Investigating the Challenges of Teamwork for 1st Year Undergraduate Engineering Students

Mauryn C. Nweke, University College London, United Kingdom
Manal Chaib, University College London, United Kingdom
Matthew Banner, University College London, United Kingdom

The European Conference on Education 2023
Official Conference Proceedings

Abstract
Literature has shown that the ability to work in teams is one of the most highly coveted skills by engineering employers (Levy & Rodkin, 2016). On the Biochemical Engineering programme at UCL, teamwork is present across the programme curriculum and has seen consistently high levels of positive feedback in annual evaluation surveys. However as the pandemic forced educators to move to the online environment, this resulted in significant implications for how students interacted with each other and engaged with teaching material, which in turn highlighted gaps in staff support. As we move to a blended approach, this project sought to understand the challenges 1st year undergraduate students face with teamwork in remote settings vs. in-person vs. a blend of both, discern any difficulties in teamwork related to inclusivity and gather information on how teaching staff could better support students working in teams for the first time at university. We addressed this with a mixed-method approach consisting of questionnaire design and case study-based workshops with our post-pandemic cohort of students who have experienced in-person, online and blended learning. Results showed that communication and engagement were the most common challenges students faced in remote teamwork settings, specifically related to language barriers and accessibility. The results also highlighted issues with inclusivity related to students who do not have English as a first language. It was also highlighted that there was a need to better address the implementation of adjustments for disabled/neurodivergent students in teamwork settings.

Keywords: Teamwork Challenges, 1st Year Engineering Students, Remote vs. In-Person

Introduction

Teamwork skills are of paramount importance in the field of engineering, as they play a vital role in achieving successful and efficient project outcomes. Engineering projects are rarely solitary endeavours; they require collaboration and coordination among diverse specialists to address multifaceted challenges. *Diverse expertise* is one of a number of important outcomes of teamwork as engineering projects involve multiple disciplines, such as mechanical, electrical, software, and civil engineering. Team members bring unique skills, knowledge, and perspectives to the table, contributing to innovative solutions that a single individual might not envision. A study conducted by Pazos et al., 2020 looked to explore what aspects of teamwork skills were enhanced through interdisciplinary collaborations in engineering. It was found that the diversity in disciplinary knowledge encouraged *holistic* and *innovative* solution strategising and creation. Other competencies developed during teamwork include:

1. *Complex Problem Solving***:** Engineering challenges often involve intricate problems that demand creative solutions. Collaborating with team members allows for brainstorming, idea sharing, and refining concepts to devise optimal solutions.
2. *Effective Communication*: Clear and concise communication is integral to any engineering project. Teams facilitate effective information exchange, preventing misunderstandings and ensuring that everyone is aligned towards the project goals.
3. *Adaptability:* Engineering projects can encounter unexpected challenges. A well-coordinated team can swiftly adjust plans, redistribute tasks, and find solutions in a dynamic environment.

The table below summarises further reasons why teamwork skills are crucial:

Outcomes of teamwork upskilling	Rationale	Sources
Efficiency and Speed	A well-coordinated team can divide tasks, enabling parallel work on different aspects of a project. This accelerates the project timeline, saving time and resources compared to individual efforts.	(Chowdhury & Murzi, 2019; Kozlowski, 2018; Pazos et al., 2020)
Risk Mitigation	Collaborative teamwork ensures that multiple experts review and validate designs, reducing the likelihood of errors or oversights that might lead to costly mistakes down the line.	(Baker, Day, & Salas, 2006; Salas, Bisbey, Traylor, & Rosen, 2020; Shaikh, Osei-kyei, Hardie, & Stevens, 2023)
Professional Growth	Working in a team environment fosters personal and professional growth. Engineers learn from their colleagues, develop leadership skills, and gain insights into different engineering disciplines.	(Gelbard & Carmeli, 2009; Murzi, Chowdhury, Karlovšek, & Ruiz Ulloa, 2020)

Table 1- Outcomes of upskilling students in teamwork

With this in mind, a number of stakeholders involved in engineering curriculum development, implementation and assessment, such as accreditation bodies, industry collaborators, government and professional institutions have sought to ensure that teamwork be made an integral part of engineering education. At UCL Biochemical Engineering, students are upskilled through both theoretical and practical application of teamwork (Mitchell et al., 2019). The ENGF0001 module – known as The Challenges and managed by the Integrated Engineering Programme (IEP) at faculty level, is the first exposure to teamwork that 1st year Biochemical Engineering undergraduate (UG) students get in term 1. They work in interdisciplinary teams with Chemical Engineering and Biomedical Engineering students to solve a global issue (practical application) whilst learning about engineering teamwork on the Design and Professional Skills 1 module (DPS1) (theory).

Approaches and Challenges With Teaching Teamwork

Teaching teamwork skills to engineering students requires a multifaceted approach that combines theoretical knowledge with practical experiences. A number of different approaches are used on the IEP as described below (a more extensive explanation of these approaches can be found in Mitchell et al., 2019).

Project-Based Learning: In the first term of the first year of UG studies, students are enrolled onto the Challenges module which is the largest interdisciplinary project-based module on the UG curriculum (excluding final year projects) where they are broken into sub-teams and self-assign tasks to solve a global issue. Studies have shown that incorporating team projects into the curriculum, especially *interdisciplinary collaboration* exposes students to real-world scenarios and assigning diverse tasks encourages collaboration, problem-solving, and communication (Huang, 2010; Vogler et al., 2018).

