Curtin University

It's better for the students otherwise why would we be doing it at all?

Evaluating changes to teaching practices in the School of Civil and Mechanical Engineering

Project	Understanding the Impact of Teaching and Learning Innovations in Civil and Mechanical Engineering
Grant	University Strategic Funds for Transforming Learning at Curtin School of Civil and Mechanical Engineering
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Ethics Approval	SMEC-38-13: 03 October 2013 to 02 October 2017
Acknowledgements:	All the unit coordinators who generously agreed to be interviewed – twice.

Executive Summary

The aim of this research was to evaluate the effectiveness and impact of changes to teaching practices and delivery being implemented across the School of Civil and Mechanical Engineering at Curtin University. The types of changes, their impacts and their effectiveness were determined through two interviews with the unit coordinators in all units taught in Civil and Mechanical Engineering, the first during Semester 2, 2013, and the second during Semester 1, 2014. The data for this research thus came from interviews with all the unit coordinators of non-project based units in Civil and Mechanical Engineering.

Effectiveness

Evaluating the effectiveness of changes to teaching practices and delivery proved difficult. When considering effectiveness in teaching, effectiveness is assumed to be around student learning – the more effective a teaching practice, the shorter the time for the student to grasp and apply the concept, or the more the student was able to learn over the same time period. This requires measures of student's performance at the start of the course, and a comparable measure at the end. In the absence of quantitative markers, unit coordinators determined the effectiveness of changes to teaching practices and delivery through their face-to-face teaching interactions. A move to a greater online presence with reduced face-to-face teaching interactions undermined the unit coordinators' ability to gauge and monitor their effectiveness, and to modify their teaching accordingly.

Recommendation 1: Implement pre-tests / post-tests as objective measures of students learning.

Recommendation 2: Retain face-to-face teaching interactions until an alternative system to determine the success of teaching has been introduced.

Impact

Whereas the effectiveness of changes to teaching practices and delivery is focused on the student, the impact of changes to teaching practices and delivery changes the focus to the unit coordinator and the university.

Any change in teaching practice requires time and effort by the unit coordinator. It proved difficult to quantify the time dedicated to implementing teaching changes despite specific questioning of the unit coordinators. Nonetheless, it seemed at least a day a week was dedicated to preparing and changing their teaching, and any change in teaching practice that could not fit into that one day a week was deferred to a later semester. Further, the time taken to implement a change properly always exceeded the amount of time available, especially when technology (videos, online tests) was involved.

Recommendation 3: Consider establishing boundaries on the working day – what are the starting and ending times of a typical working day? How much preparation and student interaction time is expected to take place after hours? How can academics be encouraged to attend conferences and not overly stress their families and family commitments?

Facilitating Changes to Teaching Practices and Delivery

When considering a change to teaching practice, unit coordinators undertook their own evaluation of the effectiveness and impact of the proposed change. The most important consideration about that evaluation was whether the change would benefit the students. As the title of this report states, "It's better for the students otherwise why would we be doing it at all?"

A second consideration included the applicability of the change to teaching practice to engineering. Teaching practices shown to work in the humanities, at high school or other non-engineering contexts were not automatically assumed to work in engineering contexts, and unit coordinators sought evidence of success in engineering under similar conditions before considering a change of teaching practice. Engineering educators seek specific cognitive learning outcomes that are different to the cognitive learning outcomes sought by other disciplines.

Recommendation 4: Make explicit the differences between engineering and other disciplines in terms of curriculum, assessment and cognitive outcomes. Consider which teaching methods align best with the desired engineering cognitive outcomes.

Some parts of an engineering programme are *softer* than other parts. These are the parts of the programme that emphasise professional thinking and behaviour, not just learning content. Unit coordinators noted difficulty in assessing professional thinking and behaviour. These aspects of the programme were seen as 'subjective', and students were not shy in challenging awarded marks. The resulting appeal process was noted to be time-consuming for the unit coordinator. In the language of Neumann, Parry and Becher (2002), perhaps students already appreciate that learning outcomes for *soft* disciplines involve debate and individualistic interpretations of knowledge, and see the awarding of marks in these 'subjective' areas as an exercise in debate.

Recommendation 5: Develop a suite of assessments for 'subjective' aspects of the course that will not overly expose unit coordinators to student appeals, yet still provide evidence for Engineers Australia accreditation requirements.

The third consideration that emerged in conversations with unit coordinators around considering a change to teaching practice was the issue of professionalism. Unit coordinators saw themselves as professional educators, building a body of knowledge and skills around what does and doesn't work in teaching engineering. Fundamentally, their aim was to genuinely provide the best learning experience for their students so their students succeeded in developing as engineers. This meant that not only were they accountable to university management, engineering educators also recognised their accountability to Engineers Australia, ensuring that any engineering programme in which they taught met the accreditation requirements of Engineers Australia. This two fold responsibility – to the university and to the engineering profession through Engineers Australia - was taken seriously and with pride. The responsibility for student learning also could not be delegated to tutors.

Unit coordinators placed student success at the heart of their teaching endeavours, modifying their practices in response to student need. They were also cautious about introducing any teaching change which would not be of benefit to the students.

Recommendation 6: In a trend towards more tutorial classes, investigate a pipeline of and sustainable supply of suitable tutors who may or may not be PhD candidates.

Recommendation 7: Clarify the role of the teacher in an online environment / MOOC.

Finally, collegiality – both informal and in team teaching – were important factors in facilitating changes to teaching practices and delivery. Formally, the Head of School proved to have a significant influence on changes to teaching practice. The two significant informal collegial influences were the informal conversation and the community formed by team teaching.

Informally, when unit coordinators were considering a change to teaching practice, the informal conversation proved to be vital. The informal conversation (in a tea room, in a corridor, in a department meeting, over lunch) provided a way hear about the success, failures, and challenges of teaching engineering or implementing a teaching change in the engineering context. An engineering colleague's teaching experiences carried legitimacy and authority, and a change in teaching practice was likely to be viewed more favourably if it had been shown to be successful in a colleague's class. Colleagues also shared their experiences of new technological products such as tablets, laptops and Blackboard.

Recommendation 8: Retain informal communal staff spaces such as tea rooms. When matched with a culture that values and encourages tea breaks and lunch breaks these spaces provide a safe and effective environment for sharing of teaching and learning experiences (informal conversations). Informal conversations are not as easily fostered when informal spaces are not readily accessible.

A second informal collegial influence was around team teaching. Some units are taught by a teaching team – a number of lecturers as well as tutors. Less experienced lecturers noted how much they learnt from their more experienced lecturers on the teaching team, and how the teaching team formed an informal community of practice. The teaching team formed a natural environment for more senior lecturers to share their teaching experiences.

Recommendation 9: Establishing teaching teams for a unit proved to be a natural and non-threatening way to facilitate change in teaching practice. The team could even include specialists such as programmers or non-engineering teachers. Ensure the teaching team is adequately resourced (for example, if someone on the team is creating videos).

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1 Introduction

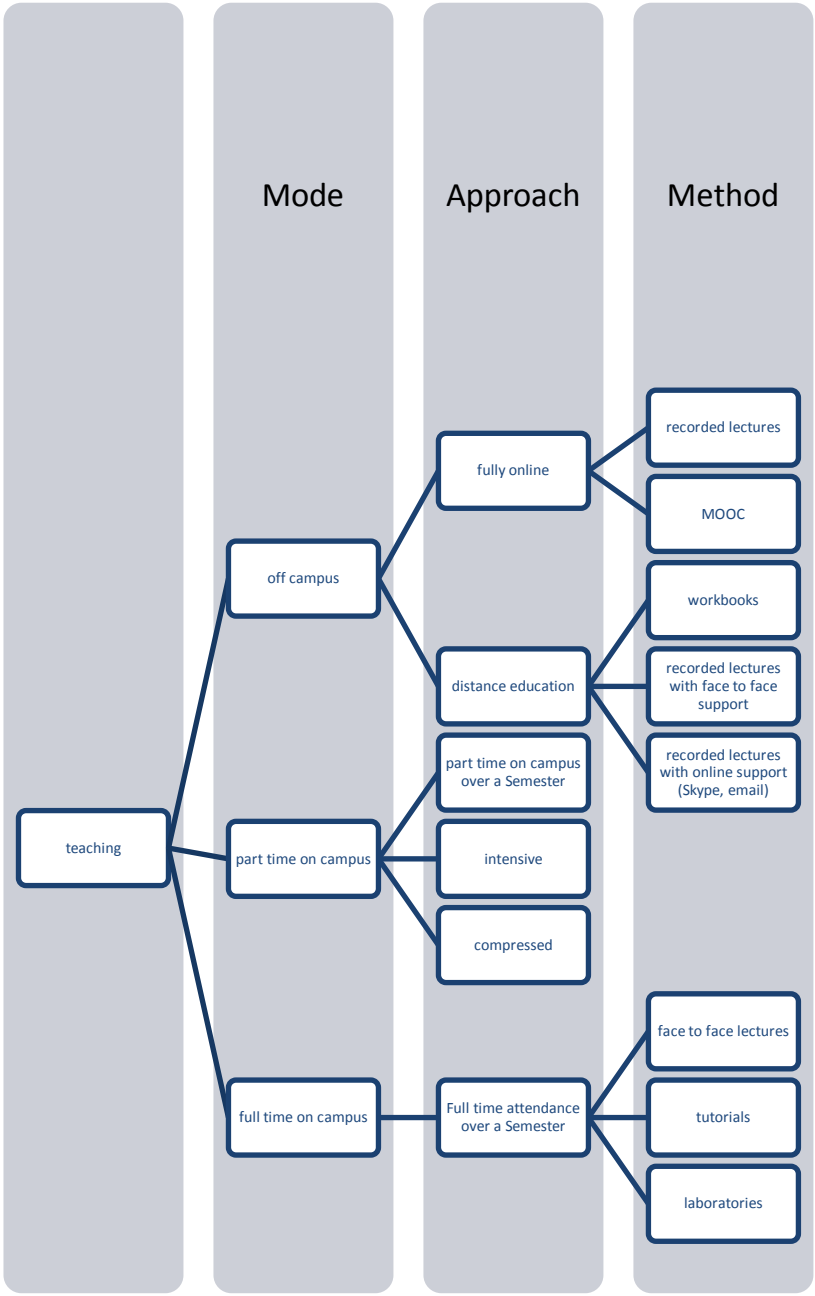
Curtin University's Vision for 2030 is to be "A recognised international leader in research and education" (Curtin University of Technology, 2008), with a mission "To change minds, lives and the world through leadership, innovation and excellence in teaching and research" (Curtin University of Technology, 2008). A focus on leadership and innovation in teaching suggests awareness of global teaching trends, together with continuous reflection, testing and application of new or improved teaching practices (looking forward), while a focus on excellence in teaching suggests any teaching innovations are shown to be effective for student learning and acknowledged by the teacher's peers (looking back).

When considering the undergraduate teaching experience, universities and colleges have always offered a range of teaching approaches. Degrees, units or courses may be taught fully off-campus (fully online, distance education), partly on campus (part time learning, intensive or compressed classes, master classes), or fully on campus, or any combination of those modes (flexible learning (Bennington, Tallantyre, & Le Cornu, 2013; Hammersley, Tallantyre, & Le Cornu, 2013)). Within each mode of teaching, different teaching methods are available: recorded lectures, recorded lectures with face-to-face support, recorded lectures with online student collaboration, workbooks with supplementary videos, full days of face to face classes spaced months apart, face to face lectures, tutorials, studios, simulations and laboratories. Further, each method may be taught in a number of ways: lectures could be 45 minutes of straight talk (presentation), short bursts of presentation interspersed with student activity, or a briefing session in advance of student activity outside the lecture. Each teaching mode, approach and method forms a part of the higher education teaching landscape.

Advances in technology also impact teaching approaches. Paper notes can be replaced by electronic interactive pages, face to face lectures by videos, and in class tutorials and discussions with Skype meetings. The pervasive availability of high speed, high bandwidth internet, notebooks and smart devices facilitates the development of new teaching tools.

The choice of teaching mode, approach and method is determined by an interplay between university administrators, heads of departments and unit coordinators and the teaching staff themselves. University administrators tend to set broad teaching directions, for example, Open Universities Australia's focus on on-line only education, or University of Notre Dame Australia's requirement for all students to undertake a set of core curriculum units. Heads of departments are required to ensure that courses meet any regulatory guidelines, for example, ensuring engineering programmes meet the accreditation requirements of Engineers Australia. Unit coordinators set the smorgasbord of learning experiences to be offered in a unit, and the teaching staff modify their teaching methods in response to student need.

In such a layered teaching environment, the aim of this research was to evaluate the effectiveness and impact of changes to teaching practices and delivery being implemented across the School of Civil and Mechanical Engineering at Curtin University. Firstly, a three year snapshot of the teaching practices being used in the School of Civil and Mechanical Engineering was taken. Secondly, unit coordinators were asked about their experiences of implementing changes to their teaching practice. The unit coordinators' perceptions of the effectiveness and impact of these changes formed the basis of this research.



2 Context

The School of Civil and Mechanical Engineering at Curtin University is accredited to deliver three undergraduate engineering programmes - Civil and Construction Engineering, Mechanical Engineering and Mechatronic Engineering. The engineering programmes are four year full-time undergraduate programmes, leading to a bachelor of engineering. The staff of the Department of Civil Engineering consists of 28 academic staff (of which 7 are research fellows or associates), 8 technical staff and two administrative or professional staff. The Department of Mechanical Engineering staff consists of 30 academic staff (of which 5 are research fellows or associates) and two administrative staff. Across the

three undergraduate programmes around 1800 students are enrolled. This does not include the number of students enrolled in the common first year of all programmes.

The three engineering programmes offered 26 taught (rather than project based) units. Across these 26 units, fourteen unit coordinators were responsible for one unit each, while six unit coordinators were each responsible for two units.

At the time of this research, the university had embarked on a university wide restructuring, with academic staff 'reshaped' and administrative and professional staff 'equipped'. Another change underway was the refurbishing of standard flat floor tutorial rooms into' collaborative learning spaces', with movable tables and chairs, computer monitors dotted around the room and no easily discernible front of room. The other change relevant to this study was in the previous year or two, university management had placed an upper limit on the number of face-to-face lectures/week in a unit (no more than 2 hours).

