Large-Scale Interdisciplinary Project-based Learning: Staff Experiences of Leading Multi-departmental Projects for Year 1 Engineering Students

Fiona Truscott
Integrated Engineering Programme and Centre for Engineering Education, Faculty of Engineering Science, University College London, London, UK, f.truscott@ucl.ac.uk

Emanuela Tilley
Integrated Engineering Programme and Centre for Engineering Education, Faculty of Engineering Science, University College London, London, UK, e.tilley@ucl.ac.uk

John Mitchell
Department of Electrical and Electronic Engineering and Centre for Engineering Education, Faculty of Engineering Sciences, University College London, London, UK, j.mitchell@ucl.ac.uk

Abel Nyamapfene
Centre for Engineering Education, Faculty of Engineering Sciences, University College London, London, UK and Institute for Education, University College London, UK, a.nyamapfene@ucl.ac.uk

Summary

There is increasing consensus that Engineering programmes need to include space for skills learning, particularly in interdisciplinary contexts. Active learning methods, such as project-based learning, are the gold standard for teaching interdisciplinary skills. However much of the literature on these approaches focuses on relatively small class sizes, making the application in larger contexts seem unfeasible. The Integrated Engineering Programme (IEP) at University College London (UCL), is one of the most comprehensive and largest applications of active learning methodologies within undergraduate engineering curricula in the UK. A key part is the cornerstone module, Engineering Challenges. This first-year undergraduate module aims to introduce students to project work and key skills such as teamwork and communication through undertaking an interdisciplinary project. Taken by close to 1000 students across seven departments, this is a complex undertaking and we have had to develop approaches to delivering large-scale interdisciplinary project work. Team teaching is central to this; with the Engineering Challenges teaching team led by a faculty-level Module Lead, with one to four academics from each department. This paper focuses on the role of the Module Lead in this unusual situation, how this role differs from a more typical role and how this links to module success.

Keywords: Project Based Learning, Large Scale Teaching, Team Teaching

Type of contribution: Research extended abstracts

1 Introduction

There is an increasing focus within the Engineering Education community on preparing students for the careers after university with the inclusion of space within the curriculum for skills learning. The World Economic Forum's Future of Jobs Report consistently discusses the need for new graduates to have a mix of professional skills, global competency and technical knowledge (WEF, 2020). Given the complexity of future work places and the problems our graduates will be asked to tackle, learning these skills in an interdisciplinary context is increasing necessary. Active learning methods, such as project-based learning (PjBL), are the gold standard for teaching skills in a wide range of contexts (Kolb, 2015). Leaders within Engineering Education have incorporated these methods in their curricula for several years now and wide spread adoption is rapidly becoming the norm (Graham, 2018).

Engineering programmes are commonly very popular and tend to have relatively large class sizes. However much of the literature on active learning is focused around small class sizes (Graham, 2018, Guo, 2020, Hernández-de-Menéndez, 2019). It is not as simple as scaling up small class methodologies due to the unrealistic volume of resources, people, time and space required. So modified active learning approaches that are practical for large classes are required. The Integrated Engineering Programme (IEP) at University College London (UCL), is one of the most comprehensive and largest applications of active learning methodologies within undergraduate engineering curricula in the UK (Mitchell et al, 2019). Active learning is central to the IEP experience and are threaded throughout the common, cross-faculty teaching framework. While creating framework, we developed, and continue to develop, approaches that allow for practical delivery of active learning experiences with large numbers of students.

A key part of the IEP is the cornerstone module, Engineering Challenges. This first year undergraduate module aims to introduce students to project work and key skills such as teamwork and communication through an interdisciplinary project. Taken by close to 1000 students each year across seven departments, with material tailored to students' disciplines, this is a complex undertaking (Truscott et al, 2021).

Engineering Challenges is a significantly different to what we might consider a typical university module. For our purposes, a typical module is one that takes place within a single department and where one or two academics, plan and deliver all of the teaching and assessment. This typical module is taken by a number of students that can easily be accommodated in most classrooms and provides a reasonable teaching load for the one or two academics running the module. This will vary between universities depending on resources and estate but at UCL we estimate this to be between 50 and 100. In this typical module, the person leading it has control of all the pedagogical aspects of the module, while administrative support is provided by a member of the department's teaching and learning administration team.