Role Rotations: On ENGF0001 students use the Clifton StrengthsFinder to understand how their attributes contribute best in teamwork settings which allows assigning different roles within a team, such as leader, communicator, researcher, and timekeeper, allows students to experience various aspects of teamwork. Studies have shown that this approach enhances their adaptability and understanding of team dynamics (Read-Daily, De Goede, & Zimmerman, 2018).

Peer Assessment: On both the Challenges and DPS1, a number of peer-assessment approaches are implemented such as the use of Individual Peer Assessed Contribution to group work or IPAC (Garcia-Souto, 2017), GoReact for presentations (Nweke, 2021b) or in-built functions in the Moodle Virtual Learning Environment (VLE). Incorporating self-assessment and peer evaluation within teams has been found to encourage students to reflect on their contributions and receive feedback from colleagues. Studies have shown that this practice promotes accountability and highlights the importance of recognizing and valuing each member's input (Planas-Lladó et al., 2021; Willey & Gardner, 2009).

Simulations and Role Plays: On DPS1, mechanical engineering students participate in engineering ethics roleplaying which helps them place themselves in real-life workplace ethical scenarios. Studies have shown that engineering challenges through role plays or scenarios fosters critical thinking and decision-making in a controlled environment. This approach encourages students to collaborate under pressure and consider different viewpoints (Hayes, Power, Davidson, Daly, & Jackson, 2019).

Industry Collaboration: Industry collaboration is present in various parts of the IEP programme, particularly in the DPS1 scenarios (Mitchell et al., 2019). Literature shows that partnering with industry professionals on projects or internships exposes students to real-world teamwork dynamics. Industry mentors can provide insights into effective collaboration, emphasizing practical skills that extend beyond the classroom (Faizi & Sarosh Umar, 2021).

Communication Workshops/Classes: The DPS1 module is where communication theory is learned. This includes written communication (reports) as well as verbal communication (presentations, pitches etc.). Conducting workshops on effective communication, active listening, and conflict resolution has been shown to equip students with essential soft skills for successful teamwork. Studies have shown that these workshops encourage open dialogue and mitigate potential misunderstandings (Sharp, 2001).

Reflective Practice: Both the Challenges module and DPS1 use reflections in various pieces of assessment. This was implemented in order to encourage students to analyse their teamwork experiences and their own impact and contribution to their team's efforts. A number of publications have reported that reflective exercises help students identify strengths and areas for improvement, enhancing their ability to work harmoniously in teams (Hirsch & McKenna, 2008).

Gamification: Minecraft has been used on the Challenges module as a virtual reality laboratory simulator (Yerworth, 2021). Literature reports that using educational games or simulations to teach teamwork concepts makes learning engaging and interactive. Gamified activities have been proved to help students grasp teamwork principles while having fun (Nurtanto, Kholifah, Ahdhianto, Samsudin, & Isnantyo, 2021; Zhang et al., 2018).

Combining these approaches has created a comprehensive strategy for teaching teamwork to engineering students. The IEP has been celebrated as having helped to create a well-rounded curriculum that integrates theoretical knowledge, experiential learning, and skill-building activities and better prepares future engineers for the collaborative challenges they'll face in their careers; and as such, was awarded the prestigious Collaborative Award for Teaching Excellence (CATE, 2017). However there are still a number of challenges that many institutions face (UCL included) in upskilling students in teamwork abilities.

As reported in a study by Fomunyam, 2021 *individualistic education culture* is often a tension when trying to upskill students in teamwork. The study found that engineering education often emphasizes individual achievement and problem-solving. Shifting from this solitary approach to collaborative teamwork can be challenging for engineering students as they are accustomed to working on their own. The impact of rising international student numbers in engineering (Harrison, 2011), as well as the effect of the pandemic on student wellbeing (Burns, Dagnall, & Holt, 2020) has contributed to the increase in *diverse backgrounds*, abilities and needs of the engineering student body. Aligning these differences and fostering effective communication among team members can be difficult. Other challenges that impact the upskilling of students in teamwork competencies can be found in the table below:

Challenge affecting teaching teamwork	Rationale	Source/s
Assessment	Evaluating individual contributions within a team setting poses a dilemma. Determining fair assessment methods that recognise both individual efforts and team collaboration requires careful consideration.	(Tucker & Abbasi, 2016; Willcoxson, 2006)
Uneven participation	Unequal participation within teams can hinder the development of teamwork skills. Some students may dominate discussions, while others remain passive. Balancing engagement and encouraging all members to contribute can be a persistent challenge.	(Burdett, 2003; McQuade, Ventura-Medina, Wiggins, Hendry, & Anderson, 2020)
Time constraints	Academic years and term/module times are restricted. More often than not, teamwork skills are developed during medium-long term projects, which poses problems for academic timelines.	(Alghamdi, Alsubait, Alhakami, & Baz, 2020; Kadam & Yadav, 2016; Kalu, Ozuomba, & Isreal, 2018)
Conflict resolution	Teamwork can lead to clashes in opinions, work styles, and approaches. Teaching students how to manage conflicts constructively and reach consensus is essential for productive teamwork.	(Forrester, 2013; Shapiro & Dempsey, 2008; Winter, Neal, & Waner, 2005)
Instructor training	Engineering educators may not always possess the necessary training in teaching teamwork skills. Developing their own understanding of effective team dynamics and communication can be an ongoing process.	(Kurtdede-Fidan & Aydoğdu, 2018; Malm, 2009)

Table 2- Challenges that impact the upskilling of students in teamwork

Addressing these challenges requires a multifaceted approach, involving consistent curriculum redesign, updating active learning strategies, experiential projects, mentoring and workshops. It also necessitates a cultural shift within engineering education to value teamwork as an integral part of engineering practice, rather than just a supplementary skill.