3 Research Scope and Procedures

The aim of this research was to evaluate the effectiveness and impact of changes to teaching practices and delivery being implemented across the School of Civil and Mechanical Engineering at Curtin University. The research was undertaken in two stages: in Stage 1, a three year snapshot of teaching practices in each unit over a three year period was identified, together with the reasons for any changes. In Stage 2, these changes were explored in greater depth. The workplace mood or climate influencing these changes was explored, as well as the influence of peers.

3.1 Research Process

Teaching as a practice relies on the expertise and judgement of the teacher in discerning what the students already know, identifying what the students need to know, and designing and implementing teaching activities that move the students towards what they need to know. Over time, teachers develop a toolbox of what they perceive to be useful and effective teaching methods able to move the students towards what they need to know, based on student feedback and class pass marks. Yet even these teaching methods, shown to be successful with one cohort, may be less successful with the following year's cohort. The teacher constructs an understanding of what teaching methods and practices might work and what is less likely to work with his or her students.

In this setting, the principles of a basic interpretive study (Merriam, 2002) is used to understand how teachers approach changing their teaching practices and methods, and to understand how these teachers determine the effectiveness and impact of these changes. A basic interpretive qualitative study is used to understand how people make meaning of a situation or phenomenon (Karen L. Smith Faculty Center for Teaching and Learning, 2014). This approach uses an inductive (rather than deductive) strategy, and uses data collected from interviews, observations, or document analysis. Analysis is of patterns or common themes and the outcome is a rich descriptive account that makes reference to the literature that helped frame the study (Karen L. Smith Faculty Center for Teaching and Learning, 2014).

Two sets of semi-structured interviews produced the data. The first set of interviews (Stage 1) focused on establishing a baseline of teaching practices and delivery for each unit in the School of Civil and Mechanical Engineering over three consecutive years, together with the reasons for any changes. The published unit outlines for each unit provided initial information about the structure of and some of the teaching practices in each unit. While it was possible to obtain a snapshot of current teaching practices by developing a paper or online questionnaire which could then be sent to each unit coordinator, requesting that each unit coordinator complete the questionnaire, it was felt richer data and a greater participation rate would be achieved by interviewing each unit coordinator instead. With the School in the midst of a university wide reorganisation, it was felt personal interviews by an experienced colleague, sensitively done, could allay any concerns, anxieties or pressure experienced by the interviewees, likely to generating more valid data. An interview protocol (Appendix 6: Interview Protocol (Stage 1)) was developed for each interview, and was given to the interviewee at the start of the interview. The interviews were intentionally semi-structured, to allow unanticipated material to emerge, and for the interviewee to shape the interview.

Having established a baseline of teaching practices and delivery, a second set of interviews with the same unit coordinators was conducted six months later. This second set of interviews sought to

understand changes to teaching practices and methods in more detail (Appendix 7: Interview Protocol (Stage 2)). These interviews included questions about the types of changes unit coordinators had made to their teaching practices, how participants felt about making changes to their teaching practices, and about the influence of their peers on their teaching practices. The interviews were 30 to 45 minutes long. All interviews were audio recorded. The audio recordings were transcribed by a professional transcriptionist and the transcripts were logged into NVivo qualitative data analysis software (QSR International Pty Ltd, 2014). The verbatim hardcopy transcripts were analysed manually, firstly using structural coding against the second interview questions, followed up by an iterative processes of open and axial coding (Corbin & Strauss, 2008; Saldaña, 2012). NVivo was used to electronically link codes to the data and to identify patterns across participants and to group codes into categories.

Ethics approval for research with human subjects was sought and approval granted, with the research process taking place at arm's length to the teaching staff in the School of Civil and Mechanical Engineering. The Chief Investigator, Jonathan Paxman, is part of the School of Mechanical and Chemical Engineering, and the researcher, Jolanta Szymakowski, is an independent researcher and was employed for the project. The Human Research Ethics Approval Letter forms Appendix 1.

3.1.1 Data Collection

Data collection for Stage 1 began on 15 October 2013 and was completed 6 December 2013, almost 8 weeks later. Data collection for Stage 2 began 26 Feb 2014 and was completed 19 June 2014, 16 weeks later.

The data for this research came from two semi-structured interviews with the unit coordinators of all 26 non-project based and non-Engineering Foundation Year units offered as part of the Civil and Mechanical Engineering programmes. Across the 26 units, fourteen unit coordinators were responsible for one unit each, while six unit coordinators were each responsible for two units. Each of the 20 unit coordinators was personally telephoned and invited to participate in an interview, with 17 unit coordinators interviewed in Stage 1, and all 20 interviewed in Stage 2 (n=20). The list of the 26 units is recorded in Appendix 4.

Table 3-1 Data Collection Process

When	Who	What
16 October 2013	Head of School	Email sent to all School Staff about the research project and request for interviews (See Appendix 5).
15 October 2013	Researcher	Stage 1 interviews begin.
6 December 2013	Researcher	Stage 1 interviews end.
26 February 2014	Researcher	Stage 2 interviews begin.
19 June 2014	Researcher	Stage 2 interviews end.

3.2 Ethics

Ethics approval for this study (SMEC-38-13) was granted from 3rd October 2013 to 2nd October 2017, in accordance with the National Statement of Ethical Conduct in Research (Australian Government, 2007), and the policies and procedures of Curtin University. Confidentiality and anonymity was assured by the interviewer at each interview. Each interviewee was given a copy of the Participant Information Form, and signed a Participant Consent Form if they were willing for their interviews to be recorded.

A copy of the Human Research Ethics Approval Letter forms Appendix 1. The Participant Information Form forms Appendix 2, and the Participant Consent Form forms Appendix 3.

4 Findings

The aim of this research was to evaluate the effectiveness and impact of changes to teaching practices and delivery being implemented across the School of Civil and Mechanical Engineering at Curtin University.

4.1 Stage 1: Unit snapshot

The aim of Stage 1 of this project was to develop a snapshot of teaching practices in the same unit over three consecutive years, capturing the changes. Whenever a change to teaching practice was identified, the reason behind the change was sought. The snapshot is summarised in Table 4.1.

Table 4-1 Teaching Practices in the 22 Civil and Mechanical Engineering units studied in Stage 1.

	No of units			No of units
Lectures			Tutorials, Labs, Workshops, Seminars	
• Lecture hours/ week in the unit: o 1 hour / week o 1½ hours/ week` o 2 hours / week o 3 hours / week	 3 1 17 1		Tutorial hours/ week in the unit: o No tutorials o 1 hour / week o 2 hours/ fortnight o 1½ hours/ week o 2 hours / week	 7 10 2 1 1
• Lecture is less than 50% didactic instruction, and includes worked examples, student questioning and answering.	18		Units with other teaching activities: • Science Lab • Computer Lab • Workshop • Seminar • Practical (Lab)	 9 5 3 2 1
• Lecture is mostly didactic instruction	4			
• Lecturer uses tablet:	8		Tutorials/classes in Collaborative Learning Spaces	8
• Lectures recorded and available on-line	22			
Other teaching tools used in lectures: • GLA – Guided Learning Activities. • DVDs • Short videos • Facebook • Document camera	 1 1 2 1 2		Other teaching tools used in tutorials: • Interactive whiteboards • Guided Learning Activities	 1 1
Changes planned for lectures: • Clickers / Votapedia • Use a microphone • Depends on industry feedback • Trial a tablet to capture handwritten lecture notes annotated onto his PowerPoint slides. • Introduce GLA - Guided Learning Activities – in a second unit • Change software package • Introduce / more short videos • Add more content that reflects a more practical perspective. • Update content in line with developments in industry. • Perhaps split the unit	 1 2 2 3 1 1 2 1 1 1		Changes planned for tutorials, etc: • More frequent assessments • Up to now lecturer has also taken all the tutorials. He will train some tutors. • Restructure milestones	 2 1 1

Unit coordinators raised a number of practical concerns when discussing the changes implemented and planned in their units:

- Inability of students to transfer knowledge to an unseen and unfamiliar context
- Difficulty in securing a large, flat floor teaching room to accommodate all 170 students at once, where lecturer is able to walk around unencumbered
- iLecture doesn't capture what is written on the whiteboard
- Liz Jolly Lecture Theatre is used on weekends, so lecturer arrives early for his Monday 8 am lecture to clean the room and set up the chairs.
- Inability of the timetabling system to accommodate scheduling requests, such as scheduling a tutorial *after* a lecture, or to accommodate specific requests, such as not to be allocated a room in the library
- Some lecture rooms have fold-down desktops instead of bench tops or table tops. Lecturer prefers bench/table tops as this gives students more room (laptops, tablets, paper)
- Delay in IT Support Staff responding to IT failures
- Student reliance on worked examples and their solutions
- What are the educational reasons for reducing the amount of lecture time to 2 hours a week?

When asked about their reasons for a change in teaching practice, three drivers were noted: their students, from within themselves and from university management. If students were struggling with a concept, unit coordinators changed how they taught to help the students learn. Unit coordinators would then include these changes in the unit for the following year.

The second driver was from within themselves, where unit coordinators noted a sense of professionalism to create the best learning experience for their students anyway. This inner drive for excellence was noted in all unit coordinators.

Thirdly, unit coordinators implemented a change to their teaching practice because it had been mandated by university management, for example, the recent requirement for each unit to contain no more than 2 hours of face-to-face lectures.

Surprisingly, the influence of peers seemed to have little impact on changing teaching practice. Questions about the influence of peers were thus added to the interview protocol for the Stage 2 interviews.

4.2 Changes to teaching patterns and modes

The aim of Stage 2 of this project was, building on the snapshot of teaching practices developed in Stage 1, to explore these changes in greater depth. Specifically, unit coordinators were asked to identify any changes they had made in five specific areas (teaching patterns, delivery modes, collaborative learning spaces, flipped learning and assessments) as well as the opportunity to identify any other change to their teaching practices. The next set of questions sought to highlight the workplace mood or climate influencing these changes. Finally, the influence of peers on changing teaching practices was explored.

4.2.1 Changes to teaching patterns

Unit coordinators were asked whether they had made any changes to their teaching patterns in the last five years or so, and to identify these changes. Their answers clustered around three ideas: (i) always changing, (ii) good for the students, and (iii) technological tools.

4.2.1.1 Always Changing

When asked whether they had made any changes to their teaching patterns in the last five years or so, all unit coordinators noted changes to their teaching patterns. Teaching is seen as a dynamic practice: "Actually, I think looking back I've always changed. I've always kind of tried to introduce new things as I've thought appropriate". Staff were "always tweaking" their content, their examples, their assessments. "All units are always alive and they do change." "The change is there ... because the environment is active." Sometimes these changes were externally driven, for example, the recent requirement from university management to limit the number of hours of lectures in a unit to no more than two hours a week, but more often the changes were driven by student need, and modified in response to student feedback. Implementing teaching changes in a gentle way was seen as important by one unit coordinator:

> I've just learnt that you can actually try something different, and just see what happens. And as long as you do it in an appropriate manner, and as you go through you make mistakes, and you reassure students that they won't be affected adversely. Yeah, so as long as you do it in a nice, kind, kind of way, I guess I've learned that you can get away with quite a lot.

4.2.1.2 Good for the Students

A key driver for changes to teaching patterns was the desire to make the teaching experience better for the student. Changes that were beneficial to students were retained; those that were not, were abandoned.

Units that previously did not schedule tutorials found that tutorials were good for students as they encouraged "discussion, giving students time to think." In some units, tutorials were not just about students working through a set of questions with other students but also to stimulate engineering thinking by, for example, requiring students to first produce a plan for problem solving.

However, the practicalities of running tutorials also presented problems. Many unit coordinators not just presented the lectures but also ran the tutorials. For a class of 180, this meant an additional 6 hours of teaching time above the 2 hours of lectures. Some unit coordinators trialled hiring PhD students to staff the tutorials, but noted unfavourable student feedback. Finding PhD students who had been

exposed to the content being taught, and who understood the difficulties being experienced by the students was found to be a challenge.

When working with students in tutorials, unit coordinators became very aware of the strengths and weaknesses of their students. Acknowledging the typical unfamiliarity of his students with the theoretical background to higher level mathematics, this unit coordinator felt what was best for the students was to dedicate time in lectures with the whole student cohort to step through the underlying mathematical theory:

> The students that we get at this university are more mathematical applications rather than theory so if we just tell students this, it will be hard because students need to understand how we derive the formula and there are a lot of mathematics behind this so that they can use it correctly otherwise what happens is they will receive the final equation here and they use it all the time incorrectly. They don't know which equation to use for which cases.

Other unit coordinators noted that a prerequisite to implementing teaching ideas such as flipped classroom or even self-guided problem solving is the "perfect student" – "willing to learn", self-motivated to do the work before coming to class:

> I've not probably come across many of those. Most of them are very passive and quite happy to be passive, so it's trying to address that,
>
> [Flipped learning} can .. happen if the student do the homework ...And some of them just do nothing and come to the classroom and just listen

Unit coordinators were concerned about introducing a teaching strategy that was based on the 'ideal student' when many students in their class did not fit that model.

When considering what was good for the students, the curation of written materials was raised. One unit coordinator raised the issue of working from a text book, "a very, very structured resource, with a progression built into that structure which is easy to follow." Without a text book, unit coordinators needed to develop a "resource which has never been peer-reviewed, which has never been edited, which has never been evaluated in terms of its influence on the teaching and learning". Another unit coordinator noted that no one text book contained all the unit content, and that asking his students to synthesise materials from a number of paper and online resources was too great an ask:

> If we ask the students to do it from different books they will not find all these things in one book. There are very distinct topics - there are five topics which are very distinct - and you can't find in one book more than one topic. So if we ask students to OK- go online, study and come prepared – I think that's a bit hard for this unit. You can probably do this in some other unit but this unit I think it's hard for the students.

Finally, in terms of what was good for the students, one unit coordinator noted a desire to introduce more hands-on activities for his students.

