UCL ChangeMakers Case Study: Assessing the use of peer-tutoring techniques to enhance students' learning

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Introduction and Project Rationale

The department of Chemical Engineering experienced a sudden increase in UG student intake (from 120 to 200 students) in the 2021/2022 academic year, and therefore staff felt that it was harder to keep in touch with the learning topics which students were struggling the most with, as well as students' ability to utilise formative or summative feedback. This was further compounded by a difficulty in monitoring and reflecting on students' progression after having received feedback, which indicates how well students can interpret and apply feedback for their benefit and their academic progression.

Furthermore, this project was motivated by past NSS results, where a need to increase students' satisfaction regarding feedback was identified. The NSS survey data indicated that the Department of Chemical Engineering could improve on some areas, including how the department responds (at module level) to students' module evaluation questionnaires as well as the amount of feedback/practice students receive. Although the amount of feedback provided is sufficient and in accordance with UCL guidelines, given the large size of the cohort (200 students), it is often hard to monitor students' performance, progress (i.e., how well they apply the feedback received) and expectations (e.g., additional practice with using computational tools). We therefore explored alternative strategies for students' learning, initially as a small-group activity aimed at improving students' understanding of technical knowledge and/or

professional skills (e.g., presentation/communication) and with the potential of improving NSS results. Chemical Engineering students at UCL have experienced shorter teamwork exercises and peer-work techniques through Scenarios (Tsatse and Sorensen, 2021), however, this project focused only on (non-assessed) peer-tutoring and its potential benefits.

The benefits of peer-tutoring have been widely discussed in literature, and as staff identified its potential through discussions, they were the driving force behind the initiation of the project. In addition to more effective learning (Arco-Tirado et al, 2020) for tutors and tutees, peer tutoring has been found to help tutors develop their cognitive skills (Thurston et al, 2021), as well as communication and leadership skills (key transferable skills) as they prepare and deliver the work (Duran, 2017). Tutees become more active and gain encouragement and support in the topics considered (Simonsmeier et al, 2020), while students participating in peer-tutoring exercises gain a stronger sense of belonging and connection (Colvin and Ashman, 2010). Departments may also benefit as they intensify the effort to support student success.

In a nutshell, 10 second year undergraduate students, divided into Lead and Participating students, participated in three workshops focusing on computational Process Systems Engineering and technical writing, in order to explore the potential benefits of peer-tutoring. The project had a strong element of student-staff partnership as tutors and students worked together through the entire project, and in addition, staff supported and guided the Lead students in designing the workshops. An expected outcome of the project was to understand the benefits and challenges of employing peer-tutoring as an alternative learning opportunity. This is of particular importance as this cohort is one of those impacted by COVID-19, at a time when virtual learning replaced a significant portion of in-person teaching activities, exacerbating their feeling of disconnection with university life. For staff, this was a unique opportunity to receive direct insight into the topics in which students required additional support, so as to support the development of their competency. An additional goal at the end of the project was to consider how this activity could be further improved and incorporated into the programme, delivered either at smaller (module-level) or larger (programme-level) scale.

Project development and implementation

The project was led by two lecturers (Teaching) in partnership with four Lead students and six Participating students. The selection process was targeted at assembling a diverse set of students, covering a range of backgrounds, under-represented groups and varying academic performances, aiming for a small-scaled representation of the cohort, given the size of the project. The first stage of the project consisted of identifying key learning areas/topics in which UG students typically struggle the most, followed by three workshops organised, developed, and delivered by the Lead students, with support from staff. The Participating students attended those workshops and were on the receiving end of this form of peer-tutoring.

