

CREATING A MODULE TO EMPOWER ENGINEERING STUDENTS TO BECOME CHAMPIONS FOR EQUALITY, DIVERSITY AND INCLUSION

Pallavi OJHA, Asad RAJA, Angela SUN, Chloe AGG, Julie VARLEY and Linda STRINGER

Imperial College London, United Kingdom

ABSTRACT

This paper describes the creation of an optional third and fourth year module for the Mechanical Engineering undergraduate degree course at Imperial College London through a student-staff co-creation partnership. The module was designed to empower students taking the module, to become champions for equality, diversity, and inclusion (EDI) and to subsequently play a key role in systematically improving EDI in the engineering industry. The process described here provides an exemplar for other institutions to follow. The initial module design was developed through liaison with academics with EDI expertise, outreach charities and relevant teams within Imperial College London. The aims of the module were to enable students to think in the context of global society, develop an appreciation for EDI issues, and gain experience in initiative design to improve EDI in engineering. The outcomes of the student project to develop a proposal for this module included a justification for implementation, proposed syllabus and assessments. The module was subsequently implemented with modifications to the initial proposal for logistical, financial, and pedagogical reasons. Although several other departments and institutions have created modules attempting to address EDI issues through societal engagement or design, this module's concerted focus on empowering students to become EDI champions in engineering makes it one of the first of its kind offered as part of an engineering degree in the UK. By detailing the process of creating this module at this conference, we hope to inspire and serve as a springboard for the creation of similar modules in other university engineering courses.

Keywords: Equality, diversity, inclusion, module design, co-creation

1 INTRODUCTION

The state of EDI in the engineering industry is troubling. The UK has the lowest proportion of female engineers in Europe at just 8%. The Royal Academy of Engineering reports that although 26% of engineering students identify as BAME, only 6% of professional engineers are non-white [1]. Statistics such as these lead students to feel that the industry lacks sufficient understanding and prioritisation of EDI issues, despite UK chartered competencies requiring engineers to understand diversity and equality issues [3]. Galvanised by the 2020 Black Lives Matter protests, students from the Mechanical Engineering Department at Imperial College London, including authors of this paper, wrote an open letter in their university's newspaper inviting the department to adopt several specific EDI-improvement measures. The ensuing discourse between staff and students led three students to propose an elective module; EDI in engineering. The module provided a means of bridging the aforementioned gap and empowering participants to affect change as graduates in the engineering sector. To achieve this end a 10-week departmentally funded project to design the EDI module was conducted in the summer of 2021, with staff supervisors working in collaboration with student partners. The students researched and designed the following aspects of the module: aims and objectives; curriculum and seminar topics; timeline and structure; and assessment methods. A report was written at the end of the summer project summarising the work undertaken. This report was used as a basis to gain approval for implementation. The module commenced in the 2022-23 academic year with some modifications to the original proposal made for practical and pedagogic reasons.

2 METHODOLOGIES

This section outlines the steps taken by the students during the summer project to develop this module. The project structure began with a knowledge collecting phase, then a design phase, and finally a feedback and iteration phase.

2.1 Research

Research consisted of three parts: (i) understanding the current state of EDI within the engineering industry as published in the literature, including existing EDI initiatives; (ii) reviewing existing modules within Imperial that applied EDI concepts to STEM subjects; and (iii) reviewing how EDI topics were taught in higher education more broadly. A literature review was written, compiling information from 32 EDI reports, papers and toolkits. This began with surveying reports published by Advance HE and The Sutton Trust and McKinsey [4] [5] [6]. The aim of the review was to answer several questions: what factors contribute to a consistent lack of diversity in the industry; why are current forms of outreach not working; what are the suggested avenues for improvement? IMechE key competencies for accreditation were also reviewed, in particular the requirement to understand equality and diversity. This review, along with evidence of other successful EDI-focused university initiatives, provided a strong case for implementation of such a module.

To research existing EDI-focused education both within STEM departments at Imperial, and within higher education at some other UK universities, the student authors spoke directly with those involved in relevant EDI initiatives, research and/ or education. Initial conversations led to engagement with a broader range of contacts within the field to speak with, including with non-STEM related specialisms (including politics, sociology, psychology, anthropology, economics, history, design, business). Speaking with experts not only inspired module content, but also led to invitations for guest lecturers for the module; module participants therefore benefitting from listening directly to experts and specialists in the field.