4.2.1.3 Technological Tools

Universities reflect society, bathing in a technological milieu, with a seemingly ubiquitous take up of Wi-Fi, internet, smart phones, tablets and laptops, and the software for these devices. Engineers are

typically at the forefront of technological developments and uptake, and the interviewed engineering academics were exploring how technology could best meet students' needs while also saving them time. Multiple formative assessments throughout the unit were seen by the unit coordinators as beneficial for students, but these could take a long time to prepare and mark. Some unit coordinators were moving these formative assessments into a multiple choice questionnaire (MCQ) format on an online platform (Blackboard) as one way to let the students know how they are doing throughout the semester, while at the same time not overloading the unit coordinator. Another unit coordinator was exploring using the Assessment Centre located on the 5th floor of the library.

Unit coordinators were increasingly using tablets for their lectures and presentations, appreciating the ability to write on their PowerPoint presentations. Unit coordinators were also updating their unit's Blackboard areas, inspired by exemplars from colleagues, and exploring the tools offered by the Blackboard platform. Two unit coordinators were making short videos to supplement the standard iLecture recordings. Apart from assessments, technology was used to help the unit coordinators teach, rather than the students to learn.

4.2.2 Changes to Delivery Modes

The previous question asked about changes to teaching patterns which generated a broad range of responses. This question was more focused, asking specifically about changes to delivery modes. Unit coordinators understood delivery modes to include flexible learning, blended learning, a more interactive learning style, problem based learning, greater use of online materials and lectures to supplement the lectures, restructuring the course into 4 week modules, and greater student team work activities while still retaining a regular "whole group briefing or assembly session".

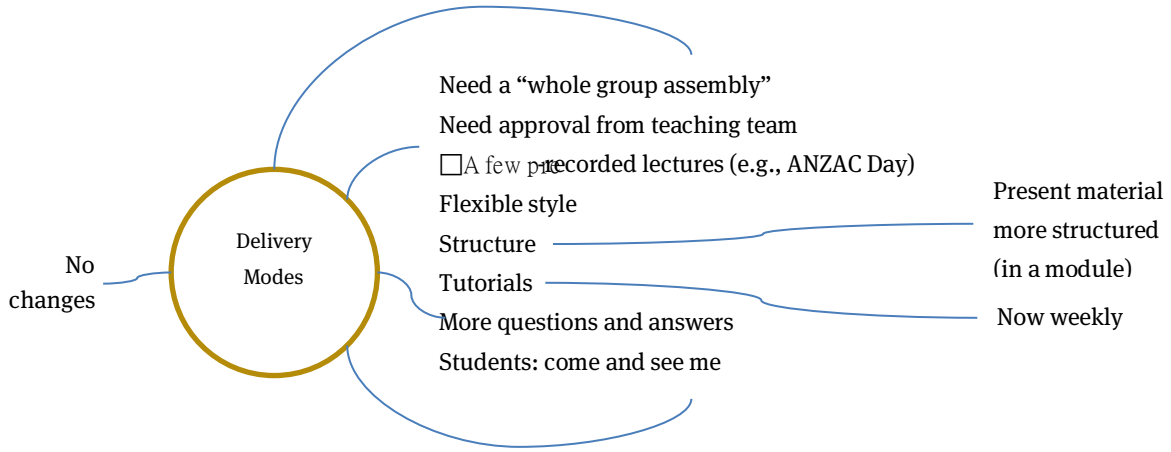


Figure 4-1 Changes to Delivery Modes

When discussing blended learning and flexible learning, conversation turned towards flipped learning. Comments about flipped learning and documented in § 4.2.4 below.

4.2.3 Changes around Collaborative Learning Spaces

Unit coordinators were asked whether they were teaching in any of the new collaborative learning spaces (CLS), and whether they had changed their teaching practices as a result of the new furniture and technology options made available by those rooms. The CLS rooms have tables on wheels, monitor screens dotted around the room, and there is no clearly defined front of the room.

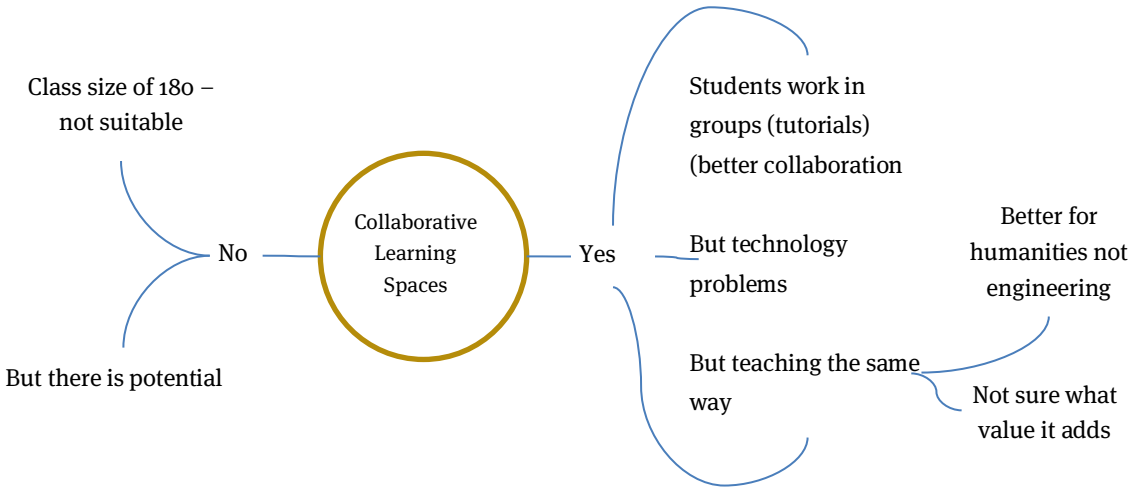


Figure 4-2 Changes around Collaborative Learning Spaces

While most unit coordinators had classes in the Collaborative Learning Spaces, most did not change their teaching practices in response to being in this space. Unit coordinators relied on lectures as a key part of their teaching plans, and preferred lecture halls with a defined front for these lectures. The Collaborative Learning Spaces were useful for tutorials, as students were able to rearrange the tables and work in groups, arranged near a computer screen. When working in groups, students would project the questions onto the screen instead of printing the questions. If the tutorial activity was able to be done on a computer, students would project the display of one computer onto the large screen and work together through the activity.

None of the unit coordinators used collaborative software such as GroupMap (a tool to help brainstorm and create group mindmaps) (GroupMap Technology Pty Ltd, 2014), VuePoint-Connect (a screen sharing collaboration tool) (VuePoint-Connect Pty Ltd, 2014), TodaysMeet.com (a backchannel chat platform (the backchannel is the conversation that goes on alongside the primary activity, presentation, or discussion)) (TodaysMeet LLC, 2014). While most unit coordinators were not aware of such collaborative software, most felt that such software was not useful in teaching engineering:

> I think this is probably partly an engineering difference is that for probably maybe in the humanities, it's a bit more option than opinion, whereas in engineering, it's very content-driven because it has to be. I mean we do have wrong answers in engineering and there is the correct way to do things.

The relevance of teaching strategies that might work in the humanities to engineering teaching was also raised in the question about flipped learning in § 4.2.4 below.

One unit coordinator who had attended a Curtin Learning Institute (CLI) workshop on 'Maximising Your Teaching Potential in a Collaborative Learning Space' was open to the idea of using collaborative

software, but related problems with the technology in the rooms – screens working only some of the time, the room's computer not working or the room's AV not working properly with the Microsoft Surface tablet:

> I saw that there was potential, because the technology so often doesn't work, I thought about adopting it and now I've thought about not bothering, because I can't rely on it working every time.

Other unit coordinators raised difficulties with the new electronic whiteboards, and lack of access to traditional whiteboards.

4.2.4 Changes around Flipped Learning

Flipped learning was described as a unit structure where face-to-face lectures are replaced with pre-recorded, online lectures that the students watch before coming together in tutorials or workshops to ask questions and work together. Unit coordinators were asked whether they had adopted flipped learning, or were intending to adopt the flipped learning approach. One unit coordinator had reshaped her unit into the flipped learning model that semester, and other unit coordinators noted that they were waiting on her feedback before trying it themselves. This question gave unit coordinators an opportunity to discuss their concerns with the flipped learning approach.

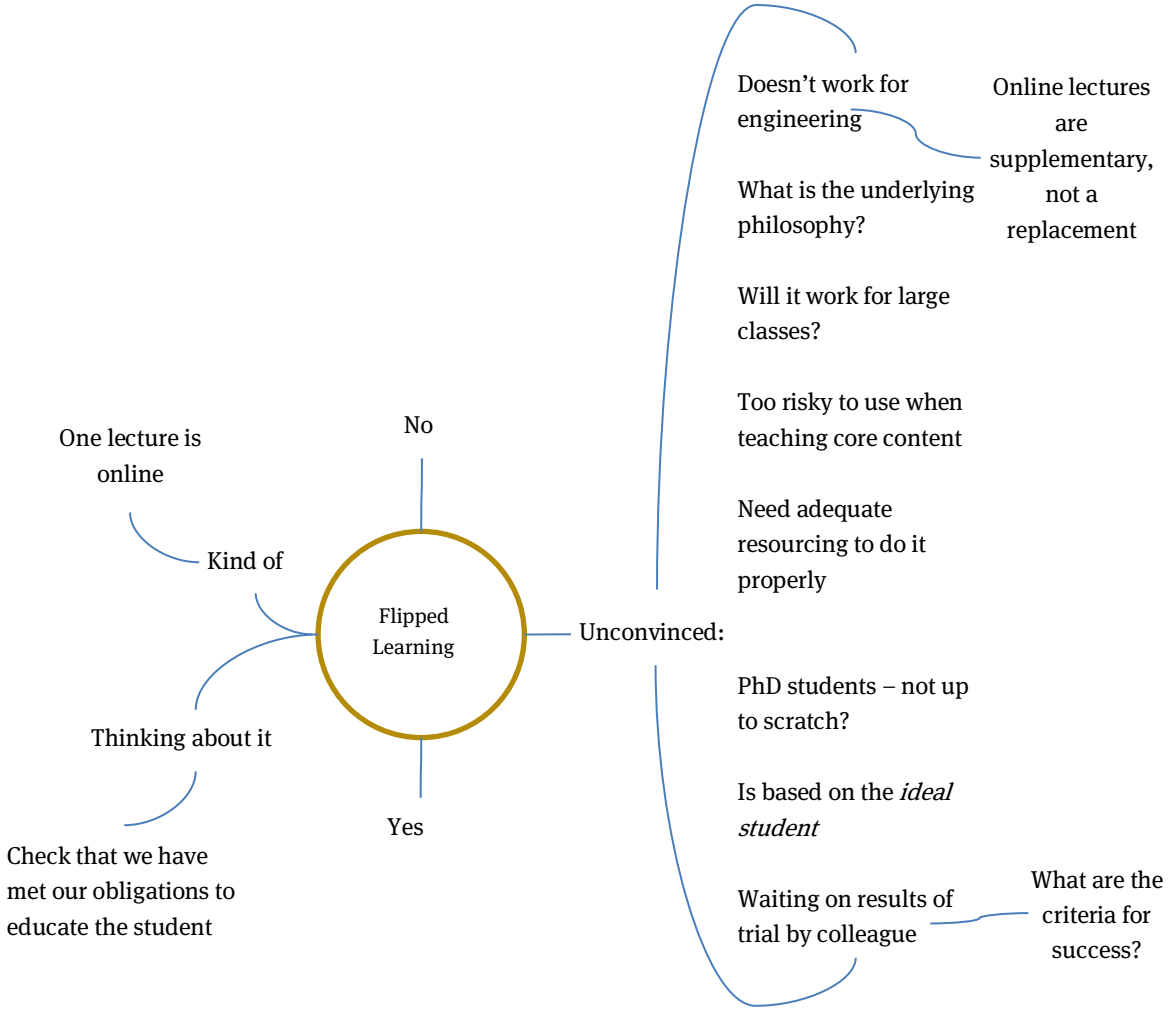


Figure 4-3 Changes around Flipped Learning

At a conceptual level, most unit coordinators acknowledged flipped learning as a valid teaching tool, but questioned an uncritical application of it to engineering. Unlike the humanities, teaching engineering involves not just the presentation of ideas and concepts, but the immediate application of those ideas and concepts in an engineering context, typically in solving questions and in practical hands-on activities in labs and workshops. Also unlike the humanities, most engineering concepts are not 'open to interpretation', and instead are founded on defined protocols and strategies. Unit coordinators raised two areas of concern around flipped learning: the pre-recorded videos, and staffing the tutorials.

Unit coordinators were comfortable with having their lectures recorded, as the university's iLecture system has automatically recorded lectures for some years. These iLecture recordings, though, were not seen as the primary teaching tool, nor as a replacement for not attending, but as a tool for revising or supplementing the lectures:

> I encourage students to come to lecture. I always say that look iLecture is what you do for revise, to see it again - not a replacement but a lot of students do that - they think they can skip the lecture.
>
> [Q. Because it sounds like you're saying, you've got a responsibility to make sure that the students learn according to what's on the unit outline.]
> A. That's right.
> [Q And that's your professional responsibility to do that. And you can't really outsource that to an online lecture. The online lecture can be complimentary.]
> A Supplementary.
> [Q. Supplementary. But it's not going to replace the learning experience.]

In an online environment where on-line lectures are the primary teaching tool, unit coordinators felt an alternative to iLecture recordings was required, as a higher standard of presentation and 'bells and whistles' would be required, requiring a longer time to prepare:

> so things like the flipped classroom thing, doing an hour lecture online to replace an hour taught lecture, the time investment to do that is more than an hour, and then also because it's online and it's recorded, the expectation from the students is the polish and the visual effects and then it multiplies and, but time wise, it's not feasible to develop... to polish something for an hour of TV is probably a couple of weeks. I reckon it won't be quite so bad for this sort of thing.
>
> And there's also the perception that it's going to be just the recycled iLecture, and it's not. The fifteen-minute short segment lecture, so it's sort of like, here's the content. Now here are some short videos and written solutions to back that up, so it's a mix of video and exemplar, and then there's another short video and then another couple of examples and written exemplars, so it's not just recycling the old ones and putting them on

Other unit coordinators expressed concern about losing the immediacy of student feedback when moving from face-to-face lectures to online lectures:

> It's my job to talk to them to get them to understand.
>
> I think there's an obvious difference. First of all, when you meet the students for a longer amount of time your interaction, your level of understanding of their problems and their level of understanding of the

> subject really increases. I can see there's some degree of loss, in terms of the students' ability to learn and my ability to understand their perspective.
>
> The students may go through the online methods. They say, "Oh, I cannot understand it. I've got question in here." And then "I cannot cope with that unit. I'll withdraw from it." So we don't want such a thing to happen.

