An Experience of Applying Active Learning to Large Classes

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Abstract

We share our experience of applying some of the active learning techniques typically used in small classes, to a large class across 2 semesters (174 and 165 students respectively) in a traditional lecture hall setting. While some of the techniques require institution-level support thus limited in what an individual lecturer can instrument in large classes, there are ones that can be readily applied and still be effective without considerable cost in running them. In particular, increased use of questions and answers throughout the lectures for sustained engagement and weekly reflection journal keeping by students as an additional, individualised feedback channel worked well despite the size of the classes. Pedagogical techniques well-advocated in the active learning community that are also cost-effective in large classes in enhancing engagement and learning will be a useful venue for further investigation especially if they do not require major restructuring of the institute's pedagogy infrastructure.

Keywords: *Active learning; Large class; Use of questions; Reflection journal; Learning log.*

1. Introduction

A typical form factor in an active learning class is to chop up the lecture session into a number of "activities" and small groups of students participate in these activities while the lecturer visits each group to guide the activities. Such in-class activities greatly help students engage and be involved during class. One crucial assumption of this form factor is that the class has a small number of students.

In Singapore University of Technology and Design (SUTD), a nationally-funded university with active learning as its primary pedagogical stance, the class sizes are kept small (maximum 45-50 students) and newly-recruited lecturers are trained and practice various active learning tools and techniques for almost all of its curriculums from theoretical subjects such as mathematics, to practical and application-oriented subjects such as computer programming and natural language processing. This paper shares one of the co-author's experiences in training and practicing the active learning in SUTD and especially how, upon joining later a different institute (Dublin City University (DCU), Ireland) with more traditional pedagogical setup, his attempts worked out at implementing various active learning techniques to much larger class sizes (around 150-180).

2. Description of Context: Training in Active Learning

Established in 2009 as a national university in Singapore, SUTD was from the start having a focus on producing the graduates who are pro-active, articulate in expressing their thoughts, willing to try new without the fear of failure, and being hands-on with design thinking[1]. Their primary pedagogy to implement this was an active learning mandated for the entire duration of undergraduate programmes. Newly-recruited lecturers received a series of training in active learning, including seminar series where experienced professors in active learning demonstrated various practicalities of running such courses, a semester-long active learning workshop run by Teaching+Learning Lab at MIT, and visits to exemplary active-learning institutes such as Olin College (Massachusetts, USA). In addition, by being involved in actual creation and delivery of heavily active learning courses within SUTD with close consultation with experienced professors in active learning, the new lecturers got intensive hands-on experience. One of the co-authors was among the first batch of lecturers who went through it (see his experiences during this period teaching calculus (Tsai et al., 2013), programming

[1] Design thinking is often characterised by an iterative refinement approach in formulating the ideas and actions, quickly moving onto tentative solution space even when there is no sufficient information or clues in the problem space but gaining new knowledge through these iterations. This contrasts with scientific/engineering approach where full understanding of problem space precedes any further steps into finding the solution.

(Yoong et al., 2015) and interaction design (Lee, 2015) all heavily active learning courses created and ran for a number of years).

While the physical campus infrastructure was designed to maximally support the pedagogy (small classrooms with rollable desks/chairs allowing easy reforming of small groups during class, 7 ceiling-mounted projectors on all sides of all classrooms allowing mini collaborative activities, etc.), and its timetable and lecturer assignment was designed to support multiple within-class activities in each session where 2-3 lecturers co-teach within classroom[2].

Joining a different university (DCU) afterwards with a more conventional pedagogy and traditional classroom settings, the author tried to apply active learning as trained and practiced from SUTD. Major challenges faced in this process include:

- *Large class size* – mandatory courses are attended by all students in the department, resulting in 100 – 200 students in a class;
- *Short class hours* – typical course has two separate 1-hour sessions per week (5 ECTS equivalent), leaving little room for running activities during a session;
- *Lecture hall configuration* – to accommodate a large number of students, sessions are in large lecture halls with forward-facing desks and chairs fixed on the floor, making it difficult for group engagement or moving around.

Table 1 summarises some major tools/techniques practiced in SUTD (middle column) and which of these were tried in DCU by the author (3rd column).

Table 1. Active learning methods and tools used and applying them to a large class (√: applied).

	Active learning tools practiced in SUTD	**Tools applied to large classes in DCU**
Infrastructure	Re-configurable classroom	
	Small class size	
	Long class hours	
Session structure	Pre-class reading	√
	Chopping up lecture hour(s)	√
	Incorporating activities during session	√
Feedback channel	Studio session (small group discussion)	
	Q&A throughout class	**√**
	Weekly journal	**√**
	In-class poll for nimble adjustment	√

[2] This means there are many lecturers involved in running one such course. There is usually a weekly coordination meeting among all lectures involved in, to ensure that all classrooms will cover the same materials and activities.