Impact of COVID-19 on Teamwork Teaching

The COVID-19 pandemic has significantly impacted the way teamwork is taught to engineering students, introducing both challenges and opportunities to the educational landscape. Some of the challenges are associated with the *lack of physical collaboration* and linked to that, *time zone differences*. Studies have shown the social nuances involved in in-person interaction related to communication and collaboration do suffer when moved to a

virtual environment and hinder the understanding needed for practical team dynamics (Goñi, Cortázar, Alvares, Donoso, & Miranda, 2020). Literature has also reported on *digital fatigue* becoming a factor when learning online. A study by Al Mulhim, 2023 showed that prolonged virtual engagement can lead to digital fatigue, diminishing students' enthusiasm for participating in online team activities and discussions.

However, as previously mentioned, the pandemic has provided novel ways to promote the teaching and learning of teamwork, particularly through the use of online platforms and virtual collaborative tools and simulations. Studies have shown that the use of technology has opened the door for global collaborations, irrespective of time zones, adaptive problem-solving due to the need to adapt to changing circumstances, which has been shown to encourage agile thinking and innovative problem-solving. Lastly, the gradual return to in-person teaching has allowed for flexibility in teaching and learning and therefore the introduction in hybrid team working models to prepare students for diverse working environments (Chafi, Hultberg, & Yams, 2022).

Aims, Objectives and Methodological Approach of This Study

Whilst face-to-face (f2f) teamwork allows for important social nuances in communication, this becomes challenging when working remotely. The pandemic has forced educators to move to the online environment which has not only impacted the way we teach but also how students interact with each other and engage with teaching material, which has in turn highlighted gaps in staff support. As we return to f2f teaching, studies have shown that there are elements of online teaching that could be useful but in saying that, more understanding is needed on how this impacts the upskilling of our students.

Objectives:

- Understand the challenges 1st year UG students face with teamwork in remote settings vs. in-person vs. a blend of both
- Discern any difficulties in teamwork related to inclusivity (e.g. language/cultural barriers, mental/physical disabilities etc.)
- Gather information on how teaching staff could better support students working in teams for the first time at university (incl. how it can best feed into our current SoRA/EC system)

***Student Sample*:** students in first year who had experienced the blended approach in the first term partook in this study during the second term of studies, class size 41 students.

The first data collection method used was a survey. In this study a survey was selected as it enables quantitative analysis and also facilitates scalability, which will be useful for the next phase of this study which aims to scale-out to other engineering disciplines. The survey approach also allows researchers to collect data from geographically dispersed participants, which may also be useful in the next phase of this study (Jones, Baxter, & Khanduja, 2013). The survey questions for this study can be found in table 3.

Survey Questions	Options
1. What is your student status?	Home, International (EU), International (Non-EU)
2. Is English your first language?	Yes, No
3. If you answered 'No', please state your first language below	Open ended
4. What gender do you identify with?	Woman, Man, Non-binary
5. What are some of the challenges you have faced with teamwork? Select all that apply	Communication: language barrier, Partially-/non-engaged team member(s), Work allocation/splitting, Assignment assembling, Conflict of ideas, Some members remote working, Problems between other team members, Working with someone you do not get along with, Other(s)
6. If you selected 'Other(s)' please specify below	Open ended
7. What is the biggest challenge you have faced when working in a team? Provide a specific example (e.g. draw from your experience on the Challenges module) and what was done to overcome it? Provide details of any support you received (e.g. from fellow students/staff)	Open ended
8. Do you have an understanding of how SoRAs/ECs are applied with regards to teamwork assignments?	Yes, No
9. If you answered 'Yes', what about this process would you change or improve?	Open ended
10. What recommendations do you have regarding how staff can better support students whilst working in teams?	Open ended

Table 3- The survey questions

The second approach used is a case-study based workshop. In this workshop, students were assigned to randomised teams for each of the case studies in figure 1. They were tasked with noting down how they would deal with the situation described and the type of support they would need. The results were analysed using thematic analysis as described in Caufield, 2019; Nowell, Norris, White, & Moules, 2017.

