Inclusive teaching practices: a comparative case study of integrated inclusion in different contexts

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***Abstract*—There is both a compelling business case and social justice case for diversity in engineering (and other professions). Diverse teams make better decisions, and cohorts should be representative of the communities from which they are drawn (otherwise some groups are being excluded).**

However, in Australia the engineering profession continues to suffer from a significant lack of diversity. In this paper, we describe one attempt to address this in three Australian university contexts by seeking to create an inclusive learning environment and to cultivate students' inclusion competencies.

***Index Terms*—inclusion, context, practice, reflection**

I. Introduction

Engineers aim to solve complex problems using their specialised knowledge, problem solving approaches and creativity. This is best achieved when problem solvers from diverse backgrounds and lived experiences can work together. In Australia, the engineering profession suffers from a significant lack of diversity and university initiatives have had little impact on the diversity of engineers completing degrees [1, Fig. 2.3], suggesting there may be limited changes in the near future without further intervention. The engineering profession does not reflect the society in which it operates, nor does every engineer feel as though they belong to the profession. This lack of diversity and gap in belonging can begin to be addressed if professional engineers create inclusive environments [2]. As engineering educators, we have an opportunity to develop students' capability and motivation to create these environments, influencing the profession and the industries our graduates will work in. This paper is part of an ongoing pilot project between three Australian universities, with the broad objective of both cultivating an inclusive learning experience for engineering students, and enabling the development of students' inclusion competencies – their capability and motivation to be inclusive in their own emerging professional practice.

The project aims to intentionally teach inclusion capabilities within learning experiences in specific units of study from first year onwards. We devised this bottom-up approach, designed to complement the inclusion initiatives already existing in universities which are often top-down and lack practical implementation within units of study. Building on theories of change, practice theory and our reflective teaching practice we have proposed the 'practice loop' described in Fig. 1 to develop and improve our inclusive practice and teaching [2].

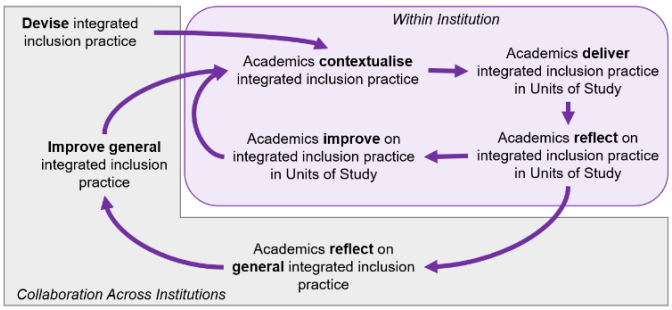

Fig. 1. Integrated Inclusion Practice Loop.

Having reviewed the research and grey literature around inclusive practice, the work reported here focuses on the 'contextualise' phase of our practice loop. That is, in this paper we present lessons learnt from adapting and implementing the inclusive approach at three different institutions, guided by the following research question:

How might we contextualise an integrated inclusion practice in engineering education at different institutions?

II. Background

The approach to integrating inclusive practice into our classrooms builds on research from [3] which highlighted the value of integrating inclusion at the level of a unit of study. They flagged that further work was necessary, but that the opportunity exists to leverage group-based project contexts in first-year engineering for such integrated inclusion unit of study design. Project-based-learning (PBL) has been presented as an opportunity to foster inclusion in a variety of contexts. There is consensus that exposure to diverse groups in a PBL setting can model inclusive practice and some authors indicate a change in attitude to social inclusion through participating in such PBL group projects [4]–[7]. A point of difference in this study is that while PBL is often reported as providing an opportunity to develop the capabilities of students so that they are more able to be included [4], [6], this project looks at PBL-based subjects as a context for developing students' abilities to be inclusive and to create inclusive environments, more in line with the transformative potential of collaborative learning identified by [7]. The integrated practice loop aims to foster an inclusion capability to develop future engineers' ability to create and maintain inclusive cultures, rather than for those who are excluded to adapt to the current exclusive environments.