Unit coordinators expressed concern that the success of flipped learning depends on having 'ideal students' in your class who watch the videos beforehand and complete the pre-work:

> Theoretically they watched beforehand. In practice I might disagree with received knowledge that says they do watch it beforehand
>
> People just don't do the stuff before they rock up. So then the tutorial session is devoted to going through the stuff that they should have done before they came in. So those few that do do the prior stuff, are sitting there thinking why did I bother doing it and then they stop doing it. Because there's no benefit to it. So in practice or in theory I can understand why people would think it's brilliant. In practice it's just – I don't know how to get students motivated enough to read that stuff.
>
> That environment can be happen if the student do the homework
>
> If it's a big flipped classroom where you have one lecturer, but then you need three or four assistants to be able to address everybody's thing, as well as there's a bit of the ideal student in that as well, in that they'll all be fully engaged permanently.
> [Q. They're self-motivated, they're going to come, they're going to do the preparation.]
> A. And the reality is that probably a lot of them will sit there and not be focused entirely on their…

One unit coordinator was reluctant to trial new teaching methods with students studying a core unit as he felt it was "too risky" and "unfair for the students" who might not achieve core learning outcomes.

Flipped learning required the students to also upskill:

> And one point this student raised, we need help to know how to learn online, and I felt, well, it's not really learning online, because most of the learning should be happening in the workshop, but what I think he was saying was we need help to navigate through the fact that the stuff's online.

The second area of concern raised by unit coordinators was around staffing the tutorials. The flipped learning model requires the face to face part of the learning experience with teaching staff to be during the tutorial, which requires the lecturer to either have greater contact hours with his or her students or to hire tutors:

> Instead of having a one hour lecture each week that's face to face, you're going to have a one hour tutorial for a class of 200 students. If that's really meaningful one hour face to face tutorial time you can't really have a class of more than 25 students, I wouldn't have thought. Maybe a few more but you're probably talking about eight tutorial classes for 200 students. So there's eight presentation hours versus one hour. Is the university happy for me as an academic to spend eight hours face to face with students rather than one hour face to face? The answer has always been no, we would get post grads to do it and as soon as you're talking about post grads doing the face to face stuff in a flipped classroom model it breaks down

because you can't expect a post grad to know the entire course. ... [The students] should be able to ask any part of the course because that's where they're meant to be learning.

4.2.5 Changes around Assessments

Unit coordinators were asked about changes to their unit's assessment structures or assessment design. Changes around assessment structure included less reliance on the end of unit exam, and introducing more formative assessments during semester. One unit coordinator was introducing high stakes assessments at the end of each 4 week module, rather than making the end of unit exam the high stakes assessment.

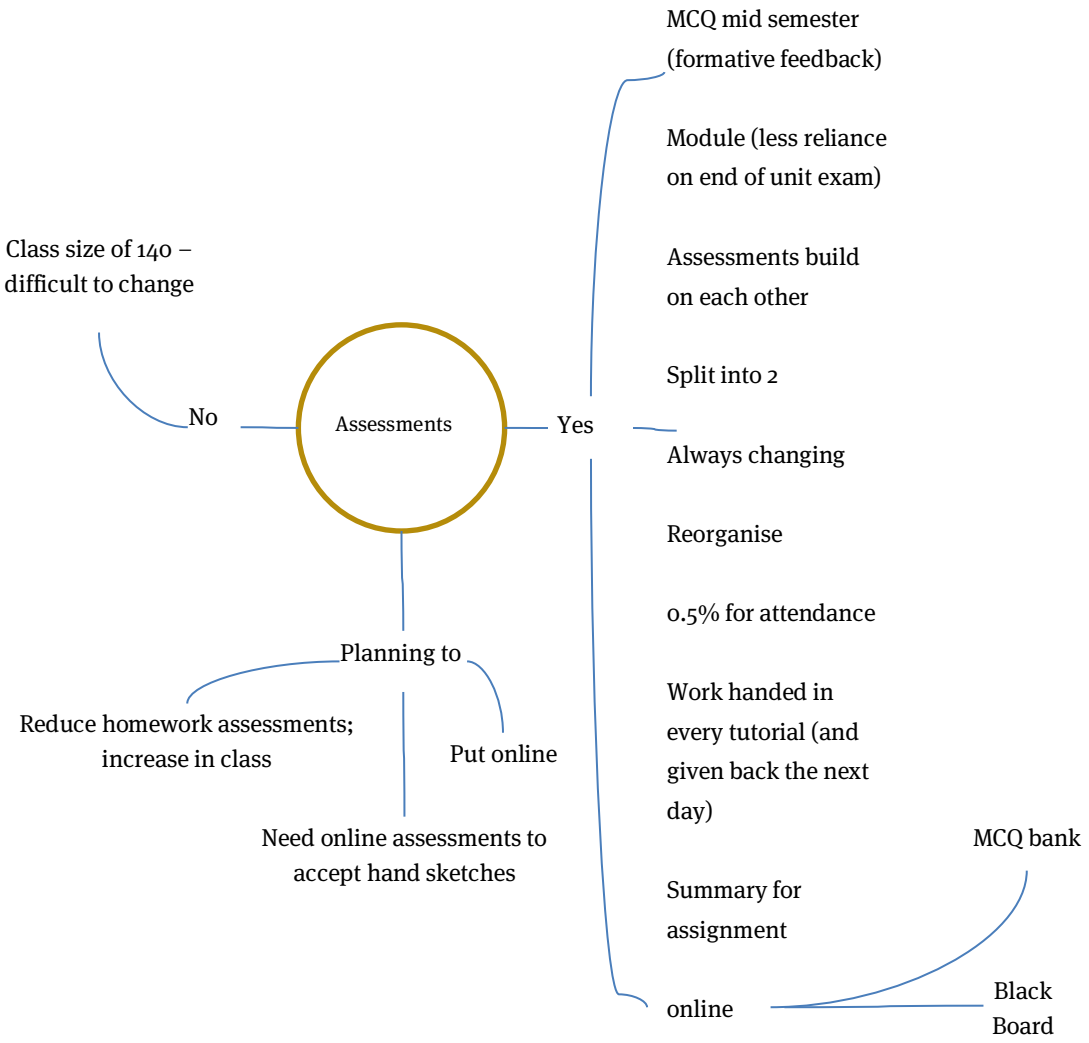


Figure 4-4 Changes around assessments

Many of the low stakes formative assessments were hosted online, with various degrees of success. An online Multiple Choice Questionnaire (MCQ) assessment would, ideally, provide the students with the feedback they require while not take too much time to mark. However, implementing online assessments on Blackboard was proving troublesome and other unit coordinators noted that

implementing an online assessment that wasn't MCQ based (e.g., recognising handwritten text or sketches) was still unrealistic.

Changes around assessment designs hinged on exemplars the unit coordinators had encountered. For example, former staff member Euan Lindsay was the inspiration for the design of a MCQ where there is more than one correct answer among the choices, with points awarded for each correct answer and taken off for each wrong answer.

Another unit coordinator noted a change in design with the front page of the assessment containing a large box into which the students wrote the answer to the main question. If the answer was correct, less time was needed to mark the rest of the assessment. If the answer in the box was incorrect, then greater time was allocated to marking the assessment. The aim of this strategy was to mark more efficiently.

4.2.6 Other Changes

Finally, unit coordinators were asked about any other changes they had made to their teaching practices, issues around these changes, and issues around student engagement, staff engagement and resourcing.

Many of the issues raised in this part of the interview had been discussed when answering earlier questions, and again, unit coordinators emphasised their professional responsibility to ensure that students learnt the material, and to ensure that the overall teaching programme met the accreditation requirements of Engineers Australia. Unlike the humanities, the learning of engineering requires hands-on activities, which need laboratories, materials and tools. Four unit coordinators expressed a desire for more hands-on activities in their units, partly to increase student engagement, but mostly as a more effective way for students to learn.

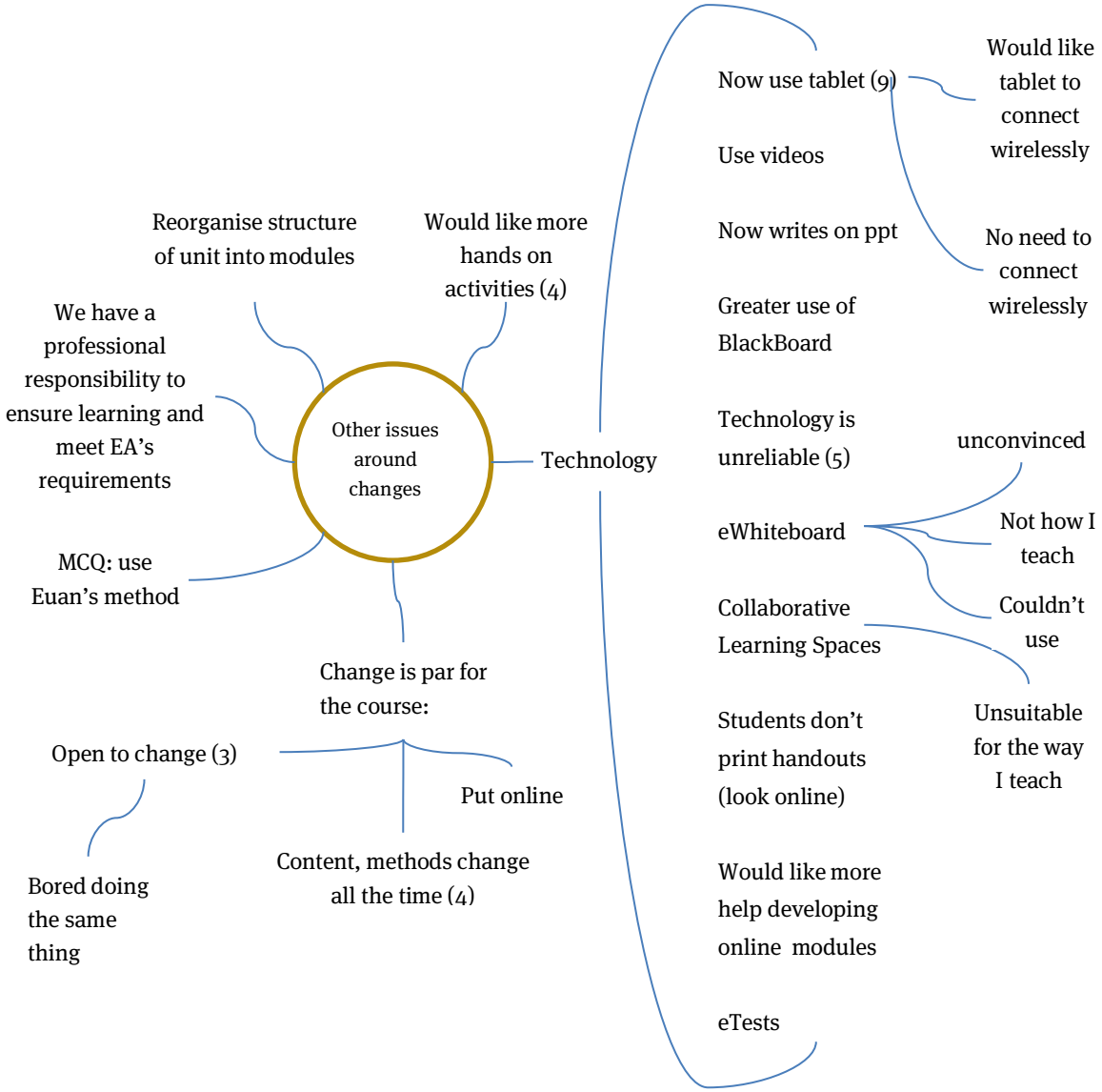


Figure 4-5 Other issues and changes

4.2.7 Time required to implement changes

Unit coordinators were asked about the amount of time they typically spent in preparing or changing their teaching materials and practices. When preparing for lectures and tutorials, unit coordinators most typically dedicated around one day a week to preparing their materials, although after a few iterations of the unit preparation time could be reduced to around half a day a week. A newer staff member noted a longer preparation time:

> [Q. So for a one hour lecture it might take you maybe eight hours to prepare?]
> It's a full day and a half at least.

Major changes to a unit needed more time than that, with one unit coordinator noting that to implement tutorials:

> I will spend almost a month, month and a half to design questions

> Sometimes to prepare the tutorials I need the whole day

A substantial change to a unit took one unit coordinator "Maybe two or three weeks" to implement, while another unit coordinator noted "To be honest, I think about it all year."

Preparing online videos was a task that took some time:

> When I first did them [they] took me a day a week for the whole semester to do just two of them each week.

> Preparing the online material, it's taking me a three-to-one ratio, so for a thirty-minute online lecture, it's taking me at least an hour-and-a-half, generally two hours, because it's the recording, replay and editing, rendering and upload, and with the recording, sometimes that takes longer.

Unit coordinators also noted that changes to a unit required a long lead time:

> we can say at least a semester's notice, for example, if there is a plan for a substantial change in the first semester next year

> If I want to change my teaching pattern I have to prepare two or three years beforehand.

Part of the long lead time for implementing a change came from consulting with and obtaining agreement from the teaching team:

> Simple changes need huge meetings. Sometimes we have ten to 15 meetings for ... changing the assessment types from assignment.

Another unit coordinator noted that marking the formative assessments took time, but that it was worth it because it benefitted the students:

> So, the other thing is to enhance their interest, so what I do, for example, today they submit their sheet in the class, the very next day they get it right back, marked. So, it has increased my work drastically, because after every lecture I have to mark 140 of those sheets, but I mean the results are very good.

However, unit coordinators recognised the limitations of what they were able to implement given their time constraints:

> I think that's a time workload issue. There are lots of things that I would implement, given infinite time to do it in.

When discussing moving to greater online learning, a unit coordinator noted the changing nature of teaching. With lectures online, the unit now becomes a 'correspondence course', with the lecturer interacting with students though emails and online fora, instead of face to face. Concern was expressed about how much time and during what hours these online communications would take place.

4.2.8 Effectiveness and impact of changes to teaching practices

After considering and implementing changes to their teaching practices and delivery, unit coordinators were asked about their evaluation of the impacts of these changes. Firstly, exam marks were not seen as

indicators of effective teaching since exam marks “won't tell you the truth - there's no correlation” [between exam marks and student learning].

