 'buy in'). The team teaching has expanded to tutors in Unit of Study 1 and 2 being shared, and the project and philosophy is now expanding into second-year subjects and into new curriculum design.
- In the classroom, as groupwork is the central platform to building students' inclusion capabilities, student project groups are formed with inclusion in mind so minority students are not isolated. Students appreciated this approach, especially when actively consulted about whether they are comfortable in their working environment. Common issues resulting from dysfunctional groups (generally relating to non-inclusive behaviours) have been presented to students

as case studies, where students identify possible solutions. This approach has received positive student feedback as they can see how to avoid problematic behaviours, and reduce the number of issues escalated. However, inclusive groupwork is still a challenge, with more work needed to address this in both Units of Study 1 and 2.

Unit of Study 2

This first-year unit of study is taught at the same institution as Unit of Study 1 with around 800 students annually. The two units are closely aligned, with the coordinators collaborating extensively on curriculum and teaching approaches. While Unit of Study 1 is for engineering students, this unit of study is for IT students, and aims to provide them with the skills they need to successfully complete their degree and to succeed in their careers. One of these skills is the ability to work in diverse teams as this is envisaged to be necessary in future technology workplaces.

- As these are IT students, it was important to get buy-in for the EWB Challenge, which is largely designed for engineers. This was accomplished by asking EWB to design specific IT challenges and to ensure that all materials and assessments are adapted to an IT context. This relates to addressing students' sense of connection and belonging into their profession from day one at university and addressing the closing gap between the engineering and IT sectors; however, there is still more work to be done here as can be seen in the survey results analysis below.
- Both units of study 1 and 2 also start the semester with classes setting their 'norms' for participation, interaction, and collaboration. This activity naturally embeds discussions around setting up inclusive behaviours as the norm for classes. This activity in the first week of semester has enabled a baseline for both students and tutors to refer back to when behavioural issues occur, helping to reduce such incidents.

Unit of Study 3

This unit of study is delivered in the first semester and has around 1000 students and approximately 30 tutors. It is a part of every engineering bachelor's program. As reported in Machet et al. (2022), inclusion is already considered part of curriculum development. Insights from reflection included:

- Students and tutors reported a significant drop in teamwork disputes and fewer disparities between self and peer assessments. This may be in response to improvements in clarity on the teamwork processes. Further clarifying processes rather than changing them may see more improvements.
- The terms ”diversity”, ”inclusion” and ”belonging” were only mentioned once in 465 comments in the student experience survey. The comment criticised an inclusive practice. This may signify that inclusion practice is well-integrated and students are not aware they are building inclusion capability. Conversely, students may oppose inclusive cultures. This may mean inclusion should be more overt and mechanisms through which students can report non-inclusive behaviour are provided.
- It was observed that not all tutors deliver all elements of inclusive practice as intended. For example, a tutor had not been delivering or asking students to deliver an Acknowledgement of Country at the start of class, which set a precedent in the rest of classes. Attention needs to be paid to ensuring the teaching team are comfortable with the inclusion practices. An issue that may influence the above insights is the perceived attitudes in the 2022 student cohort. Students seemed to be more distant in class and struggled to develop independent thinking to previous levels. There was a much higher rate of non-submissions of assessment tasks.

This may be due to online high school changing their learning approach. Changes to future practice may need to adapt to the needs of the incoming cohort.

Unit of Study 4

This unit of study has an enrolment of approximately 900 students and was delivered in its current form for the first time in 2022. Insights from reflection on the unit and on the pilot survey outcomes include:

- Professional development training was offered to all sessional tutors, but was not a required element. Consequently, there was not a shared understanding of inclusion and inclusion capability. In a teaching team reflection, there were mixed views on what was achieved and what could be achieved. This was a reminder that to effectively focus student attention on a capability, we must be certain that the teaching team agrees on and is capable of facilitating the learning of that concept.
- While" inclusion" was a term used by a number of students in qualitative comments within the pilot survey, there was one student who commented on the mismatch between what we espoused in terms of inclusion and our practices which did not show this to students in a "meaningful way".
- The two points above show it may be worth exploring what Villanueva (2018) refer to as the "hidden curriculum" within our units. The hidden curriculum, as opposed to the formal or null curriculum, "represents the unwritten, unofficial, and often unintended lessons, values, and perspectives made by individuals and found in physical spaces within an academic environment" (Villanueva, 2018).

