Exploring Equity, Diversity and Inclusion with Engineering Students

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CONTEXT

Engineering ethics, as specified by professional bodies, includes calls to respect all people; diversity enhances the resilience of engineering teams; and, post-graduation, students need to comply with legal requirements around equity, diversity and inclusion (EDI), both in the workplace and society more generally. Hence, it is important for these sensitive topics to find space in formal education programs. However, teachers exploring the topics of EDI with engineering students face many challenges: evolving professional expectations, complex and changing social context, relevance to students, instructors' ability, authenticity and ethical aspects of their pedagogy, and evaluation of effectiveness.

PURPOSE OR GOAL

The authors report some activities that were found useful to promote discussions of diversity, inclusion and unconscious bias, and these may be helpful starting points for others. They may also cause further reflection and discussion by teachers of EDI topics.

APPROACH

Class-room activities were designed to present simplifications of reality, in the context of EDI and engineering project teams, to provide a gentle opening for meaningful conversations, because they less threatening than such discussions often are. The activities were supplemented with facilitated class discussion and self-reflection to cause students to examine their own attitudes and biases.

ACTUAL OUTCOMES

The reported exercises were successful in causing students to think about topics associated with EDI, recognising a need to do so and their willingness or otherwise to engage in conversations about these topics. They helped students see the value of diverse teams and the associated need to develop relevant skills so their own actions would be more inclusive. There was some growth in both self-awareness and awareness of others' differences.

CONCLUSIONS & RECOMMENDATIONS

We conclude that it is possible for students to recognise the need for diversity, have them examine their own "unconscious" biases, and want to improve their skills to be more inclusive as team-members.to get such teams to work well. Ideally such learning should be early in their education so they can practice relevant skills before graduation.. It is important to remember that growth in understanding and accepting EDI principle only happens when a student wants it to.

KEYWORDS

Engineering ethics, diversity, inclusion, equity, unconscious bias

Introduction

This paper provides an autoethnographic account on how to engage with engineering students in exploring themes associated with equity, diversity and inclusion (EDI). We hope you will find it of interest, if not thought-provoking.

Respect for EDI principles forms a pillar of engineering ethics. However, while EDI is well researched with respect to overcoming barriers to students engaging in engineering degrees (e.g., Beddoes et al, 2016), there is less research on how to effectively teach engineering students about principles associated with EDI, as per accreditation requirements. Few people would disagree that such teaching is challenging. How do we design authentic, effective learning activities? Here we share our *experience,* born of classroom learning activities that proved helpful to start conversations and provoke reflections about EDI, particularly about engineering project teams. This is not about EDI principles as such.

Many universities agree that diversity amongst students and staff and equitable and inclusive policies and practices are central to providing a high-quality education. This leads to initiatives promoting awareness and wider acceptance of EDI principles and values at universities. These initiatives sometimes take the form of overt celebration of EDI principles targeted at the students, e.g. a coloured shirt day. While these initiatives can increase awareness of EDI principles, it is the opinion of the authors that they are at best tokenistic to the students if they are not combined with carefully designed instructions which will help students. While the effects of specific training designed to increase awareness and decrease unconscious bias are inconsistent (Atewologun et al, 2018), there is evidence that teachers and classroom climate moderate the impact of bias, and using teaching activities which focus on awareness, motivation, individuation and empathy may have a promising effect in reducing bias (Dee & Gershenson, 2017)

This paper first reviews some challenges that teachers experience when instructing about EDI principles and then reviews, as case studies, three classroom activities which succeeded in improving students' self-awareness concerning these principles as they apply to teamwork. The paper finishes with reflections on what we learnt from our experiences and what needs to be done to help grow stronger self-awareness of EDI principles.

Challenges

First, the understandings of EDI principles and their implications for teaching are still evolving. Expressions of EDI values are not immutable. For example, the current Engineers Australia (EA) code of ethics (EA, 2019) tells members to "Support and encourage diversity," whereas the previous version (EA, 2000) says members should "Act with honesty, good faith and equity and without discrimination towards all." The newer words call for more action. Indeed, two generations ago, EDI principles were not part of the engineering syllabus at all, and rarely mentioned in professional ethics. For example, Lloyd's discussion (1973) is serious but completely un-inclusive. This contrasts with, for example, safety, which has been documented for over 4000 years. (Harper, 1904). This history highlights, too, a need to prevent biases from carrying forward. Further, despite teaching ethics being a core requirement of accreditation, EDI's relatively recent addition means there is not an extensive body of expertise in delivery.

