Challenges and Teaching Improvement of Engineering Classes: Meeting Student Expectations

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Extended Abstract

The aim of this paper is to explore the students’ perception of the teaching quality in engineering education and based on this, discuss the relationship between student feedback and students’ learning orientation and strategies in two similar course cohorts.

In conjunction with this, the paper also investigates the teacher’s application of the Lesson Study approach and changes undertaken in the module over a three-year period. This work aims to find some answers to some issues/problems relating to lectures, tutorials, assessments that the teacher personally encountered/experienced from 2011 to 2014.

Introduction

The course in focus is the National University of Singapore (NUS) module “Mechanics of Solids”, given as a daytime class (ME3211) for regular full-time engineering students, and as an evening class (ME3211E) for part-time students (BTech students).

Both ME3211 and ME3211E are elective modules intended for full-time and part-time students (BTech) in Year 3 and 4 respectively. Students taking the modules have an interest in the stress analysis of isotropic and composite materials. The two modules cover the same topics and have the same lecture content; these topics include studying the field of linear elasticity for complex problems, stresses in pressurised thick-walled cylinders and the mechanics of composite materials. The topics covered in the modules are applicable to chemical, civil, mechanical and aeronautical engineering.
Addressing Teaching Challenges Encountered in Engineering Classes

Analysing Student Feedback

Both modules were taught by Dr Duong, covering 50% of the lectures for the modules and dealing with lecture topics such as linear elasticity, mechanics and failure of composites. Dr Duong taught the modules over three years, from 2011 to 2013.

ME3211 consists of younger full-time students (ages 20-22) and ME3211E of older part-time students (ages 28-35), who are mostly working full-time while pursuing their studies. The student numbers are summarised in Table 1.

<table>
<thead>
<tr>
<th>Academic year (AY)</th>
<th>Number of students in ME3211 (number of respondents)</th>
<th>Average evaluation score of ME3211 (department average) Scale 0.0 (min) – 5.0 (max)</th>
<th>Number of students in ME3211E (number of respondents)</th>
<th>Average evaluation score of ME3211E (department average) Scale 0.0 (min) – 5.0 (max)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AY 11-12</td>
<td>28 (17)</td>
<td>3.706 (3.791)</td>
<td>10 (5)</td>
<td>3.800 (4.055)</td>
</tr>
<tr>
<td>AY 12-13</td>
<td>41 (31)</td>
<td>3.419 (3.838)</td>
<td>12 (3)</td>
<td>4.000 (3.927)</td>
</tr>
<tr>
<td>AY 13-14</td>
<td>41 (20)</td>
<td>4.275 (4.038)</td>
<td>43 (16)</td>
<td>4.471 (4.159)</td>
</tr>
</tbody>
</table>

NB: Students’ evaluation scores are teacher-based rather than covering the whole module. Thus the scores in Table 1 refer only to Dr Duong’s portion of the modules.
Based on the teaching evaluation of the two modules over three years, it is possible to identify four main challenges on which students provided feedback: (1) teaching delivery, (2) tutorial conduct, (3) student communication during the question-and-answer (Q&A) sessions, and (4) the teacher’s language ability, as shown in Table 2.

Table 2. A selection of students’ qualitative evaluation/feedback of ME3211 and ME3211E, 2011-2013. Indicative quotes included and categorised.

<table>
<thead>
<tr>
<th>Teaching challenges</th>
<th>Teaching evaluation of daytime class ME3211</th>
<th>Teaching evaluation of evening class ME3211E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching delivery</td>
<td>“Try to be more in sync with the students. Go through lectures instead of diving into how to answer the questions because we are not only interested in the exam. Doing questions before allowing us to leave is good but too much is stressful and taxing.”</td>
<td>“Suggest to better organize the slides since there are too many slides in the introduction while less in the later part.”</td>
</tr>
<tr>
<td>Tutorial conduct</td>
<td>“Please try to explain more about the significance of the content, instead of barely trying to teach us the method of solving questions. I feel like a calculator when I go for your class, simply typing in values and not knowing their physical meaning.”</td>
<td>“Give more detailed calculation. The matrix is too complex for us to finish in exam. Don’t put presentation near to the end of the module.”</td>
</tr>
<tr>
<td>Student communication on Q&amp;A</td>
<td>“Perhaps the prof could answer the questions asked by the student instead of throwing it back to us and end up no answer at all. Answer the questions face to face.”</td>
<td>[ NIL ]</td>
</tr>
<tr>
<td>English ability</td>
<td>“Accent tends to be a bit too strong so it is hard to understand certain points taught. May suggest to speak louder instead as voice tends to get lower as time passes.”</td>
<td>“Improve on your English? If possible”</td>
</tr>
</tbody>
</table>

It is also possible to identify a number of differences between the two otherwise identical modules taught to the different student groups (part-time/full-time; younger/older) over the three years. For one thing, the qualitative feedback seems to indicate that the teacher’s ability to speak very good English is desired or sought after by students in both modules. However, there is less expectation in this respect from the older students taking ME3211E. Instead, they are more focused on solving the tutorial problems and the final examination, while the students taking ME3211 are more focused on learning the scientific meaning behind the problems; once they understand the “significance of the content” (as one student puts it in the feedback), it makes it possible for them to explain the problems to non-engineers effectively.

The former approach, adopted by the ME3211E (part-time) students can be understood as a surface learning approach to learning (Ramsden, 1992), whereas the ME3211 (full-time) students clearly seek a deep learning approach. Felder and Silverman (1988) also refer to two corresponding categories of learning among engineering students: deductive versus inductive learning.
The student feedback collected from the evaluations highlighted the differences in the aims and goals between the two different student groups taking the modules. Intuitively, the expectation was that the older students with working experience (i.e. those taking ME3211E) would be more focused on a deep or inductive approach. Instead, the evaluation results indicate the opposite to be the case.

