Deviating from traditional lectures: Engineering students' perception of active learning

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SESSION

C1: Integration of theory and practice in the learning and teaching

CONTEXT As an early career academic, I was asked to teach one of the modules (out of four) in a postgraduate Engineering course. I took this as an opportunity to redesign the module to tackle one of the main issues in the previous years: lack of student engagement. My redesign included principles of constructive alignment. I developed new learning outcomes and introduced two activities to promote student engagement in the classroom. The class size was small, a total of 19 students, the majority of whom were international. Two types of activities were included: (a) a class discussion and (b) a formative assessment, a quiz to test students' basic knowledge of the lecture material. In this paper, I analyse the feedback from the students and share my own experience. I provide a pathway for other early career academics who are looking to make similar changes to their courses.

PURPOSE The purpose of this study is to describe the pedagogical changes and show their effects through data on students' perceived learning of the lecture material.

APPROACH A survey was undertaken pre- and post- completion of the module. The questions included in the pre-completion survey were on students' previous experience of the subject, and their preference for lectures taught in the traditional transmissive model or with class activities during the lecture. The second survey included questions on their perceived knowledge of the subject and if they found the quiz and in-class discussion helpful in assisting them to achieve the learning outcomes.

RESULTS All students, except one, stated that they felt more confident to work in a job involving public transport after the completion of the module. Thirteen students (out of the 16 students who completed both surveys) indicated that they found both activities useful for their learning. Around 6 students out of 16 initially indicated that they prefer lecture only classes and later indicated that they found the in-class activities to be helpful in their learning. The main reasons why the students found the quiz helpful was because it gave them an opportunity to review the lecture material and be proactive in their study. As for the in-class discussions, the main reasons students found it useful was because they could engage with the material, hear the opinions of their peers and express their own views.

CONCLUSIONS Overall, the feedback from the students showed the usefulness of the constructive alignment concept when creating new lecture material. The learning outcomes were connected to the two in-class exercises and this produced a positive feedback from the students. The findings of this study showed that the theory of constructive alignment can help scope what to include in the lecture material and how it can be taught. I would like to encourage early career academics to try innovative approaches in their teaching.

KEYWORDS Early career academic, constructive alignment, student engagement

Introduction

A new staff member often finds themselves included in a course designed by someone else and asked to either modify or create new lecture materials. This can be a nerve-racking task, as not only do you need to define the scope of the material to be taught but also to determine how it will be taught. Making a mark as an innovative teacher may be difficult when the original course authors are still involved in the course. These co-teachers are more likely to be higher in the institutional hierarchy and well-established within it, while the new staff is typically an early career academic. I argue that in such a challenging situation, early career academics can perceive it as an opportunity to try an innovative approach to their teaching. The life of a student is still fresh in the minds of an early career academic. They remember what it is like to sit in lectures that are not engaging and become disconnected from the content being taught.

There are many methods of teaching and each discipline has its own traditional way, often influenced by expectations on career trajectories. For example, Engineering produces a body of professionals who are required to possess certain trade skills and to be aware of the code of ethics for their practice after graduation. Yet despite the need for practical competence, most courses are taught with the teacher transmitting knowledge. As such, students expect lecture times to be where they take notes while being taught about the course materials. Despite the growing evidence of active learning in Engineering courses, many courses are still taught in the traditional transmissive model (Freeman et al. 2013). As such, deviating from this form of teaching takes courage. Activities outside of class times are undertaken mostly in groups or pairs, and Engineering students are accustomed to working in groups outside the class. So, what approach might an early career lecturer take to bring this level of enthusiasm for learning into the classroom?

As an early career academic, I was asked to take one of the four modules in a postgraduate course. In the previous year, I sat as an observer to the course. I noticed that many students quickly became disengaged from the teaching and this lack of interest continued throughout the day. Here, let me explain that most Masters degree courses in Engineering in my institution are taken in blocks. In each block, students are taught from 9am to 5pm for 2-3 days. A semester will typically have three blocks for one course. These courses commonly have around 20 students. Therefore, when I was asked to be part of this course, I decided to re-design the module I will be teaching to include more student engagement during the lecture. I adopted Biggs theory on constructive alignment. Most of the Engineering courses do not have constructive alignment, so adopting this concept is my contribution to the course. For this theory, Biggs (1996) emphasises that pedagogy is strongest when it is the learner who is central, not the teacher as the transmitter of knowledge. The learner accumulates knowledge by actively selecting and constructing their knowledge through individual learning and social activity.

