Collaborative teaching approaches in Engineering and IT

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ABSTRACT

CONTEXT

Academics teaching into the compulsory core engineering and IT program in the School of Professional Practice and Leadership (SPPL) at the University of Technology Sydney have engaged in a collaborative teaching approach to the design and delivery of individual subjects. This approach was applied to program development, to the wider teaching team, and to engagement outside of the program. The program involves over 2500 students across six subjects every semester. The collaborative approach began in 2019 as an informal sharing of experiences and ideas. This continued through the COVID disruption. Changes in roles and program redesign have now been formalised and continue as a leadership supported approach to teaching in SPPL.

PURPOSE OR GOAL

A significant feature of the team's collaborative teaching approach is the provision of a model of teamwork and collaboration for their students. The approach presented an opportunity to model and to share learning with colleagues outside the team. This culminated in recognition through a university teaching award. As the team has grown, changed roles, and further developed collaborative teaching practices, more has been learnt about the benefits and challenges of maintaining collaborative teaching practices across a program. Collaborative teaching is rare but valuable to academics and to student experience. This paper aims to share the experiences with the engineering education community.

APPROACH OR METHODOLOGY/METHODS

This paper uses a collaborative autoethnography approach to capture the team's experience of building and working in a collaborative teaching program at UTS. Personal reflections from academics involved in the collaborative teaching approach have been gathered and analysed for key themes. The academics represent a range of roles (e.g. subject coordinators and tutors). Also included in the collaborative autoethnography is a reflection from a colleague who worked with (but outside of) the team.

ACTUAL OR ANTICIPATED OUTCOMES

The process of reflection and sharing experiences provides insights into good practice for establishing and maintaining collaborative teaching team approaches within engineering and IT programs. These insights provide opportunities for engineering and IT colleagues to consider adopting a similar approach to teaching across programs.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

We conclude that the collaborative teaching approach is valuable to the academics involved, particularly the inclusive, supportive environment that breaks down the silos often found in academia. Benefits include distributed expertise and enhanced teaching practices. We also identify the challenge of maintaining and growing a team beyond those who chose to work this way. This approach could be adapted by other institutions as a model of good practice.

KEYWORDS

Collaborative teaching, collaborative autoethnography

Introduction

At the University of Technology Sydney (UTS), all undergraduate engineering students complete eight compulsory subjects as part of their engineering degree: three foundational science subjects (typically taken in the first two semesters), and five engineering core subjects focusing on the development of transferable, professional capabilities. Each subject has cohorts of ~1000 students per year. The engineering core subjects run from first year to fourth year consecutively. They form an integral part of the students' learning experience at UTS and are taught through the School of Professional Practice and Leadership (SPPL). Over the last five years, three key events have fostered collaborative approaches in the teaching team responsible for these subjects:

1. Establishing the new SPPL School
2. Navigating the emergency transition to online teaching during the COVID pandemic
3. Re-designing the engineering core subjects

A team-teaching approach emerged with the appointment of new academic staff to teach the engineering core subjects from 2017, and the formation of SPPL in 2019. Bringing together the programs that focus on the development of professional skills is unusual in Australian engineering faculties (though somewhat more common in the US). The new team identified an opportunity to connect subjects across the core engineering program. This aimed to foster a more connected student learning experiences, with a focus on progressively developing students' professional practice skills. The range of knowledge, skills and capabilities needed to teach and engage students in professional practice makes our collaboration particularly valuable. Furthering this need is teaching at scale: the subjects require a large team of full-time and casual academics across engineering and IT core subjects from first-year undergraduate to fourth year.

The COVID-19 disruption accelerated team collaboration There was significant value in sharing experiences given the sudden requirements of supporting students and tutors through uncertainty, adopting new technologies, and continuously evaluating online teaching approaches. The team informally developed mechanisms to deepen collaboration: meetings were held to familiarise tutors and subject coordinators with technology; the more technology-savvy tutors would hold training sessions for the team; and online groups were established to troubleshoot and step in for emergency problems. This led to new levels of relational trust (Edwards-Groves & Grootenboer, 2021) developing amongst the teaching team. During this stage, the team added new academics in the core program and extended the collaboration to academics in other schools.