Pilot Survey

Approach

The pilot phase of the project focused on the development of an initial integrated inclusion practice and then (after contextualisation) the delivery of that practice followed by reflection, stages 1-5 in Figure 1. In the pilot phase the interest was on understanding more about students:

- feeling of belonging to engineering or IT
- perceptions of inclusion as a part of engineering or IT practice
- perceptions on skills and capabilities to create inclusive environments
- how identification with the engineering or IT profession may affect the above

A survey produced initial insights into the effectiveness of the delivery of integrated inclusion practice. It was required to be as simple as possible but also broad enough that it could be implemented into all participating units of study. A focus on quantitative measures was chosen due to the sample size of almost 3,000. To account for the difficulties in measuring intersectionality and intersecting dimensions of diversity (May, 2015), no demographic data is captured. There is less interest in improving the representation of a specific group and more on the general diversity of the profession. The main area of interest to the project is that the burden of behaviour change is on the majority rather than the minority. As we are avoiding using demographics as a measurement of identity to the majority or minority, an alternative is required. To achieve this, this study borrowed a concept from The Journal of Engineering Education which asks for a person's affinity to the engineering education research community using five Venn diagrams. The same technique was used with students asked to consider their understanding of the engineering or IT profession in Australia and

their identity with it. “Which of these images best reflects how you identify with the engineering (or IT) community? The options are shown in Figure 2.

Figure 2: Students alignment to the engineering (or IT) community

A Likert scale was used to capture levels of agreement with six statements. Four of these statements were used to indicate a sense of belonging (B). These four statements were adapted from those used by (Rainey, Dancy, Mickelson, Stearns, & Moller, 2018). One statement related to competency (C) and the final one to professionalism (P). In addition to the statements, one open-ended qualitative question relating to each of these three concepts B,C P, was asked (the insights from the qualitative questions will be presented in a future paper).

Survey Results

The survey was distributed to almost 3,000 students enrolled in a unit of study involved in the integrated inclusion pilot. A total of 847 responses were received covering all four units of study. A confound is that half (n=418) of the responses came from a single unit of study; the below discusses the differing response rates across the units of study. The responses to the level of alignment to the community is shown in Figure 3. The breakdown of responses to the Likert-scale questions is provided in Table 1.

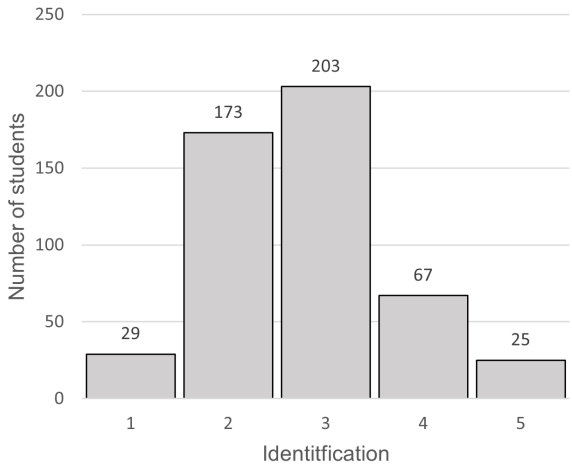

Figure 3: Results for students alignment to community

Survey Analysis Unit of Study 1

The response rate for Unit of Study 1 was low, at 17%. Whilst tutors provided class time to complete the survey, it is likely that students were allowed to disengage or complete other tasks. Students identified some sense of belonging between themselves and what they perceive to be the engineering community. However, given that the unit is focused on a group design project that models