Instead, unit coordinators used their face-to-face contact time with students to determine the impact of their teaching. Face-to-face contact with students also allowed unit coordinators to track how the students were developing as engineers and in their engineering thinking. Changes to teaching practice were not just about students learning content, but students developing as engineers:

> It’s a matter of responsibility. You need to make sure that the students who are graduating, they have got enough competency in terms of in my area, [xxx] engineering
>
> what I’m trying to emphasise, and I tell this in the class with varying degrees of success, is when they finish, the thing that they have to do most is look at a problem and then work out a plan to solve it, [rather than just come up with a solution]
>
> That what we’re trying to do - we’re trying to introduce engineering thinking and ways of looking at things. Not follow through marks and well “Can I get paid for this much, although the bridge fell down. I put all of this time and effort into it; therefore I want to be paid for that.”
>
> One of my colleagues said, if we don’t fail them then they'll pass, and if they pass they'll go into profession and if they're in profession they'll build a bridge, and if they build a bridge and you've passed them through the goodness of your heart, you ought to be the first to cross that bridge.

Face to face contact with the students also allowed unit coordinators to assess how much learning had been transferred from earlier units, which was accepted to be on the low side:

> So as you know, if you learn something quick, you forget quick. They just want to learn for the exam and then finish. Today, I was talking with [] because he teaches the same students in third year, so what I taught, they don’t take it to third year. They all forgot.
>
> [Q. Because it would be interesting to find out from the person who takes over in the following year if they’ve managed to retain the content from your unit.]
> A. We know the answer to that which is no. It never is. It doesn’t matter what the unit is or who the teacher was.
> [Q. Or how it was taught.]
> A. Yes.

Secondly, unit coordinators considered *e*VALUate feedback circumspectly, since this student feedback seemed to capture more how students felt rather than student learning:

> some things aren’t popular with students, even if it’s in their best interests, and there’s probably a bit of recognition that *e*VALUate’s not perfect, particularly when you start seeing complaints about timetabling and venues in the written comments of *e*VALUate, [about] which we’re totally powerless.

Since exams and *e*VALUate weren’t considered genuine measures of student learning, unit coordinators were pressed further to explain how they knew that any changes to their teaching practices were successful or effective. Success and effectiveness was not measured, as such – it was evaluated at the coal face, in face-to-face teaching, one student or one group at a time, when a student is able to correctly

undertake engineering thinking / design/ solving when previously he or she was unable to do so. If enough students in the class passed, that provided indirect confirmation that the teacher's efforts were effective.

Finally, when considering a change to teaching practice, there was discussion about the more general issue of knowing whether a teaching strategy would be successful with your students, including having explicit criteria for success:

> Yeah but in terms of how to make decision works or doesn't work. I'm not sure we have the criteria to catch up these decisions or not

Concerns about the applicability of teaching successes in non-engineering units to engineering students is discussed further in § 4.4.2.

4.3 Climate around making changes

The second part of the Stage 2 interviews explored unit coordinators' experiences of workplace mood or climate when implementing changes to their teaching practices. The aim of these questions was to uncover barriers and enablers to implementing change. The question also sought to understand the unit coordinators' philosophies behind changes to their teaching practices.

All unit coordinators expressed feeling safe to make changes to their teaching practices, with four unit coordinators explicitly acknowledging the positive impact of advice and support from the Head of School. When pressed, however, some unit coordinators felt the ability to resist making a suggested change to teaching practice had been taken away.

Comments from the unit coordinators around what it was like to make changes to their teaching practices clustered around three themes: students, practicalities and professionalism. As mentioned in responses to earlier questions, unit coordinators noted that teaching engineering was dynamic, and were open to changing their teaching practices, as long as the changes benefited students.

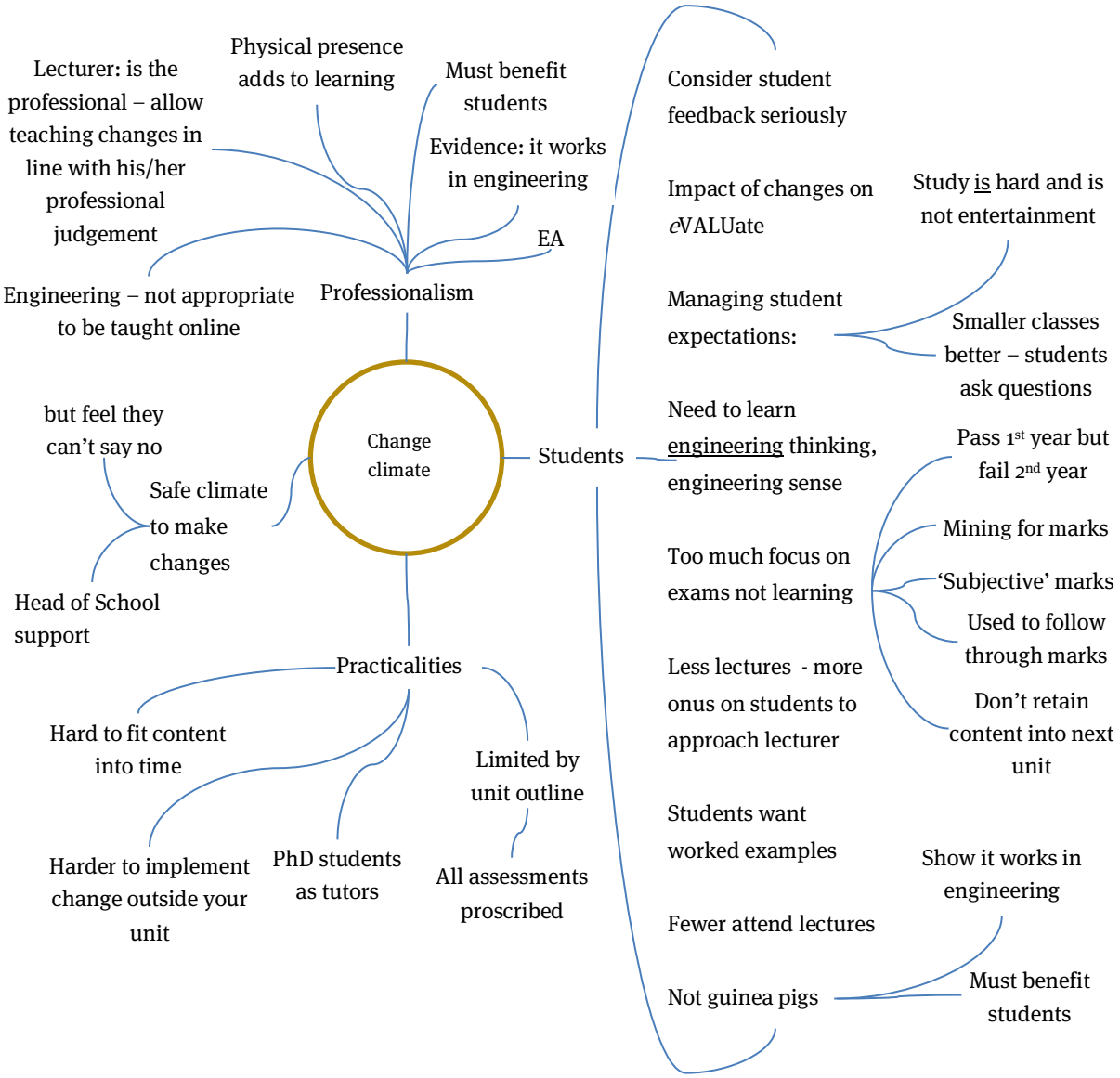


Figure 4-6 Change Climate

4.3.1 Students

When discussing changes to teaching practice, unit coordinators reiterated that suggested changes to teaching practice must be shown to work for engineering students, not just students in general. The welfare of the students was paramount, and unit coordinators did not want to risk student learning success by using them as guinea pigs in a new teaching method. One approach adopted in the School was to support the unit coordinator of one unit to pilot and trial a proposed teaching change, and discuss the results with the other unit coordinators. Once a teaching change had been shown to work in engineering, it was easier to adopt.

A second aspect around implementing teaching changes and students was managing expectations. Students needed to be reminded that engineering study is hard rather than entertainment, and that it is about developing engineering thinking, skills and knowledge rather than mining for marks. Changes to teaching practice do not remove the need for students to put in effort, although the effort may be directed in new ways.

4.3.2 Practicalities

When discussing changes to teaching practice, unit coordinators noted a number of practical constraints. The issue of sourcing enough suitable PhD students to be tutors for the many tutorials required with flipped classrooms has been previously raised. Another constraint was the legally binding nature of the unit outline, which limited implementing spontaneous teaching activities and assessments.

4.3.3 Professionalism

The third theme that emerged in conversations with unit coordinators around what it was like to make changes to their teaching practice was the issue of professionalism. Unit coordinators saw themselves as professional educators, building a body of knowledge and skills around what does and doesn't work in teaching engineering. Further, not only were they accountable to university management, engineering educators also have an accountability to Engineers Australia, ensuring that any engineering programme in which they teach meets the accreditation requirements of Engineers Australia. This two fold responsibility – to the university and to the engineering profession through Engineers Australia - was taken seriously. The unit coordinators took pride in their professionalism. They expected the university to take their professionalism seriously as well, to recognise their professional judgement and to support the implementation or a choice to not implement changes to teaching practice.

4.4 Influence of peers

The third and final part of the Stage 2 interviews arose from an analysis of the responses to the Stage 1 interviews, where no mention was made of the (expected) influence of peers to changing teaching practice. Eight possible ways peers could influence teaching practice were raised, and unit coordinators were asked whether any of the eight influences had led them to an actual change in teaching practice. Ideas and talk about changes to teaching practice is a constant part of the teaching landscape, but listening to an idea is very different to choosing and then implementing that idea. The eight possible peer influences were: Witnessing Good Teaching, Conferences, Other Universities, Peer Review of Teaching Schemes or programmes, the University Teaching and Learning Unit: Curtin Teaching and Learning (CTL), effect of their teaching qualifications, Informal Discussion with Colleagues, and School / Faculty Teaching and Learning Events. Finally, unit coordinators were asked about their influence on others.

4.4.1 Witnessing Good Teaching

Despite the difficulties in getting an opportunity to witness good teaching in another class, unit coordinators did implement changes to their teaching practices after witnessing good teaching in another's class. Co-teaching a unit with other teaching staff was an effective way to witness good teaching.

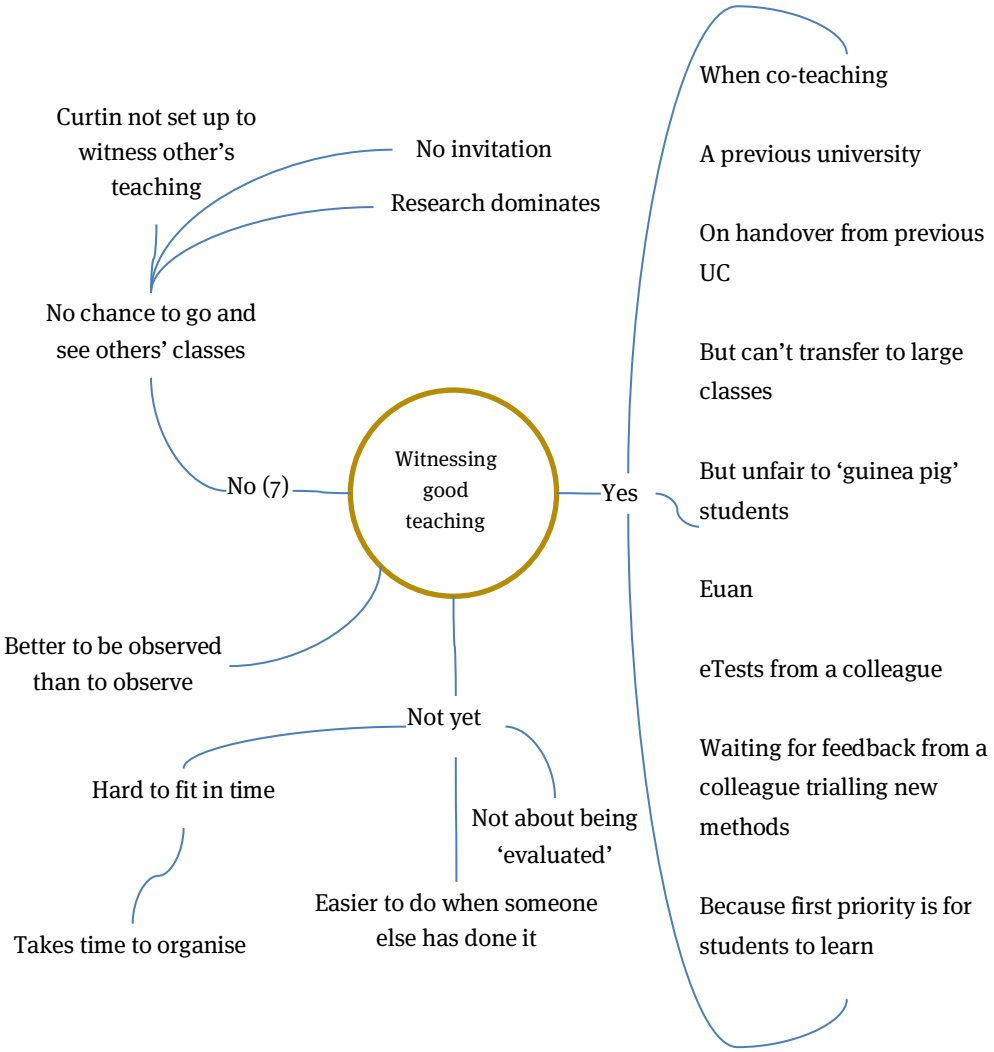


Figure 4-7 Witnessing Good Teaching

4.4.2 Influence of conferences

Almost all unit coordinators stated that they did not attend teaching conferences, attending instead conferences in their discipline area. However, when pressed, unit coordinators noted that even at these technical conferences, some formal sessions reported on the results of a teaching innovation. Further, discussions around teaching would take place informally at the conference.