The third event in fostering this collaborative teaching culture was the re-design of the engineering core beginning in 2022. The core subjects were developed at the turn of the millennium. Over the years, these subjects diverged from their original design and alignment. There was also a need to adapt to changing engineering practice and Engineers Australia (EA) accreditation requirements. This refresh was undertaken in line with the Australian Council of Engineering Deans (ACED) 2035 report's recommendation that "[e]ngineering education providers review and revise professional engineering education programs to embed a stronger focus on student engagement with contemporary engineering practice and its sociotechnical contexts," (Crosthwaite, 2021, p. 4) with the aim that all UTS graduates are equipped with the skills and knowledge required for future industry and society needs. The re-design process was led by two of the authors, who were given a blank slate to develop curriculum and pedagogy addressing the goals of internal UTS strategy, Engineers Australia accreditation, and the vision of the ACED 2035 report. This re-design process brought together this paper's authors and other stakeholders in a series of workshops to unpack and develop our ambitions for the core program. This provided the opportunity to embed collaborative approaches across our core curriculum and teaching, with a shared tutor team, coherent development of skills, curriculum governance mechanisms, and more.

Literature Review

Academics are often focused on their own content areas but have a fragmented view of the whole degree (e.g. Hardy, 1991; Johns-Boast, 2013). This leads to coordinators having limited knowledge outside their subjects. Therefore, staff turnover often means new employees are not aware of content in other subjects or other parts of the degree. Accreditation requirements and student feedback can also exacerbate piecemeal changes, scope creep, or curriculum drift (e.g. Deeley et al., 2019; Martin & Polmear, 2023). The nature of academia is a further constraint to collaboration. Promotion criteria are usually connected to research and individual achievements (Kemp, 2013); thus, there is no incentive to work with others to create a holistic program. This reflects beliefs about the nature of engineering, as Trevelyan notes '[n]early all the literature on engineering education and practice reveals an overwhelming belief that engineering is all about solitary technical work' (2010, p. 384). Consequently, the curriculum becomes a collection of individual subjects rather than an integrated whole (e.g. Ktoridou & Eteokleous, 2014). This can result in key learning areas being repeated or omitted.

Collaborative and collegial approaches can have a significant positive impact on teaching (Newell & Bain 2020). In particular, such approaches support the professional development of teaching staff due to peer learning (Moore et al., 2021; Palaniandy, 2017), increased reflection on their teaching practices (Kelly, 2024) and greater psychological safety in teaching (Miao et al., 2014). As a result, this results in improvements in subject design and student learning (Buckingham et al., 2021). Moreover, collaborative approaches to curriculum redesign, such as the integration strategy (changes mapped across existing curriculum) or re-building strategy (cultural shift across educators), ensure curricular continuity by moving away from reliance on individual champions whose practice is lost when they leave (Kolmos et al., 2016). Nevertheless, there remains a lack of clarity around how best to implement good collegial practice (Newell & Bain, 2020).

Based on our experiences, and on the literature, the following research question frames our study: *what elements are identified by team members that contribute to collaborative teaching approaches across an engineering program?*

Methodology and methods

In line with the collaborative and collegial practices underpinning this research project, the team discussed what methodology to use, whom to involve, and how to collect and analyse the data.

The chosen methodology for this research project is collaborative autoethnography. This approach provides opportunities for members of a research team to combine their experiences of certain phenomena or events and 'collaboratively analyse and interpret them for commonalities and differences' (Chang et al. as cited in Hernandez et al., 2017, p.251). Advantages of using collaborative autoethnography (CAE) include efficient collection of data, as the stories are provided by the researcher-participants; multivocal interpretations of social phenomena; and interdisciplinary collaborations. In our case, CAE allowed a range of experiences and understandings of the development of the collaborative teaching approach to be communicated, and hence to be analysed and interpreted.