As each institution has its own terminology (e.g., subject, course, paper), for clarity and consistency in this paper the term 'unit of study' is used, with a full-time student usually completing four units of study each semester.

In line with an inclusive approach to our practice, the project has been expanded to include multiple universities and educators from first and further years across engineering and Information Technology (IT), with a shared interest in integrating inclusive practice within their teaching. Over the last 18 months the research team has met regularly to problematise the concepts of inclusion and belonging in engineering, as well as related concepts such as intersectionality. The outcome of this process has been to develop a shared vision of how we can cultivate inclusion in our teaching practice.

III. Approach

To generate the insights presented in this paper, a comparative case study approach was used [8]. Comparative case studies go beyond examining a single case to hopefully generate more insights about "how or why particular programmes ... work or fail to work" by comparing multiple instances where they have been implemented. This approach is appropriate here as comparative case studies are "particularly useful for understanding and explaining how context influences the success of an intervention" [8, p. 1]. In this paper, the cases being considered are the *contextualisation* of the integrated inclusion practices in large-enrolment first-year engineering or IT units of study at three different Australian institutions.

Comparative case studies can include both qualitative and quantitative data. In this paper, we will be using qualitative data from the ongoing reflective practice discussions of the team, and written reflections after the semester from each institution. The case studies have been written by authors who were directly involved in each unit of study design, with implementation based on the emerging insights noted from discussions in regular team meetings and their own experience of the units. Insights were then drawn out by other authors who work in further-year professional practice units of study, and are synthesised in the Discussion section below.

IV. Case Studies

A. Overview

In this section, authors from the different universities and units of study will describe and reflect on their particular context, with the unique challenges the different contexts offer (referred to as Units of Study 1 to 4). Each will describe their motivation for participating in the project, how they have addressed inclusion and belonging up to this point, any outcomes thus far, and insights for the future.

Before those individual stories, it is important to note some overarching similarities across the different contexts. All four units of study are compulsory, large-enrolment (around 1000 enrolments each year), first-year units for engineering or IT students. Within their respective degree programs, each unit is intended to highlight the human dimensions of engineering and IT, and cultivate personal and professional skills in group-work, communication, design, and more. Although the cohorts are very large, teaching is typically in tutorial class sizes of $\sim$30 students, taking a PBL approach with students in groups of 4-6 members working under the supervision of a tutor.

All of the units of study are aimed at providing first-year students with the foundations of what it means to be an engineer or IT professional. Students learn and apply engineering design skills whilst developing the complementary skills required to practice competently, collaboratively, ethically, and safely. The units of study utilise PBL through a partnership with Engineers Without Borders Australia (EWB), specifically using the context of the EWB Challenge. This is a mature initiative which engages thousands of engineering and IT students around Australia and internationally to respond to real-world design briefs from EWB's community partners [9]. In recent years, EWB has partnered with the Centre for Appropriate Technology and the Dawul Wuru Aboriginal Corporation, both Indigenous community organisations in northern Queensland, to deliver the EWB Challenge. Connection to land, to Country, is fundamental in Aboriginal and Torres Strait Islander cultures and the EWB Challenge in part contributes to reconciliation with Indigenous Australians, by highlighting to engineering and IT students the diversity of Indigenous cultures [10], the importance of different cultural perspectives in design, and the importance of practices like the Acknowledgement of Country, in which the Traditional Owners of the land are affirmed.

The COVID-19 pandemic has imposed particular challenges on all teaching practices, in re-creating what has historically been extremely interactive face-to-face sessions in an online environment, and supporting the development of communication and group-work skills remotely.