The context in which engineering students need to learn about EDI principles is not easy to negotiate. Students bring their own personal values and experiences, their conscious and unconscious biases. This contrasts with teaching technical material when teachers can be confident that few, if any, students have pre-existing knowledge. Conventional training (e.g., Dee & Gershenson, 2017; Wynn & Correll, 2018) facilitates reflection on unconscious biases expressed in the workplace. We have found scant reports encouraging similar self-examination by students. We find that most students favour utilitarian ethics arguments,

perhaps because they resemble cost-benefit analyses. Asserting the duty “to respect all persons” is does not persuade many students. Education is not indoctrination.

A glance at most engineering classes shows that, at least superficially, there is not much explicit diversity beyond the obvious differences in gender and ethnicity. If other forms of diversity exist, it is rarely acknowledged or used to create an opportunity for students to learn how to interact and engage with others who are not like themselves or think like they do. Work on individual differences in higher education has identified several important personal characteristics, beyond demographic characteristics, e.g. even diverse patters of sleep and wake (Gao et al, 2018). Engineering students need to see that EDI (1) applies to them and (2) matters if they are to have authentic and meaningful discussion about topics or issues associated with EDI. How can EDI principles be taught to such engineering students? More importantly, can they be taught at all?

Engineering academics are not particularly well prepared by their own education to take on the responsibility of teaching EDI principles (Beddoes & Panther, 2018). They lack the language to engage with psychology and human behaviour. Furthermore, when discussing EDI principles with their students, neither party is likely to have the words to share ideas with precision and at depth. While the principles may be simple to define, they can prove quite complex in specific cases.

There are further difficult challenges associated with ensuring learning activities are both authentic and ethical of themselves. One approach to EDI training seeks to engender empathy for others by creating simulations in which students experience the treatment of exclusion or deprivation in some way that they think is unfair (e.g. Bloom, 2005). Unfair treatment to encourage fair treatment is not necessarily an ethical approach and may also cause anger and resentment. Training associated with EDI often uses simple models of homogeneous sub-groups – most commonly gender or ethnic background – and, thereby, reinforces differences. (Dobbin & Kalev, 2018). Poorly designed EDI training program may also be unethical when, instead of fostering commonalities, they reinforce the differences between individuals and lead to stigmatization and further alienating individuals or groups from each other. They may cause individuals to avoid sensitive topics rather than learn to communicate and engage with each other. Another problem (Dobbin & Kalev, 2018) is the focus on ‘sensitivity training’ where people are often forced to focus on interpersonal conflict. These were the training courses that produced a backlash, as they were intrinsically accusatory. Blaming and shaming don’t work and education should not be seen as ‘re-education.’

Finally, how do we know that it even works? Is there a measurable outcome in the limited context of a degree program? Can it even be measured? How? Who does the measurements?

We are by no means the first to identify these challenges associated with professional ethics instruction (e.g., Colby & Sullivan, 2008; Chang et al, 2018). The first three though, pose particular challenges for discussing EDI.

Case Studies

Case Study 1 • Self-Selected Team

To highlight the relevance of EDI to students, we discussed their revealed reluctance to work in diverse teams. All students in the year 4 and postgraduate ethics courses were asked to select one new team-member, from four fictitious applicants, by ranking them from most to least preferred. Each applicant had a short biography, with a mix of strengths and weaknesses. These biographies were deliberately varied from class to class. Half the class had de-identified applications; half had named applications. Students completed the exercise

individually, online, before class. A typical result (in the form of a Borda count of votes) is seen in Fig. 1. In this case, the collective choice is that made by the local, male students, from one day's tutorials. They wanted Charlotte's skillset (as described); they did not want Charlotte. This example was chosen because it had "sufficient" particpants. Specific results of different sub-sets of students could be analysed, but such detail is beyond the scope of this work as data was generated to prompt discussion rather than for research purposes.

