Encouraging Engineering Students' Participation in Face-to-Face Peer Learning

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STRUCTURED ABSTRACT

CONTEXT
It is widely accepted that graduate engineers should be equipped with a range of interpersonal skills to be effective team-players in the workforce (Nguyen, 1998). Study Group sessions constitute a platform for students to practice cooperation with peers in a unique learning environment. Specifically, students learn by experience how to collaborate within a diverse group, which helps preparing them for a diverse workforce. Additionally, Study Groups provide real-life support networks beyond the internet domain (Kim, LaRose, and Peng, 2009). However, attracting many students with a variety of backgrounds to attend Study Group sessions is challenging.

PURPOSE
This study aims to find effective strategies to attract large numbers of students with a variety of backgrounds and academic performances to participate (in-person) and actively engage in weekly Study Group sessions. The sought strategies do not involve direct academic performance incentives.

APPROACH
The Study Group Project (SGP) is an initiative of setting weekly meeting sessions for a variety of subjects (15 subjects in Semester 1, 2018). These sessions, during which students are given a subject-related learning activity to attempt collaboratively without (or, almost without) staff support, are not assessed (thus, attendance is voluntary). In each SGP-hosting subject, a different implementation strategy is used to recruit students. Data on the number of participants and their profiles is collected. End-of-semester surveys are issued to further improve the SGP.

RESULTS
Many factors affect Study Group attendance rates. These can be very significant, as can be witnessed from the cumulative attendance rates in Study Group sessions (during a semester) ranging from less than 2% (of number of enrolled students in the subject) in some subjects to more than 80% in others. Low attendance rates correlated with inappropriate levels of the learning activities (either too difficult or too easy), timetable clashes, and insufficient promotion on the Learning Management System (LMS). While some initial assistance by a tutor and supplying answers in the following session have contributed to attendance rates, these were not essential. In contrast, consistency of implementing Study Group sessions across semesters proved very beneficial.

CONCLUSIONS
Our project highlights some communication challenges faced by engineering students (resulting in diminished collaboration skills), their reliance on having correct final answers and/or authorised support person available, and their prioritisation of learning outcomes that are formally assessed (thus neglecting important skills for their future career). We hope to disseminate the idea of holding Study Groups, where students work collaboratively in a diverse environment that somewhat imitates a workplace. We provide practical implementation strategies to help found similar initiatives.

KEYWORDS
Study Groups; student attendance; collaboration in a diverse environment.

Introduction

It is said that learning how to swim should not be done by correspondence. Analogously, expecting engineering graduates to thrive in a diverse workforce is in vain without promoting opportunities for face-to-face, work-like engagement amongst students. Such engagement opportunities provide situations which simulate cooperation between a variety of team-players in a work environment, thus exposing students to a range of interpersonal skills that they are expected to enforce and possess upon graduation.

Unfortunately, today's teaching and studying culture for engineering students is characterised by a decline in face-to-face peer learning: class attendance rates are reduced, arguably due to the availability of lecture recording; group assignments are often done with minimal or even without in-person meetings by using file sharing, virtual communication and exclusive distribution of tasks (Bolton et. al., 2013); teaching material is made more and more accessible from a distance which, along with the associated advantages, has the negative side of students getting used to self-learn everything from home.

In this reality, it is hard to expect graduates to develop strong skills that are essential to working in a diverse environment, such as: group brainstorming, group problem-solving, effective verbal communication, equitability and tolerance of different cultures and working styles (De Graaf and Ravesteijn, 2001).

Another growing problem that is attributed to the lack of face-to-face engagement is loneliness faced by engineering students, especially international (Sawir et. al., 2008). Loneliness is an underlying cause for a variety of physical and mental health problems. In a vicious cycle routine, lonely students tend to rely more on online social media thus exacerbating their isolation and feelings of loneliness (Caplan, 2006). In addition, low real-world social engagement was found to be correlated with poor academic performance (Burton and Dowling, 2009).

Cooperative face-to-face learning combines social interaction with study. It is therefore suitable for addressing both the need to prepare engineering graduates for integration in a diverse workforce and the issue of loneliness and isolation (Boud, Cohen and Sampson, 2014; Falchikov, 2001). Cooperative learning is sometimes implemented within normal classes (lectures, tutorials or workshops), however, it mostly involves the attendance of a person that knows the correct answers and applies some techniques to increase students' cooperation. In contrast, work environments normally present no direct cooperation incentives, nor do they supply a backup person that can always produce the right answer.