B. Unit of Study 1

This is a first-year engineering unit of study. The learning outcomes focus on the *process* of an engineering group design project, rather than the design outcome or output; that is, focusing on developing students' professional skills rather than on just the technical design. However, seeing study and work cultures developing amongst students with embedded stereotypes and bias motivated the urgent need to address building a 'norm' of inclusive study and work culture from day one at university. A key advantage of introducing inclusive practices into first year is the mixing of all engineering disciplines in this design project. This embedded discipline diversity is a 'safer' dimension that students are more likely to openly discuss diversity about, than the more 'personal' dimensions such as gender, culture and ethnicity.

Initial inclusive teaching practices from 2020 focused on three key aspects:

- **'Safe space' for learning:** a key activity in the first week of class with students self-identifying class 'norms' (with respect generally a central value identified).
- **Group-work:** group formation actively taking into account diversity across multiple dimensions, giving students agency to decide what group they are comfortable with; formal group charters self-developed by students to identify how unacceptable (e.g., non-inclusive) behaviours will be addressed; regular check-ins with tutors on group-work challenges, self and peer-assessment for feedback and marks-based consequences, and training tutors to identify and intervene early with group issues.
- **Diverse tutor teaching team:** role modelling a diverse and inclusive team is critical. The unit coordinators intentionally recruited a diverse tutor team and introduced team teaching in larger classes across dimensions such as gender, ethnicity, age, background (e.g., mixing humanities, engineering, and IT tutors). Previously, tutors individually teach a class of $\sim$30 students. By combining 2-4 classes in a collaborative classroom taught by a tutor team, this enables diversity in the tutor team to be visibly and functionally part of our teaching practice.

Informal feedback from the teaching team identified that students appreciated the activities setting up class norms early. However, it was a challenge to maintain the norms and values throughout the semester, and for students to action the norms, especially when group-work challenges arose. What has been a successful activity in the attempts for group-work inclusion is the mid-semester check-in and introducing the Lencioni model [11], which focuses on building trust as fundamental. Previous attempts to introduce group-work models earlier led to students not yet seeing the relevance. Introducing team teaching has been the most successful initiative to date, due to the diversity in tutor skills improving the teaching approaches and student learning experience. What could be explicitly measured in future is whether students notice and/or value the diverse teaching team.

C. Unit of Study 2

This first-year unit of study is taught at the same institution as Unit of Study 1. 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 a future technology workplace. Initial inclusive teaching practices from 2020 focused on two key aspects:

- **Diverse tutor teaching team:** Together with other units, we created a dedicated, diverse team of tutors who were keen to help all our students reach their goals. This meant attention had to be paid to diversity. Perhaps the biggest asset we had was a collegiate atmosphere where ideas for encouraging students to work together were discussed in regular meetings.
- **Case studies and group dynamics:** From past experiences, case studies were given to student groups to help them anticipate diversity problems before they occurred. Students were also given time to create a group contract which had specific questions about inclusion and working together. This contract was revisited throughout the semester.

Although diversity in our groups is far from perfect and problems still exist, we have seen a definite improvement in the understanding of others' needs. To some extent this occurs through self interest. Students are made to realise that if group members are excluded, more work will need to be done by the in-group. As standards are set from the beginning by the tutors, students become aware that including everyone is a step to achieving their goals. We have learned that establishing an environment where inclusion is expected from the beginning of the course is essential.

D. Unit of Study 3

The coordinator was motivated to develop and deploy an integrated inclusive practice after seeing students dismiss existing university diversity initiatives as not being relevant to the unit of study. Specific challenges include a particularly large cohort ($>$1000 students per delivery) and a corresponding large teaching team (25-35 casual and permanent academic staff). In contextualising integrated inclusion practice, the coordinator initially focused on the structure and style of learning activities. However, more recently there has been a shift to supporting the large teaching team to deliver the integrated inclusion practice. Some examples of practice include:

- **Group-work process:** particular focus has been placed on moving students through a more appropriate group-work process. The HERDSA model [12], has replaced the Tuckman model [13] emphasising the use of group charters and expected group behaviours. This transition has seen group communication move onto central platforms such as MS Teams and away from platforms such

as Facebook Messenger, where there were indicators that bullying and non-inclusive practice were becoming more prevalent. To provide better integration, the group-work set-up mimics those in industry e.g., using a Common Data Environment.