This exercise, first used in 2017, comes in the second half of the course, after students have been introduced to relevant ethics principles. The advantages proved twofold. First, the students knew they were talking about themselves. Standard training about unconscious bias, focussing on the workplace, is seen as less relevant by students. Second, because a student sees aggregated results, they accept the need for the class to explore such matters, even if they personally don't see it applies to them. Once the collective votes are revealed, they see how the choices made by them and their peers failed to deliver equity. They see they are biased. Students are not told about this concept until the end of discussion, when the ideas of overt and unintended bias are introduced by the teacher. This is not top-down EDI principle persuasion, but a bottom-up process of self-discovery of unintended bias. There is no requirement for students to admit any bias in selecting a team member, but it provides the data showing a conflict between their decisions and ethics expectations.

Using their own data can have a very big effect on their self-awareness of EDI principles, but it poses its own challenge: the outcomes can only bear fruit if students are willing to discuss their true feelings. Responses from students varied from group to group, as no two groups are identical. Sometimes the revelation of the collective choice is met with absolute silence, from the surprise of realising that there is a need to think about these matters. Individual student reactions have not been collected systematically. The purpose of the task is to motivate the need for conversation. The ensuing flow of class discussions are guided to look for what is missing or not missing in EDI context, the advantage or disadvantage of including the missed applicant, and reflection about why the bias arose (unconscious or not).

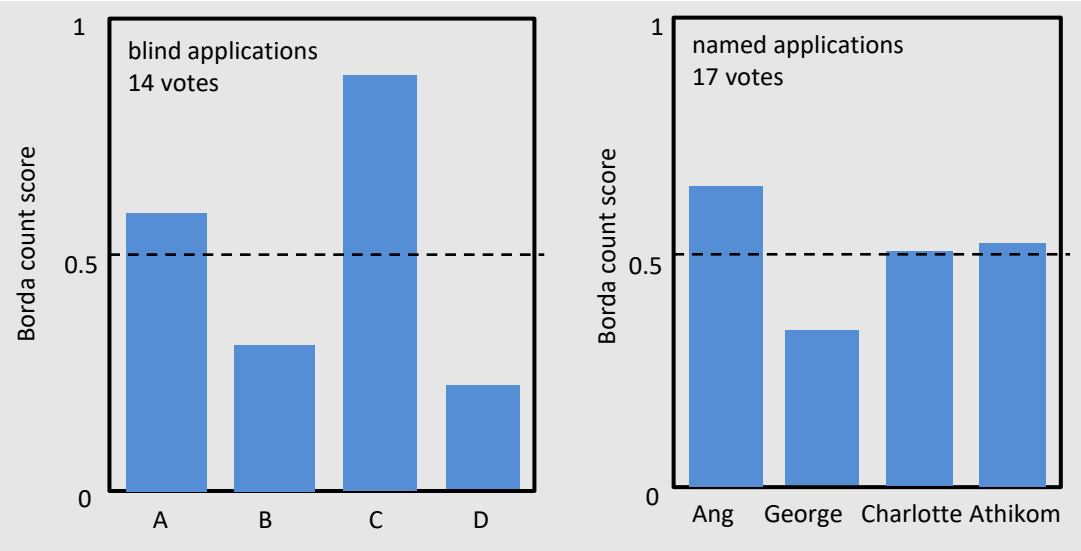

Figure 1: Votes by local male students for a new team member. Charts show the Borda count of de-identified application (left) and named applications (right).

One student described this exercise as the biggest mindset change, adding his attitude towards life was now more open and more willing to listen to different people with more interaction with people from different backgrounds. Using such real-world data to address these matters of interest is one of the four suggested means (Bustard, 2018) to improve student engagement with ethics.

Case Study 2 • Forced Diverse Team

In another course, we utilised a range of psychometric instruments focusing on personality, preferences, styles, demographic profile and academic achievement to assign students to diverse teams for a year 3 design project (Bergey and King, 2014). Each week for five weeks, teams participated in an hour of formative learning which was integral to the project and out-of-class collaborative work was conducted.