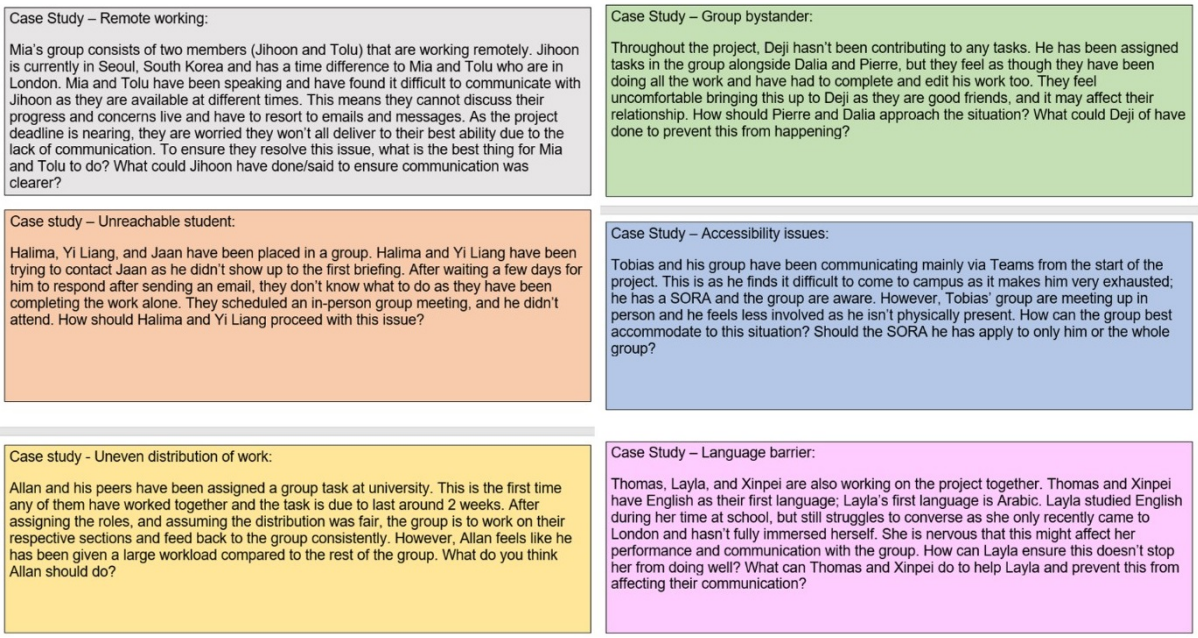

Figure 1- Workshop case studies

Conclusion

Quantitative data from the survey shows that 65% of students have international student status and the same percentage are non-native English speakers (figure 2). As demonstrated by question 3, of the non-native English speakers, 70% had Chinese as a first language, followed by Korean (7%), Spanish (7%), Malay, Italian, Polish and Swedish (~4% each).

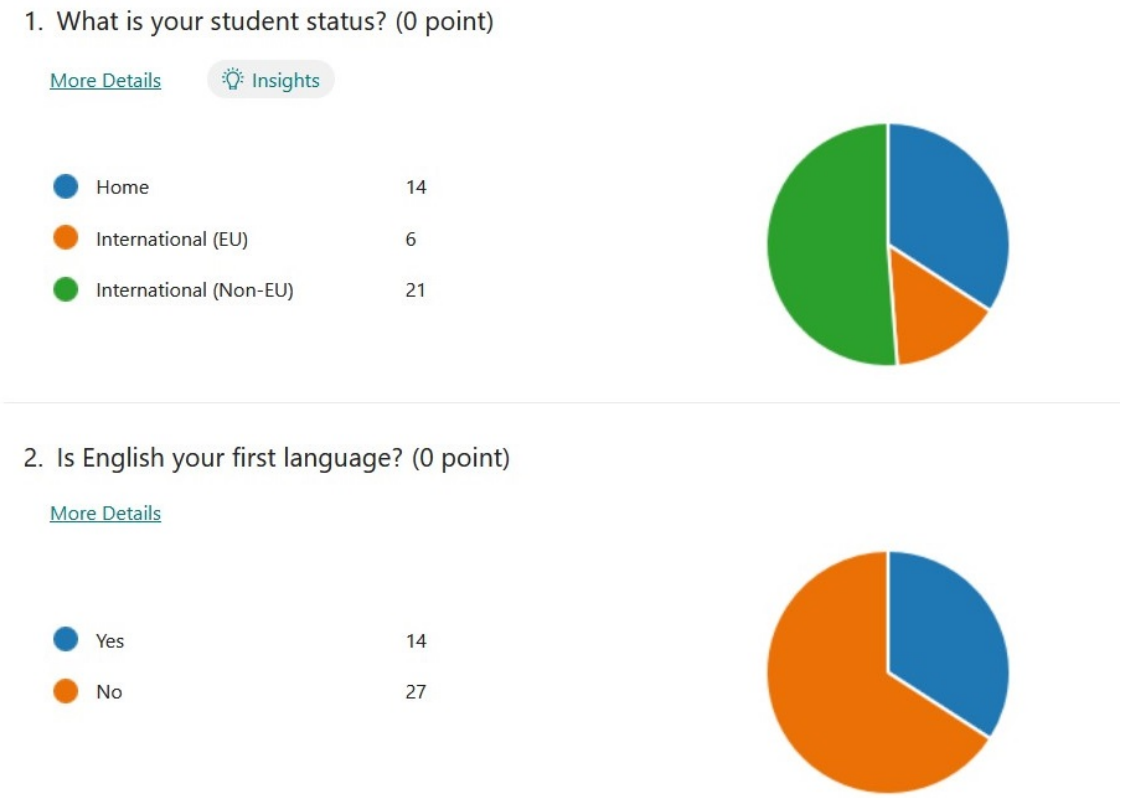

Figure 2- Survey questions 1 and 2: 1. 65% international student status.
2. 65% non-native English speakers

A study conducted by the University of Exeter in 2020 sought to understand international students' participation in teamwork and the main barriers that impact team cohesion and success (Straker, 2020). The main outcome suggested that English language competence was the main barrier. This corroborates the results gathered in this study, particularly in question 5 (figure 3) where 'Communication: language barrier' was the highest rated challenge faced by students working in teams (68%). This was closely followed by 'Partially-/non-engaged team members' (61%).