Students were crucial to this project as the organised sessions focused on topics indicated by the 10 students, based on where they felt they needed more feedback and practice. Students filled in a Microsoft form where they indicated their preferred topics were: Computational Modelling and gPROMS, Simulation in AspenPlus and Academic and Technical Writing. The three two-hour workshops took place between March and June 2023 so that the Lead students had sufficient time in between to reflect on their previous practices, prepare the workshop material and meet with staff to discuss any questions. After each workshop, staff released a survey to all students to monitor how they found the workshop, how they felt during it, and provide any suggestions to improve their experience. In addition, Lead students prepared a short report after each workshop, where they described their experience as peer tutors; parts of their reports are included in the next section.

Implementation and Lead students' perspective

This section discusses how each of the three workshops were planned and executed by the Lead students based on their written reports following the workshops (i.e., using students' statements), and also presents their reflections on the workshops' delivery and how they could improve similar activities in the future. Students' opinions and statements are presented as quotes in italics, whilst the rest of the text represents staff's reflections.

Workshop 1 focused on modelling a Plug Flow Reactor followed by a distillation column as part of a larger styrene process using gPROMS Model Builder (Siemens Process Systems Enterprise, 2023). Lead students studied the problem provided by staff, examined the relevant reaction kinetics, and gathered essential data: *"By discussing and thoroughly understanding the project's details, we were able to allocate different sections of the task among our group of four individuals. Each of us focused on a section that we felt most comfortable with, ensuring a balanced distribution of work. Since the problem presented was unlike anything we had encountered before, it took some time for us to grasp its intricacies. However, once we had a solid understanding, planning our respective sections became a straightforward task."*

During the workshop, Lead students provided the background information on the MODEL and PROCESS sections of the gPROMS code to their peers, describing its structure and how participating students could fill in missing parts of the code so that they were able to run the code: "*As tutors, teaching this content proved to be a great learning experience for us, as we had not previously encountered such a challenging code. We encountered unexpected errors during the workshop that we had not dealt with during our preparation, requiring additional time to troubleshoot and resolve them with the participating students, highlighting the importance of brainstorming and proactive troubleshooting in future workshops to prevent such issues from arising*." The Participating students seemed to actively engage in the session, asking relevant questions. Lead students felt that they were able to troubleshoot errors and simulate the process. As they told us, "*the first workshop served as a foundational step in our role as mentors and helped us reacquaint ourselves with the software… However, one key takeaway from the first workshop was the need to better manage our presentation time. We recognize the need to refine our time management skills to ensure that we deliver a comprehensive presentation within a reasonable timeframe."*

Workshop 2 focused on AspenPlus simulation of a heat exchanger and a distillation column for a methanol-water system. Lead students divided the workshop into two parts: an introductory session that provided crucial contextual information about the exercise, followed by its practical application. "*To optimise time management, we allocated a dedicated segment to theoretical explanations. This segment delved into*

the discussion around the operation of the unit, as well as an exploration of the significance of several parameters. Additionally, we successfully ensured active engagement from all students by encouraging them to work simultaneously on the exercise. This synchronized approach enabled us to progress through different stages of the exercise together. It was inspiring to witness some students, who were already familiar with the software, immediately immersing themselves in the exercise. Meanwhile, we provided valuable assistance to those who required more time to comprehend the concepts and instructions, which involved one of us personally going to them and helping them. Each step in AspenPlus was carefully explained by one of the Lead students, who guided them through the process. Furthermore, we supplemented their understanding of Aspen basics by offering additional explanations, such as efficient methods to search for different components and seamlessly navigate between sections." In this workshop, time management worked much better than in Workshop 1.

Workshop 3 was about Technical Writing. For this workshop, Lead students wrote: "*We recognized the significant role it plays in various fields and aimed to equip participants with valuable tips and guidelines to enhance their technical writing abilities. Our workshop began by providing general advice that applied to all types of technical writing, laying a strong foundation for the activities that followed. During the initial segment, we emphasized the importance of clear and concise language, logical organization, and effective communication of complex ideas. We discussed the significance of considering the intended audience, appropriately structuring documents, and utilizing visual aids like figures and tables to enhance comprehension. To demonstrate the impact of good writing versus poor writing, we selected a scientific article written by one of our professors as an exemplary piece. By comparing it to a poorly written example, we highlighted the significant differences in clarity, organization, and overall impact on readers."*