The research team is interdisciplinary, comprising members of the Engineering stream and the IT stream from the Faculty of Engineering & IT, and a member of the university Teaching, Learning and Curriculum unit.

Name	Roles at the time of CAE data collection
Timothy Boye	Faculty Accessibility Officer for undergraduate students, subject coordinator for 1st year core engineering subject, previous subject assistant in core engineering
Eva Cheng	Head of School, School of Professional Practice and Leadership, previously coordinated 1st year core engineering subject
Scott Daniel	Co-Program Coordinator for Engineering Core and subject coordinator for late degree core subject, previously coordinated 1st year core engineering subject
Rosalie Goldsmith	Critical friend of the Core Programs, working with the core on embedding academic literacy development, Associate Professor Academic Language & Learning team
Jeremy Lindeck	Engineering Professional Practice Program coordinator, subject coordinator for professional practice subjects, and subject coordinator for 1st year IT core subject
Tania Machet	Course Director for Undergraduate Engineering, Co-Program Coordinator for Engineering Core Program, and subject coordinator for 2nd core subject
Guien Miao	Subject assistant for 1st year core subjects

Each member of the research team was asked to write a one-page response to the question: *What is your experience of the collaborative teaching approach in the Engineering and IT Core program?*

The responses were collated by two members of the research team who independently conducted a reflexive thematic analysis (Braun & Clarke, 2022). This was done by reading and re-reading the responses, locating broad categories, listing terms/phrases that exemplified the categories, and identifying possible themes and examples of themes in the collated responses. The approach was intended to find 'thematic patterns of shared meaning' (Braun & Clarke, 2020, p.18). The two researchers then critically compared and discussed findings until agreement on the final analysis was reached.

Several themes were identified during the analysis, three of which we discuss in this paper: academic practices; collaboration and collegiality; and conscious team-building. These are summarised and discussed in the next section.

Findings

Theme	Term/word/phrase	Representative quote
Academic practices	Isolation; unit/subject ownership;	*Traditional "one to many" teaching is actually quite an isolating experience; Academia...oftentimes feels like a solo venture; junior staff...feel so isolated and unsupported in their teaching*
Conscious team-building	Creating, team-building, developing, (cf. The word 'team' occurs 65 times in the combined reflections)	*We share feedback with each other, revise our approaches each semester, learn from each other's insights and experiences, and are constantly looking for incremental strategies to improve the teaching and learning experience for academics, tutors, and students.*
Collaboration and Collegiality	Support, Shared practice. Collaboration, Diversity	*Diversity in expertise: Between unit coordinators, this strengthens the curriculum quality. We all bring different knowledge and ideas which build on each other's strengths. and learn from each other.*

Academic practices

In our initial findings, we have concentrated on academic practices, conscious team-building, and collaboration and collegiality. Other themes will be discussed in a subsequent paper.

The theme of *academic practices* occurred in several of the reflections. A contrast was made between the practices of collegiality and collaboration with 'traditional' academic practices. These practices include subject [unit of study] ownership, 'lone ranger' beliefs of engineering educators, and the siloed environment that such beliefs and practices enable. The following comments capture some of the ways in which academic practices were understood by the team members:

> *Collaborative unit curriculum design means letting go of the innate academic habit of "owning" the unit that you design and teach. This is not easy for all, as it relates to academic intellectual belonging and your perceived "place" in the School/Faculty, exercising and sharing your academic expertise with a captive audience (students).*

> *Academia prides itself on collaborations but oftentimes feels like a solo venture.*

These comments provide insight into the perceived state of academic silos and ownership while also presenting the work of breaking these walls down.