Given that the class size is small, I decided to include two activities which required participation from everyone. The present study looks at the effects of these changes on the students' perceived learning. This paper discusses students' perceptions of: (a) whether the activities helped them achieve the learning outcomes and (b) their perceived learning given the inclusion of activities which required their engagement in class. Pre- and post- surveys were undertaken for the module I taught to determine these two research objectives. The next section provides a summary of relevant published articles.

Literature review

Biggs (1996) suggests that when selecting different types of teaching/learning activities, it is important to bear in mind that lecturers do not need to be the sole source of knowledge. Peer learning is a great alternative as it allows the students to hear different options. Exercises undertaken in the classroom from now on will be referred to as active learning, promote

engagement and peer learning. They differ to the traditional lectures, in which students primarily listen and take notes. Active learning, particularly problem-based activities, allows the students to achieve *deep learning* instead of *surface learning* (Marton and Salijo 1976). The traditional transmissive model tends to entail surface learning. In deep learning, students think critically about the information they are given and apply that thinking to a task, while, in surface learning, students focus on memorizing the information (Wang et al. 2013). Teachers who intend to promote *deep learning* require the student to actively process and apply information in a variety of forms. Lectures including active learning within the classroom, for example, by using quizzes, group discussion and problem-solving exercise, were shown to improve students' test scores and reduce failure rates (Wieman 2014). Hartley and Davies (1978) suggested that breaking up the lecture time helps to keep students engaged. Students are shown to remember 70% of the first 10 minutes and 20% of the last 10 minutes. In-class activities give students some time to absorb the material being taught, while also giving them a break from listening and this helps them retain the knowledge for a longer period.

Prince (2004) discussed the types of active learning exercises that have been incorporated into Engineering courses. The main distinguishing feature between active learning exercises and a take-home assignment is that they are completed in the classroom at lecture times. There are three kinds: (a) collaborative learning, (b) cooperative learning and (c) problem-based learning. Collaborative learning includes small groups of students working together while cooperative learning includes a small group of students in which each are individually assessed (Bruffee 1995). In Engineering, cooperative learning and problem-based learning are the most common. The study highlights that the results from problem-based learning varies and that in some cases the improvement is marginal. To produce deep understanding, they need to be designed around learning outcomes and promote engagement from the students (Wiggins and McTighe 1998, Forbes et al. 2001). Active learning has been seen to have the highest impact on courses with 50 or fewer students and was shown to have a positive effect on learning, evidenced by reduced failure rates (Freeman et al. 2013).

Feedback to students during the course is an important tool to aid in their learning. However, providing feedback to students has been identified as one of the weakest aspects in higher education teaching. A solution to improving this weakness is to conduct formative assessments. Such assessments are used to provide feedback, both to the lecturer (on how much the students know the material) and to the students (how much they have learned and what is expected of them) (Dixson and Worrell 2016). Formative assessments are also known as "early-warning summative" assessments and "assessments *for* learning". They can be included during class times to engage students with the lecture material and keep learners' minds in the classroom during teaching (Dibu-Ojerinda 2006). Formative assessments challenge the learner to think deeply about the content and discourage surface learning. How the feedback is provided has an effect on the students' learning. If feedback is transmitted to the students on the right and wrong elements of their academic work, then students can become empowered to develop self-regulation skills. Such skills are required in the profession, particularly in Engineering, where you are made accountable for any mistakes. Nicol and Macfarlane-Dick (2007) discussed the seven principles of good feedback. One of them is to encourage the teacher-student dialogue around learning. Teacher needs to clarify what is the standard performance and how students can close the gap between current and desired performance.

A fundamental question across the science, technology, engineering and mathematics (STEM) disciplines is whether we should ask or we should tell (Freeman et al. 2013). Many STEM courses (Freeman et al. 2013) have been including active learning in one form or another. However, lecturers commonly worry that not as much material can be covered by deviating from the traditional model. Buck (2016) states, in defence of the traditional transmissive model, that a skilled lecturer can present the material so effectively that the material seems clear, even to the most naïve listener. However, is this full mastery of the

material? Without a chance to apply the content, is the student truly able to achieve mastery in their learning? Graduates are expected to have full mastery of their subject area. They are perceived by the industry personnel to be the ones who bring fresh and exciting knowledge with them from the university. As such, mastery of the subject area is important not only for their employability but also for their career growth. As lecturers, it is our duty to ensure that students had the opportunity to practice the concepts. Simply providing lecture notes cannot be expected to produce full mastery of the subject. Active learning exercises can assist with this issue by allowing the students to apply the content in class under the support of their peers and the lecturer. By *asking* questions instead of *telling* about the material can be an effective way to teach. It provides students with an opportunity to engage their minds. This ends up allowing the students take ownership of their learning which will inenviably lead to better understanding of the subject (Stegemann and Sutton-Brady 2013).