When planning the workshop, Lead students anticipated it would require more time than it actually did. As a result, when Lead students finished presenting their workshop material, staff provided examples of high-grade anonymous reports in the projector as extra content for the session, making use of the time left. It was then left to Lead

students to discuss with the participants which good (or bad) elements of Technical Writing they could observe: "*This activity encouraged critical thinking and provided a practical application of the concepts discussed earlier. It also facilitated valuable peer feedback on writing styles and allowed participants to learn from each other's work. Throughout the workshop, we felt we created an interactive and engaging learning environment. However, looking back, we now recognize that we could have taken a more proactive approach to enhance the workshop by providing participants with additional support and resources. By equipping participants with these resources, we could have empowered them to continually develop their technical writing skills even after the workshop concluded. This approach would have ensured that participants had a comprehensive guide to refer to and reinforce their learning, facilitating consistent progress in their technical writing abilities.*"

Project evaluation and future work

As mentioned in the Project development and implementation section, before each workshop, staff met with Lead students to be informed about how the upcoming workshop would be structured, what content would be delivered, any questions, etc. Staff observed that during the first workshop, students expected that staff would provide all the material as well as instructions on how the workshop would progress. In addition, it was observed that it was particularly difficult for the Lead students to come up with a suitable problem or exercise which needed to be sufficiently manageable for them to deliver and feel confident with, but challenging enough for the Participating students to deal with. Staff explained that it was the Lead students' responsibility to lead the non-assessed exercise and define the workshop structure and content, and effectively, that it was an opportunity to feel free to think how they wanted the workshop to be delivered, placing them in the tutor's position. Towards the final two workshops, Lead students became more independent, asked for less guidance and delivered the final workshop on Technical Writing with confidence. Participating students also found the final workshop the most engaging, an observation that shows that Lead students needed some time to adjust to their new role, but managed to fully understand it before the project was over. In the Project

development and implementation section, it was also mentioned that all students completed a survey at the end of each of the three workshops to collect their opinions on peer tutoring and workshops' efficiency. The results of the surveys are presented and discussed below.

Based on the three online surveys conducted at the end of each workshop, all students felt more knowledgeable at the end of each workshop, and what they found most useful about the workshops was the fact that the theory was "*broken [in]to very simple pieces*", "*the presentation was very clear*", and that "*student explanation was easier to understand*" compared to lecturers' teaching. In addition, it was interesting to see that most students positioned the workshop as an opportunity to apply existing knowledge, rather than learning new things. Moreover, all students identified that this exercise helped them develop their communication, time management, critical thinking, organisational and presentation skills, as well as their teamwork, whilst the majority of students recognised the peer-work and support character of the workshop compared to traditional lectures.

Focusing on the Lead students and how they felt as peer tutors, we received the following responses:

- *"Having to critically think in order to fully understand what was required was a really great challenge. I found that I was also able to develop my confidence, my presentation skills and my skills which help me think on the spot since when being posed with a question from a participating student. This meant that I had to be well informed about all aspects before the workshop".*

- *"Sometimes, I get quite nervous before presenting but it was very relaxed and so I felt completely fine".*

- *"I believe I have improved my communication skills as well as presentation skills from the workshop".*

Lead students also mentioned they were pleased with how they organised the workshops, as they *"designated parts that people felt comfortable doing"* and *"went through content together so that we were on the same page"*. Lead students found the preparation of the workshops enjoyable since they were "*able to work with other peers whereby we are able to all input different ideas and come up with a unique one"*.

From the students' perspective on how to further improve the workshops, they suggested better time management and increased interaction. Furthermore, when asked about potential upscaling of peer-tutoring and whether they would prefer a Lead or Participating role, it was surprising to see that the majority of (both Lead and Participating) students would prefer a Lead role which may mean that even the "quieter" students felt comfortable to unravel within the "unconventional" peer-tutoring environment.