- **Considerations of inclusive language:** whilst participation in the unit of study is intended to enhance inclusion capability and motivation, the unit also attempts to model inclusion best practice. Checks are performed to ensure that inclusive and accessible language is used in teaching materials and in the examples and case studies that the students are presented with.
- **Reconciliation journey:** professional development sessions were run with staff to consider their relationship with Indigenous Sovereignty and how this could form part of their teaching practice. With this support, and reconciliation modules integrated into the unit of study, students had to explicitly consider Indigenous communities' perspectives, wishes, and ways of being in formulating their designs.

The coordinator has noted that there has historically been hesitation in integrating materials into units of study as it is difficult to then measure how many students have participated or engaged with those materials. As a simple example, a video played in a lecture theatre of 300 students only counts as one view on the metadata of the video. This insight has fed into the way the success of the integrated inclusion practice is being 'measured'. Instead of looking at the effectiveness of individual initiatives or practices, there are so many intersecting factors that the focus of measurement is on the overall student experience in the whole unit of study. This is important in understanding the relevance of the intervention and that there may be other factors outside of the classroom that have larger effects. This was highlighted in [3] in that inclusive practice may be taking place in only one quarter of the students' learning load and classroom impacts may be outweighed by other aspects of their lives within and beyond the university.

E. Unit of Study 4

This unit of study is in first year, first semester, with an enrolment of $\sim$900 students. It is focused on introducing the engineering design process and laying the foundations for professional practice. The unit of study was developed and offered for the first time in 2022, following a review of the overarching degree but explicitly built from a previous version that had similar foundations. Reflection from previous offerings had led to a desire to more explicitly address inclusion and respectful group processes. Further, this unit was identified as the first opportunity in the degree for students from all majors to engage with Aboriginal and Torres Strait Islander knowledges and perspectives. The unit of study seeks to include content, case studies, and examples of the ways in which the work of professional engineers connects to Aboriginal and Torres Strait Islander people's status as First Nations owners of land and seas. In practice this occurred through invited presentations from working engineers who connected their design work to the Queensland Aboriginal Cultural Heritage Act 2005, and with a focus on stakeholder engagement in early design processes.

Tutors within the unit were offered professional development before semester commenced that included explicit activities around creating an inclusive classroom environment by prompting tutors to consider what would create a sense of belonging for them and to consider the power of images, text, and language in creating a sense of who engineers are and what they do. The limitation of this approach to fostering inclusion was that the development was optional and not all tutors attended.

The assessment associated with the unit was reframed as a professional engineering task, with the project overview incorporating explicit notions of professional conduct, including framing a requirement that group members contribute to the creation of a respectful and inclusive environment, linked to the university student code of conduct and the Engineers Australia Code of Ethics [14]. It is hoped that this linking of inclusive capability to professional competencies and conduct avoids some previous experiences in which students expressed a lack of connection between inclusion and their aspirations to be an engineer. Student negative feedback on some previous attempts to highlight the need for inclusion suggest that they align engineering with technical, rational and 'masculine' identities, and not with the need to consider the human dimensions of engineering design or practice [15]. In that sense a commitment to inclusion capability development on the part of the educator is as much about helping students unlearn what they understand engineering to be, as it is to teach them new things.

In the next offering which is in second semester, the critical reflection task will be updated to focus more on inclusion capability and reconciliation. Plans for collecting tutor reflections and developing tutor development are also under way.

V. Discussion

The case studies across four units of study in three institutions provide insight into the application of the proposed practice loop and how inclusion practice can be contextualised. These cases had similar contexts as first-year, large cohort units using PBL approaches to address the EWB Challenge; however, the institutions, educators and the make-up of the student cohorts varied.

