

Challenges and solutions of teamwork in engineering education

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ABSTRACT

The challenges, issues and concerns regarding the use and assessment of students group work have many commonalities across all engineering disciplines, as well as the methods used to address them. Hence, it is highly significant for the engineering community to discuss and share experiences. This workshop does this two-fold:

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- i) Gets a diverse range of staff from a variety of engineering disciplines and institutions to reflect on, share and discuss in this workshop their practice to make the running and assessment of group work more successful;
- ii) Gathers teamwork teaching experiences and common challenges across the sector when teaching teamwork and to start identifying methods and approaches for tackling these challenges.

This workshop is relevant to all those in engineering education using group work (instructors, curriculum designers, etc) regardless of their level of experience. Pre-workshop survey (optional): <https://forms.office.com/e/6xzKt2GqA6>

1 INTRODUCTION, MOTIVATION AND LEARNING OUTCOMES

Teamwork has become an intrinsic element of professional life regardless of the engineering field, allowing diverse and multidisciplinary or specialized teams to address more complex/bigger problems. The World Economic Forum's Future of Jobs Report consistently discusses the need for graduates to have a mix of professional skills, global competency, and technical knowledge (World Economic Forum, 2020). Active learning methods, such as project-based learning (PjBL), are the gold standard for teaching skills in a wide range of contexts (Kolb, 2015). Participating in group projects help students to develop their skills and ability to work in teams in a variety of scenarios, but also develop their technical skills and knowledge further. Consequently, now the use of teamwork activities is highly common in Engineering Higher Education (HE). However, running and assessing group work in any engineering discipline has its own challenges and has raised a range of concerns among students, staff, external examiners and professional bodies that perform external-led degree audits e.g. for accreditation purposes.

Riebe et al (2016) in their systematic review of various case studies, categorised challenges associated with delivering and assessing teamwork in HE context into two themes, i.e., teamwork pedagogy and transaction costs. Challenges associated with teamwork pedagogy include: (I) Instruction strategies, whereby educators and learners lack prior experience, view teamwork as an inefficient use of time and find moving away from tutor-centred teaching challenging (Holt et al, 1997), (II) Curriculum design – the degree to which team skills development is incidental or intentional in the curriculum, (III) Team composition, and (IV) Assessment.

Williamson's (1979) transaction cost theory assumes that engagement is a function of the benefits or costs derived from developing, coordinating, monitoring, participating in, interacting with, and evaluating teamwork pedagogy. Thus, challenges associated with transaction costs include, (I) meeting employer and accreditation body expectations, (II) tutors' readiness to develop resources, strategies and interventions for teaching teamwork, (III) learners' readiness and (IV) availability of institutional resources and focus.

The use of self - and/or peer assessment procedures including the implementation of online team tools to provide feedback on the effectiveness of team members have the potential to reduce the temporal and efficiency related costs (Delaney et al, 2013). This paper focuses on one such tool, the Individual Peer Assessment of Contribution to group work (IPAC), developed at University College London (Garcia-Souto et al, 2020). The application of this tool entails the tutor assessing and

awarding a group mark to a group task completed by learners. The learners then assess the level of contributions of each of their peers, including themselves, from which an IPAC factor is generated after moderation by the tutor. This IPAC factor may then be applied formatively or summatively to generate individual marks for the group members. The IPAC assessment methodology has been seen to mitigate a number of the challenges and concerns typically observed by staff and students (Garcia-Souto, 2019, Seatwo A, 2019). UCL has developed an LTI that allows practitioners to implement this assessment methodology easily and time efficiently within their institutional virtual learning environment. The IPAC methodology and system are briefly presented, and attendees invited to try in their own institutions.

The leads of this workshop bring to the table their collective experiences of running 6 different case studies within the Integrated Engineering Programme (IEP) at University College London (UCL) - one of the most comprehensive and largest applications of active learning methodologies within undergraduate engineering curricula in the UK (Mitchell et al, 2019). The selected case studies, all of which use the IPAC methodology, provide a comprehensive representation of the journey the students take from year 1 to year 4, in different class sized (80 to 1000) and with projects of different length and weight towards the final degree classification. A series of challenges/concerns and also mitigations found by the authors (Garcia-Souto et al, 2024) were explored in the workshop.

A long-term potential outcome of this workshop is the identification of further methods that can support any academic in an engineering subject in any HE institution when planning/running group work.

2 BACKGROUND AND RATIONALE OF THE SESSION

The challenges faced by academic staff when implementing and assessing group work truly apply across engineering fields and educational institutions/universities. Yet, staff discussions of good practice and published literature typically (if not always) occur at “local” level and lack breath of disciplines and experiences.

This workshop is an excellent opportunity to discuss and reflect on experiences from a broad range of staff running teamwork activities in engineering education (covering as many case studies, engineering disciplines and institutions as possible) and to help to truly identify good practice across the sector. Analysis will then be done post-workshop to identify common challenges across the sector when teaching teamwork and to start identifying methods and approaches for tackling these challenges. An initial summary will be included in the workshop paper as part of the proceeding with the aim of a more comprehensive paper published later (register interest in the link provided in section 4). This is of relevance to the overall community of engineering educators across institutions, countries, engineering fields that currently run or plan on running group work within their modules or engineering degrees.