As can be seen, it was not possible to apply infrastructural elements; neither was studio sessions in which the lecturer visits each group and discuss their progress in class while other groups continue their project work, due to the large class size.

3. Literature Review

The significance of student engagement in higher education classes for effective learning has been well recognised, shown in many pedagogy studies both face-to-face (e.g., Kahu (2013), Kahn (2014), Quaye et al. (2019)) and online (e.g. Meyer (2014) and Paulsen and McCormick (2020)) as well as national-level surveys focusing on student engagement (e.g. annual Irish Survey on Student Engagement by Higher Education Authority (HEA, 2023)). Active learning community suggests various methods to increase student engagement during the class hours, its pedagogical tools and techniques applied and experimented in higher education (e.g. see a review Bernstein (2018)) and detailed analyses of active learning studies becoming more available today (e.g. see Nguyen et al. (2021)). Pedagogical concerns and strategies for higher education large classes include, among many others, principles for teaching in large online class that involve active learning techniques (Hornsby, 2020), use of online self-test tools for formative assessment in large classes (Ward, 2022), and use of card-based quiz in a large class as an alternative to clicker devices often used in active learning (Chanialidis, 2019). Effectiveness of active learning tools in large classrooms has also been studied (e.g. see Barak et al. (2006), Walker et al. (2008), Smith and Cardaciotto (2011), Carloye (2017)). Efforts in finding suitable pedagogical tools in large classrooms also show a number of active learning strategies, including asking more questions, maintaining Q&A forums and providing short feedback mechanisms (McDonagh and Radaković 2022). Identifying those active learning tools and techniques that scale in larger classrooms without requiring extensive infrastructural or institutional support will be a useful angle which we address in this paper.

4. Methodology/Data: Applying Active Learning in the New Context

The classes reporting here are a 12-week mandatory user-interface design course for 3rd year undergraduate computing students in DCU in autumn 2021 (174 students) and then repeated in autumn 2022 (165 students). Among the active-learning methods applied, in this paper we focus on two feedback mechanisms (*Q&A throughout the class* and *weekly journal*) as these were most scalable explained below.

4.1. Q&A throughout Class: Low-cost Engagement in Large Class

Turning the class delivery from a lengthy, monologue lecture to an engaging conversational session between lecturer and students via suitable questions and answers throughout the

lecture has been a technique used in active learning to enhance engagement during class. There have been studies of positive effects of this technique in terms of engaging the students (e.g. see Byers (2001)) and now majority of active learning guidelines include the use of interactive questions and answers during the lecture (e.g. those by King's College London[3] and Arizona State University[4]).

Throughout the sessions, the lecturer (author) asked questions and let students answer, and used their answers to continue the explanation. Majority of these Q&As were in the form of oral questions by the lecturer casually asked in the middle of concept explanations during the lecture, e.g. "… so why do you think this is the case?" or "… but could there be any simpler solution, do you think?" The lecturer paused to let some of the students (orally) answer. The lecturer then augmented or paraphrased the students' answers in order to further lead to explanations or follow-up questions. Where the nature of questions was more stand-alone and would benefit consensus from larger numbers of answers (e.g. students' level of background knowledge, the pace of lecture, etc.) a clicker tool Vevox was used, though less frequently.

By increasing the number of questions during the lecture in this way, the perceived level of engagement considerably improved, evidenced from the attention level in the class itself, as well as feedback from students (names are modified):

> "The lecture was very informative and very interactive" (Louise, week 1 journal, 2021)
>
> "I loved how engaging the class was" (Mark, week 2 journal, 2021)
>
> "I'm glad that we were encouraged to question…" (Dawn, week 5 journal, 2021)
>
> "A very engaging lecture, I learned a lot" (Alina, week 6 journal, 2021)
>
> "Greater understanding of the course, due to the interactive lecture…" (Cian, week 7 journal, 2021)
>
> "…delivered in such an interesting and engaging way" (Grainne, week 9 journal, 2021)

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[3] 7 Ways to Engage Students in Lectures. Staff Quick Guides, King's Learning Institute, King's College London. https://www.kcl.ac.uk/study-legacy/learningteaching/learning-and-teaching-support/quickguides/kcl-qg/dl/7ways-engage-students-lectures.pdf

[4] Active Learning Instructional Strategy: Pose a Question. Learning and Teaching Hub, Arizona State University. https://lth.engineering.asu.edu/2021/09/pose-a-question/

> "It is amazing how the lecturer is readily available to answer any questions, and also make the class as interactive as possible by asking questions or opinions" (Oliver, week 3, journal 2022)
>
> "Great engagement in the class" (Alice, week 5, journal 2022)
>
> "…the lectures this week were very engaging!" (Muhammad, week 5, journal 2022)
>
> "Very engaging and interesting lectures this week" (Tim, week 6, journal 2022)

4.2. Weekly Journal: a Cost-effective Extra Feedback Channel

Students keeping weekly journal (sometimes called "reflection journal" or "learning logs"[5]) has often been practiced in SUTD as part of active learning in maximising their learning by encouraging a reflection after activities (e.g. see McCrindle (1995) and Moon (1999)), as well as for the lecturer to give timely feedback in a light-weight, personalised manner.