Description of the module's re-design

Development of learning outcomes

Setting goals at the beginning of class can provide clarity on what is expected from the students (Martin 2006). It also provides for the instructor a way to focus the teaching material. One way of setting these goals is to develop learning outcomes. Learning outcomes inform students about what they are expected to know from a course or module. Once they are set, the course content can be delivered by creating teaching/learning activities which will help the students to achieve the learning outcomes. Assessments can be used to test if the learning outcomes have been met. This concept is known as "constructive alignment", developed by John Biggs in the 1996 (Wang et al. 2013). Constructive alignment is a useful tool for teaching, particularly for early career academics. The concept helps create a road map when creating new lecture materials and assessments.

Bloom's taxonomy (Adams 2015) was used to develop the new learning outcomes of the teaching material for the module I was teaching. These learning outcomes were presented at the beginning of the lecture notes. Bloom provides a list of verbs and the relative effort required to achieve them by the learner (Stegemann and Sutton-Brady 2013). For example, the verb "*summarise*" places the expectation on the student to memorize and repeat the concept, whereas the term "*analyse*" requires the learner to draw a connection among the ideas taught and apply them to a problem. In formulating the outcomes, typical questions the teacher can ask themselves are "*What do I want my students to be able to do?*" and "*What do I want my students to appreciate/ value?*". Following these questions, the new learning outcomes I developed are given in Table 1, with the verb for each learning outcome emphasised. The table shows that several levels of mastery (summarise, understand, create, analyse) of the subject area are expected from the students.

Table 1: Learning outcomes for new module

Learning outcome 1	***Summarise*** the important concepts in Integrated Public Transport system's operation.
Learning outcome 2	***Understand*** the psychological and statistical models used for travel behaviour.
Learning outcome 3	***Create*** data collection procedures for travel behaviour models.
Learning outcome 4	***Analyse*** current issues related to transport and the future of public transport.

The learning outcomes were also aligned with two attributes stated in the Postgraduate Coursework Graduate of the university:

(a) **Specialist knowledge**: An understanding and appreciation of current issues and debates in the field of study [first and second learning outcome];

(b) **General intellectual skills and capacities**: An ability to analyse information, where appropriate, using appropriate tools, technologies, and methods [third and fourth learning outcome].

Development of the active learning exercises

The goal of higher education is to produce individuals who are confident and independent learners to "sustain a learning society" (Taras 2010). The National Association of Colleges and Employers (2016) conducted a survey and found the top attributes desired in new university graduates. Table 2 shows the top five attributes. Team work and communications skills are among these top five attributes.

Table 2: Attributes employers want to see in new graduates

Attribute	Percentage of Respondents
Leadership	80.1%
Ability to work in a team	78.9%
Communication skills (written)	70.2%
Problem-solving skills	70.2%
Communication skills (verbal)	68.9%

The course had 19 students, 14 of whom were international students (those who did not complete their undergraduate degree in the country). This dynamic was considered when developing the activities to engage students. A key motivation for the international students to undertake a Masters degree is to find a job in the industry. As such, I developed class activities which will give students an opportunity to work in a team and practice their communications skills, both written and verbal.

One of the activities was a class discussion. The students had an opportunity to engage in a group discussion about a specific topic. The discussion was supplemented with recent magazine articles on the topic. After the students discussed for approximately 30 minutes, a member was selected to report back to the class. The purpose of this exercise was to allow the students to express their own views and to learn from their peers. This activity helped the students to achieve Learning outcome 4. In the Engineering profession, it is a common practice to have group discussions and this in-class activity gave the international students an opportunity to practice their verbal communication skills. While I was planning this activity, I was apprehensive about its success. This is because most international students are accustomed to the traditional transmissive model of learning (Kember 2000). The class discussion was very successful; everyone in the class engaged and expressed enthusiasm. Given its success, for the next class I designed the class notes to have gaps. These gaps were filled by mini class discussions throughout the lecture.

The second activity comprised of an in-class quiz, worth 5% of the total grade. The questions in the quiz were designed to help the students meet the first two learning outcomes given in Table 1. They are:

- Summarise the important concepts in Integrated Public Transport system's operation.
- Understand psychological and statistical models used for travel behaviour.

Assessments can be an effective way of assisting students' learning through motivation. Formative assessments are an important component of teaching as students require accurate self-assessments to guide their learning process (Marchand and Furrer 2014). As such, when formative assessment are properly aligned with learning outcomes, the feedback can be used to help the students achieve them (Wanous et al. 2009). The weight of the assessment was kept at the lower end as the purpose of this activity was for students to receive feedback on their learning.

