

## **Designing Inclusive Teamwork Activities to Improve International Masters Students' Teamwork Skills in Chemical Engineering**

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I am a PhD candidate in engineering education at the University of Sheffield. With a strong academic background in engineering and a genuine passion for educational advancement, I decided to specialise in engineering education, seeking to contribute to the enhancement of pedagogical practices within the engineering and science domain. My current PhD research is focused on investigating overseas students' learning experience in engineering master programmes at UK universities. Before joining the Department of Chemical and Biological Engineering at the University of Sheffield, I worked as an educational consultant in China. Alongside research, I worked as a graduate teaching assistant (GTA) in multiple labs in the Faculty of Engineering and joined a research group of inclusive research culture in the Department of Electronic and Electric Engineering.

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## Work-in-Progress:

# Designing Inclusive Teamwork Activities to Improve International Master's Students' Teamwork Skills in Chemical Engineering

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**Abstract:** The internationalisation of higher education has led to a rise in the number of international students enrolling in British universities. This trend is especially noticeable in the enrollment in one-year engineering postgraduate taught (master's) programmes. Then another significant change is the recent shift in engineering education towards project-based approaches, which means that more student teamwork is required. However, many international students lack the essential teamwork skills as the development of these skills is often under-emphasised during their previous studies. In addition, most of these students have limited or no relevant work experience. Consequently, developing strong teamwork competencies not only enhances the effectiveness of their present academic endeavours but also augments their prospects for future career progression. By recognising this need, this study presents an inclusive workshop framework, aiming to provide master's students with the opportunity to develop general teamwork proficiencies whilst exploring new team roles and dynamics that are more appropriate in an educational context. To assess the student's performance in the workshop, a teamwork assessment questionnaire is used to help students reflect on learning and evaluate teamwork behaviours. Subsequently, semi-structured interviews and focus group studies are conducted after the workshop to investigate students' perceptions of teamwork in depth.

**Keywords:** International Students; Master's Students; Team Performance; Engineering Education.

## Teamwork in Engineering Education:

In the context of global higher education reform, engineering education has emerged as a strategic priority for universities, underscoring the imperative for institutions to bolster their capacities in talent acquisition and development, scientific research and education, as well as social engagement and responsibility (Shuman et al., 2002; Monteiro et al., 2018; Ren et al., 2020; Fan et al., 2021). Also, acknowledging the evolving landscape of engineering education, there is a pressing need to enhance engineering graduates' professional competencies, particularly in international and intercultural collaboration, to enhance their future employability (Gladysz et al., 2020). The acquisition of teamwork and collaboration skills has become indispensable for engineering graduates in both societal and industrial contexts (Ercan & Khan, 2017). It is thus increasingly important to provide university students with comprehensive learning and practice on teamwork, as the encompassing skill set, including communication, leadership, and conflict resolution, constitutes essential soft skills

crucial for their future careers (Scott-Ladd & Chan, 2008; Gantasala, 2015; Ostafichuk et al., 2020; Adham, 2023). By gaining experience via team collaboration, students can prepare themselves for future collaborative projects in the workplace, helping them navigate multidisciplinary working styles and contributing to increased motivation (Pardo-Garcia & Barac, 2020). Furthermore, it promotes peer-to-peer learning (Maccabe & Fonseca, 2021), enhancing mutual understanding through shared efforts (Volkova et al., 2021). Therefore, it is essential for educators to guide and facilitate teamwork among university students, enabling the development of their transferable and soft skills through continuous practice while learning technical expertise.

Within engineering education, collaborative efforts can augment learning beyond the required textbooks and other materials, proving to be more efficacious than in-class instruction, particularly when focusing on higher-order cognitive processes (Bayram & Bütün, 2020). An examination by Ismail et al. (2019) evaluated the impact of teamwork within project-based learning, shedding light on its influence on individual cognitive and affective performance to complete coursework. Another research conducted by Misaki et al. (2020) also aligned with the growing consensus advocating for developing engineering students' competencies in knowledge acquisition, communication, teamwork, and creativity via engaging students in more team-based activities with local cultural perspectives. Lukusa et al. (2020) conducted a case study involving honours students in Information Systems, examining the interplay between teamwork, team members' success, and overall team performance. Van den Beemt et al. (2020) illustrated the conceptualisation, implementation, and facilitation of Industry-Engaged Education (IEE) in higher engineering education, addressing challenges related to defining clear learning goals and support, teaching and learning elements, required skills and assessments for interdisciplinary contexts.