Table 1: Agreement Rate (%) for survey questions, where n = engineering or IT

Area	Question	Responses	Agreement Rate (%)
P	A core part of n practice includes creating inclusive work environments	613	87
C	I have the skills to create inclusive work environments	606	78
B	I feel socially connected to my n peers and the n community	606	78
B	I feel like an n person	609	64
B	I am interested in the course material and concepts	609	77
B	I understand the course material and concepts	614	80

professional engineering practice, we should strive for a higher sense of belonging to the profession being developed. Encouragingly, students responded with a mean of 4.25 in answer to seeing inclusive work environments as being a core part of engineering practice; however, we need to be careful that the survey wording and design is not influencing a positive bias for this question. In comparison, students feel less confident about their inclusion skills and capabilities, scoring a mean of 3.88 for this question. The statement that scored the lowest at 3.41, was students feeling socially connected to their peers and the engineering community. It is worth further studying this relationship between social connection and inclusion, whether more social connection leads to a better sense of inclusion or the inverse, or a more complex correlation exists.

Survey Analysis Unit of Study 2

The unit saw a response rate of 39%, attributed to tutors assigning time in class to complete the survey. The results for IT students are similar to those for engineering students in Unit of Study 1. A mean of 4.12 see IT as a profession which creates an inclusive work environment. One significant difference is that a mean of 3.78 see that they have the skills to creative inclusive work environments, which is a narrower confidence gap than for the engineering students. Another difference is that students do not relate to the materials as much as the engineering subjects. This could be due to the persistent perception that that the EWB Challenge is designed for engineering students. The main point of interest is the lack of identification as an IT person. This maybe because IT is not seen as a united profession in the same way as engineering. In addition, the stereotype of an IT professional may be seen as negative.

Survey Analysis Unit of Study 3

Unit of Study 3 had a response rate of 41%. As students were supposed to be given 15 minutes in class time to complete the survey, this response can be seen as quite low. This might represent a low number of interested students. It may also be that tutors did not follow instructions for survey completion.

Some students struggled to identify themselves on the Venn diagram (see Figure 2). Around 350 students completed the Likert statements so 83% of those who opened the survey, but only 302/418 (75%) students identified themselves on the Venn diagram. This suggests that around 14% of those who engaged with the survey could not identify themselves on the Venn diagram. This requires further investigation and may suggest that students can't yet identify themselves in the profession. This conclusion is supported by many respondents selecting the halfway option (3) or mid-overlap options which indicates that students were unsure of their position in the profession. A major positive in the results is that 87% of students see creating inclusion as part of the profession. There is a gap between students understanding that inclusion is a part of creating inclusive environments, and them having the ability to create inclusive environments. It is noticeable that the lowest agreement was in feeling connected and feeling like an engineering person. Therefore, belonging to the course

was much higher than belonging to the profession.

Survey Analysis Unit of Study 4

High responses for the statement “A core part of engineering includes creating inclusive work environments” indicate that students see the alignment between inclusive work environments and engineering. Unit of Study 4 students feel the least crossover with the engineering community and are less likely to feel socially connected. The comments suggest a disconnect between what is said about inclusion (i.e. ‘talking the talk’), versus what actions are actually taken (i.e. ‘walking the walk’), which may not be resulting in students developing a sense of belonging or being included. In addition, inclusion concerns bridging the gap between students confidence in their capabilities and their sense of professional engineering practice. Students seem to understand that certain capabilities are important (inclusion and others) but did not feel tuition starts from their level. Therefore, the subject is not showing them they can succeed in becoming a professional engineer.

Comparison of Reports

While writing this paper, Engineers Australia released a new report, entitled Women in Engineering: Identifying avenues for increasing female participation in engineering, by understanding motivators and barriers around entry and progression (Romanis, 2022).

As we continue to develop our practice towards inclusion capability, it is worth reflecting on what the report indicates about our profession and its progress towards a more sophisticated understanding of diversity, equity and inclusion. It is disappointing that the report’s recommendations continue to reinforce the idea that efforts around changing the diversity of our profession should be focused on attraction alone. The report perpetuates a view that all people who identify as women fit within one life narrative and stereotype, one in which women are seen as wanting to make a difference in the world and men are seen as mathematically capable. Even more disappointing are the final recommendations around non-inclusive workplace cultures, that focus on “empowering women” to navigate the challenges. The idea that we should not change the culture of our profession, that the burden of change is on the minority, and on our educational offerings to empower those who do not align to the dominant hegemony is problematic. The report noted that perceptions of engineering are that it is male-dominated and challenging, not “impactful or fulfilling.” It does not question why this perception dominates, despite those identifying as male continuing to be the majority of those who study and work in engineering.