In terms of the educators reporting on the integrated inclusion practice, the case studies highlight that these implementations extend their pre-existing interest in this topic. Unsurprisingly, given their participation, these academics all saw the value in developing inclusion capabilities in their students, and had already begun to address this. For example, Unit of Study 3 indicates that there was a shift in approach from a focus on learning activities to teaching group-work capability development. This has implications for the proposed practice loop. Rather than beginning at stage 1 in Fig. 1, these academics began at the stage of *reflecting on their own*

practice. Their improvements and approaches were informed by discussions across institutions within this larger project, however, there was no 'external' point at which the practice was devised. This suggests a need to change the practice loop to incorporate this lived experience. Devising an integrated inclusion approach sits within institutions, with the educators themselves and in collaborations across institutions where sharing ideas informs practice: stage 1 in the practice loop should shift to reflect this boundary-spanning feature. Stage 1 is also not a *necessary* step where educators have already devised some inclusive practices and it should be indicated that it is not a requirement for implementing this practice loop (dashed line rather than solid line). It is proposed that the practice loop be updated to include this finding as in Fig. 2.

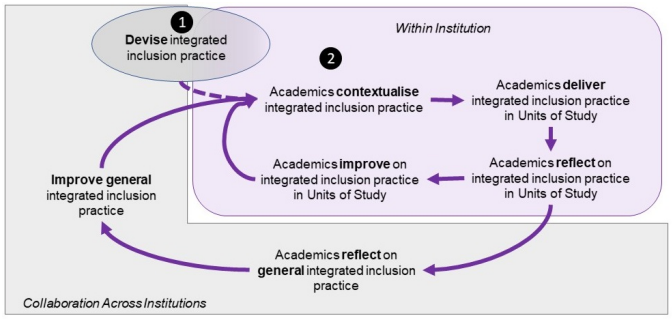

Fig. 2. Revised Integrated Inclusion Practice Loop.

The case studies highlight an approach that is not explicit in the practice loop but emerges from the details of the implementation. The coordinator of each unit of study has a particular focus on modelling the inclusive practice through their teaching. Rather than simply impart knowledge on the development of inclusive practice capabilities to students, they have each operationalised this and sought to develop this capability themselves and with their teaching teams. This approach to modelling practice, rather than discussing theory, is perhaps reflective of the action-oriented nature of engineering culture. As examples of this modelling, Units of Study 1 and 2 explicitly select a diverse teaching team, Unit of Study 3 focuses on developing inclusive language, and Unit of Study 4 includes a range of voices in their guest speakers. Each unit of study identifies the development of professional practice skills needed by engineering and IT professionals as learning outcomes for their units of study, and they implement these professional skills in their own practice. None of the case studies have included approaches that measure how potentially excluded students can adapt to the expectations of the current engineering profession. Rather, this modelling of an inclusive environment is in line with the differentiated approach to inclusive practice presented here, where we aim to develop students' ability to create inclusive environments.

VI. Conclusion

The case studies presented in this paper demonstrated the scope, challenges, and possibilities of contextualising inclusion practice within different institutions. While the implementations varied as expected, *modelling* inclusive practice emerged as a key component and this was implemented as afforded by the teaching context and institution. Significantly, each academic brought their own previous interest and experience to the contextualisation of inclusive practice so that we can consider the academics who design and teach these units as part of the context itself. These insights led to an adaptation of our practice loop, where we recognise that stage 1 is not a necessary or distinct action for those academics and institutions which already value and implement inclusive practice.

The next steps in this ongoing project include obtaining student feedback to gauge their sense of belonging in their studies and in the engineering profession at large. This data, accompanied by ongoing shared reflections across the team, will be used to iteratively improve and evaluate contextualised inclusive teaching practices at our different institutions. These learnings and outcomes will be shared in future publications.

Acknowledgements

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