2.2 Designing Aims and Objectives

When designing the module syllabus, dialogue between students and staff was frequent and essential. Staff provided information on the processes to be followed for a new module to be approved, such as a module descriptor, including aims and objectives, structure and content, and assessment methods. The detailed module aims and objectives were based in a large part on the lived experiences of the student module designers and their departmental peers. Using resources from the Imperial Educational Development Unit, including guidance on writing module aims and objectives, students were able to write aims and objectives in their own words which would meet the requirements for module approval. Research described above also influenced the choice of aims and objectives. The module aims and objectives are shown below and influenced all other stages of curriculum design;

2.2.1 Aims

- This module will encourage students to critically think about and proactively engage with engineering in the context of global society.
- The module will develop students' appreciation and understanding of equality, diversity, and inclusion (EDI) within the engineering industry, as demanded by the IMechE Engineering Chartership.
- Students will gain practical experience of initiative coordination, allowing them to champion better EDI as well as improving interpersonal skills.

2.2.2 Learning Objectives

- Define EDI and provide an overview of its status in engineering.
- Present the importance of EDI in engineering & the positive impact of widening participation.
- Present the barriers to better EDI in engineering and the obstacles to removing these barriers.
- Present EDI consideration through engineering with a more accessible, empathetic, and inclusive approach to engineering design.
- Present the effective design of a positive EDI initiative.
- Develop critical analysis and evaluation skills with regards to EDI initiatives.
- Develop communication & interpersonal skills in discussing, planning & actioning initiatives.
- Develop data gathering skills to classify the impact of initiatives.

- Facilitate reflexive practice regarding EDI in engineering.

2.3 Determining Module Content

Following the research stage, student designers and supervising staff were all keen to ensure that content was delivered by experts. Student partners identified key topics to be covered and appropriate experts to approach. Staff and students discussed what information experts may need to help them make a decision as to whether they could participate, including e.g., delivery mode, content area, time commitment (the initial expectation being that guests would participate on a voluntary basis). Students led on developing content scope and curating a list of seminar/lecture topics to include in the module. As design teaching forms a significant component of the degree, the initial proposal included discussion on accessible design to encourage students to use learning from the EDI module in their degree. In terms of structure, the proposal was to split the module into a series of seminars/lectures in the Autumn term, followed by project work in the Spring term. This choice was based on very similar structures in existing modules within the department; consideration was given to assessment timings to avoid busy assessment periods for students.

2.4 Initial Assessment Design

The importance of constructive alignment [7] between module objectives and assessments was emphasised in staff-student discussion. The initial assessment deliverables proposed were as follows (weightings given in brackets): a reflective/reflexive logbook (25%), an individual task to promote/improve EDI within the department (10%), a group project to design and implement an EDI-focused initiative (45%), and a conduct of task mark including peer assessment (20%). The tasks and weightings of the initial assessment design are typical of other coursework-based modules within the department. For the group project section of the assessment, example initiatives proposed included: an online engineering outreach event for autistic students; creating a toolkit for lecturers within the Mechanical Engineering department to use when embedding EDI into their courses; designing and implementing a reverse mentoring scheme within the department.

Of particular note is the reflective/reflexive logbook. This format was chosen as being familiar to students on the course as they are taught to use project logbooks to record progress from their first year of studies. The decision to make this reflexive was based on discussions with the programme lead for the International Inequalities Institute. Reflexive practice is an extension of reflective practice in which the practitioner, in addition to observing their reaction to a situation, also identifies their role within the context of the situation and understands that this will influence their interaction [8]. The choice to include this extension of critical thinking was to enable students to extend their learning from EDI issues within wider society, to identifying their role in society and how this in turn can affect the EDI issues an individual observes (and in particular, their role and influence within the engineering industry).

2.5 Student Body Feedback to Proposal

The student module proposal was well received by staff. Surveys were also conducted to identify whether the general student body also felt the proposed module was needed to fill a learning gap in the Mechanical Engineering degree course. The results formed a valuable basis by which the need for the module was justified in a presentation to the department at the end of the project. The surveys were sent out by the student authors via conventional e-mail channels, as well as through personal networks, reaching out directly to students and alumni. When interpreting the qualitative survey results the student authors were able to contextualise critiques and comments from their experience as fellow students and addressed them through design developments. The key conclusions from the survey results provided support for its adoption, and can be summarised as follows:

- A disconnect was identified between student's desire for more EDI in engineering and their ability to act on this due to a lack of structure and available time. The EDI module provides both structure, and time within the student workload and schedule for this learning.
- Under-represented students in general, had not been participants in targeted engineering outreach in the past, showing a lack of EDI initiatives in engineering. The EDI module is a form of outreach itself but will also generate EDI initiatives for future implementation.
- Non-underrepresented students were less interested in learning about EDI and less likely to see it as important than underrepresented students but were equally confident in discussing the topic

and so were potentially overconfident in discussing EDI issues. Positionality education within the module would address this.