It is desirable, therefore, to implement cooperative learning activities that better reflect the work environment within engineering courses[1]. Moreover, it is important to study ways in which such activities can be made more effective in achieving the desired goals for as many students as possible (Cooper et. al., 1990).

Approach

In this study, we created and tracked Study Groups in a set of 14 subjects from various engineering departments during Semester 1, 2018. In each of these subjects, we hired a tutor who was asked to develop a weekly study activity to be attempted by the students in a collaborative manner. The activity had to be closely related to the subject's curriculum and suitable for 50 minutes of work, similar to a short assignment question. These activities were then printed and distributed to students who attended the weekly study group sessions. These sessions were advertised from within the subjects in various manners (such as weekly LMS announcements). The sessions normally ran between Week 2 and Week 12 of the semester.

In some of the subjects, the tutor who developed the activity was not present in the study group session at all (the learning activity was distributed to students by another subject's tutor) whereas in other subjects, the tutor was available for some period of time at the beginning of the session to answer questions in case students could not even begin solving the problems. Through the attendance at these activities, students were exposed to a collaborative learning environment: one's success could be often influenced by another's; there was a general permission to cooperate but no

[1] In this paper, the term 'course' refers to a study program and the term 'subject' to a unit of study within a course.

direct prompting to do so; students were mostly left to their own devices in terms of initiating communications between one another similar to workplace group dynamics.

We tracked the attendance at each of the sessions using attendance sheets, where students wrote their name. We wished to understand any patterns of "good implementation" versus "bad implementation" of study group sessions, based on the number of students attending (out of the total number of enrolled students). Clearly, many factors can make one session more successful than another. In the Results and Discussion section we will elaborate on the various implementation methods and present their resulting attendance rates.

In addition, despite academic performance not being the main purpose of attendance, we wished to examine a hypothesis of correlation between the frequency of attendance to study group sessions and final exam performance. Clearly, even if such correlation exists, there is no proof of it being causal (since high-performing students could be those interested in attending study group sessions in the first place). However, establishing a result of correlation and making it publicly known can spark some motivation for more students to attend such sessions in future years. At the same time, we do not wish to enforce attendance by using formal assessment, since this may replace the intrinsic motivation of students to form bonds with a diverse network of peers with a competitive prioritization of academic success over building interpersonal skills.

Results and Discussion

Attendance in study group sessions

Table 1 below presents the weekly and cumulative attendance rates (in percentage, where 100% is the total number of students enrolled in the subject) for each of the participating subjects. The subjects are arranged in order of descending cumulative attendance rate. For example, in Week 2 of the semester, 21.6% of the enrolled students of subject SUB_1 (58 students out of 268) have attended the Study Group session. Wherever 'n/a' is indicated, no session was held (e.g., if it was cancelled by the tutor).

Table 1: Weekly attendance rates (in %) in the participating subjects

Subject	Week of the semester											Cumulative (%)	Total Enrolment
	2	3	4	5	6	7	8	9	10	11	12		
SUB_1	21.6	11.9	11.6	11.2	10.4	7.5	7.5	6.7	5.2	4.1	4.5	102.2	268
SUB_2	9.9	11.3	8.5	11.3	8.5	9.9	0.0	8.5	11.3	2.8	0.0	81.7	71
SUB_3	8.3	7.5	9.2	8.3	3.3	7.5	3.3	0.0	2.5	1.7	0.0	51.7	120
SUB_4	0.0	3.4	1.7	1.7	5.2	10.3	1.7	1.7	3.4	1.7	3.4	34.5	58
SUB_5	n/a	2.1	4.5	3.8	n/a	2.1	3.8	2.1	3.5	4.5	3.5	29.8	289
SUB_6	6.8	1.7	1.7	1.7	1.7	3.4	3.4	0.0	1.7	5.1	1.7	28.8	59
SUB_7	n/a	n/a	4.0	2.4	1.6	2.0	0.0	2.4	2.8	0.8	2.8	18.8	392
SUB_8	n/a	n/a	n/a	7.5	4.7	3.6	n/a	n/a	n/a	2.2	n/a	18.2	358
SUB_9	n/a	4.9	4.4	0.5	1.6	1.1	1.1	1.1	1.1	0.0	1.1	16.9	183
SUB_10	0.5	0.5	0.5	0.5	0.5	0.0	1.0	1.6	1.6	1.0	1.0	8.9	192
SUB_11	0.8	0.8	0.8	0.8	0.8	0.0	0.8	2.4	0.0	0.0	0.0	7.2	125
SUB_12	n/a	0.0	0.0	0.0	3.0	1.5	1.5	0.0	0.0	0.0	0.0	6.0	67
SUB_13	n/a	n/a	n/a	0.8	1.2	0.0	0.0	0.0	0.0	0.0	0.0	2.0	250
SUB_14	n/a	n/a	1.2	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	1.6	218

