Lightening Up Mathematics-intensive Classes: A Case Study Using A Flipped Classroom Approach

Alberto CORRIAS
Dept of Biomedical Engineering

Introduction

The application of mathematical theory to real life problems is at the core of an engineer’s skill set. As a consequence, any Engineering curriculum involves several courses where a certain set of mathematics concepts are explained to the students. Engineering students should typically share an appreciation for or at least an inclination towards mathematics. Nevertheless, it is the application of mathematics, rather than the mathematical theory itself, that actually sparks an Engineering student’s interest. For this reason, some of the most theoretical classes often end up perceived as being rather dry and, taken in isolation, quite uninspiring. According to Chen (2010), as part of a social constructivist approach to learning,

“…learning occurs when students socially build and agree upon knowledge. By exchanging and sharing notions with others, knowledge is formed and thinking occurs” (p.26).

Hence, in order to enhance student engagement, I decided to implement a flipped classroom concept, incorporating participation incentives for the students. The key underlying idea of this case study is to cover the most theoretical topics in pre-recorded video lectures while focussing on specific applications of the theory during the classroom sessions with some level of interaction with them.

Implementation Details

This experiment was conducted in a large undergraduate class (145 students in total). The topic of the course was data analysis. Following a paradigm that is similar to that of the flipped classroom (Hamdan, McKnight, McKnight & Arfstrom, 2013), I pre-recorded the video lectures and made them available to the students a week before the classroom sessions. The video lectures were typically 20 to 30 minutes long. The content covered the most theoretical and mathematical aspects of the topics in the syllabus. The fact that the most theoretical topics were covered in the video lectures allowed me to use the classroom sessions to focus my students’ attention on the applications of the theory. In fact, each classroom session started with a problem taken from scientific literature in the relevant field (bioengineering) and consisted of getting students to apply the theory covered in the video lecture to the specific problem.

Students were encouraged to view the video lecture before the classroom session, which falls on a Tuesday. Email reminders were sent to them regularly. To promote student participation in the classroom session, I asked the class several questions throughout the lecture. At least 5 questions per classroom session were asked, often more. Students who watched the video lectures beforehand should be able to answer the questions easily. After asking the question,
I would do a visual sweep of the lecture theatre to spot the first student who raised his/her hand and listened to the answer. For every correct answer I gave a small prize; typically, a chocolate bar.

I emphasised to the class many times that there was no penalty for wrong answers, and that one student can answer multiple times, even after getting an earlier question wrong. In addition, I emphasised that the answers they give in class will not have any effect on their overall grades.

Methods of Assessment & Results

The efficacy of the proposed strategy was assessed by two independent methods: a survey and a focus group discussion with the students, two of the most commonly used methods (Cousin, 2009).

Survey

A questionnaire was distributed to the students during the last lecture of the term. The questionnaire consisted of the following statements:

<table>
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<tr>
<th>Statement</th>
<th>Description</th>
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<tr>
<td>1</td>
<td>“I found the video lectures useful.”</td>
</tr>
<tr>
<td>2</td>
<td>“I would have preferred a traditional lecture + tutorial format without any video lecture.”</td>
</tr>
<tr>
<td>3</td>
<td>“Because of the video lectures, the lectures on Tuesday were useless: that time could be better invested practising on computers.”</td>
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The reference to practising on computers in Statement 3 is related to the tutorial session that followed the Tuesday lecture the next day. Students were asked about their level of agreement in a 5-point scale (i.e., 1-Strongly disagree, 2-Disagree, 3-Neutral, 4-Agree, 5-Strongly agree). An open box for comments and suggestions was included as well. 107 students (74% of the class) responded to the questionnaire.

About the Author

Dr Alberto Corrias currently teaches several modules related to computing, statistics, design and modelling to biomedical engineering students. He also teaches a junior seminar course on biomedical technology to the students of the College of Alice and Peter Tan (University Town). He believes that a judicious use of new technologies can have a significant and positive impact on students’ learning of engineering subjects.
According to the survey results shown in Figure 1, when asked whether they found the video lectures useful, none of the students disagreed and only 5% were neutral about it, providing a strong indication that the video lectures were appreciated by most of the class. Nevertheless, when asked whether they would prefer a traditional classroom concept as opposed to the presence of video lectures, a sizable proportion of students (34.9%) gave a ‘neutral’ answer and only 50.5% agreed or strongly agreed.

Only 13.5% of students thought that the classroom session on Tuesday was no longer useful because of the video lectures, suggesting that the interplay between video lectures and the classroom session was well received.

*Note: Statements 2 and 3 and their respective responses have been rephrased in a positive way in Figure 1, e.g., the green column for Statement 2 represents the number of students who disagreed with “I would have preferred a traditional lecture + tutorial format without any video lecture.”

**Focus Group Discussion**

Five (5) students were randomly selected for a focus group discussion. The objective of the discussion was to substantiate the results of the survey and gather more feedback and ideas from the students. It was conducted about six weeks after the end of the term. The first topic of the discussion was the video lectures. Four out of five students watched the video lectures (one student missed a couple). They all agreed that the ability to rewind and “re-listen” to the videos was critical to their learning and most appreciated having these videos on hand because as one student put it, in a normal classroom, at some point “my mind goes somewhere and I miss what the lecturer says”. The length of the video was deemed appropriate by all students. Two students watched the video before the actual lecture throughout the course (as recommended). Two other students said that sometimes they would watch it afterwards or in some cases, just before the exam.

The second topic of the discussion was the classroom session. All the students in the focus group agreed that the presence of video lectures was not a factor in their decision whether to...
attend the classroom session or not. In fact, they all attended the classroom sessions. They agreed that the focus on the application side of the problem—made possible by the presence of the video lectures—was useful. They all enjoyed the rewards system (chocolate bars) and explicitly encouraged me to maintain it next year. They also suggested limiting the number of answers any one student is allowed to give.

**Reflections & Future Directions**

Implementing the flipped classroom concept required considerable extra work, such as additional time to record and edit the video lectures. Nevertheless, I believe it was well worth the effort. The positive survey results were encouraging and with the flipped classroom approach, the classroom sessions turned out to be livelier than I expected given the topic and the size of the class. The system of participation incentives worked well, and I managed to obtain answers for all the questions I have asked in class throughout the course. The focus group discussion essentially confirmed the survey results—that the video lectures were considered valuable by the students, particularly because of the added capability listening to certain parts of the lecture multiple times. It would be interesting to collect more data from future runs of this course to confirm and validate what is presented here. For example, one plan could be to incorporate some online quizzes for students to attempt right after viewing the online lectures. It is hoped that such quizzes may provide prompt feedback to students, a way to check on their level of understanding after viewing the lectures. Furthermore, it would be interesting to quantify the impact of the proposed approach on students’ learning; such a task could be achieved by comparing the performance of students who watched the video lectures with students who, perhaps choosing a self-study approach, did not watch the video lectures.

**Endnote**

This case study was presented at the Technology-enhanced Learning 2013 (TEL2013) Symposium on 7 Oct 2013.

**References**