Team-teaching is used extensively within the IEP to deliver large-scale interdisciplinary teaching but Team-teaching has not been widely used generally in HE contexts (Nyamapfene, 2016). For Engineering Challenges, the teaching team is lead by the Module Lead based at faculty level and contains one to four leads from each department that takes the module. Given the relative rarity of this situation, this study sets out to understand how staff working on the module describe their experience of active learning and team-teaching within this large-scale context, key elements for the success, what barriers and challenges they have faced and how they overcame them.

2 Methodology

The data discussed in this paper comes from a slightly larger review project on the views of those teaching within Engineering Challenges at all levels. In that project staff who have held the Module Lead role in the past and currently were interviewed, and the current and most recent Departmental Leads were invited to join focus groups. In this paper we have focused on the data collected during the Module Lead interviews.

Three staff members were interviewed for this small study: two past Module Leads and the person holding the role currently. As two of the authors are part of this group (ML1 and ML3), interviews were conducted by one of the other two authors who isn't involved in the delivery of the module. The interviews were semi-structured with topics decided beforehand by all four authors, but questions chosen by the interviewer. Interviews were conducted online via Microsoft Teams, recorded and auto-transcribed. The first Module Lead, referred to as ML1 in this paper designed, delivered and established the module from the start of the IEP in 2014, for two academic years until 2016. The second Module Lead, ML2, took over the leadership and continued in the role for two academic sessions until 2018. At which time the lead role changed hands again to ML3, who has led the module for last 5 academic sessions including through the recent pandemic years and is still Module Lead.

A thematic analysis was conducted of the Module Lead interviews by two of the authors followed by discussion and consolidation of the final themes list amongst all authors, as well as comparison to the themes

that came from the focus group data (not part of this paper). Interviewees were asked to discuss what the Module Lead role involved, their approach to it, the impact of scale, their thoughts on active learning approaches, the advantages and disadvantages of interdisciplinary teaching and if they could identify and comment on success factors and barriers in delivering the module.

3 Results and Discussion

Although the sample size is by definition very small, one clear conclusion comes through in all three interviews. The role of Module Lead within Engineering Challenges is substantially different to what is required of someone leading a typical module. This seems to come from both the size of the module and the interdisciplinary nature of it. The Engineering Challenges Module Lead involves much more executive function; co-ordinating groups of staff (both academic and administrative), providing vision, direction and resources; and is involved much less in the day to day business of the classroom than we might expect. It is probably more accurate to think of the Module Lead role as similar to a programme lead or, given the cross-departmental nature of the module, a faculty head of education, than a typical lecturer role. There are several strong themes that emerge from the interviews conducted related to what the role requires and what is needed for success. Leadership was by far the most discussed theme in all three interviews, with interdisciplinary and interdepartmental working, student experience and scale all also featuring within the discussions on success factors.

3.1 Leadership

For all three interviewees, as the job title of Module Lead suggests, leadership was key to their conception of what their role within the module was. This covered a wider range of aspects of leadership, which included the day-to-day project management of the module as well as providing vision and a path forward in times of large-scale change. We can break down the quite broad concept of leadership into four key aspects within the Module Lead role: Pedagogical, Organisational, Advocational and Facilitative.

Pedagogical leadership covers both educational standardisation across the module, as noted by ML1,“Module Lead has to make sure there's consistency of assessment”, as well as providing the way forward in times of large scale change such as the move to online teaching in 2020 as a result of the COVID pandemic, as outlined by ML3, “you're the Module Leader. We don't know what we wanna do, come up with a kind of way forward for us.”. While the need for pedagogical vision could be argued to be necessary in a typical Module Lead role, the need for someone to be thinking about consistency across the module is unique to large scale and/or interdisciplinary teaching where multiple people involved in the delivery of the module and need to be on the same page.

Organisational leadership within the module is likened to project management by ML2, “So it's very much like a project managers.”. There is a key troubleshooting element during the running of the module as well as the structural work done prior. Again, while planning and problem solving again can be argued to be necessary for any type of teaching, the large scale, interdisciplinary nature of the module makes it a much larger and more complicated aspect of the Module Lead role.