Teaching ideas presented at conferences were treated with some scepticism. Unit coordinators noted that often the successful teaching innovation could not be replicated in their own units: the innovation was successful in a class of 25, whereas they teach a class of 160; the successful teaching innovation was supported by three teaching staff, whereas the unit coordinator is funded for only one person; the successful teaching innovation had a champion who saw it through, but ended up not being self-sustaining. Part of the scepticism was based on the conference presentation not presenting all the factors influencing the successful teaching innovation, so it was unclear whether the innovation would translate and be successful in a different context.

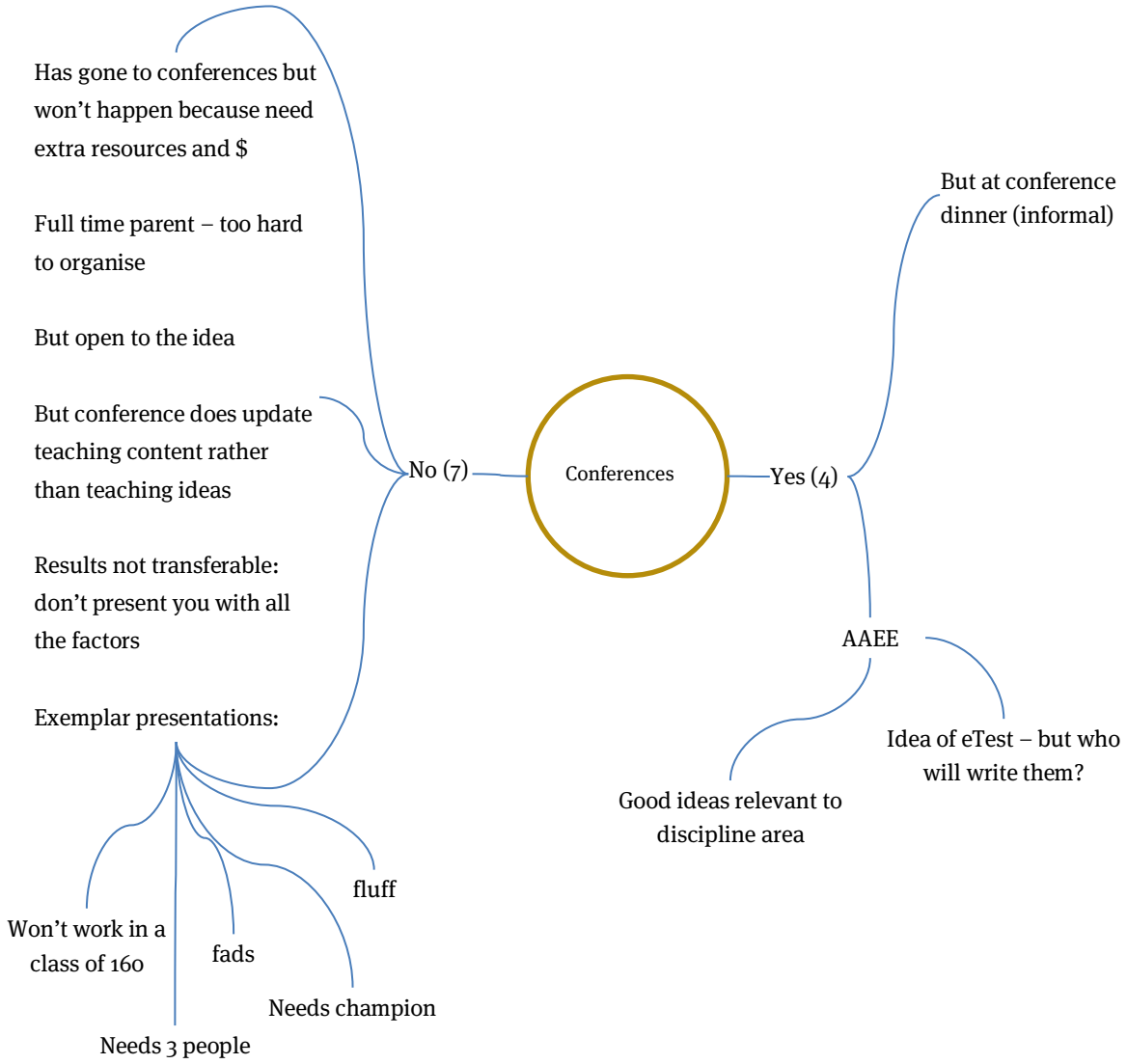


Figure 4-8 Influence of Conferences

4.4.3 Influence of Other Universities

Most unit coordinators had been students at other universities and thus exposed to teaching at other universities, or had themselves taught at other universities. Further, most unit coordinators accessed other universities' websites or STEM websites for teaching resources. Unit coordinators who had attended Australasian Association for Engineering Education (AAEE) conferences shared teaching experiences with staff from other universities.

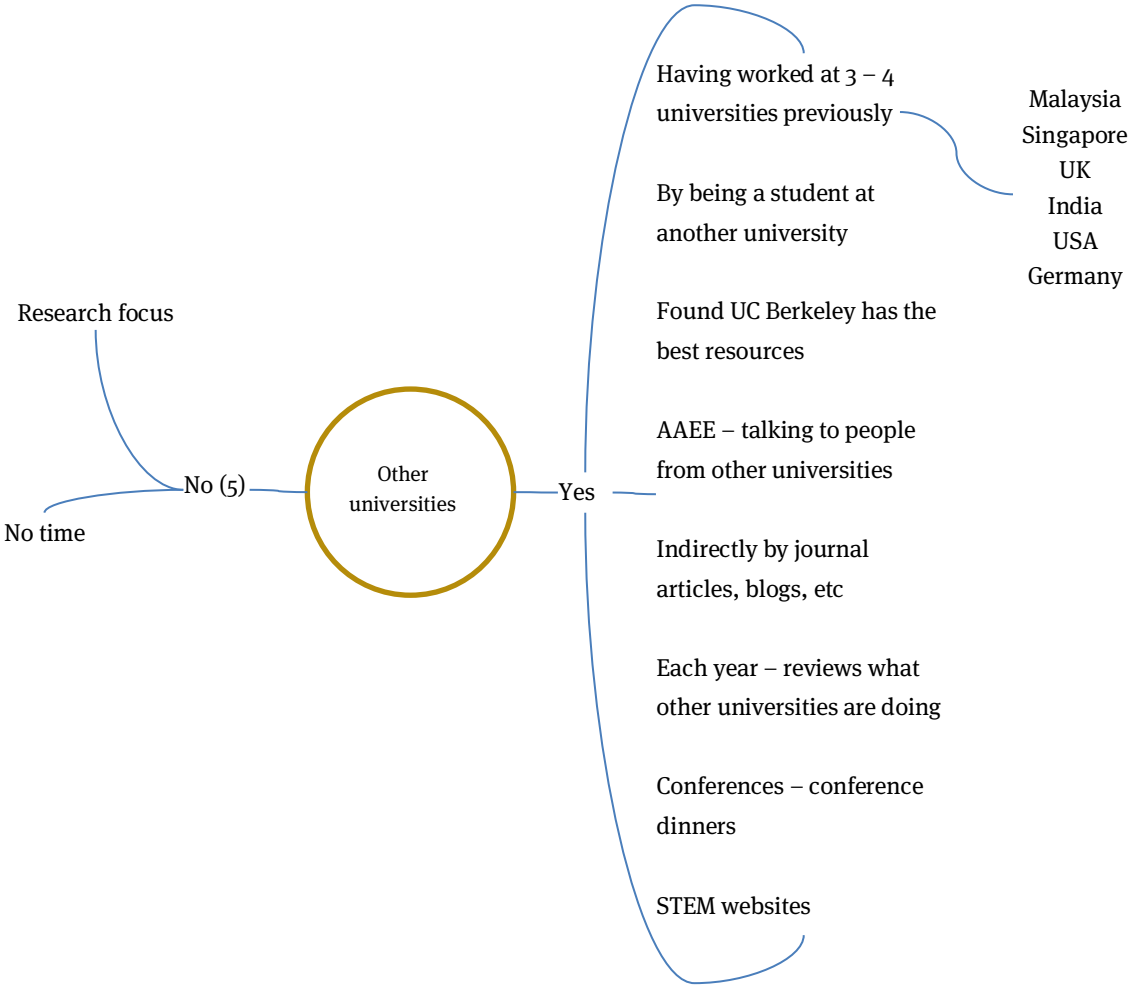


Figure 4-9 Influence of other universities

4.4.4 Peer Review of Teaching

This question asked about the influence of formal Peer Review of Teaching Schemes or programmes. Most unit coordinators had not participated in these formal schemes, but those who had spoke highly of the effectiveness and usefulness of the review. A caveat to the endorsement was that the peer reviewers had to be respected and effective themselves.

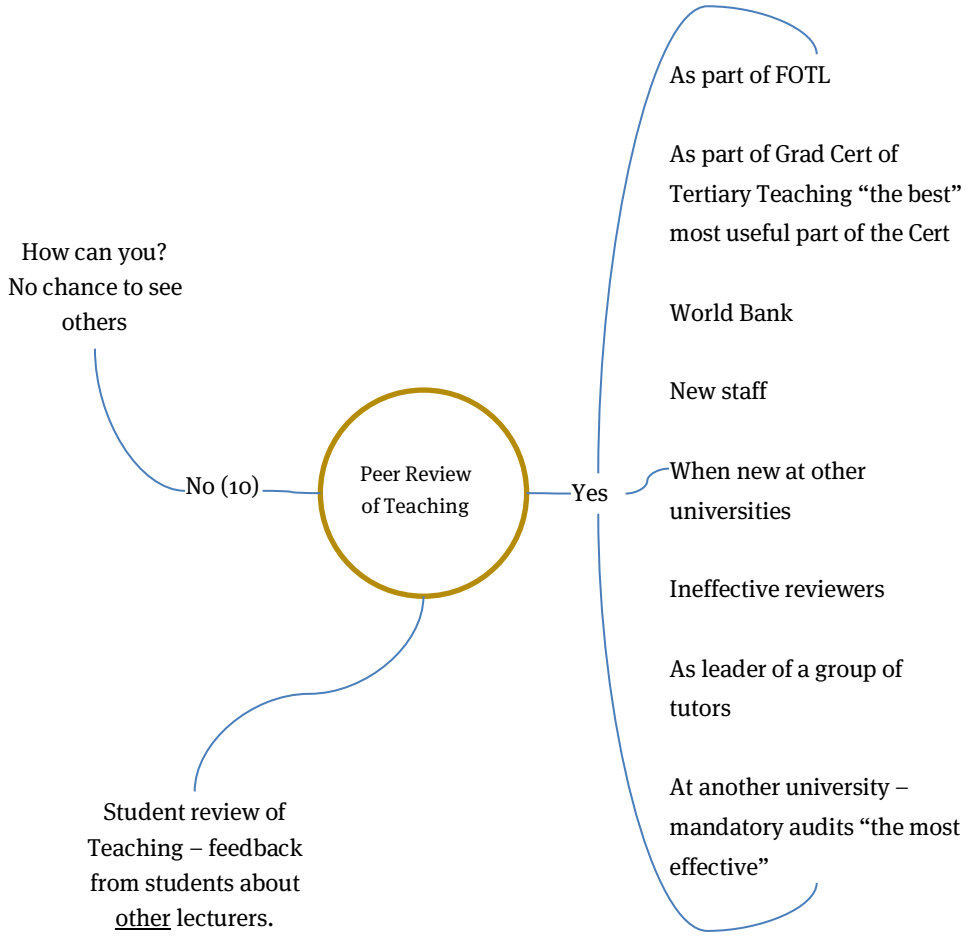
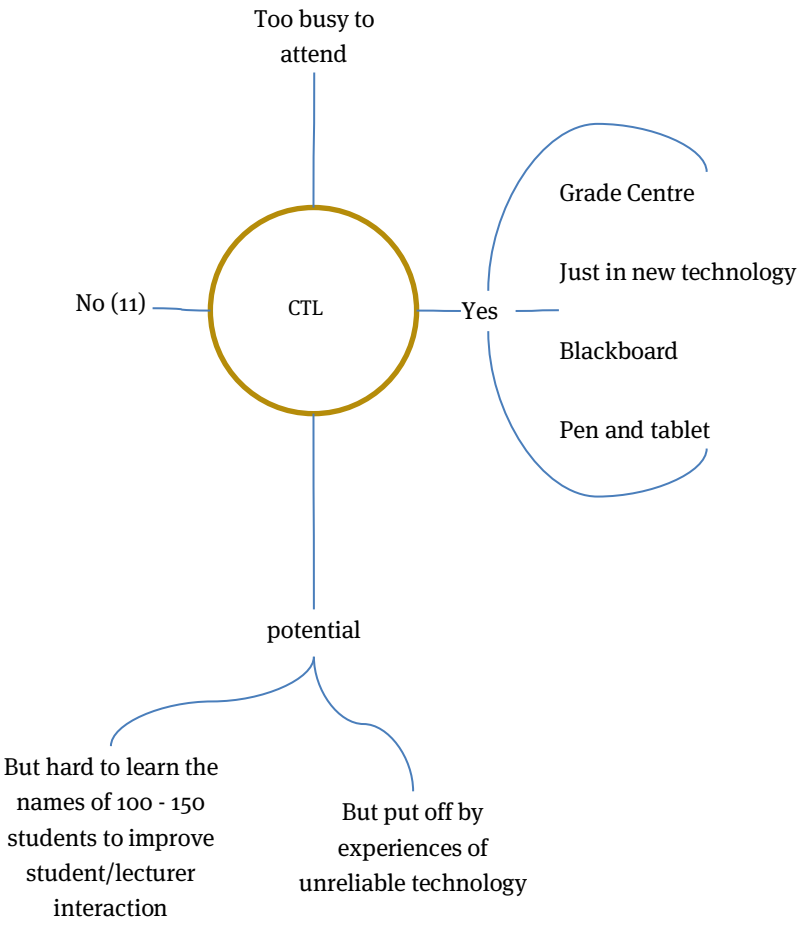


Figure 4-10 Peer Review of Teaching Schemes

Another unit coordinator noted that she was the recipient of unsought 'Student Review of Teaching', where because of her rapport with the students, the students would give her feedback about the teaching of *other* lecturers.