- When alumni were asked how they felt the degree course developed a range of key skills related to chartered competencies and employability, they rated empathy the lowest. In improving understanding of EDI in engineering and allowing students to engage with it through planning collaborative initiatives, it is hoped that the proposed module will place a heavy emphasis on the development of empathy skills [9].

2.6 Staff Proposal Feedback and Changes to Module

The module proposal was presented to the Equality, Diversity, Departmental Culture Committee (EDDCC) and Courses Committee (CC) and accepted for implementation. There were a number of changes made to the initial proposal before implementation for pedagogic reasons. These changes focused on initiative implementation, peer assessment and overall assessment content. The initial proposal for the module included implementation of a group EDI initiative and the grade for this included evaluation of the initiative by outside participants. This meant grades would be dependent on third parties. It would also have been difficult to implement such an initiative within an 11-week term. To address these issues, the group project was changed to include development of initiative design, evaluation and communication strategy, but removing implementation. After assessment students would be supported to implement their initiatives if they wish. The initial proposal also included assessment of team member's group input (peer review); however, peer review is known to be subject to unconscious bias [2] and thus may disproportionately negatively impact marginalised students. As such, the summative peer review was replaced with a formative one. This formative peer review now forms the basis for a reflective essay in which students write about their role in the project team, their personal development journey and how this has been impacted by positionality. In the overall assessment, two smaller elements were removed to reduce student workload, enabling the initiative design to be given greater credit. This also allowed for the removal of a "conduct of task" element which can also be subject to unconscious bias.

3 RESULT OF MODULE DEVELOPMENT

The module began as a pilot in October 2022, with the module running over Autumn and Spring term. 24 students enrolled, which was considered to be a reasonable number for a pilot module (a maximum number of 30 had been set). Attendance has been on average proportionately higher than other optional modules at this level, with high levels of engagement as measured by in class discussion. There have been challenges in sourcing expert lecturers from within engineering to match all the proposed topics. Whilst speakers were identified for this pilot module from within Imperial, other HEIs, industry and EDI consultancies, we are looking to supplement, replace, film and or train these in order to enhance the quality of the lectures. Running the course has been beneficial for all involved as the level of staff learning about the expert topics, in addition to the student learning has been noticeable, leading to adaptations to teaching and other processes throughout the department. The lectures themselves, which were engaging and provided key content often occupied much of the allocated timetabled hours; there may be scope in the future to increase the time available for discussion and reflection in the first term. The plan is to continue the module within the department next year. We will also either invite students from other departments to join us or to support other departments, many of whom have already expressed an interest in the module, in running their own version of it. We are also supporting other universities with a similar interest.

The syllabus for the module can be found on the Mechanical Engineering Department page of the Imperial College website, under Undergraduate Study; Detailed Module Information; Year 3; Equality Diversity and Inclusion in Engineering (https://www.imperial.ac.uk/mechanical-engineering/study/undergraduate/detailed-module-information/?module=MECH60025&year=22_23).

4 DISCUSSIONS

We consider that the summer project to develop the EDI module was a success. A few key factors contributed toward this. Firstly, a passion driven approach was taken, as the authors all have a desire to improve the experience in engineering for underrepresented groups with whom we identify, and beyond. This was demonstrated in the interview process when the student authors approached EDI experts and were able to break down unnecessary formalisms to allow for passion-led discussion, facilitating lateral

creative thinking. Interviews led to breakthroughs in module design and enabled the team to grow a powerful EDI-network for use during the module. Secondly, because the project was entirely self-proposed and self-managed there was freedom to determine which direction module development would take, as appropriate. This allowed for transparent and easy communication between student authors and staff. The role of staff in this was centred on signposting resources, providing an educator's perspective, and supporting during ideation. This co-creative approach allowed for innovative module design, without the need to adhere to standard engineering module design practices.