The quiz was a mixture of multiple choice and short questions. The short questions helped the international students practice their written communication skills. It is expected that the feedback will help the students know the gaps in their understanding of the lecture material and allow them to prepare for the final examination that is worth 50% of the total grade.

Data collection

The data was collected using pre- and post- surveys of teaching the module. This research method has the advantage of allowing the lecturer to assess the effects of their teaching. One of the disadvantages is that a control group was not allocated. Given the small class size, everyone was invited to participate in the survey. The students were handed an envelope with a number. The number was unknown to me to keep the surveys anonymous. This helped the students feel comfortable to express their authentic views in the surveys. Each envelope contained two survey forms and a participant information sheet (PIS). The survey forms had the same number as the envelope's number. This allowed the survey forms to be tracked and compared for analysis. The PIS outlined the objective of the study and informed students that the surveys have been approved by the university's Ethics Committee. Students were also informed that participation is voluntary and that they could opt out at any point. The survey forms were completed and collected during class time. All students returned the questionnaires in a box to preserve anonymity. Table 3 provides the items in the questionnaires and the response options.

Table 3: Items in questionnaires

	Question	Response options
Survey 1		
Item 1	Does your current job involve any work on public transport? If "yes", please rate from 1 (poor) to 10 (very good) your confidence in working on public transport systems.	Rate 1 (poor) to 10 (very good)
Item 2	Did you complete your bachelor degree in New Zealand?	Yes/No
Item 3	What kind of class interaction do you prefer?	Lecturer provides notes only/In-class activities along with lectures
Survey 2		
Item 4 (links with Item 1)	Do you feel more confident about working in a job involving public transport?	Rate 1 (poor) to 10 (very good)
Item 5	Did the quiz help you to achieve at least one of the learning outcomes?	Yes(explain)/No(explain)
Item 6	Did the class discussion help you achieve at least one of the learning outcomes?	Yes(explain)/No(explain)

Results and discussion

Out of 19 students, 16 completed both pre- and post- surveys. Figure 1 shows a comparison of the students' personal rating of their knowledge, on the subject area (public transport systems), before and after the completion of the module. The rating choice given to the students was 1 is poor and 10 is very good.

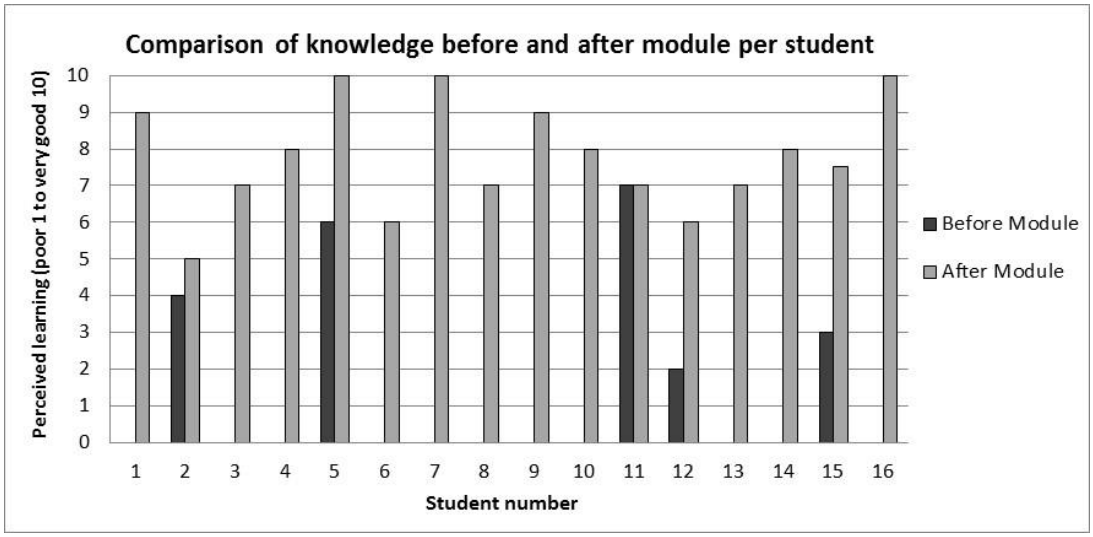

Figure 1: Comparison among students' knowledge before and after module completion

From the 16 students, two rated themselves 6 and 7 for Item 1 (current job involves public transport), three rated themselves between 0 and 4 and the rest responded "no" to the question. Out of the 16 students, 13 were international (those who did not complete their undergraduate degree in the country). The course commonly attracts many international students. Those who are domestic students usually work in the transport industry. Out of the five students who had knowledge of the topic prior to the lectures, three were domestic students. Figure 1 illustrates that majority of the students perceived that they have gained sufficient knowledge on the topic after the completion of the module. The increase is particularly significant for those who did not have any prior knowledge on the topic. The rating increased for all the students except for Student Number 11. This student perceived that they did not learn anything from completing the module. In Survey 2, under "other comments", this student commented that they did not feel anything new was taught in the module. The student felt that the material was too basic and they wanted more advanced knowledge to be taught.