The most successful subject in terms of student attendance into study groups was SUB_1. In this subject, there has already been a study group in the preceding year, so students might have heard about its advantage from a previous cohort. In addition, weekly announcements were posted via the subject's LMS. The activities themselves were very appropriate in terms of level of difficulty so students were quite compelled to try them. The timetabling of the session was carefully selected. In

this subject, no subject-related tutor was available during the session – students had to work without availability of any correct answers.

Subjects SUB_2, SUB_3 and SUB_4 were also quite successful probably due to a tutor being present for about half the session to provide some direction for the students. In these subjects, students were given the correct final answers in the following session, which also prompted subsequent attendance.

Unsuccessful subjects included, for instance SUB_13, in which the hired tutor was not very knowledgeable with the subject content and produced inappropriate learning activities that were not suitable for cooperative learning, and SUB_14, in which there has been a serious clash between the session time and another lecture of a core subject taken by most of the cohort. Despite this clash being resolved in Week 6, the initiative has lost the momentum and students did not come.

Relationship between attendance and final exam marks

Figure 1 below presents the set of final exam marks (worthy 60% of the final subject mark) in the subject SUB_1. Each dot represents a student of the subject. The horizonal coordinate is the number of study group sessions the student has attended, and the vertical coordinate is the raw final exam mark that the student has scored. It can be seen, as predicted, that most (though definitely not all) of the students who attended study group sessions, scored higher than the mean exam mark (49.0). Perhaps some of the students were very serious with their studies in the first place and others arrived to try and seek help from their peers.

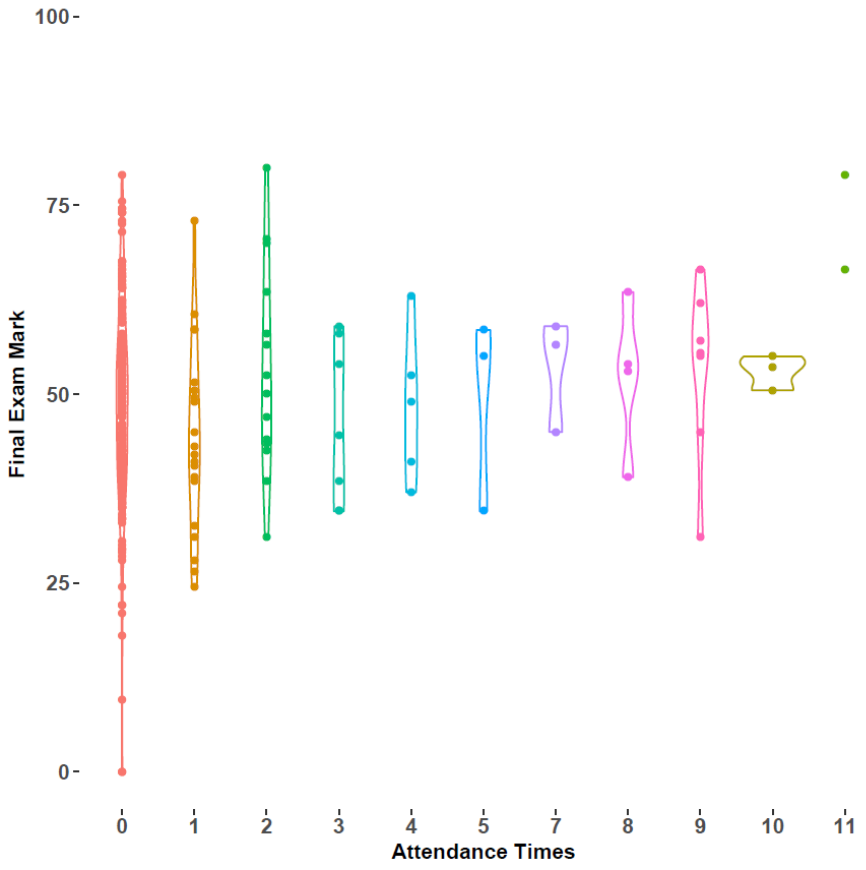

Figure 1: Final exam marks in SUB_1 versus attendance frequency in study group sessions

Survey results

All students in the participating subjects were invited to answer a short anonymous survey related to the Study Groups Project, whether they had attended any sessions or not. Students were also asked not to reflect about their experience in study groups in other formal media, such as Subject Evaluation Surveys. The survey was advertised immediately after the end of the examinations period (in order to minimise any effect on students' performance in their exams), and responses were accepted in a

period of two weeks. The total number of responses was 69 (across all subjects). The survey questions and students' responses are described below. Note that respondents could skip questions.