Figure 3- Survey question 5. 'Communication: language barrier' and 'Partially-/non-engaged team members' were the most highly rated challenges

A study conducted by Liu, Hu, & Pascarella, 2021 makes a link between communication/language and engagement and suggests that engagement of non-native English speaking students is impacted by challenges in language and further linked to that, reduced cognitive outcomes. Thematic analysis of question 7 corroborates this from the perspective of non-native English speaking students. There was a frequent occurrence of themes related to 'a lack of understanding of the work allocated' as well as a frequent occurrence of themes related to 'how this impacted team workload' from native-English students' perspectives:

Non-native English Speaker 1:

> *"Language problems. Sometimes I cannot understand what they are talking about."*

Non-native English Speaker 2:

> *"Sometimes I can't express my idea in English correctly. I tried to use simple words to explain ideas."*

Native English Speaker 1:

> *"When there is a language barrier involved, the distribution of work is not made simple, and often times team members do not contribute to discussions and cannot come up with solutions to the assigned problems. Also non cooperative teammates mean that the rest of the team has to undertake more work."*

Native English Speaker 2:

> *"In the group project … last year, half of my team could not speak English which meant that only two of us did all of the work. The biggest challenge was during challenge 2 where I was paired with someone who also could barely speak English and barely provided any ideas of his own to solving the problem. Even though he was helpful at times, I did most of the research and all of the writing of the report. In this case, the other team members offered to help out but I ended up doing most of the work."*

Non-native English Speaker 3:

> "*My team members are so nice and they finished all things themselves without my help."*

The next phase of this study will involve further analysis into the link between these perspectives and teamwork grades to ascertain if there is a link between communication, engagement and desired cognitive outcomes.

Question 8 (figure 4) showed that 44% of student did not understand how the current UCL academic adjustments for those impacted by disabilities (incl. neurodivergence) applied to teamwork assignments. The current college regulations allow for assignments to be adjusted for the whole team if at least one team member has a SoRA or EC. However this can be challenging depending on the student's condition, therefore a common approach is a deadline extension. A good recommendation was proposed in a response to question 9:

> *"Sometimes a team wide deadline extension is not a proactive way of considering a SoRA, perhaps a different mark scheme could be beneficial, as well as perhaps removing certain penalties for tasks which don't correlate to academics. For example going overtime in presentations."*

This suggestion corroborates the Good Practice Framework report published by The Office for the Independent Adjudicator on Supporting Disabled Students (OIA, 2017) which advocates for the use of a range of assessment methods. Different universities have different applications of adjustments for disabled students, however not enough has been published on best practice in teamwork applications, especially within the context of Engineering.

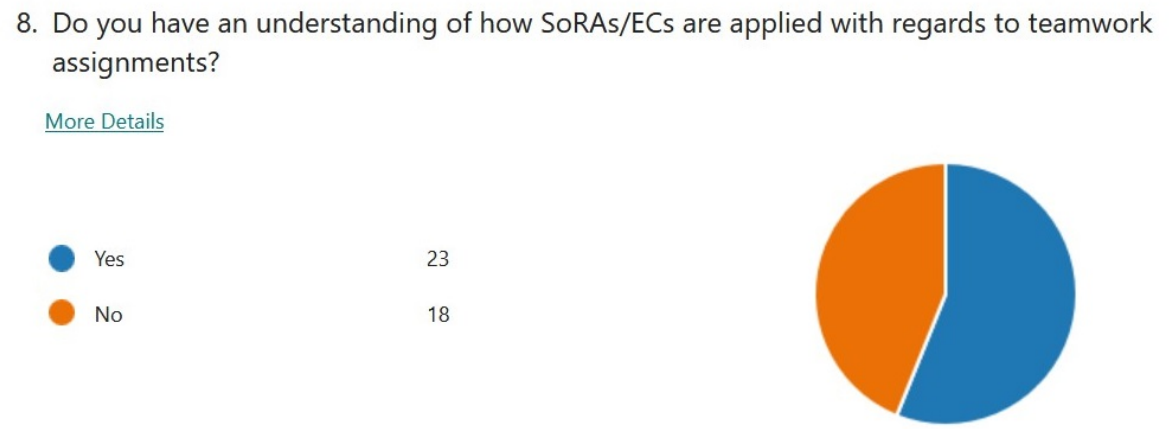

Figure 4- Survey question 8. 44% of students do not understand how SoRAs/ECs are applied to teamwork assignments

Question 10 used thematic analysis to evaluate suggestions made by students on how staff can better support students in teamwork contexts. Frequent themes related to more staff monitoring of teams, harsher penalties for non-contributing members, issues with space for teamwork:

> *"They can allocate a specific time to the team and make sure that they are all present but mostly it is the job of the students. The staff can monitor via meeting minutes and interfere if necessary."*
>
> *"Have rooms designated for project work and time allotted in timetables to see a lecturer/teacher as a team."*
>
> *"Making it more strict regarding the final grade if people are not involving."*

Another frequent theme identified was around language support:

> *"Provide better support for students who struggle with English and ensuring all the students are on the team allocations."*
>
> *"Help translate and surpass language barriers. Push students into contributing in the teams."*

As a result of some of these suggestions, a number of initiatives will be implemented for the next academic year and the next phase of this study aims to assess the impact of these changes on teamwork and student performance. With the opening of the UCL East campus, all teaching activities will go back to face-to-face and adequate teaching spaces for teamwork activities have been reserved as well as an increase in staff support (via the increased use and training of post-graduate teaching assistants – PGTAs), this will aid in more frequent staff check-ins and monitoring of team progress. After a successful pilot of the Academic Communication Centre's services in the department of Electronic and Electrical Engineering (reported in Nweke, 2021), this service will be made available to all departments across the IEP to help students improve their English language skills.