Related is the need to advocate for the module, the teaching approach it uses and the resources and requirements it needs, effectively being the voice of the module. This is a key part of the Module Lead role due to the relative unusualness of the scale and approach as discussed by ML3, I “do a lot of representing the module to do with timetabling and central UCL for example, and the faculty.”. This also requires the Module Lead to be more involved with the administrative and logistical sides of the module than we might typically expect.

Central to the educational success of Engineering Challenges is the facilitative leadership aspect of the Module Lead’s role, as this enables the other three aspects. The ability to build and develop relationships with a wide range of people across the engineering departments and the wider UCL community is essential.

ML2 comments on this central importance, “It's having the skills to make the relationships and sort of bring people with you without trying to force issues.”. Again, this is very different to a typical Module Lead role and is a function of both the large scale the module works on and the interdisciplinary nature of it as well as being key tot eh success of the team teaching approach to module delivery. (“The team teaching means that you need someone with Module Leadership to be there.” [ML1])

3.2 Success Factors

Three themes came out of the discussion on success factors; student experience, interdisciplinary and interdepartmental working, scale and teaching team. Student experience is a familiar consideration for anyone teaching and within the context of Engineering Challenges, this is the most familiar topic to come up in discussion with similar ideas and issues being raised to the majority of other modules. The other two themes are more specific to the context and specifics of Engineering Challenges.

Interdisciplinary teaching within Engineering Challenges comes in two forms, 1) between Engineering disciplines and 2) through bringing in topics and disciplinary studies perceived to be outside of Engineering such as ethics. This can lead to clashes between disciplinary approaches that need to be resolved by the Module Lead. Moreover, as indicted by ML2, interdisciplinary teaching combined with scale can result in not having enough space to fully explore a topic, “So if you're trying to so fuse it with some kind of social context or considerations, that's actually really difficult, with the scale of the students involved.”. An interdisciplinary approach also means working across departments at an operational level. Within UCL, central educational administrative systems and services function around a department model, allowing for departments to each having their own approach to, for example, communication or student support. In order for a faculty level module such as Engineering Challenges to function the Module Lead needs to try and find consensus across departments as well as tap into central systems that assume teaching is happening at a departmental level. This has become even more important in the context of the pandemic emergency teaching when changes were prevalent and occurred at pace. The Module Lead needs to be able to bring groups, information and approaches together, to find and construct consensus and, crucially, know when provide flexibility for different approaches to successfully deliver the module.

Engineering Challenges is one of the biggest modules, if not the biggest module, at UCL and one of the biggest PjBL modules in Engineering globally. That scale, in and of itself, can be a barrier to what can be done within the module. ML2 described the implications of scale as the person leading the module, “The scale of it sometimes means, I think that you can do a bit less than you would like. That's the downside of it.”. ML3 also mentions it indicating that even normal straightforward parts of the module become complex and time consuming, “as the number of students goes up, the logistics and everything isn't linear.”. A key success factor is knowing how to handle the complexities of scale and working in a supportive context that understands the difficulties that scale can introduce to any teaching activity.

4 Conclusion

The need for an unconventional Module Lead role in a central position is key in the success of large scale interdisciplinary active learning modules. Within Engineering Challenges, the large scale, interdisciplinarity nature and active learning approach combine to create the complex and relatively unique nature of the Module Lead’s role. However, it is clear that when implementing new educational activities within any of these three aspects, anyone leading the development and running of these activities will need to employ a different set of approaches and skills to those that are typically used. Different structures will also be needed particularly when creating new interdisciplinary or large scale educational activities as centralised leadership seems to be key to the success of these. Institutional leadership will need to understand the non-typical nature of the Module Lead role and will need to think outside the box when putting in place large scale and/or interdisciplinary structures as well as the support needed for those leading this type of module or educational change. All three interviewees identified institutional buy-in and backing to be a key success factor, for

example from ML2, “We had to stamp of approval”. Also, as we approach ten years of Engineering Challenges and the IEP, it’s clear that, in contrast to the stereotype of traditional lecturing, this approach to teaching isn’t static and provides opportunities for constant innovation and improvement, as highlighted by ML3, “it's always a work in progress, it's always evolving”. This is can be very useful way to improve student experience and reflect on current events or thinking but does incur a resource penalty which needs to factored into things like teaching load.

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