Flipped Class Learning in a Large Class Setting

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Introduction

With the advancement of technology over the past two decades, there has been a myriad of pedagogical advancements and evolving methods for teaching in universities/schools. One noticeable method that is gaining influence is “flipped learning”, in which “teachers shift direct learning out of the large group learning space and move it into the individual learning space with the help of one of several technologies” (Hamdan, McKnight, McKnight & Arfstrom, 2013, p. 2). This approach “allows instructors to include active learning elements without sacrificing course content” (Zappe, Leicht, Messner, Litzinger & Lee, 2009). For instance, the lecturer may prepare short videos in advance to deliver the content and students are expected to have gone through the videos beforehand so that they can come prepared to work through the problems and interact with the lecturer during the lecture itself, thus inculcating meaningful discussion rather than involving the lecture time for content delivery.

While there are several positives to this method, the success of this approach also depends on the class size and the teaching methods employed. Last but not least, student participation in this approach is very important in order to achieve the relevant learning outcomes. We introduced flipped learning in a section of the module CN2125 “Heat and Mass Transfer” which has a large class setting (Total enrolment: 280 students) and in this study, we present the survey results solicited through the voluntary participation of chemical and biomolecular engineering (ChBE) students taking the module.

Methodology

Two 45-minute lectures on the subject of heat exchange equipment were recorded before the target delivery day at the NUS Computer Centre’s auditorium during normal teaching hours. Students were informed via e-mail to view the video clip, which had been uploaded to the IVLE (the university’s in-house course management system) before the lecture. Since students would be coming for the lecture prepared, this regular lecture time slot was converted to an open discussion on the lecture materials together with a guest lecture by an industry practitioner who will address practical aspects of heat exchangers. During the session, the guest lecturer offered students a wider scope of the practical problems one would encounter in Singapore’s chemical industry and a review of various types of heat exchangers it uses. After the flipped class, the evaluation of its impact on student performance was measured through the homework assignment and final examination. Students were also requested to provide online feedback (qualitative and quantitative) three weeks after the completion of the flipped class.

Recommended Citation

Using Pre-recorded Video Lectures to Explain the Basics of Heat Transfer Equipment

This video lecture covered the fundamental aspects of heat exchangers, including the classifications of different types of heat exchangers, such as double-pipe heat exchangers, shell-and-tube heat exchangers, and the cross-flow heat exchanger. In the video, students were taken through derivations of the term “log-mean temperature difference”. The video also introduced the energy balance concepts for “co-current flow” and “counter-current flow” heat exchangers together with case studies that offered specific examples. Students were requested to use the standard chart of correction factors for cross flow and shell-and-tube heat exchangers (for benchmarking against the counter-current configuration heat exchangers) to determine the actual heat transfer areas required in the process.

Using the Actual Lecture for Discussion & Clarification

After doing the required preparation and self-study using the video lectures, the students joined the discussion session in the lecture theatre during normal teaching hours. The lecturer-in-charge began the flipped class with a brief summary of the content covered in the video lecture. He then took a few questions from the students regarding how the lecture would be conducted and also how student performance would be evaluated in these sessions. Since the students had completed the review of the video lecture, the official teaching hours could be shortened without compromising the quality of teaching. The lecturer used the time saved as an “opportunity to maximise [their] students’ learning opportunities in the classroom” (Hamdan et al., 2013, p. 6) by getting a practitioner from the industry to conduct a guest lecture, which was usually not possible under the normal curriculum.

Including a Guest Lecture by An Industry Practitioner

The second half of the flipped class was dedicated to a guest lecture given by an industry practitioner. The speaker, Mr. Nagaraj Tumma (Chevron Oronite Pte Ltd, Singapore), delivered a lecture entitled “Heat Exchanger Fundamentals”. His lecture covered subjects such as the role of heat exchangers in process industries, design considerations, thermal and hydraulic designs, fouling and monitoring, mechanical design considerations, and maintenance. These topics were a good complement to the basic information provided in the pre-recorded video lecture and also gave students invaluable opportunities to understand the applications of heat exchangers in practical process industries.

Evaluations of Student Performance

As part of the continual assessments, the concepts covered in the flipped class were tested in the follow-up homework assignment and final examination. For instance, one concept question was assigned to students as a homework assignment on the choice of heat exchangers and the required heat transfer areas:

“A shell-and-tube heat exchanger having one shell pass and eight tube passes is to heat kerosene from 80 to 130 °F. The kerosene enters at a rate of 2500 lbm/hr. Water, entering at 200 °F and a rate of 900 lbm/hr, is to flow on the shell side. The overall heat-transfer coefficient is 260 Btu/hr ft² °F. Determine the required heat-transfer area.”

At the end of semester, one more structured question was given in the final examination for the students to calculate the heat transfer coefficients associated with the condenser of a power plant, focusing on the heat transfer between the water and the tubes, and the number of tubes needed to achieve the indicated heat transfer...
transfer rate. Judging from the results obtained for these two sampling points of evaluation, students were doing relatively well on this topic under this new approach. Their academic performance was just as good as that of earlier cohorts of ChBE students taught by the same lecturer in the past three years, even though the formal teaching hours for this cohort have been reduced.