Several students vocally objected and expressed high level anxiety about being assigned to a team, instead of being allowed to choose their own. Cited reasons included differences in academic aspirations, communication barriers, difficulty with building rapport and maintaining connection with new teammates when working online, and previous negative experience with a forced team. One student even stated that teamwork in courses is "unlike the real-world where each member in the team is motivated by pay and the risk of being fired if they do not perform." Student concerns prompted teachers to monitor the teams' activities and online interactions closely. Students completed two formative and one summative team-and-self-evaluations. All students were surveyed, and some were interviewed about their experience at the start of term and a week after they submitted the team report.

Instructors' observations, interviews with students, outcomes of team evaluations, and student surveys combined to show that, in this exercise, students' working in diverse teams proved inefficient due to the extra effort (cost) in terms of communication and cultural differences, i.e., slower progress in terms of Tuckman's model. Two primary factors for the poor team performance were identified: (1) a lack of cultural awareness, particularly in relation to communication between native and non-native English speakers; and (2) a lack of skill to engage with team members who are different. We noted no student referred to skills for working in a diverse team in their initial assessment of what is required for successful collaboration.

When surveyed at the end of the course, 31 (of 65) students indicated that their team experience was better than they had experienced previously in random allocated teams, and only 6 students indicated that the experience was worse. When asked to reflect on how their team experience could be improved, 36 indicated a need for self-improvement, e.g. improving their communication and interpersonal skills, so they could better engage with diverse team members. A further 16 identified that a need to better understand, engage or support team members who are different. The quotes below show a few students reflected upon how internal team diversity made it more challenging for them to work together and articulated the type of support they will need to improve their engagement with others. Some expressed their appreciation and articulated the benefits of being placed in a diverse team.

> *"It would be great if we could have some resources/training about how to build a culturally sensitive team before the group work assignment (e.g. always take minutes, be aware of these different cultural norms (include common examples)."*

> *"… is my first time working with other locals and international students inhibit my performance as I feel like there is communication gaps. However, being able to be in this group has help in boosting my confidence level and I'm looking forward to be in a forced team; with other students to polish my communication skills."*

Case Study 3 • Intervened Self-Selected Diverse Team

The students' reluctance to choose diverse teams can be side-stepped by teachers forming the teams. Wouldn't it be nice for students, instead, to *want* to be in diverse teams? In this last case study, we explore whether it is possible to shift the students' thoughts enough for this to happen by use of examples.

First, consider the devices in Fig 2. What is the ethics challenge, in terms of EDI, that has been "missed" by these designs? Please pause and answer before reading on.

Figure 2: What is the ethics ("inclusion") problem with these products as designed?

As a student said, "They are both unfair to left-handed people." Left-handedness is part of the diversity of humanity but is not listed in standard training, policies, etc. associated with EDI. Precisely because it is not discussed in such fora, it does not get the instant "here we go again" response from students. It also cuts across the standard categories, avoiding those which are mired in socio-political controversies. Further, since many hand-tools are made specifically for left- or right-handed use, the need of this minority group is something that, sooner or later, most engineering managers will need to consider so it has a direct workplace relevance for engineering students. Finally, engineering delivers common artefacts, like those in Fig. 2, and considering inclusiveness of design choices is a less confronting opening than inclusiveness of inter-personal behaviours.

Discussion of left-handed diversity was prompted by using a simulation game previously shown to help explore ethics topics (Skinner et al, 2017). It involves teams cutting out and trading paper-shapes, having started with a random set of resources. A simple variation is to only distribute left-handed scissors, with a consequence that teams including a left-hander have an advantage. Students recognised this in their respective reflections (Fig. 3) which also showed the wide range of pre-existing insights about the topic. These comments were not chosen to be representative, but to show the full range of responses to the class.