4.4.5 University Teaching and Learning Unit: Curtin Teaching and Learning (CTL)

Most unit coordinators had not been influenced to change their teaching practices by the university's teaching and learning unit, because, in part, the timing of their presentations was inconvenient, and although the ideas presented seemed interesting, there was uncertainty about how to apply them, whether these ideas would work in their own classes, or there was not enough confidence that that the technology (e.g., smart boards) would work. CTL was, however, seen as useful in providing information about general university-wide teaching thinking, initiatives, and technology, for example, Grade Centre, Blackboard and pen and tablet.



4.4.6 Qualifications

Most unit coordinators did not have formal teaching qualifications such as a Graduate Diploma of Education (although two did), but all unit coordinators had completed a university provided 'Foundations of University Teaching' type programme. Reactions to the perceived usefulness of the teaching qualification were mixed: there was a sense that these programmes were rather general, aimed more for the education department rather than helping tertiary educators change students into engineers. Those who had completed a graduate teaching qualification noted that it had impacted on their teaching practice.

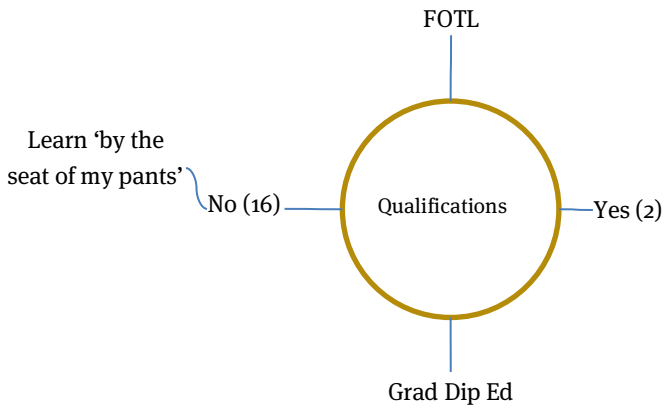


Figure 4-11 Influence of Qualifications

4.4.7 Informal Discussion with Colleagues

All unit coordinators noted that informal discussion was very important in implementing changes to their teaching practices.

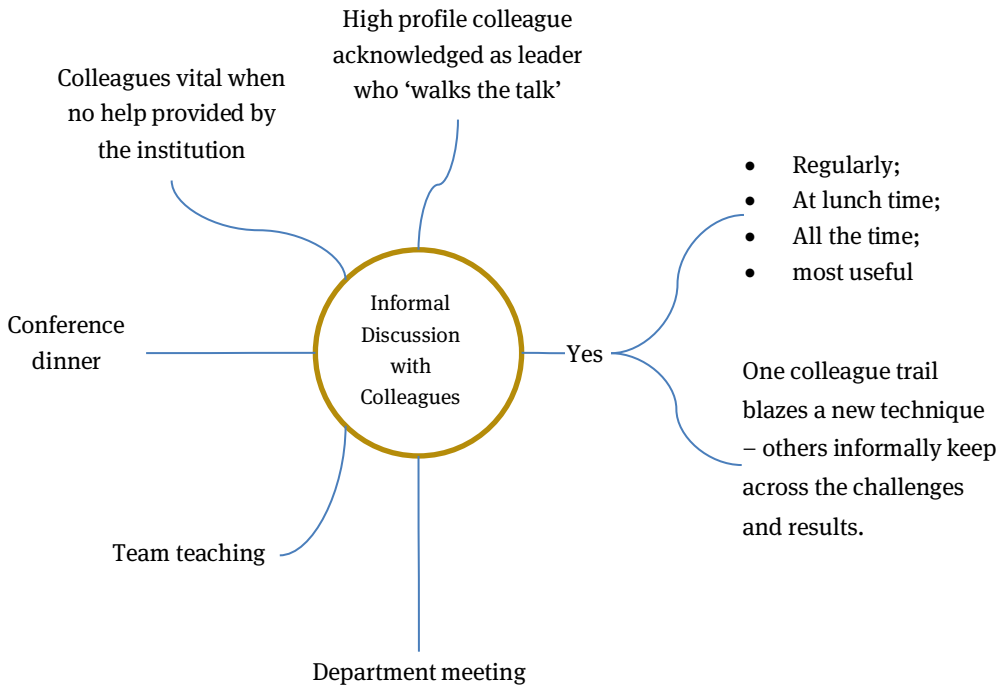


Figure 4-12 Informal Discussion with Colleagues

Even if the changes weren't immediate, the informal conversations planted ideas:

> [the influence of peers is] there .., but it's not direct. It's kind of people saying, I tried this, and it worked, or I tried this, and it didn't work, but not formally, I guess. We're pretty friendly in the department, we all talk to each other, so most of it's probably informally through that, but peer influence definitely is there.
> [Q . It sounds like the peer influence is not in response to an immediate change, it's more like it's something that gets filed away, and then possibly implemented later?]
> A. Yeah, and it does filter through, probably quite effectively as well because rather than everybody changing all at once, people will try things and evaluate them, tune them a bit, and then say, yeah, it's working now because this is what I did, this is what I had to do ...

Colleagues trialling new technologies were sought out to find out how various models of tablets or laptops were working.

Informal conversations with colleagues were facilitated when a unit was being team-taught.

4.4.8 School / Faculty Teaching and Learning Events

Unit coordinators appreciated the engineering focus of School and Faculty teaching and learning events, and reported filing away many ideas for their teaching. One unit coordinator noted that he implemented greater industry involvement as a result of attending one session, and another noted he followed up the FLET team after they let staff know how they could help.

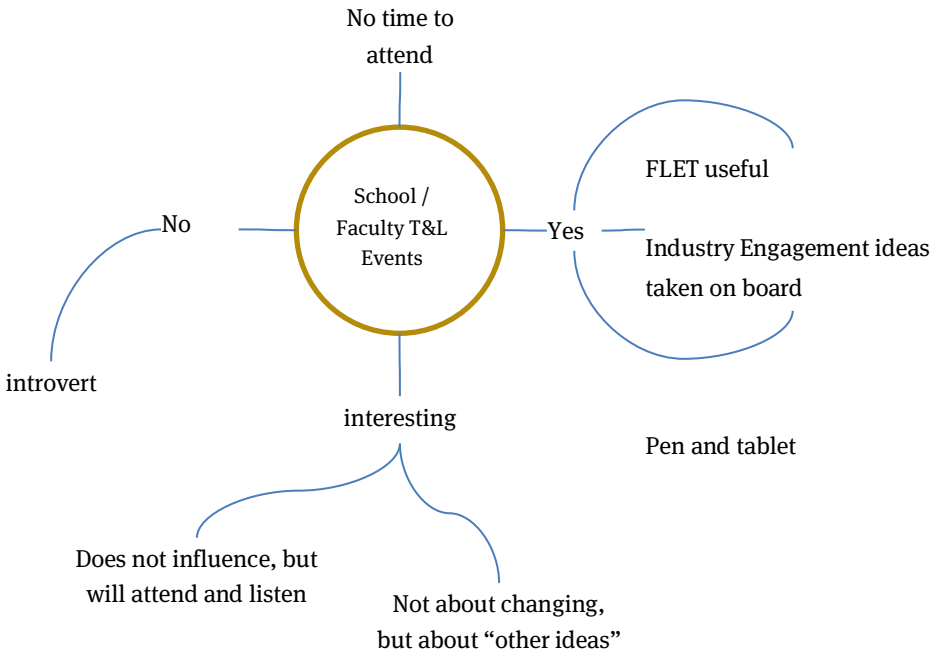


Figure 4-13 School / Faculty Teaching and Learning Events

4.4.9 How have others been influenced by you?

The final question in this section about the influence of peers on changing teaching practice reversed the direction of influence, this time asking whether the unit coordinator had had any influence on their peers.

Figure 4-14 Influencing Others

Apart from team teaching or succession planning, most unit coordinators were not aware of directly influencing the teaching practice of others. A unit coordinator who had been invited to write a book chapter on his teaching practice thought that that might influence his peers. Some lecturers noted that visitors to the university observed their lectures, and perhaps there was some influence there. Other unit coordinators noted positive feedback from audience members when giving presentations about their teaching. Those who were trailblazers in trialling a new technology or teaching method knew they were influencing their peers.

5 Discussion and Recommendations

The aim of this research was to evaluate the effectiveness and impact of changes to teaching practices and delivery being implemented across the School of Civil and Mechanical Engineering at Curtin University. Changes to teaching practice affect three groups of people: (i) the unit coordinators, who consider and implement the change to their teaching practice; (ii) the students, whose learning depends on the practices of their teachers, and (iii) the university, which provides the resources that support teaching practice. Evaluating the effectiveness and impact of changes to teaching practices and delivery begins with the unit coordinators, as they work with students and negotiate resources from the university. The unit coordinators thus not only set the teaching delivery and practices in their units, they also are in the pivotal position of gauging the effectiveness and impact of changes to teaching practices. The data for this research thus came from interviews with all the unit coordinators of non-project based units in Civil and Mechanical Engineering.

5.1 Effectiveness

Evaluating the *effectiveness* of changes to teaching practices and delivery proved difficult. When considering *effectiveness* in teaching, effectiveness is assumed to be around student learning – the more effective a teaching practice, the shorter the time for the student to grasp and apply the concept, or the more the student was able to learn over the same time period (Hattie & Yates, 2013). Over this research period, the teaching practices and delivery in the School were identified as student-centred interactive lectures, tutorials, laboratories and workshops – all standard in the delivery of an engineering degree. Changes reported by unit coordinators included a greater use of laptops, tablets and short video recordings in their teaching toolkits, modifying their assessments and ensuring a bank of worked examples was available to their students. These teaching practices are also common in engineering programmes, and are already known to be effective in student learning. One unit coordinator had structured his unit into 4 week modules (shown previously to be effective), and another was halfway through semester, trialling flipped learning, and it was too soon to determine how effective the flipped learning structure would be on student learning. The teaching practices used in the School are known to be effective for student learning.

A more statistically robust understanding of teaching effectiveness has been developed by John Hattie (Hattie, 2009, 2012). Hattie examined the statistical effectiveness of a (K – 16) teaching intervention (measuring what the student was able to do before a teaching intervention and comparing it with what the student was able to do after the teaching intervention), calculated the effect size, and compared the effect sizes of the various reported teaching interventions. As Hattie noted, almost any intervention can stake a claim to making a difference to student learning -'everything works':

> If the criterion of success is 'enhancing achievement' then 95% of all effect sizes in education are positive. (Hattie, 2012, p. 2)

Hattie noted the effect sizes were normally distributed with an average effect size of $d = 0.40$. His recommendation, therefore, is that for a teaching practice to be considered effective, it should demonstrate an effect size of $d = 0.40$ or greater.

Hattie's list of effective teaching practices (interventions) provides a starting point for evaluating the effectiveness of teaching practices and delivery in engineering, in particular, to a change in teaching practice. However, a similar statistical analysis of the teaching methods used during and introduced into engineering studies is difficult to run as student baseline data is not readily available. Students would need to sit a pre-test at the beginning of a unit to establish a baseline of their learning, as well as sitting the traditional end of unit exam. Pre-tests are not common in engineering education, and those universities that do run pre-tests use them to identify gaps in student knowledge, rather than as a basis for teaching effectiveness (Kavanagh, O'Moore, & Samuelowicz, 2009; Shepherd, McLennan, Kavanagh, & O'Moore, 2011).

In the absence of quantitative markers, unit coordinators determined the effectiveness of changes to teaching practices and delivery through their face-to-face teaching interactions. A move to a greater online presence with reduced face-to-face teaching interactions undermined the unit coordinators' ability to gauge and monitor their effectiveness, and to modify their teaching accordingly.

Recommendation 1: Implement pre-tests / post-tests as objective measures of students learning.

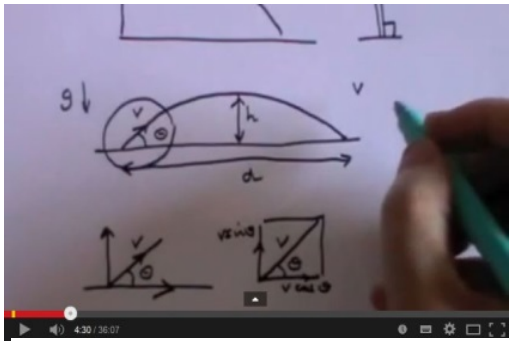
Recommendation 2: Retain face-to-face teaching interactions until an alternative system to determine the success of teaching has been introduced.

5.2 Impact

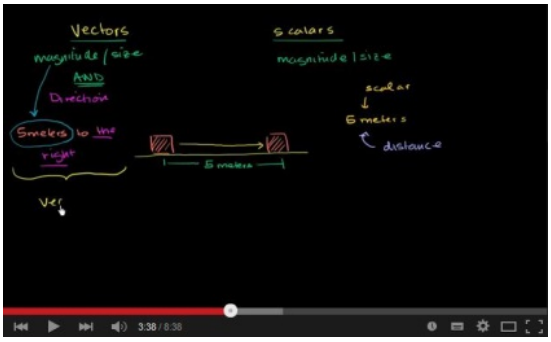
Whereas the effectiveness of changes to teaching practices and delivery is focused on the student, the *impact* of changes to teaching practices and delivery changes the focus to the unit coordinator and the university.

Any change in teaching practice requires time and effort by the unit coordinator. It proved difficult to quantify the time dedicated to implementing teaching changes despite specific questioning of the unit coordinators. Nonetheless, it seemed at least a day a week was dedicated to preparing and changing their teaching, and any change in teaching practice that could not fit into that one day a week was deferred to a later semester. Further, the time taken to implement a change properly always exceeded the amount of time available, especially when technology (videos, online tests) was involved.

Some of the changes to teaching practice introduced a greater use of technology during the teaching and learning process. At least two unit coordinators were replacing or supplementing their lectures with online videos, and noted impacts on their preparation time and access to resources. Online videos range from (a) a screen capture of displayed text with a recorded voice over and written additions – hand visible (e.g., DrPhysicsA (DrPhysicsA, 2012)), (b) a screen capture of displayed text with a recorded voice over and written additions, no hand visible – just a screen capture (e.g., Khan Academy videos (Khan Academy, 2011)), (c) shots of the lecturer talking with edited images or graphics (e.g., edX videos (edX, 2014a, 2014b), through to(d) an edited series of images with a voiceover but no images of the lecturer.(e.g., (Khan Academy, 2014b). Each of these videos requires different software, hardware, editing skills and time commitments. Each video requires storyboarding, rehearsing and editing.