Indeed, most teamwork has been studied in student groups, but the impact of individual students' characteristics and educational development on teamwork skills has also attracted the attention of researchers. De Prada et al. (2022) endeavoured to address this point by investigating the teamwork skills among college students and their correlation with socio-academic variables such as gender, academic year, and grade point average (GPA), thereby fostering equity and fairness in higher education classrooms. Another recent study suggested that deficits in Chinese international students' intercultural communicative competence (ICC) may impact their self-perceptions and compromise their ability to engage effectively with peers (Lin & Zhang, 2021). The result may imply the possible influence of language and cultural factors on team collaboration.

Besides addressing individual traits, another issue often discussed during teamwork activities is members assessing each other on a peer-to-peer basis. Team formation requires members to build relationships and interact with each other. Peer review in Team-Based Learning (TBL) serves three primary purposes: promoting individual behaviour reflection, fostering professional skill development, and preventing the emergence of free riders who do not contribute effectively to team tasks (Burgess et al., 2021). De Graaff et al. (2007) also illustrated that peer review can promote teamwork and prevent free riders while helping faculty reduce the burden of assessments. Furthermore, drawing from organisational theories, Van Diggele et al. (2022) proposed models of leadership as a conceptual framework for fostering student leadership qualities during collaboration and evaluating team outcomes by providing constructive written feedback to each other. Similarly, Mandala et al. (2018) indicated that peer review as a team is an effective form of providing high-

quality feedback on team activities, allowing students to learn from each other while assessing the work of others.

In short, the importance of teaching teamwork in higher education is underscored by a wealth of research highlighting its multifaceted benefits for preparing students for the collaborative demands of the professional world. Moreover, the exploration of various teamwork teaching strategies and curriculum designs reveals that effective implementation not only enhances student engagement but also promotes a positive learning environment. Engaging in teamwork activities in the classroom allows students to holistically recognise the diverse perspectives within teams, facilitate peer-to-peer learning, and create network opportunities. Thus, as higher education continues to evolve, acknowledging and integrating these insights of teamwork into educational practices becomes increasingly vital for preparing students academically, socially, and professionally.

### **Methodology:**

This study employs a mixed-methods research design to comprehensively investigate the teamwork behaviour and team dynamics of international engineering master's students within a workshop setting. The design incorporates quantitative and qualitative data collection methods to understand the students' teamwork experiences holistically. By combining quantitative data from the workshop questionnaire and qualitative insights from in-depth semi-structured interviews and focus groups, a more detailed picture of student teamwork dynamics will emerge and contribute to developing a new team role test tailored specifically for educational contexts.

#### **Workshop Design:**

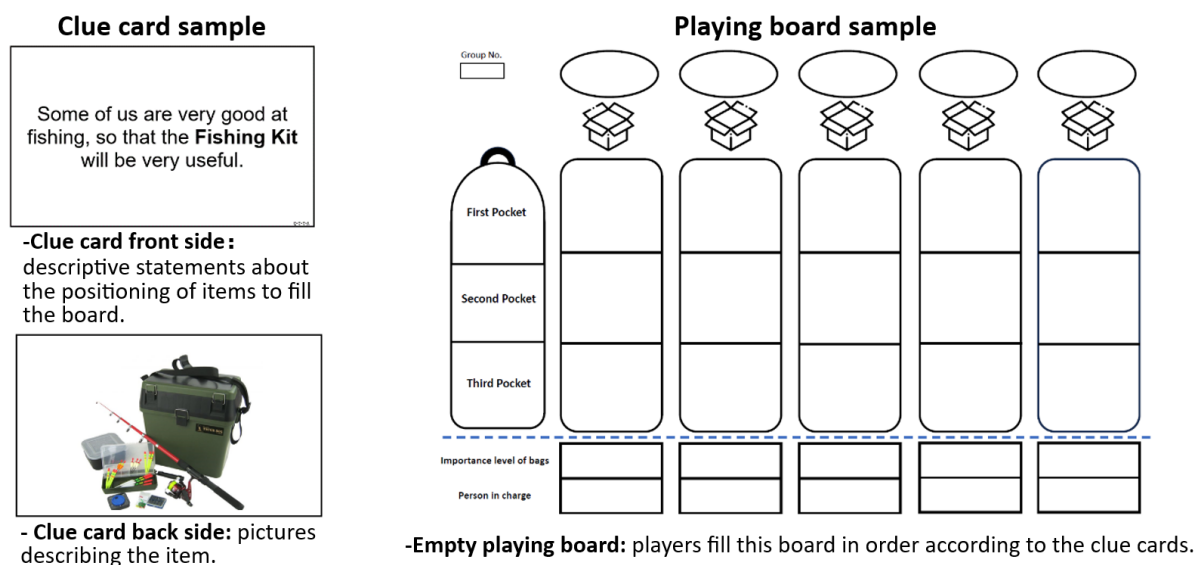
This inclusive teamwork workshop comprises a board game (Activity 1) adapted from the team-building activity "Lost at Sea" (*Lost at Sea - a team building game*) and a project-based learning activity titled "Create Your Project" (Activity 2). The students participating in the workshop are grouped into teams of 5-6 individuals, with the group formation predetermined by the departmental academic staff. In the workshop, we provide each group with the teamwork game instructions, a set of clue cards, an empty game board for Activity 1 and another set of the project design instructions for Activity 2, as well as the relevant individual task materials for the five roles in the project design activity. Figure 1 illustrates the design template of the clue cards and the playing board for teamwork Activity 1. Table 1 outlines the principle for assigning roles in the project-based learning Activity 2.