Question types: MC – multiple choice; MA – multiple answer; OE – open-ended.

Question 1: Have you heard about the Study Group project? (MC)
Response (number of students): Yes – **56**; No – **13**.

Question 2: If yes, for which subject(s) did you hear about it? (MA)
Response (number of students): {SUB_14, SUB_15, SUB_16, SUB_17, SUB_18, SUB_19, SUB_20, SUB_21} – **0**; {SUB_13, SUB_22, SUB_23, SUB_24, SUB_25, SUB_26, SUB_3} – **1**; {SUB_27, SUB_28, SUB_29, SUB_30, SUB_31, SUB_2} – **2**; {SUB_4, SUB_32, SUB_33, SUB_34, SUB_9, SUB_6} – **3**; SUB_35 – **4**; SUB_7 – **5**; SUB_12 – **9**; SUB_5 – **10**; SUB_8 – **17**; SUB_1 – **18**.
Note: subject codes numbered 15 and over did not participate in the project in that semester; SUB_22 had a Study Group initiative in the past. Some other subjects run their own version of a study group, regardless of our initiative, however students could associate those with our project.

Question 3: How did you hear about the Study Group project? (MA)
Response (number of students): Announcement on LMS – **32**; From my lecturer – **38**; From my tutor – **13**; From emails – **28**; From my friends – **8**.

Question 4: How many Study Group sessions in total for all subjects have you attended? (MC)
Response (number of students): Never attended – **29**; 1-2 times – **11**; 3-5 times – **11**; 6-8 times – **6**; More than 8 times – **8**.

Question 5: What motivates you most to attend Study Group sessions? (MA)
Response (number of students): I want to further develop my understanding of the subject – **32**; I want to get more practice questions – **28**; I enjoy studying with my friends – **15**; I want to meet new study mates – **15**; I like the subject – **12**; The content in the study group activity is interesting – **10**; My lecturer inspired me to attend – **10**; Other (please specify) – **5** {"Have some questions with the subject", "N/A", etc.}; My tutor inspired me to attend – **3**.

Question 6: If you have attended less than 4 sessions (or haven't attended any session at all), please specify the main reasons why: (MA)
Response (number of students): I am too busy to attend – **17**; The study Group activity clashed with my other study duties (lecturers, tutorials and workshops) – **15**; No final answers are provided – **14**; I didn't get enough information – **13**; Other (please specify) – **10** {"there's not many sessions at all, I've attend most of them (3 or 4 out of 5)", "I did not know about it", "Often behind on lecture content and am not up to the questions being provided", "The day it was on didn't work with my schedule", etc.}; I do not enjoy studying as a part of a group – **6**; I prefer to study off campus – **6**; I was the only one to attend – **4**; I forgot to attend – **4**; There was no tutor around – **4**; I do not like the subject – **3**; I asked my friends who attended to share the activities with me, so I can do them at my convenience – **3**; The content in the study group activity is not interesting – **2**; The learning activity is too challenging for me – **2**; The learning activity is too trivial for me – **2**; I have already got my preferred study mates, and do not wish to have additional ones – **2**; I didn't enjoy studying with the other students who attended – **1**.

Question 7: Would you recommend your friends to attend Study Group activities? (MC)
Response (number of students): Yes – **52**; No – **12**.

Question 8: Which of the following changes would you recommend to increase student attendance in Study Groups? (MA)
Response (number of students): Better timetabled sessions – **36**; Tutor available in the session – **36**; Offering activities with different levels of difficulty – **24**; Better advertisement – **18**; Other (please specify) – **5** {"Making the questions available on the LMS", "Eventually releasing solutions to the questions, since putting 40+ confused students in a room who've reached different conclusions and are adamant they are correct is not conducive to learning", "Need a couple of tutors wondering around able to help the students because some of the questions were very hard and had no solutions, and even working with friends we couldn't figure some out", "Provide snacks", "answer provided"}; Longer sessions – **4**.

Question 9: Have you made any new contacts by participating in Study Group sessions? (MC)
Response (number of students): Yes – **25**; No – **35**.