Weekly journal assignment was set up in the university's Learning Management System (LMS), and the students were asked to enter it by the end of each week, anything they want to write down about what they learned that week: any thoughts, feelings, questions or complaints. There were no constraints regarding the length of the entry: one or more paragraphs, one sentence, one phrase, or one word: as long as they entered anything it was a legitimate entry, since the main purpose was to encourage the students to reflect and the lecturer to get back to them as feedback. This was 5% of the course grade. The entries included simple sentiments, such as:

> "Fun lecture and very interesting." (Eve, week 8 journal, 2022)

as well as more elaborate reflections, such as:

> "I found summarising the design guidelines and principles in week 5 to be very helpful with re-enforcing the material and it helped with not forgetting to implement certain aspects of UI design into the group project… Overall I feel a lot more familiar with these after this week." (George, week 5 journal, 2022)

Also observed are entries that show how some of the other features of the course are working, e.g. all the quotes on the Q&A being engaging shown in the previous section were captured by weekly journal; or on the project feedback promptly provided so that they could use it for their next submission:

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[5] Learning Journals and Logs. Teaching & Learning Resources, University College Dublin (UCD). https://www.ucd.ie/teaching/t4media/learning_journals_logs.pdf

> "Grateful for feedback returned on group project. Feel like it will help us proceed forward with the next stage of the project." (Sophie, week 8 journal, 2022)

During latter part of the course, overall sentiments on the course are witnessed, well before conducting the final exit survey:

> "I don't want this module to finish, I really do like this module, learned a lot in terms of UI design principles and guidelines. I had great fun attending each of the lectures…" (Kim, week 9 journal, 2021)

> "I learned many things from this module which I will be able to use whenever I am creating my own UI. The material provided by the lecturer has been great and very helpful. This module was an overall great experience." (Rion, week 10 journal, 2022).

The lecturer read through all entries each week. All entries received at least a simple approval comment from the lecturer (e.g. "Good" or "OK") and where appropriate, more detailed feedback. Going through all entries in this way took on average 1 hour 45 minutes to 2 hours per week. The usefulness of the reflection was often explicitly expressed by students, in verbal communications as well as from the exit survey results (anonymous):

> "I loved the weekly diaries [journal entries], they really helped me remember what we'd learned that week." (exit survey, 2021).

> "Weekly journals were a great idea since it is a good tool to help retain the information that was given during the lecture" (exit survey, 2021)

> "The journal writing after each session helps us memorize key terms and topics." (exit survey, 2021)

For the benefits of getting the overall sense of how the students are feeling and learning each week and serving as an additional personalised channel for feedback to the students, the extra 2 hours required to review 160+ journal entries each week were a worthwhile investment.

5. Reflection and Implications

While it seems difficult to make a large class engaging (and it is, in many practical ways), applying some of the well-practiced active learning methods in a relatively large class shows that they still work effectively.

Using Q&A as a way of explaining the new concepts in a large class can end up doing dialogues with only a few, same students who always answer, with the rest of the class "hidden in the crowd". In SUTD, having small number of students often meant the lecture remembered the majority of the students by their names. Asking questions by calling names

of different students works well when the students know that the lecturer shows respect to the answering student and would not ridicule if the student did not know the answer or answered incorrectly. In a large class, the use of a classlist to randomly call a student to ask a question may be a good strategy although there will be cases where the called student is not present in the class. Some students in our class proposed a final-year project to develop an app that logs the attendance in real-time in each session for the lecturer to use to randomly pick a student's name among the currently-attending students.

Facilitating weekly reflection journal is a light-weight way of reaching to individual students, instead of resorting only to group-level output/feedback as typically happens in large classes. It does require some amount of discipline on the side of the lecturer for having to go through the written entries each week, but the benefits shown above outweigh the drawbacks, especially since it is readily implementable without requiring additional infrastructural or extra university-level support.

Last year, DCU has set up an internal working group across departments to implement a set of pedagogical guidelines to enable a more innovative collaborative engagement with student peers and lecturers in order to produce the graduates more ready for solving real-world challenges using the knowledge and skills learned. An important part of this pedagogical upgrade will be to respond to the recurring question of how to engage the students more in large classes. First step for DCU as well as for other higher education large classes may be to identify versatile tools available in active learning community, then customise and tailor some of the proven methods to best support the large classes.

Acknowledgement

This work was conducted with the financial support of the Science Foundation Ireland Centre for Research Training in Digitally-Enhanced Reality (d-real) under Grant No. 18/CRT/6224.

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