The qualitative data collected from the responses to the case studies used thematic analysis to evaluate the feedback provided by the students. The table below summarises the themes that occurred most frequently.

Case study	Main Theme/s	Quote/s
1.Remote working	• Use of shared documents • Time zone/time adjustments	*"Mia and Tolu could meet up in person and do part of the work, and give the rest of the work for Jihoon to work on remotely. Additionally, using a live google doc they could comment on each other's work."*
2.Unreachable student	• Consult staff • Adjust assessment	*"Approach the group leader / professors to discuss about the issue."* *"Do the project on their own with appropriate marking changes."*
3.Uneven distribution of work	• Seek help (from peers/staff) • Evaluate how work is distributed	*"Split up work differently: if done by splitting number of pages, could try splitting the number of chapters."*
4.Group bystander	• Understand if there are any ECs • Consult staff	*"As friends, you should warn them about bad behaviour. Talk to him directly and ask him why he isn't completing the work, if there are personal issues etc. If he doesn't respond well or continues not to do the work, tell a member of staff."*
5.Accessibility issues	• Meet closer to his/at his accommodation • SoRA should apply to team	*"He can invite his team members to his home and have a meeting."*
6.Language barrier	• Use of resources to improve language • Assign simpler tasks for Layla	*"Thomas and Xinpei should task Layla with something that does not involve much language (e.g. maths)."*

Table 4- Summary of outcomes of workshop case studies

One of the aims of this study involved exploring how students coped with teamwork in remote settings and compare this with in-person settings. One of the main themes identified in question 10 of the survey indicated the need for in-person meetings and dedicated spaces for teamwork. The outcomes from case study 1 in table 4 presented some challenges associated with time zones and how this impacts the team's ability to meet. This corroborates a study conducted by Wildman, Nguyen, Duong, & Warren, 2021 who reported on the challenges of remote teamwork for students and the challenges associated with team members in a variety of time zones. However what is less reported on are the positive impacts of remote working in teams, which have loaned themselves to the development of the hybrid approach of teaching and learning as staff and students return to face-to-face classes. Magomedov, Khaliev, & Khubolov, 2020 reported on the positive and negative impact of the pandemic in education and it was highlighted that the use of new technologies as well as more frequent and improved use of existing technologies (such as shared documents) was a major positive in collaborative work, as indicated in case study 1.

In conclusion, this study has fulfilled its project aims stated in the introduction. Through a combination of the survey and workshop, it was found that the main challenges student

generally face with teamwork with a high number of non-native English speakers is related to communication and English language issues. This is further exacerbated in remote settings where issues related to different time zones further impact team cohesion. A benefit of remote working has encouraged the use of collaborative technologies, which has enabled a hybrid approach of working in teams. The main issues related to inclusivity were related to language barriers and a lack of understanding on the application of SoRAs/ECs to teamwork assessments. There appears to be a correlation between English language competence, workload and type of work allocated among team members, impacting stresses on those members who have a higher workload. The main suggestions from students on how staff support can be improved were related to increased language support and increased staff monitoring of team progress. To address these, the faculty of Engineering will roll out the use of the Academic Communication Centre to all departments on the IEP to allow for equal and improved access to language resources. There is also an expansion of space to support teamwork activities (via the opening of the UCL East campus) and an increase in staff support (via increased support from PGTAs) to ensure better monitoring of team progress. The next phase of this study aims to assess the impact of these enhancements on student teamwork and general academic performance.

Acknowledgements

The authors would like to acknowledge the support of UCL ChangeMakers as project sponsors and the department of Biochemical Engineering, UCL.

References

Al Mulhim, E. N. (2023). Technology Fatigue During the Covid-19 Pandemic: the Case of Distance Project-Based Learning Environments. *Turkish Online Journal of Distance Education*, *24*(1), 234–245. https://doi.org/10.17718/tojde.1034006

Alghamdi, H., Alsubait, T., Alhakami, H., & Baz, A. (2020). A Review of Optimization Algorithms for University Timetable Scheduling. *Engineering, Technology & Applied Science Research*, *10*(6), 6410–6417. https://doi.org/10.48084/etasr.3832

Baker, D. P., Day, R., & Salas, E. (2006). Teamwork as an essential component of high-reliability organizations. *Health Services Research*, *41*(4 II), 1576–1598. https://doi.org/10.1111/j.1475-6773.2006.00566.x

Burdett, J. (2003). Making Groups Work: University Students' Perceptions. *International Education Journal*, *4*(3).

Burns, D., Dagnall, N., & Holt, M. (2020). Assessing the Impact of the COVID-19 Pandemic on Student Wellbeing at Universities in the United Kingdom: A Conceptual Analysis. *Frontiers in Education*, *5*(October), 1–10. https://doi.org/10.3389/feduc.2020.582882

Caufield, J. (2019). How to do thematic analysis. Retrieved May 7, 2020, from https://www.scribbr.com/methodology/thematic-analysis/

Chafi, M. B., Hultberg, A., & Yams, N. B. (2022). Post-pandemic office work: Perceived challenges and opportunities for a sustainable work environment. *Sustainability (Switzerland)*, *14*(1), 1–20. https://doi.org/10.3390/su14010294

Chowdhury, T., & Murzi, H. (2019). Literature review: Exploring teamwork in engineering education. *Proceedings of the 8th Research in Engineering Education Symposium, REES 2019 - Making Connections*, (July 2019), 244–252.