**Adapting Classroom Learning Activities Based on Student Feedback**

Based on the student feedback collected, some changes were made to improve the teaching of both modules. The changes undertaken to the modules over the specified period included improvements in the delivery of the lectures (such as improving the teacher’s language skills) and providing students with clear commitments at the start of the course (see Figure 1). In addition, a more challenging task was addressed: managing the deep versus surface (or deductive versus inductive) learning styles of the two differing module cohorts. In this regard, the teaching set-up and style adapted to improve their learning experiences can be termed active work with *constructive alignment* (Biggs, 2003). It includes the active communication of (desired) learning outcomes to students, as well as the conscious use of teaching methods that favour meeting these set outcomes. In addition, *constructive alignment* includes setting up learning situations that lead to the student being an active learner, focused on a *deep learning approach* (Ramsden, 1992).

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**Commitments of Module ME3251E - Part 1**

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   mpedhm@nus.edu.sg  Tel: x61567

2. Two open book for mid-term quiz (15% for each) and final exam (70%). The quiz date is on 10 Feb 20:14 at 6:30 pm (90mins, Tuesday, week 6). Ms Liu Peng will be your examiner.

3. Tutorial questions will be conducted during lectures.

4. What I teach can be in the final exam and quiz. It can be calculated problems or solving problems. No question is from the video clips shown during the lectures.

5. Please post your questions on the IVLE forum. Your questions will be answered every Friday afternoon including the recess and reading weeks. Please do not just study during the reading week.

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**Figure 1. Lecture note for ME3211 and ME3211E: Commitments/clarification.**

Felder and Brent (2005) highlight a number of teaching strategies that are constructively aligned with a deep learning approach, including providing students with clear expectations and feedback on their progress; incorporating assessment that encourages students to develop a conceptual understanding of the modules’ content rather than mere recall of knowledge; as well as having the teachers adopt a teaching style that is caring and stimulating. Importantly, Felder and Brent (2005) also note that “students who perceive that teaching is good are more likely to adopt a deep approach than students with the opposite perception” (p. 64).
The teaching changes and improvements implemented in ME3211 and ME3211E with the support of department colleagues were in line with the principle of constructive alignment (Biggs, 2003) and the strategies identified by Felder and Brent (2005). They include:

- **Improvements made in the delivery of the modules’ content.** Several things were put in place to improve delivery of the modules’ content. For instance, the teacher ensured that lecture materials were more organised. Students were also kept alert and attentive in class by the instructors asking them to write some notes during the lectures. Amusing and funny quotes were used at the start of the lectures to get their attention, and short video clips were used throughout the lectures to create variation and break the monotony of viewing static lecture slides. Clear commitments were stated on the first day of the class (Figure 1) so that students had a clear sense of what to expect about the course from the start. Finally, the teacher set up a structured discussion on the university’s Integrated Virtual Learning Environment (or IVLE) to answer any module-related questions students might have.

- **More emphasis placed on teaching development.** To develop his expertise in teaching, the teacher attended relevant courses at NUS’s Centre for the Development of Teaching and Learning (CDTL), and also sought advice on best practices in teaching and models in good lecturing styles from colleagues and senior faculty members in the Department who have won teaching awards.

- **Improvements made to how tutorials are conducted.** When it came to the tutorials, the teacher spent considerably more time on providing students taking ME3211 with the scientific meaning of the tutorial questions. Tutorials were conducted at the end of every session, during which students were guided through the major steps to solving the problems presented in the tutorial questions. Students practiced problem solving in class, and the teacher was on hand to personally answering students’ questions. The tutorial solutions were then published on IVLE within 1 to 2 weeks after the tutorial session.

- **Improvements made in the area of student communication.** The teacher focused on developing a greater awareness of students’ differing learning strategies and abilities, to cater to the whole spectrum. The teacher’s communication to students reflected this, including providing them with reminders of tasks and the tutorials in advance.

- **Improvements made to the teacher’s command of English:** The teacher improved his pronunciation of English terms through the English assistant programme at NUS.

Table 1 provides a quantitative indication of the positive outcome which came about from the changes undertaken. Teaching evaluation scores improved over the specified period and in AY2013/14 were actually higher than the average department scores. There has been increased demand from students to take up this elective module, especially among the BTech (evening class) students. The qualitative student feedback for AY2013/14 is also much more positive, with student providing comments such as:

- “good teaching style makes [for a] class filled with [the] fun of learning”;
- “[teacher is] very approachable for consultation and problems”;
- “[teacher] interact[s] with each of us and to urge us to finish and learn the tutorial”, and
- “Cheerful, approachable and responsible [l]ecturer [concerned about] student progress”.

**Conclusion**

From the teacher’s perspective, in the teaching situation the student’s limited training or lack of good industrial experience can pose a challenge. Students without training or knowhow cannot solve the problems independently and choose the right materials based on industrial needs. As such, identifying and collaboratively studying the best practices in teaching and innovatively employing other means teaching such as using YouTube clips will go a long way in helping the teacher improve student engagement in the lectures and tutorials and more effectively manage these limitations.

It is evident that following the changes made to improve the teaching of ME3211 and ME3211E, the teaching evaluation for both modules were subsequently more positive; teaching scores have also improved and were higher than the department scores. A key lesson learnt from this experience is that when the teacher is planning the module’s syllabus, there is a need to consider the modules’ learning outcomes and to also take into consideration that students are “customers” with differing learning approaches and ambitions. To this end, providing module-related commitments/clarifications on the first day of the class and discussion platforms on IVLE are very helpful. It is also important to note the markedly different learning approaches and expectations of the older students of ME3211E (part-time evening class).

**References**


