

2023-10-10

## Staff Experiences Of Leading Large-Scale Multi-Departmental Project-Based Learning For Year 1 Engineering Students

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### Recommended Citation

Truscott, F., Tilley, E., Mitchell, J., & Nyamapfene, A. (2023). Staff Experiences Of Leading Large-Scale Multi-Departmental Project-Based Learning For Year 1 Engineering Students. European Society for Engineering Education (SEFI). DOI: 10.21427/7Y9A-6C85

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# Staff Experiences of Leading Large-Scale Multi-Departmental Project-Based Learning for Year 1 Engineering Students

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**Conference Key Areas:** *Innovative Teaching and Learning Methods, Engineering Skills and Competencies*

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

## ABSTRACT

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

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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.

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## **1 INTRODUCTION**

There is an increasing focus within the Engineering Education community on preparing students for 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 (World Economic Forum, 2020). Given the complexity of future workplaces and the problems our graduates will be asked to tackle, learning these skills in an interdisciplinary context is increasingly 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).

### **1.1 UCL's Approach to Incorporating Skills-Based Learning**

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 approaches are central to the IEP student experience where they are threaded throughout the common, cross-faculty teaching framework. A key part is the cornerstone Engineering Challenges module. 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 each year across seven departments, with material tailored to students' disciplines, this is a complex undertaking (Truscott *et al*, 2021).

In this way Engineering Challenges provides a significant contrast to what we might consider a typical module. In this paper a typical module is one where there is one or two academics who plan and deliver all of the teaching and assessment and it takes place within one department. In terms of scale a typical module would have a number of students where there are lots of available rooms and provide a reasonable teaching load for the one or two academics running the module. 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 and while administrative support is provided by a member of the department's teaching and learning administration team.

## **1.2 Difficulties in Large-Scale Active Learning**

Much of the literature on active learning is focused on small class sizes (Graham, 2018, Guo, 2020, Hernández-de-Menéndez, 2019). Engineering programmes are commonly very popular and tend to have increasingly large class sizes as is the case at UCL. Simply scaling up small class methodology is not possible due to the unrealistic volume of resources, staff, time and space required. So modified active learning approaches that are practical for large classes are required. Team-teaching has not been widely used in HE contexts, but it is something that the IEP uses regularly (Mitchell *et al*, 2019). Team-teaching is used extensively in order to deliver large-scale interdisciplinary teaching. For this module, the teaching team is lead by the Module Lead based at faculty level and contains one to four (based on student cohort size) leads from each department that takes the module. It is very clear anecdotally that the Module Lead position within Engineering Challenges is very different to a typical Module Lead role. While we have previously gathered staff experiences of PBL and related approaches within departments, we haven't yet focused on the faculty level Module Leadership role (Mitchell and Rogers, 2020).

This study sets out to start identifying how the Engineering Challenges Module Lead role differs from a typical one and how this is linked to successful implementation and delivery of large scale interdisciplinary active learning, through project-based learning.

## **2 METHODOLOGY**

The data discussed in this paper comes from a slightly larger research project on the views of those teaching within Engineering Challenges at all level. 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.

Interviews were chosen due to the very same sample size (only three people have ever held the Module Lead position for Engineering Challenges) and because it allowed for exploration of the topics discussed (Bell, 2005). This last reason was particularly useful given the unusual nature of both Engineering Challenges and the IEP and the lack of general consensus within the literature on large scale project work modules and team teaching within this context.

### **2.1 Data collection**

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.

## **2.2 Topics Selected for Discussion**

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.

## **2.3 Data Analysis**

Thematic analysis was chosen as the data analysis method as we wanted to draw out the module leads' understanding of what their role involved and find commonalities across all three interviewees' experiences (Clarke *et al*, 2015). Engineering Challenges and the IEP itself are both relatively unusual within Engineering Education and so thematic analysis allows us to explore something with relatively little literature consensus. Two of the authors initially coded all three interviews, with one interview being coded by both for comparison. This was followed by discussion and consolidation of the final themes list amongst all four authors, as well as comparison to the themes that came from the focus group data (not part of this paper).

# **3 RESULTS**

It is clear throughout the interview data, that the role of Module Lead within Engineering Challenges is very different to a typical Module Lead role. It has much more of an executive function, co-ordinating groups of staff (both academic and supporting) and providing vision, direction and resources, with relatively little involvement in what happens day to day in the classroom. This makes the role more similar to a programme lead or given the cross-departmental nature of the module, a faculty head of education. Although a small sample size given the very specific nature of those interviewed, there are several strong themes that emerge from the interviews conducted with the past and present Module Leads. Leadership was by far the most discussed theme in all three interviews, with interdisciplinary and interdepartmental working, student experience, scale, and teaching team all also featuring within all three interviews.