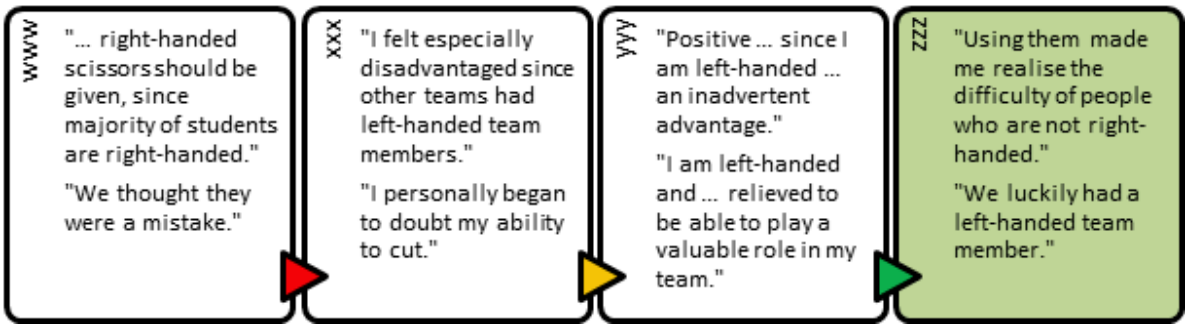

Figure 3: Students' reflections, arranged to show progressively higher self-awareness of EDI

This is an effective means of persuading students that diversity of itself is a benefit, and those with a utilitarian perspective on ethics find motivation to be more inclusive in behaviour. This shift happens because students experience the value of diversity themselves. Such experiential learning is not difficult to implement in a normal classroom and experiential learning is standard in the engineering discipline. Once students understand that, if all a team's members have the same abilities and perspectives, then it is less resilient in the face of random challenges, students are far more open to discussions about EDI principles. Further, they then want to know more respectful ways to work with a diversity of team-mates.

Although recognition of functional worth is not the social justice motivation to embrace diverse teams that some prefer students acquire (reviewed by Beddoes, 2011), it is a start. Discussion showed, too, that students were aware of the extra cost of having left-handed tools but that providing them was necessary for maximum productivity. Again, inclusion arises from utilitarian considerations.

In the "blue eyes/brown eyes" game (Bloom, 2005), players are treated unfairly based on an inherent, arbitrary trait of the individual, the intent being an unhappy experience will promote empathy. This game above conceptually differs. Its aim was simpler: reveal the limitations of less diverse teams and thus open conversation, using a utilitarian argument, about teams welcoming (valuing) a diversity of team members. That some students found this unsettling was an unexpected outcome. Nevertheless, it highlights the complexities that teachers face when designing classroom activities about ethics. Might students become distressed? Compare requirements for ethical research (NHMRC, 2018).

Conclusion

Each of these team selection cases showed the importance of self-awareness to prompt change and direct students towards acting more consistently with EDI principles. In the self-selected team case, students' self-awareness was promoted when their own data suggested a bias in team selection, showing the missing principles of equity and inclusion. In the forced-diverse team, students were directly placed into simulated engineering practice and needed to deal with differences between team members. Students who did not see the value of EDI principles shared high concerns of extra time cost and poor team performance, while other students benefited from team diversity to increase awareness of EDI principles. In the intervened self-selected diverse team, students gained their self-awareness by experiencing the difficulty posed by of a non-diverse team before making decisions. This also helped identify non-inclusive current products and consider inclusiveness in their design choices. It was observed how students do see the benefit and discover the value of having diverse teams when given suitable team tasks.

When designing learning activities to promote self-awareness, we also learned that activities need to be related to the context of engineering practice to enhance student engagement. During these activities, pragmatic decisions are needed, and the drawback and reward of diverse compositions can be highlighted. The three different approaches to team selection exhibited more or less of these activity attributes.

However, challenges remain. As the self-selected team case suggests, measurement and evaluation of how much students have learned from these activities is not easy. No-one likes to admit to individual bias and the problem of unconscious bias is that, by definition, it is hidden. Actions speak loudly, but they are not necessarily immediately enacted. Relevance to students is also a challenge. As shown in the forced-diverse team, all that was seen by some students was the extra effort dealing with diversity. How do we scaffold activities to maximise inclusion of students in learning the benefits of collaborating with different people? That the value of diverse teams is acknowledged, despite their being harder to get to work, is an important start, combined with improving students' skills for doing this. To this end, we recommend more education and practise with communication skills.

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