We contrast the statements in the EA Report with a publication with similar aims from 1995 entitled Gender in the Engineering Curriculum (Moxham & Roberts, 1995) albeit focused primarily on women, “As more women enter the profession, engineering will be enriched by a greater diversity in the engineering culture and will become more representative of the society for whom engineers are working”. This publication, while still drawing on ideas about “women’s ways of knowing”, recognised that curriculum and pedagogy in engineering should “examine implicit assumptions that are based on gender in our society, for example the interests, motivations, skills and abilities that are attributed to women or men.” In contrasting these two reports, it seems very little has changed in engineering over 25 years. While we continue to focus on increasing diversity via stereotypes and assumptions about people and their gender, we risk perpetuating systemic discrimination and marginalising those who do not align to the dominant stereotype. As Fox, Sonnert, and Nikiforova (2009) note with regard to programs for women in science and engineering, ”the least successful programs focused more on addressing women as individuals and on helping women students cope.” Instead they recommend questioning the institutional structures that exclude diversity. Mendick (2006) highlights why this matters in her study of Masculinities in Mathematics, linking the stories

and narratives told within educational experiences with the acceptable ways of being a student or a professional in a domain. Those who do not see themselves in our curriculum, our classroom experiences, and our professional contexts are unlikely to feel a sense of belonging nor to continue within our profession.

Next Steps

Having collected pilot data on students' perspectives on inclusion in engineering, we will iterate our approach to integrating inclusion into engineering education and practice. This will be based on sharing reflections across the team, and be informed by pre-/post- survey data, complemented by interviews and focus groups with students, to better understand how we can tailor students' learning experiences to develop their inclusion competencies.

References

Brown, N., Pearson, A., & Rosenqvist, T. (2020, December). Understanding what integrated inclusion looks like in a mega first year team-based engineering course. In *Proceedings of 31st annual conference of the australia association for engineering education.*

Dobson, I. (2018). STEM in Australia: The statistical patterns of university science and technology in the twenty-first century. *Australian Council of Deans of Science*.

Fox, M. F., Sonnert, G., & Nikiforova, I. (2009). Successful programs for undergraduate women in science and engineering: Adapting versus adopting the institutional environment. *Research in Higher Education*, *50*(4), 333–353.

Machet, T., Daniel, S., Bhatia, T., Boye, T., Brown, N., Cheng, E., … Whelan, K. (2022). Adapting inclusive teaching practices to different contexts [manuscript submitted for publication]..

Maslow, A. H. (1954). The instinctoid nature of basic needs. *Journal of personality*, *22*, 326-347.

May, V. (2015). *Pursuing intersectionality, unsettling dominant imaginaries*. Taylor&Francis Group, New York.

Mendick, H. (2006). *Masculinities in mathematics*. McGraw-Hill Education (UK).

Moxham, S., & Roberts, P. (1995). *Gender in the engineering curriculum*. published jointly by the Equal Opportunity Unit, The University of Melbourne, Swinburne University of Technology and the University of Ballarat.

Rainey, K., Dancy, M., Mickelson, R., Stearns, E., & Moller, S. (2018). Race and gender differences in how sense of belonging influences decisions to major in stem [Journal Article]. *International Journal of STEM Education*, *5*(1). Retrieved from `https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6310405` doi: 10.1186/s40594-018-0115-6

Rolfe, G., Freshwater, D., & Jasper, M. (2001). *Critical reflection in nursing and the helping professions: a user's guide*. Palgrave Macmillan.

Romanis, J. (2022, June). *Women in Engineering: Identifying avenues for increasing female participation in engineering, by understanding the motivators and barriers around entry and progression* (Tech. Rep.). Engineers Australia. Retrieved from `https://engineersaustralia.org.au/sites/default/files/women-in-engineering-report-june-2022.pdf`

Villanueva, I. (2018). What does hidden curriculum in engineering look like and how can it be explored? In *Proceedings of the American Society of Engineering Education Annual Conference and Exposition, Minorities in Engineering Division.*

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