There are a few areas where future student-staff collaborations could be improved, particularly for EDI related initiatives. The funding for this project was through a standard UROP (undergraduate research opportunity) bursary. This bursary is not based on an hourly rate and there are no fixed set hours. It is suggested here that an alternative funding mechanism should be based on an hourly rate, to ensure students are fully funded for all hours spent or that alternative sources of funding are sought. On reflection, it may have been useful to hold focus groups with students when collecting views on the introduction of an EDI module, instead of or in addition to surveys to allow more detailed analysis of responses. The design and implementation of the module relied heavily on input from minoritized groups. It should be acknowledged that often the burden of diversity and inclusion work often falls on those in oppressed groups. This was particularly evident when interviewing EDI initiators in the engineering industry or at HEIs who felt at times they were taking on work that was not part of their job description, at the detriment to their career. There was a delay between proposing the implementation of this module and the implementation itself; there were a number of reasons for this. Firstly, the timing of the project itself and the time scales for approving new modules. Secondly, changes in staffing meant that a module lead was not immediately available. The eventual module lead was also not directly involved with the initial design, and some changes were made in module content and design to take into account the module lead's areas of expertise. One of the initial project staff partners was able to take on the role as associate module lead ensuring continuity from module initiation to implementation. On reflection, it may have been useful to include in the module design proposal what aspects students felt were essential and what parts they felt were not. This allows for a continuation of the student-staff co-creative process even after handover.

The project has had a major impact on subsequent EDI development for the student authors. Following the summer project and after graduating, these students wished to continue EDI work in an industry environment. One student became involved in several initiatives at their company, including founding their own ethnic minority network and running a series of inclusive design workshops. Another student joined several employee resource groups to do with diversity inclusion and belonging at their company. They have developed a scheme that helps line managers have more productive and actionable conversations with employees about DIB issues.

5 CONCLUSIONS

In response to the student and staff desire for mechanical engineering students to have a positive impact on EDI in engineering, an optional module 'Equality, Diversity and Inclusivity in Engineering' was designed and implemented through a successful co-creation project. The design phase was funded through a departmental bursary and took place over 10 weeks in summer 2021. The design phase included extensive research and discussions with both internal and external EDI experts. The module syllabus and assessment methods proposed by students were written up in a report and approved by the department for implementation. Some minor changes, primarily to coursework and assessment elements were made for pedagogic and practical reasons. The module began being taught as a pilot in October 2022; the first term being lecture based and the second term being focused on the design of an EDI in engineering initiative. The assessments include bi-weekly initiative-based tasks, a curated logbook and reflective essay. Engagement and student progress have so far been encouraging and the module will be offered again next academic year. The success of this project is a result of strong student staff partnership and the direct and personal experiences of the student partners, as well as broader interest from within the UK higher education sector.

REFERENCES

- [1] Peters J. *Designing inclusion into engineering education*, 2018 (Royal Academy of Engineer, London)

- [2] Stonewall J. et al A Review of Bias in Peer Assessment. In *The Collaborative Network for Engineering and Computing Diversity Conference, CoNECD 2018*. Virginia, April 2018 (American Society for Engineering Education, Washington)
- [3] Engineering Council. *EngTech, IEng and CEng UK-SPEC*. Available: www.engc.org.uk [Accessed on 2023, 1 February], (2014).
- [4] *Embedding equality, diversity and inclusion in the curriculum A programme standard*. 2018 (Advance Higher Education Institute)
- [5] *Responding to the new landscape for university access*, December 2010 (The Sutton Trust).
- [6] Dixon-Fyle S. et al *Diversity wins: How inclusion matters*, May 2020 (McKinsey and Company).
- [7] Imperial College London. *Constructive Alignment and Student focused ILOs / Educational Development Unit*. Available: <https://www.imperial.ac.uk/staff/educational-development/teaching-toolkit/intended-learning-outcomes/ilos-and-constructive-alignment/> [Accessed on 2023, 6 March], (2021).
- [8] Fook J. *Rethinking Ideas; Reflexivity, Reflectivity, Reflective Practice and Contextuality. Social Work: Critical Theory and Practice*, 2002. (Sage Publications Ltd., London)
- [9] Imperial College London. UROP Proposal in *Equality, Diversity and Culture / Department of Mechanical Engineering*. Available: <https://www.imperial.ac.uk/mechanical-engineering/about-us/equality-diversity--culture/> [Accessed on 2023, 6 March], (2023) 2 February.