Faizi, J., & Sarosh Umar, M. (2021). A Conceptual Framework for Software Engineering Education: Project Based Learning Approach Integrated with Industrial Collaboration. *International Journal of Education and Management Engineering*, *11*(5), 46–53. https://doi.org/10.5815/ijeme.2021.05.05

Fomunyam, K. G. (2021). Engineering Education and Individualism: The Quest for Individual Excellence. *International Journal of Emerging Trends in Engineering Research*, *9*(11), 1418–1424. https://doi.org/10.30534/ijeter/2021/099112021

Forrester, W. R. (2013). Resolution In Student Teams : A Structural Equation Modeling Approach. *Journal of College Teaching & Learning*, *10*(1).

Garcia-Souto, P. (2017). Peer assessing individual contributions in a group project. In *SRHE conference*. London. Retrieved from https://srhe.ac.uk/arc/17/0281.pdf

Gelbard, R., & Carmeli, A. (2009). The interactive effect of team dynamics and organizational support on ICT project success. *International Journal of Project Management*, *27*(5), 464–470. https://doi.org/10.1016/j.ijproman.2008.07.005

Goñi, J., Cortázar, C., Alvares, D., Donoso, U., & Miranda, C. (2020). Is teamwork different online versus face-to-face? A case in engineering education. *Sustainability (Switzerland)*, *12*(24), 1–18. https://doi.org/10.3390/su122410444

Harrison, A. (2011). Overseas student numbers rise in the UK. Retrieved August 14, 2023, from https://www.bbc.co.uk/news/education-15018449

Hayes, C., Power, T., Davidson, P. M., Daly, J., & Jackson, D. (2019). Learning to liaise: using medication administration role-play to develop teamwork in undergraduate nurses. *Contemporary Nurse*, *55*(4–5), 278–287. https://doi.org/10.1080/10376178.2018.1505435

Hirsch, P. L., & McKenna, A. F. (2008). Using reflection to promote teamwork understanding in engineering design education. *International Journal of Engineering Education*, *24*(2), 377–385.

Huang, J. (2010). Improving undergraduates' teamwork skills by adapting project-based learning methodology. *ICCSE 2010 - 5th International Conference on Computer Science and Education, Final Program and Book of Abstracts*, 652–655. https://doi.org/10.1109/ICCSE.2010.5593527

Jones, T. L., Baxter, M., & Khanduja, V. (2013). A quick guide to survey research. *Annals of the Royal College of Surgeons of England*, *95*(1), 5–7. https://doi.org/10.1308/003588413X13511609956372

Kadam, V. J., & Yadav, S. S. (2016). Academic Timetable Scheduling : Revisited. *International Journal of Research In Science &*, (April), 417–423.

Kalu, C., Ozuomba, S., & Isreal, S. (2018). Development of Mechanism for Handling Conflicts and Constraints in University Timetable Management System. *Communications on Applied Electronics*, *7*(24), 22–32. https://doi.org/10.5120/cae2018652804

Kozlowski, S. W. J. (2018). Enhancing the Effectiveness of Work Groups and Teams: A Reflection. *Perspectives on Psychological Science*, *13*(2), 205–212. https://doi.org/10.1177/1745691617697078

Kurtdede-Fidan, N., & Aydoğdu, B. (2018). Life Skills from the Perspectives of Classroom and Science Teachers. *International Journal of Progressive Education*, *14*(1), 32–55. https://doi.org/10.29329/ijpe.2018.129.4

Levy, F., & Rodkin, J. (2016). The Skills Gap. Retrieved May 4, 2020, from https://www.bloomberg.com/graphics/2016-job-skills-report/

Liu, J., Hu, S., & Pascarella, E. T. (2021). Are Non-Native English Speaking Students Disadvantaged in College Experiences and Cognitive Outcomes? *Journal of Diversity in Higher Education*, *14*(3), 398–407. https://doi.org/10.1037/dhe0000164

Magomedov, I. A., Khaliev, M. S. U., & Khubolov, S. M. (2020). The negative and positive impact of the pandemic on education. *Journal of Physics: Conference Series*, *1691*(1). https://doi.org/10.1088/1742-6596/1691/1/012134

Malm, B. (2009). Towards a new professionalism: Enhancing personal and professional development in teacher education. *Journal of Education for Teaching*, *35*(1), 77–91. https://doi.org/10.1080/02607470802587160

McQuade, R., Ventura-Medina, E., Wiggins, S., Hendry, G., & Anderson, A. (2020). Students' strategies for managing social loafers in PBL: interactional means of dealing with unequal participation in group work, (May), 1–15.

Mitchell, J. E., Nyamapfene, A., Roach, K., Tilley, E., Mitchell, J. E., Nyamapfene, A., & Roach, K. (2019). Faculty wide curriculum reform : the integrated engineering programme programme. *European Journal of Engineering Education*, *0*(0), 1–19. https://doi.org/10.1080/03043797.2019.1593324

Murzi, H. G., Chowdhury, T. M., Karlovšek, J., & Ruiz Ulloa, B. C. (2020). Working in large teams: Measuring the impact of a teamwork model to facilitate teamwork development in engineering students working in a real project. *International Journal of Engineering Education*, *36*(1 B), 274–295.