Survey Questions

Following the flipped class, the lecturers for CN2125 prepared a survey form to collect qualitative and quantitative feedback from the students. The following questions were designed for that purpose:

<table>
<thead>
<tr>
<th>Survey Questions</th>
<th>Format</th>
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<tbody>
<tr>
<td>1. Is flip class learning appropriate for large class (&gt;250 students)?</td>
<td>Multiple choice</td>
</tr>
<tr>
<td>2. Flip class learning increased my workload.</td>
<td>Likert scale</td>
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<tr>
<td>3. Do you think flip class learning should be experimented in other modules?</td>
<td>Multiple choice</td>
</tr>
<tr>
<td>4. Comments, if any?</td>
<td>Essay</td>
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Survey Results

Figure 1 shows the survey results for Q1 “Is flipped class learning appropriate for a large class (>250 students)?”

Figure 1 shows the survey results for Q1. The sample size for the data presented is 144 students which is about 50.7% of the class (total class size: 284 students). As can be seen from the students’ response, about half the respondents think that flipped class learning can be implemented for a large class setting and it is quite appropriate albeit a bit challenging to engage a large class. It is noted that only about a sixth of the respondents said “No”, while about 30% of the respondents were “fence sitters” leaning towards the positive aspect of the question. This is an encouraging sign from the students’ perspective, that they are able to adapt to new pedagogies and approaches to teaching/learning.
Figure 2 shows the survey results for Q2. This is an interesting question as it directly addresses students’ perceptions towards the workload aspect of the flipped class learning initiative. The students’ response shown in Figure 2 indicate that about 38.2% of the respondents think that flipped class learning increased their workload while the majority (43.1%) remained neutral, indicating that this initiative neither increased nor decreased their workload. It is also interesting to note that none of the respondents strongly disagreed while a small number of respondents (3.5%) strongly agreed. One student decided to skip this question and is duly represented under “Skip” in Figure 2.

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Figure 3. Students’ response to Q3 “Do you think flipped class should be experimented in other modules?”
The third survey question was quite general; we wanted to gauge students’ acceptance levels to new and bold teaching/learning initiatives and we designed Q3 with that in mind. Figure 3 shows students’ response to Q3. 48.6% of the respondents chose “Yes” for this question, meaning that they were appreciative of new teaching/learning techniques in spite of the fact that 40% of the respondents had agreed in Q2 that the flipped class learning increased their workload. This is an encouraging sign for faculty members wanting to implement flipped class learning in a large class set-up, a typical situation for undergraduate level modules in many departments here at the NUS and may be applicable to many other universities as well. It is also interesting to note that only about 17.4% of the respondents said that flipped class learning should not be experimented while about one third chose to sit on the fence (“Maybe”) but leaning towards a positive response.

Apart from the three questions (Q1, Q2 and Q3) that were based on multiple choice and the Likert scale, the rest of the survey responses consisted of qualitative comments from the students about this initiative. After analysing the comments we realised that among the comments which were directly relevant to the flipped class learning approach, about 90% of them focused on the positive aspects while about 10% of the comments focused on the negative aspects. We have highlighted a few examples to give the readers a perspective of the comments we received on this initiative:

### Positive aspects

- “Good initiative. [This] should be done more often. As university students, we are expected to do a tad bit of self-learning. With flip flop lectures, this opportunity is given to us.”

- “It is an interesting initiative and might open up new possibilities in the current education system.”

- “This is a good change. A change in the lecture style [gives] students a change in the learning environment.”

### Negative aspects

- “I feel that this type of learning is more appropriate for small group.”
Conclusions

Our initiative to experiment using flipped class learning for one session in CN2125 has been a learning curve for us (the instructors) and it has received positive feedback from the students. The survey results show strong indications of students being appreciative of such new pedagogical initiatives being implemented, even though about 40% of them surveyed stated that it has increased their workload. In addition, there is a strong indication in the survey results that students would welcome such new learning approaches being implemented in future.

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References


About the Authors

**Professor Chi-Hwa Wang** currently teaches the following three modules in the Dept of Chemical & Biomolecular Engineering: CN2125 and CN2125E “Heat & Mass Transfer” and CN3124E “Particle Technology”. He believes that large student-lecturer ratio makes it extremely difficult for effective class interactions on an individual basis. In order to achieve this objective, he feels that teaching materials and methodologies have to be updated and enhanced regularly based on the state-of-the-art Internet and IT (e.g. webcast) facilities.

**Dr. Praveen Linga** currently co-teaches an undergraduate module, CN2125 “Heat & Mass Transfer” and a graduate module, CN5192 “Future Fuel Options: Prospects & Technologies”. He believes that teaching at the University level is to entrust students with the tools for obtaining knowledge, and to show them the relevance of such knowledge, thereby inspiring them to actively seek out further directions.