## **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. From the interviews there were four key aspects to leadership within the Module Lead role Pedagogical, Organisational, Advocational and Facilitative.

The pedagogical leadership aspect covers both educational standardisation across the module, as noted by ML1, "*Module Lead has to make sure there's consistency of*

*assessment so that they (- all the students) get a fair chance at being marked consistently with the same assessments, the same rubrics. You know, in the same way, in the same format, because if there are a number of markers, definitely a number of academics in the classroom explaining the assessment, there has to be one point of truth and that's where the Module Lead certainly has to come out in terms of organizing*", 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, *"That was a lot of what I was bringing. OK? How? What? What's the structure gonna look like when we make a big change, you know? Because it was like, OK, you're the Module Leader. We don't know what we wanna do - you know, come up with a kind of way forward for us to do that."* 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 there are groups of people involved in the delivery of the module.

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 highlighted by ML3, *"I am the problem solver."*, as well as the structural work done prior discussed by ML1, *"There is definitely a pace through each of the projects that the departments have to follow and that is set by the Module Lead... So there are milestones that the department, the Module Lead sets."* Again, here we can see the impact of large scale and/or interdisciplinary teaching on the Module Lead role, with the need for much more structure within the module as well as a much closer relationship with administration at all levels within UCL. *("I guess you have to put it in place in order to manage the large scale and that's where the Module Lead comes in... operationalizing it; there has to be one decision maker at the end of the day, ... there has to be one point of truth and that's where the Module Lead certainly has to come out in terms of organizing" [ML1])*

The active learning approach of Engineering Challenges may also require more involvement with the administrative side of the module due to the different administrative requirements. The need to advocate for the module, the teaching approach it uses and the resources and requirements it needs, is a key part of the Module Lead role due to the relative unusualness of the scale and approach as discussed by ML3, *"do a lot of representing the module to do with timetabling and central UCL for example, and the faculty."* Here advocacy requires the Module Lead to be the voice of the module, arguing for resources and campaigning for particular approaches with entities across both the faculty and UCL as a whole.

Central to the educational success of the Engineering Challenges module 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."*, and is supported by ML3, *"the central organization, the central kind of mediator about it, the central kind of ability to bring everyone together and speak with one voice"*. 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. (*"So, you know it is team teaching and that is a very different way to even teaching a module with a partner or an academic lead and a supporting academic. The team teaching means that you need someone with Module Leadership to be there."*) [ML1])

### 3.2 Interdisciplinary, Team Teaching and Scale

Following on from leadership four other significant themes arose in all three interviews, student experience, interdisciplinary and interdepartmental working, scale and teaching team. Student experience should be a key aspect of any Module Lead's role, however the other three themes are more topic or approach dependant. All three have already been briefly mentioned in the discussion of leadership but it is useful to consider them outside of their relationship of leadership of the module.

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. This is highlighted by a comment by ML1, *"there is still that dynamic of computer scientists do this part, and the electrical students do this part or, you know, the civil engineers and the mechanical engineers do two different things. And I think that's the nature of disciplinary focused people coming into an interdisciplinary space and forcing the relationship that way"*. 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. At UCL, a lot of its 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. ML3 reflects on how this aspect has become a major part of the Module Lead role as a result, *"bringing these departments together - so there are seven different approaches to teaching - there are seven different approaches to student support - there are seven different approaches to assessment, seven different approaches to communication with, like everything is slightly different every single time."* Additionally ML3 adds *"UCL central systems, when they come to me as Module Lead, assumes certain things about what I do."*

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.”*

#### **4 CONCLUSIONS AND RECOMMENDATIONS**

The need for an unconventional Module Lead role in a central position is key in the success of large scale interdisciplinary active learning modules such as Engineering Challenges. In this particular situation it is difficult to separate what parts of the Module Lead’s role relate to large scale, interdisciplinarity or an active learning approach. However it is clear that when implementing new educational activities within any of these three aspects, Module Leads will need to employ a different set of approaches and skills to those that are typically used in the role. Different structures will also be needed particularly when creating new interdisciplinary or large scale educational activities as centralised leadership seems to be central 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 ML1, *“the module itself is really evolved”* and 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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