3 WORKSHOP STRUCTURE

The structure of the workshop is as follows:

- Introduction – the challenges of running and assessing group work (10 mins):

- Groups discussion - discuss current practice/possible process to address/mitigate challenges of group work (30 mins):
- Groups feedback moderated by workshop leads (10 mins)
- Presentation of the IPAC system/methodology used for the assessment of individual contribution to group work (3 mins)
- Summary of outcomes and closure (3 mins)

4 RESULTS FROM THE WORKSHOP

A total of 20 people from a variety of institutions attended this workshop and agreed to participate in the study (UCL Research Ethics Committee: Project ID number: 6257/003 – part1). They were asked to assess the prevalence and impact of a series of challenges as well as usefulness of various mitigations. Results are presented in tables 1 and 2 respectively. They were also encouraged to comment on additional challenges and mitigations.

Rating criteria: 0-Negligible; 1-Low; 2-Significant; 3-Very

Table 1. Assessment of prevalence and impact of various challenges when running group work.

Challenge	Prevalence			Impact		
	N	avg	SD	N	avg	SD
A. Uneven student contribution/engagement	15	2.2	0.6	14	2.4	0.8
B. Validity of assessment (Is assessment representative of contribution?)	14	2.0	0.9	12	1.8	0.9
C. Diversity in the team (Potential conflict from differences in a team's experiences and background)	14	1.9	0.6	14	2.0	0.9
D. Teams with students requiring adjustments (due to disabilities or emergency circumstances)	10	1.1	0.6	11	1.1	0.9
E. Readiness of students to work in a team	14	1.6	1.0	14	1.8	1.0
F. Formation of teams	11	1.2	1.1	11	1.0	0.9
G. Team cohesion	13	2.0	0.7	13	1.9	0.6
H. Staff workload	11	2.4	0.8	12	2.4	0.7
I. Readiness of staff to teach teamwork	10	2.3	0.7	10	2.2	0.9

Table 2. Assessment of how useful were various mitigations when running group work.

Mitigations	Usefulness		
	N	avg	SD
1. Peer assessment of individual contribution (IPAC)	10	2.3	0.6
2. Training students on teamwork skills development	10	2.3	0.5

3. Check points with staff (e.g. IPAC, attendance...)	11	2.2	0.5
4. Team contract	11	0.8	0.8
5. Balance team formation (e.g. diversity, avoiding known conflicts)	10	1.9	1.1
6. Resilience in the projects (e.g. feasible even with a missing team member)	9	1.4	0.5
7. Staff resilience	10	1.8	0.8
8. Exceptional cases addressed/dealt/supported by staff	11	2.4	0.7
9. Staff training	7	2.4	0.5

Workshop participants reported experiencing to some extent all the challenges listed by the authors, although the prevalence and impact of each varied for each participant. Statistically, the challenges with larger prevalence and impact are *A-Uneven student contribution/engagement*, *H-Staff workload*; and *I-Readiness of staff to teach teamwork*. Participants also pointed out additional challenges, with the most common being “language barriers”, “lack of time management skills” or “students dropping out”.

Participants shown to have engaged with a number of the mitigations presented by the authors, but often just a subset. The mitigations that participants used and found most useful were *1-Peer assessment of individual contribution (IPAC)*; *2-Training students*; *8-Staff addressing exceptional cases*; and *9-Staff training*. In regards to the “student training”, participants felt compelled to list a series of examples of good mitigations or something that should be incorporated (e.g. self-reflection, teaching time management or conflict resolution), just stressing the importance of training. Some participants also suggested that student training should be done at programme level, with coordination between academics that run group work, which agrees with the approach used by the authors (Garcia-Souto et al, 2024). Another additional mitigation used by some participants was allowing students to choose their own groups, particularly when they know each other from earlier group work in the course.

There was some criticism about how the challenges and mitigations were assessed, since it was considered that some of them were very context dependent and/or had several dimensions, especially when talking about “diversity in the group”. Authors agree with this, and it was a limitation of the workshop time length, but authors hope to address this by collecting more in-depth views via the online form (link in section 5).

5 WORKSHOP OUTCOMES

- Gathered and evaluated teamwork teaching experiences and common challenges across the sector when teaching teamwork and to start identifying methods and approaches for tackling these challenges.
- The IPAC assessment methodology (Individual Peer Assessment of Contribution to group work) has been identified among workshop participants as a commonly used method of addressing/mitigating a number of issues/concerns related to the group work. Staff from all universities are

invited to try the IPAC system, that makes the running of this assessment methodology very easy - just send email to Pilar Garcia-Souto (p.garciasouto@ucl.ac.uk).

- Institutions and teaching teams should be providing staff training to better equip their academics on the running of group work. Training to students should also be expanded or formalized within the course. The actual specifics on staff and student training needed still needs to be defined.
- Authors need to collect a wider and in-depth range of experiences and views from academics. Can you tell us about your experience? Please complete the form here, still open for submissions (<https://forms.office.com/e/6xzKt2GqA6>) or get in touch.

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