Another theme related to academic practices was that of isolation, whether that was the traditional (and possibly preferred) way of academic practice:

> *...the traditional university boundaries (such as Subject Coordinator autonomy in each subject);*

or an undesirable fact of life, particularly for junior staff:

> *Traditional "one to many" teaching is actually quite an isolating experience;*

> *junior staff...feel so isolated and unsupported in their teaching*

A third and related dimension of the theme of academic practices was that of 'academic culture': the creation of a new School constrained the 'traditional' culture of individualism and isolation, and enabled the development of a more collegial culture. This in turn facilitated the collaborative and collegial practices of the Core teaching team. Coordinators and tutors felt free to reach out and discuss issues relating to their subjects as well as find out about other subjects in the school:

> *leading to both opportunities to define culture as well as less existing institutional knowledge*

Another aspect of 'culture' was the identification of a need for "(teaching) culture change amongst academic teams":

> *the key challenges to these goals lie ... in the (teaching) culture change amongst academic teams and addressing the traditional "silos" of academia*

The culture of the Core team, and the School to which it belongs, fostered our collaborative approach to many aspects of subject and course design. Often, it becomes difficult to distinguish which was cause and which was effect:

> *What's been interesting in being involved in the development of the new engineering core, is recognising how many of these aspects of our little community and curriculum approach are implicit – part of the culture and therefore not often explicitly remarked upon, and how we've had to try to make them visible to other stakeholders*

Conscious team-building

The theme of *consciously building a team* intersected with the themes of *academic practices* and *collaboration,* but could be identified as a separate theme due to the specific comments in the reflections that referred to the deliberate actions taken to build and maintain the teaching team.

> *Whilst the subjects do differ, a range of resources are shared across the subjects, including activities, rubrics and drop-in sessions, which reduces the workload for the individual subjects.*

The intentionality of the team-building activities and approaches is recognised by most of the researcher-participants in this study, as is the understanding that the impacts of COVID-19 played their part in enabling such team building:

> *there were frequent meetings where tutors and coordinators learned from each other... to make the most of the skills available, it made sense for tutors to be shared across subjects, and for coordinators to share techniques that worked.*

This comment illustrates the practices of sharing ideas, and support for colleagues, including the tutors. The meetings were regarded as necessary from a pragmatic point of view (sharing skills and successful techniques in an emergency context). However, they also created an environment where sharing and learning from one another was valued. This environment enabled relational trust to develop, which supported a strong team spirit.

Collaboration and Collegiality

The *academic practices* theme displayed a commonly siloed academia where academics own their subjects and develop them individually. This was in contrast to the collaboration and collegiality that was integral to the way the team worked. As EC suggests in the comment below, diversity of expertise is a strength, and collaboration builds better quality subjects and courses. It was clear the team shared a desire to build and maintain such diversity and collaborations.

> *Diversity in expertise: Between unit coordinators, this strengthens the curriculum quality, as we all bring different knowledge, ideas, build on each other's strengths and learn from each other.*

While some collaborations were related to specific projects (such as core renewal), day-to-day collaborations were also prevalent and normalised. These collaborations became business as usual and extended to reflection on practice.

> *We share feedback with each other, revise our approaches each semester, learn from each other's insights and experiences, and are constantly looking for incremental strategies to improve the teaching and learning experience for academics, tutors, and students.*

Collaboration and collegiality had further benefits beyond improving quality. GM described how two of the subjects were connected and how the collaborations and the collegiality between coordinators improved effective use of resources including academic time, and how it built psychological safety for the team. This included support in dealing with the inevitable issues as they occurred.

> *They also share frustrations and know that they're not alone in experiencing first-year transition woes, so there is a psychological safety net there.*

Discussion

The themes emerging from our reflections of a collaborative teaching approach in the UTS Engineering and IT core program reflect the initial conditions that enabled the collaboration. They also point to how collaborative teaching can be developed and maintained.

The researchers perceive that their academic practice differs from 'traditional'. In some cases, this has required adaptation. The researchers identify that extending this collaboration means others need to adapt to this change in practice (e.g. Sochacka et al., 2020). It requires us to continue to consciously build our team. New collaborators will need to align to the team's approach of collaborative ownership of subject matter expertise and be open to engaging in academic practices that go against recognition structures (such as promotions) in academia (Macfarlane, 2017; Newell, 2019).