In order to ensure that the entire workshop was delivered accordingly, the module leader facilitates the session. Two graduate teaching assistants (GTAs) are recruited as co-facilitators to support the teaching activities. The workshop facilitators are responsible for introducing the gameplay, addressing any queries regarding the activities, managing the time for Activity 1; and reminding students of the various stages and managing the time for Activity 2.

#### **Research Sequence:**

- Introduction of the teamwork activities and their objectives.

- Participants engage in teamwork activities.
- A post-activity questionnaire is given after the session to promote students' reflections on teamwork (A structured questionnaire comprises close-end, Likert-scale and open-ended questions, probing participants' perceptions of their individual and collective contributions to the teamwork activity).
- Semi-structured interviews and focus group studies are conducted with the master's students after the workshop to delve deeper into their perceptions of teamwork, the effectiveness of the workshop, and any challenges encountered during the team-based activity. Conversations in these studies are audio-recorded and transcribed for qualitative analysis.



**Figure 1.** The design template of the clue cards and the playing board for activity 1.

**Table 1.** The role and task assignment principle for Activity 2

If you choose ... in activity 1:	You consider to be ... in activity 2:	Role description & task:
1 <sup>st</sup> rank survival bag	Leader	Learning material pack 1
2 <sup>nd</sup> rank survival bag	Responsible for calculating work	Learning material pack 2
3 <sup>rd</sup> rank survival bag	Responsible for hands-on activity	Learning material pack 3
4 <sup>th</sup> rank survival bag	Generating ideas	Learning material pack 4
5 <sup>th</sup> rank survival bag	Making slides	Learning material pack 5

Data

Analysis:

- Quantitative data from the questionnaire will be analysed using SPSS. Descriptive statistics and inferential analyses will be employed to identify patterns and correlations.
- Qualitative data from in-depth interviews and focus group studies will undergo thematic analysis by NVivo to gain deeper insights into participants' perceptions of teamwork.

### Early Findings:

The study aims to investigate and comprehend the team performance of international students enrolled in one-year engineering master's courses at a British university. In order to design practical

workshops and activities to enhance students' teamwork proficiencies, we applied the Belbin Self-Perception Inventory (BTRSPI) questionnaire to gain preliminary insight into the team role orientations of master's students. We chose to use the Belbin team test because it has been widely known and utilised in higher education practice (Aritzeta et al., 2007; Aranzabal et al., 2022).

The initial results of the Belbin team test showed that the frequency of performance in social-oriented roles was 49% of the international students attending the workshop, followed by 24% for action-oriented roles, and the most minor frequency, at 19% for thinking-oriented roles. However, the observed team performance of the students does not quite align with these Belbin results. This discrepancy may be attributed to the fact that most popular team role assessments, such as Belbin, are designed and utilised within commercial organisations' management and operations. Belbin is primarily targeted at individuals with extensive professional and employment backgrounds, so it may not adequately meet the needs of university students in their academic journey.

In our latest investigation into students' teamwork, we have found that 90.3% of international students identify themselves primarily as collaborators rather than leaders within a team. Moreover, a significant portion of the challenges they faced revolved around language barriers, with 25% indicating difficulties in communicating in English and 20.8% struggling with effective communication.

According to the literature review, fewer studies focus on developing specific team role tests for student cohorts. Most previous research on student collaboration predominantly features domestic undergraduate students in Western academic settings, resulting in a lack of reports regarding team dynamics among international student cohorts. Therefore, we will investigate more in future studies to fill this gap.

#### **Future Work:**

The current research stage has gained a preliminary understanding of master's students' teamwork behaviour within an inclusive workshop, thereby providing theoretical and empirical support for the subsequent design of the new team role test in educational settings. Consequently, the forthcoming phase of this study will refine the design of the inclusive workshop framework and further explore international students' perceptions of teamwork performance and roles through semi-structured interviews and focus group studies. Additionally, the study endeavours to innovate by adapting the teamwork games into more flexible and accessible digital formats to benefit a diverse group of students. These efforts seek to accelerate the process of team building among student cohorts within educational environments. This study is expected to provide valuable insights for enhancing international students' learning experience and efficiency in British universities, as well as to provide references for students from different backgrounds to develop lifelong learning skills.

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