Table 4 provides a summary of the responses from students for Item 3 from the pre-completion survey (Survey 1) and items 5 and 6 from the post-completion survey (Survey 2). For Item 3 (preference for lecture only classes or in-class activities), six students indicated that they preferred lectures only, while majority of the students (10) preferred lectures with in-class activities. Two of the students who said "yes (Y)" in Survey 1 to in-class activities, stated that they did not find either the quiz helpful or the class discussion helpful. Student Number 2 wrote in the survey that the main class discussion was only about one topic. Student Number 10 stated that they did not find the quiz helpful for their learning.

Majority of the students liked the in-class activities. 8 out of the 16 students stated in Survey 1 that they prefer class activities over lecture only classes and they also agreed that they found the quiz and class discussion useful exercises in helping them achieve the learning outcomes. More interestingly, 6 out of the 16 students stated in Survey 1 that they prefer lecture only classes and in Survey 2 agreed to finding the quiz and class discussion useful in their learning. The main reasons why the students found the quiz helpful was that it gave them an opportunity to review the lecture material and be proactive in their study. The quiz also allowed them to understand the key points of the material.

Table 4: Summary of responses from the students

	PRE-MODULE SURVEY (Survey 1)		POST MODULE SURVEY (Survey 2)	
Student Number	**Prefer in-class activity**	**Prefer lectures only**	**Found quiz helpful**	**Found class discussion helpful**
1	Y	N	Y	Y
2	Y	N	Y	N
3	Y	N	Y	Y
4	N	Y	Y	Y
5	Y	N	Y	Y
6	N	Y	Y	Y
7	Y	N	Y	Y
8	N	Y	Y	Y
9	Y	N	Y	Y
10	Y	N	N	Y
11	N	Y	Y	Y
12	N	Y	Y	Y
13	Y	N	Y	Y
14	Y	N	Y	Y
15	Y	N	Y	Y
16	N	Y	Y	Y

From the comments made by the students in Survey 2, it was clear that the quiz helped the students achieve Learning Outcome 1 which is “Summarise the important concepts in Integrated Public Transport system’s operation” more than Learning Outcome 2 “Understand psychological and statistical models used for travel behaviour”. This result is logical as most of the questions in the quiz where short-answer questions which targeted Learning Outcome 1 more than 2. As for the in-class discussions, the main reasons students found it useful was because they could engage with the material, hear the opinions of their peers and express their own views.

Overall, the feedback from the students showed the usefulness of the constructive alignment concept when creating new lecture material. The learning outcomes were connected to the student engagement activity and the formative assessment; this produced an overall positive feedback from the students.

Conclusion

One of our main responsibilities as new staff members is to become involved in existing courses. This task at first feels daunting. There are expectations on how the course should be taught, as it was previously done by senior academics. Sometimes we receive previous lecture notes that have been taught for years and other times we are required to create completely new lecture materials. As a new staff member, I was asked to take one of the four modules of an Engineering postgraduate course. I took this responsibility as an opportunity to deviate from the traditional transmissive model and adopted the concept of constructive alignment. In this paper, I described the changes made in the redesigned module. I

developed four new learning outcomes and included two main in-class activities (a quiz and a class discussion) to promote student engagement and assist the students in achieving the learning outcomes. To evaluate the changes, I conducted pre- and post- module completion surveys. This was a small class consisting of 19 students, with 16 completing both surveys.

Overall, the feedback from the students was very positive. The result which stood out for me the most was when 6 students in the pre-completion survey stated that they prefer lecture only classes and in the post-completion survey agreed to finding the quiz and class discussion useful in their learning. They found that studying for the quiz gave them an opportunity to review the material and the class discussion allowed them to hear the opinions of their peers as well express their own views. This is the type of assistance we want to provide for our students. As many of the students were international, the two activities also gave them an opportunity to practice their communication skills (written and verbal). In conclusion, the redesign of the module was successful. I would encourage new staff members to try innovative approaches to their teaching. It may feel like a risk, given the high importance placed on student evaluations, especially for those on a tenure track. However, I found that taking the risk is well worth it and can be successful if we take the time to carefully design the tasks. Students appreciate new approaches to teaching.

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