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic Analysis : Striving to Meet the Trustworthiness Criteria. *International Journal of Qualitative Methods*, *16*, 1–13. https://doi.org/10.1177/1609406917733847

Nurtanto, M., Kholifah, N., Ahdhianto, E., Samsudin, A., & Isnantyo, F. D. (2021). A Review of Gamification Impact on Student Behavioral and Learning Outcomes. *International Journal of Interactive Mobile Technologies*, *15*(21), 22–36. https://doi.org/10.3991/ijim.v15i21.24381

Nweke, M. C. (2021a). Assessing skills development across the undergraduate degree programme: An IEP review - biochemical engineering. *Journal of Engineering Education Transformations*, *34*(Special Issue), 93–97. https://doi.org/10.16920/jeet/2021/v34i0/157111

Nweke, M. C. (2021b). *Assessing teamwork and presentation skills development across the engineering undergraduate degree programme: An IEP review*. University College London.

OIA. (2017). *The Good Practice Framework: Supporting Disabled Students*. https://doi.org/Office for the Independent Adjudicator

Pazos, P., Cima, F., Kidd, J. J., Ringleb, S. I., Ayala, O. M., Gutierrez, K., & Kaipa, K. (2020). Enhancing teamwork skills through an engineering service learning collaboration. *ASEE Annual Conference and Exposition, Conference Proceedings*, *2020-June*(June). https://doi.org/10.18260/1-2--34577

Planas-Lladó, A., Feliu, L., Arbat, G., Pujol, J., Suñol, J. J., Castro, F., & Martí, C. (2021). An analysis of teamwork based on self and peer evaluation in higher education. *Assessment and Evaluation in Higher Education*, *46*(2), 191–207. https://doi.org/10.1080/02602938.2020.1763254

Read-Daily, B., De Goede, K. M., & Zimmerman, S. L. (2018). Gallup StrengthsFinder in engineering. *ASEE Annual Conference and Exposition, Conference Proceedings*, *2018-June*. https://doi.org/10.18260/1-2--30553

Salas, E., Bisbey, T. M., Traylor, A. M., & Rosen, M. A. (2020). Can Teamwork Promote Safety in Organizations? *Annual Review of Organizational Psychology and Organizational Behavior*, *7*, 283–313. https://doi.org/10.1146/annurev-orgpsych-012119-045411

Shaikh, A. Y., Osei- kyei, R., Hardie, M., & Stevens, M. (2023). Review of drivers of teamwork for construction health and safety. *International Journal of Building Pathology and Adaptation*. https://doi.org/10.1108/ijbpa-08-2022-0136

Shapiro, E. J., & Dempsey, C. J. (2008). Conflict Resolution in Team Teaching: A Case Study in Interdisciplinary Teaching. *College Teaching*, *56*(3), 157–162. https://doi.org/10.3200/CTCH.56.3.157-162

Sharp, J. E. (2001). Teaching teamwork communication with Kolb learning style theory. *Proceedings - Frontiers in Education Conference*, *2*, 1–2. https://doi.org/10.1109/fie.2001.963699

Straker, J. (2020). Object in view: Understanding international students' participation in group work. *Journal of International Students*, *10*(4), 1040–1063. https://doi.org/10.32674/jis.v10i4.1370

Tucker, R., & Abbasi, N. (2016). Bad Attitudes: why design students dislike teamwork. *Journal of Learning Design*, *9*(1), 1. https://doi.org/10.5204/jld.v9i1.227

Vogler, J. S., Thompson, P., Davis, D. W., Mayfield, B. E., Finley, P. M., & Yasseri, D. (2018). The hard work of soft skills: augmenting the project-based learning experience with interdisciplinary teamwork. *Instructional Science*, *46*(3), 457–488. https://doi.org/10.1007/s11251-017-9438-9

Wildman, J. L., Nguyen, D. M., Duong, N. S., & Warren, C. (2021). Student Teamwork During COVID-19: Challenges, Changes, and Consequences. *Small Group Research*, *52*(2), 119–134. https://doi.org/10.1177/1046496420985185

Willcoxson, L. E. (2006). "It's not fair!": Assessing the dynamics and resourcing of teamwork. *Journal of Management Education*, *30*(6), 798–808. https://doi.org/10.1177/1052562906287964

Willey, K., & Gardner, A. (2009). Developing team skills with self- and peer assessment: Are benefits inversely related to team function? *Campus-Wide Information Systems*, *26*(5), 365–378. https://doi.org/10.1108/10650740911004796

Winter, J., Neal, J. C., & Waner, K. K. (2005). Student Teams Learning to Cope with Conflict. *Business*, *XLVII*(2), 67–75.

Yerworth, R. (2021). Minecraft: hands-on & collaborative leaning in a virtual world. In *Academic Practice and Technology Conference*. Retrieved from https://mediacentral.ucl.ac.uk/Play/61271

Zhang, X. C., Lee, H., Rodriguez, C., Rudner, J., Chan, T. M., & Papanagnou, D. (2018). Trapped as a Group, Escape as a Team: Applying Gamification to Incorporate Team-building Skills Through an 'Escape Room' Experience. *Cureus*, *10*(2015), 10–15. https://doi.org/10.7759/cureus.2256

Contact email: c.nweke@ucl.ac.uk