In the survey, students were asked how they would feel if some lectures were replaced by peer-tutoring activities. Students' opinion was uniform, mentioning that they felt it would still be important for the lecturers to deliver classes themselves. They felt that peer-tutoring could be complementary to the main lectures through extra tutorial sessions or practice sessions, for instance. They remarked that *"discussing solutions to engineering problems with students of our cohort doing the same level of study would make us better engineers"*. With regards to the character of future peer-tutoring activities, most students thought it should be optional as it depends on how knowledgeable students are about a given topic. In addition, students realised that traditional lectures are suitable for some of them, whilst others may benefit from seeing content *"through the eyes of other students"*. An interesting alternative suggestion was that if the first few workshops were compulsory and then turned into optional, it would allow students to decide whether peer-tutored workshops were beneficial to them or not, without rejecting the concept in advance.

From a staff's viewpoint and when reflecting upon the project, there are a few areas that the lecturers would like to bring attention to, which could potentially improve the implementation of similar future projects by colleagues. First of all, it is important to have a clear time plan, keeping in mind that these workshops are dependent on students having "free" time and that they do not compete with projects or exams, as

it is expected that such extra-curricular activities would fall down in the priorities list. In addition, it is crucial to establish a communication platform where all files and material can be shared and students can reach out to staff or other students on demand – we used MS Teams for that purpose. Furthermore, although staff are experienced in time management and are used to working towards deadlines, students do not have the same expertise. We therefore recommend allowing more time for students to get back to staff with assigned tasks. Finally, having a clear idea of what concept-idea-technique it is that you want to explore is significant, so that the project is formed and managed accordingly.

With regards to future work, now that the evaluation of the project is complete, it will be considered how this activity could potentially be incorporated into the programme, delivered either at smaller scale (e.g., through workshops co-created by students and staff, which staff tutors could organise and students could deliver) or at a larger scale (e.g., in several undergraduate or postgraduate modules through relevant small or large group teaching activities), in collaboration with the Departmental Tutor and relevant departmental committees. The project and its outcomes were discussed during a departmental meeting and all members of staff who would be interested in incorporating such activity in their modules were invited to contact us. Furthermore, exploring how this activity could be upscaled might be an interesting continuation of the UCL ChangeMakers project, which would provide more feedback, help identify potential challenges (e.g., students' engagement, content delivery, evaluation of outcomes in larger scale) and further encourage discussions on how peer-tutoring and content co-creation could be more widely implemented in the curriculum.

Conclusion

This work discusses the implementation and associated learning following a peer-tutoring project in UCL Chemical Engineering. The project was successful as workshops enhanced both Lead and Participating students' understanding of the suggested topics, whilst being described as enjoyable activities which helped them develop their technical and communication skills, confirming the benefits of peer-tutoring stated in

relevant literature as presented in the first section. Staff gained insight into which topics students have difficulties with, so as to provide additional feedback and practice in the future. Students identified that this activity helped them create a "less stressful" peer community and develop their communication, time management, critical thinking, organisational and presentation skills, as well as their teamwork. The project was also well received by the department as it heavily depended on healthy staff-student partnerships. Future work will focus on exploring how this can be upscaled whilst addressing the relevant challenges, however, a gradual introduction of smaller peer-tutoring exercises can provide sufficient feedback and time before this alternative, yet clearly beneficial, teaching strategy can be more widely applied to module or programme level.

Acknowledgements

The authors would like to thank UCL ChangeMakers for funding and supporting the project throughout its duration. The authors would also like to acknowledge and thank the following students (alphabetically) for leading and participating in the project: Ali Shahzaib, El Eulj Lina, Melwani Daryanani Jahaan and Shibu Febha (Lead students) as well as Abdu Yasmine, Chang Hsuan, Gui Runzhong, Lee Andrea, Loh Yi Hui and Rhee Hanbin (Participating students).

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