The establishment of this academic practice was facilitated by the greenfield context in the School. This provided opportunities for different practices and relationships to develop. The urgent transition to online teaching during the pandemic enabled a more supportive and collegial relationship amongst team members, including the sharing of expertise. We consider that this experience contributed to collective 'ownership' of expertise in our context. This relatively rare academic practice provides opportunities for team members to contribute ideas, innovations, and shared understandings, without the threat of straying onto a colleague's 'expert turf'. As noted in the reflections, this is unusual and challenges the hegemony of the subject matter expert working in isolation. Our approach aligns with the recommendations made by Dart and colleagues (2023) regarding the capabilities for engineering educators and the importance of valuing good pedagogical knowledge and practice.

It is rare that new Schools are established, or that educational practice requires the rapid transition necessitated by the COVID move to remote teaching. While our experiences trace the foundations of collaborative teaching to these external factors, it is not necessarily the disruptions themselves that enabled the success of the collaborations. Newell & Bain (2020) highlight the reliance of successful collaborations on individuals' capacity to collaborate, but as "conscious team-building" is prevalent in the reflections, it is important to ensure structural supports and practices to continue building collaboration and establishing it in other contexts.

Building relationships with regular meetings, sharing of resources, drawing on others' expertise and contributing to their success are examples of "good group work practice" taught to students in our professional practice classes (e.g. Lindeck et al., 2021) These are well studied factors that contribute to group success and should be applied in our own context, so the collaboration can extend to a broader team and into the future.

Related to this conscious team-building is the explicit management of expectations and motivations. We found that team collaboration is unusual (for now) but is rewarding and beneficial to those involved. Reflections indicate how collegiality and collaboration improved psychological safety and work management. New participants to the team (or completely new teams) should be recruited and inducted with the expectations of collaborative academic practice. It is 'out of scope' for us to change the structure of reward and recognition in academia. However, through recruiting academics open to engaging in shared teaching, we may shift 'traditional' academic practice to model what we want from our graduates: collaborative practitioners (e.g. Beddoes, 2020).

Limitations

While the findings indicate that we believe our experiences of collaborative teaching bring benefits to program design, this study has not looked at the student experience. The next phase of the study intends to seek student perspectives on learning in the core subjects. In addition, we plan to gauge the perspectives of other stakeholders, such as recent graduates and employers. Another limitation is that the reported perspectives are specific to the researcher-participants. We

recognise our context's unique conditions, but acknowledge it is worth reviewing what has worked, so that others can utilise our insights and adapt this approach to their own context.

Conclusion

Through a collaborative autoethnographic approach this study explored the experiences of researcher-participants engaged in an innovative approach to collaborative teaching across compulsory core engineering and IT units of study focused on developing professional capabilities. The study sought to uncover the conditions which enabled this approach to emerge and flourish, and how the approach has created rich learning experiences for those involved. The study identified three themes which influenced collaborative teaching approaches, namely: *academic practices*, *conscious team-building*, and *collaboration and collegiality*. The theme of academic practices described a dichotomy between "traditional", siloed "lone ranger" approaches, ideas of subject ownership, and feelings of isolation. This contrasted with a culture of collegiality and collaboration. The theme of conscious team-building spoke to the intentional actions taken to build and maintain the teaching team. This included the sharing of ideas, support for colleagues, and the development of trust. Finally, the theme of collaboration and collegiality spoke to the idea of being a collaborative team as well as the experience of collaboration on projects and tasks.

The reflections made it clear that the approaches aligned with team members' values and that this was a key enabler of team development. An ongoing challenge is growing a team beyond those who choose to work this way.

The findings show team collaboration is unusual but rewarding to those involved. Reflections indicated collegiality and collaboration improved psychological safety as well as improving work management; these benefits should be considered by all academic teams. This study provides insights for the (re)development of such a collaborative team to enable a shared culture, and provides a call-to-action to do such work consciously.

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