Question 10: Studies show that students who attend Study Group sessions perform better in final exams; would this motivate you to attend in the future? (MC)
Response (number of students): Yes – **51**; No – **13**.

Question 11: Do you have any other comments you would like to share about the Study Group Project? (e.g., best aspects, ideas for improvement, etc.) (OE)
Response: A few students expressed being content with the format ("The practice problems were really helpful as it provided a deep insight in the subject"; "I like the aspect of independent learning and the follow up discussion with other peers. This encourages me to attempt a more open question, but still leaves me with an opportunity for checking and verifying with other people."). Some students expressed the wish to have final answers ("Please release answers at some point, no one knew which answer was correct and there were a lot of differing results"). Others advised to better timetable the sessions ("I think timetable should be more better which does not have conflict with other subjects."). Some students wished the activity would be available online ("Putting the problems on the LMS / creating a community on the LMS for the program would make things more accessible to students") or located in a more suitable venue ("The room we had our Study Group in was not an ideal room for group collaboration. It was set up as a lecture theatre, with increasing rows of seats all facing forward. I recommend a large study room, so students can sit around a table to have proper discussions."). A few students stated that they needed a tutor on site to either provide guidance ("Need a couple of tutors wondering around able to help the students because some of the questions were very hard and had no solutions, and even working with friends we couldn't figure some out") or to help socialise ("At the beginning, I recommend tutors, or some students introduce some other students to us, because some of us are not social people. If no one would like to find me, I think I will go ahead study alone."). Finally, some students expressed regret for not receiving information about the sessions timely ("I never received any information about study groups unless I saw this survey.").

Conclusions

It is generally challenging to motivate students to attend and actively participate in a group activity that somewhat resembles teamwork in a diverse workforce. Survey responses have supported to some degree our assumptions that:

- Students are not very motivated to learn in a team when no member of the team has definitely-correct answers.
- Students expect external assistance in forming social bonds. Many engineering students face hardships integrating in a diverse group due to underdeveloped interpersonal skills.

Recommendations for future implementation

We highly recommend implementing ongoing Study Group initiatives across engineering departments. The following are some ideas that could assist making large numbers of students attend these sessions:

- Timetable the sessions well, avoiding clashes with other lectures of the same cohort.
- Ensure that the learning activity is not too challenging (average students should be capable solving the activities with a reasonable level of confidence) nor too trivial (do not repeat tutorial questions).
- Provide a tutor who can give at least a minimal support to the students, ensuring they have some direction
- Solutions can be provided in the beginning of the following session
- Active support of the initiative from the subject coordinators is advantageous
- Promotion of the activity via weekly announcements is quite essential
- The initiative should last for several years to build a positive reputation amongst students

Expected challenges

Instructors wishing to set up a Study Groups project within their organisation are to expect and prepare for the following logistical challenges:

- Subject coordinators were often reluctant to implement the initiative within their subject, especially if they are very concerned about students' feedback in a subject evaluation survey. We found that confident and reputable lecturers were more likely to keenly consent for their subject to be part of the project. Sharing information about other participating subjects also increases the likelihood of new subject coordinators joining the project.
- It was difficult at times to hire a tutor who was able to dedicate the required time for the project. On average, tutors were paid for 9 hours of work per subject for the program (marking

rate). It is important to hire motivated tutors, otherwise they can hinder the success of the initiative for their subject, as happened several times in this study.
- It is difficult to manage a large number of tutors, so we assigned some to be coordinators of a few subjects, such that a hierarchy of reporting was created.
- It is sometimes hard to find suitable rooms to book for the weekly sessions. In-advance preparation is recommended.

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Appendix

The following list of subject codes (at the University of Melbourne) relates to the subjects reported in Table 1:

MCEN90038 Dynamics is SUB_1; CHEN30005 Heat and Mass Transport Processes is SUB_2; CHEN30001 Reactor Engineering is SUB_3; CHEN20010 Material and Energy Balances is SUB_4; ELEN20005 Foundations of Electrical Networks is SUB_5 ; CHEN20009 Transport Processes is SUB_6; COMP20005 Engineering Computation is SUB_7; COMP90007 Internet Technologies is SUB_8; ELEN30010 Digital System Design is SUB_9; MCEN30017 Mechanics and Materials is SUB_10; MCEN30018 Thermodynamics and Fluid Mechanics is SUB_11; ELEN30012 Signals and Systems is SUB_12; CHEM20018 Chemistry: Reactions and Synthesis is SUB_13; INFO20003 Database Systems is SUB_14.