(a) Video, screen capture, with hand



(b) Video, screen capture, no hand

(c) Video, camera, with lecturer

(d) Video, all images, no lecturer

Figure 15 Four possible types of online videos

The videos which were (a) a screen capture of displayed text with a recorded voice over and written additions – hand visible needed a video camera and ideally a recording studio to optimise the light and sound environments. Difficulty accessing the Curtin-provided recording studios during normal working hours was noted. These videos could record pen writing on paper, chalk on a blackboard, or marker on whiteboard. Typically, the video camera generated an mp4 which was edited using Camtasia (TechSmith Corporation, 2015) or VidBlaster (Versteeg, 2015) software.

In contrast, the videos which were (b) a screen capture of displayed text with a recorded voice over and written additions, no hand visible, did not need a video camera, using software to record voice and images, and ideally a pen (rather than a mouse) for the written changes. These videos did not need a recording studio, and could be recorded at home or in the office, although unit coordinators noted the noisy environment of their offices, and often had to wait until long after hours for the building to empty before recording their videos. Once again, videos would be edited with Camtasia software (Khan Academy, 2014a).

The videos which included shots of the lecturer talking with edited images or graphics (c) needed not just a camera and recording studio, but the ability to skilfully edit images and videos. Any video device which generated an mp4 could be used, and possible video editing software includes Camtasia, Final Cut Pro, Adobe Creative Suite, or ScreenFlow for Mac.

Finally, the videos which were (d) an edited series of images with a voiceover but no images of the lecturer did not need a recording studio, but did need the ability to source and edit appropriate content.

The completed videos needed to look professional, reflecting the increasing sophistication of students and the expectations set by online videos on platforms such as edX and Khan Academy.

In all cases, the impacts of these technological teaching changes included a requirement to undertake the recordings after hours, to access equipment such as cameras, pens and tablets, to access recording studios, and to upskill in video editing. The videos were not just recordings of 45 minute lectures – they were a redesigned series of short videos, needing at least three times their finished length to prepare to a suitably high broadcast quality. The impacts of a greater use of online videos in teaching practice included a greater preparation time, more of that preparation time needing to be done after hours, negotiating for access to technology, learning new skills, needing to also upskill the students, greater online communication with students ('correspondence course'), and greater communication with students after hours. The impacts of technological teaching changes were not just in greater preparation time, but in the unit coordinator needing to be available and in contact with students for longer after hours. At this stage, it was difficult to quantify this greater demand on the unit coordinator's time.

Thus, evaluation of the *impact* of changes to teaching practices and delivery proved difficult to quantify, with the impacts felt rather than measured. Unit coordinators expected to make changes to their teaching practices and delivery, fitting those changes into around one day week, but they also felt they needed to work after hours to follow up on any student feedback on implemented changes. They also felt that whatever time was dedicated to teaching, their research outputs were not to diminish.

Recommendation 3: Consider establishing boundaries on the working day – what are the starting and ending times of a typical working day? How much preparation and student interaction time is expected to take place after hours? How can academics be encouraged to attend conferences and not overly stress their families and family commitments?

5.3 Facilitating Changes to Teaching Practices and Delivery

When considering a change to teaching practice, unit coordinators undertook their own evaluation of the effectiveness and impact of the proposed change. The most important consideration about that evaluation was whether the change would benefit the students. A second consideration included the applicability of the change to engineering. Underlying both of these considerations was a commitment to professionalism as an engineering educator. Finally, collegiality – both informal and in team teaching – were important factors in facilitating changes to teaching practices and delivery.

5.3.1 Students

Unit coordinators adapted their teaching practices overwhelmingly in response to student need. Unit coordinators noted differences in ability and attitude between 1st year, 2nd year, 3rd year and final year engineering students and adjusted their teaching practices accordingly, for example providing greater scaffolding in 1st year. Secondly, as the semester unfolded, unit coordinators modified their teaching practices based on their interactions with students during the teaching of the unit. Finally, when the semester had finished, unit coordinators modified their teaching practices based on their *e*VALuate feedback. This focus on student need is embedded in the responsibility unit coordinators felt as professional educators – both in the sense of educating students for a profession (engineering) but also

in the unit coordinator's self-identity as a professional educator. The unit coordinator's purpose was to move the student towards learning the skills, knowledge and attributes that are required of an engineer.

5.3.2 Engineering and discipline differences

When considering whether a proposed teaching change would benefit their students, unit coordinators looked for evidence of success of the teaching innovation in engineering classes. Teaching practices that were reported to be successful in a non-engineering context were not automatically assumed to be successful in an engineering context.

In the organising framework of Neumann, Parry and Becher (2002), engineering is classified *as hard applied*, whereas the humanities are classified as either *soft pure* (e.g., history, anthropology) or *soft applied* (e.g., education, management studies). (For completeness, the fourth area is *hard pure* (e.g., physics, chemistry)). In this framework, the curriculum, assessment and cognitive outcomes of an engineering programme are different to the curriculum, assessment and cognitive outcomes of a humanities programme or even a science programme. For example, in the humanities, the essay, logically debating and describing one of many possible interpretations, is an important way of assessing whether the educational goals of a humanities programme have been met:

> Smart & Ethington (1995) have contrasted undergraduate educational goals in hard pure and soft pure fields, finding that knowledge acquisition is emphasised more in pure disciplines than applied disciplines, while the latter attach more importance to knowledge application and integration. This finding is reflected in typical assessment practices in those disciplinary groupings: science-based subjects are more likely to utilise assessment tasks that emphasise the acquisition of knowledge blocks in a cumulative process, whereas in the humanities and social sciences, together with the social professions (soft pure and soft applied fields), assessment tasks emphasis knowledge application and integration, usually in essay or explanatory form. (Neumann et al., 2002, p. 408)

The nature of the knowledge taught in a *hard applied* area such as engineering does not lend itself to essays. In contrast, the nature of knowledge in *soft* areas is such that individual interpretation is important, and teaching practices reflect these differences:

> Hard pure degree courses are based, particularly in the early years, on large group lectures, supplemented by class laboratory sessions and in some cases by fieldwork .... In so far as there is scope for seminar-type study, the emphasis is placed on problem classes, in which smaller groups of students (often supervised by a doctoral or post-doctoral researcher) work on the solution of predetermined questions related to the current lecture topics. Undergraduate teaching on an individual basis or in very small tutorial groups is relatively uncommon. Typical presentational techniques, in line with the sequential and propositional nature of hard pure knowledge, include the use of overhead projectors and the circulation of handouts to emphasise key points in face-to-face settings, and study guides, summaries and self-test questions in the context of distance teaching. In some topic areas, slides and other media illustrate appropriate material in visual form, and demonstration experiments are mounted or simulated to replicate established empirical findings.
>
> The countervailing practice in soft pure fields is to organise students in face-to-face settings into smaller groups. Apart from occasional 'set piece' lectures, commonly presented on a one-off basis by star academic performers to large groups, most courses seem to cater for quite modest audiences. Seminars and web-based discussion groups, which may or may not be linked to the material of the lectures, typically deal with

> controversial issues, designed (more or less successfully) to involve students in debate. Where resources allow, tutorial teaching is also provided, in which students are encouraged, individually or in small numbers, to put forward their own ideas in the form of written essays or verbal presentations. All of these practices can be seen to relate to the reiterative, open-ended nature of soft pure knowledge, with its scope for individualistic interpretation. (Neumann et al., 2002, pp. 411-412)

The differences in how the disciplines are taught reflect the differences in the aims of the disciplines. In Australia, the aims of an engineering programme are substantially set by Engineers Australia. In particular, an engineering programme is required to be about 60% content/skills/tools, 20% engineering design and projects, and 10% integrated exposure to professional engineering practice, including management and professional ethics. The last 10% can be allocated to more of any of the above elements, or other elective studies (Engineers Australia, 2008). The content heavy course requirements set by Engineers Australia shape how engineering is taught.

In particular, at least 40% of an engineering student's course is required by Engineers Australia to be dedicated to learning foundational content - mathematics, science, and engineering principles, skills and tools appropriate to the discipline of study, with a further 20% of the course dedicated to learning the content of the relevant engineering discipline specialisation (Engineers Australia, 2008). This means at least 60% of an engineering course involves the student learning a hard pure and hard applied curriculum. Similar to medical studies, most engineering content is not open to interpretation or debate. The human body has a certain number of organs which perform in certain ways. How bridges, capacitors and code work is not open to interpretation. The core content needs to be mastered.

Students report that they felt they understood the core content when they were able to successfully solve engineering questions, and that working through worked examples was key to learning engineering concepts (Szymakowski, 2013). Unit coordinators also noted the positive student response to worked examples, and almost all engineering lectures were student centred interactive sessions with not just content explanation, but with the lecturer talking and writing through a number of worked examples, and with opportunities for student questions and interactions. The supplementary videos prepared by unit coordinators also showed the lecturer talking and writing through a number of worked examples, although this time without the student questions and interactions.

As well as learning engineering content, engineering students need to develop engineering thinking/design/solving, and this is typically developed in engineering project work. Engineers Australia requires around 20% of an engineering course to be dedicated to engineering design and projects, allowing students to apply the learnt content. Laboratories, workshops, and student meeting areas are vital in supporting students' project work, as projects tend to be something physical, and students tend to work collaboratively on their projects.

Finally, around 10% of an engineering course is dedicated to integrated exposure to professional engineering practice, including management and professional ethics. This is typically delivered through 'vacation work' and lectures from industry guest lecturers.

The interviewed unit coordinators understood the differences between engineering and other disciplines. These differences were not about being contrary or elite – they reflected an appreciation of

the specific outcomes of an engineering programme. The understandings were also nuanced: appreciating that constructivist learning by the student is not the same as collaborative or peer teaching. Unit coordinators appreciated tutorials for students, since that allowed students to work with each other, but, unlike the humanities, the tutorials were not there to allow students to debate or develop individualist interpretations of knowledge. Across the disciplines, the learning aims of the tutorial are different, even though they are both called 'tutorials', involve groups of students working together and take place in a tutorial room or 'collaborative learning space'. Similarly, engineering lectures were almost all whole group, interactive workshop sessions rather than 45 minutes of one-way information dump, despite the activity being called a 'lecture' and held in a lecture hall.

Recommendation 4: Make explicit the differences between engineering and other disciplines in terms of curriculum, assessment and cognitive outcomes. Consider which teaching methods align best with the desired engineering cognitive outcomes.

In the language of Neumann, Parry and Becher, some parts of an engineering programme are *softer* than other parts. These are the parts of the programme that emphasise professional thinking and behaviour, not just learning content. Unit coordinators noted difficulty in assessing professional thinking and behaviour. These aspects of the programme were seen as 'subjective', and students were not shy in challenging awarded marks. The resulting appeal process was noted to be time-consuming for the unit coordinator. Again in the language of Neumann, Parry and Becher, perhaps students already understood that learning outcomes for *soft* disciplines involve debate and individualistic interpretations of knowledge, and see the awarding of marks in these 'subjective' areas as an exercise in debate.

Recommendation 5: Develop a suite of assessments for 'subjective' aspects of the course that will not overly expose unit coordinators to student appeals, yet still provide evidence for Engineers Australia accreditation requirements.

In summary, teaching practices shown to work in the humanities or other non-engineering contexts were not automatically assumed to work in engineering, and unit coordinators sought evidence of success in engineering under similar conditions before considering a change of teaching practice.

5.3.3 Professionalism

The third consideration that emerged in conversations with unit coordinators around considering a change to teaching practice was the issue of professionalism. Unit coordinators saw themselves as professional educators, building a body of knowledge and skills around what does and doesn't work in teaching engineering. Fundamentally, their aim was to genuinely provide the best learning experience for their students so their students succeeded in developing as engineers. This meant that not only were they accountable to university management, engineering educators also recognised their accountability to Engineers Australia, ensuring that any engineering programme in which they taught met the accreditation requirements of Engineers Australia. This two fold responsibility – to the university and to the engineering profession through Engineers Australia - was taken seriously. The unit coordinators took pride in their professionalism.

The sense of professionalism and responsibility was evident in conversations around online learning and MOOCs. Firstly, unit coordinators felt the responsibility for student learning was not something that could be outsourced or delegated to tutors: tutors tutored, lecturers taught. Nonetheless, when unit coordinators included PhD candidates in their unit's teaching team to act as tutors, they noted difficulty finding enough suitable PhD candidates, so that, in response to student feedback, lecturers ended up staffing the tutorials themselves as well as any lectures / workshops. That difficulty was not resolved in moving to an online environment. Tutors were still likely to be required, and the unit coordinator was still responsible for student learning. How the responsibility to ensure student learning would be fulfilled in an online or MOOC environment was unclear. MOOCs and online learning provided opportunities for students to access and work through materials where and when they wanted, but the role of the teacher was unclear. Up to now, MOOC literature has identified two main teacher roles, connected to the way the MOOC is designed: the academic celebrity teacher in xMOOCs and the facilitator in cMOOCs (Bayne & Ross, 2014). The academic celebrity teacher is a respected authority in their area and is based in an elite institution. These lecturers are not available to MOOC participants in any interpersonal way but primarily through the recordings of their lectures. The recordings are supplemented with automatically marked quizzes, discussion posts and pass/fail tasks. In cMOOCs, the teachers' role focusses on facilitating self-directed learning. A team of tutors moderate posts, undertake random auditing of submitted assessments and answer queries, communicating with the teacher, who may also interact with participants. The Curtin unit coordinators did not see themselves fitting into the academic celebrity teacher role, but also did not have a team of suitable tutors to manage the online learning environment. A move to online learning did not absolve unit coordinators from the responsibility to ensure student learning.

Unit coordinators sometimes felt that their identity as professional educators was not respected by university management. Two actions by university management had recently led to changes in teaching practice: (i) Introducing a university wide strategy that set an upper limit to the number of face-to-face lectures (no more than two hours a week), and (ii) Initiating a restructure which led to the merging of a number of units. As professional educators, most unit coordinators felt disquiet about reducing the number of face-to-face lectures with their students, as their professional judgement was that this would be detrimental to student outcomes. Unit coordinators expected the university to take their professionalism seriously, recognise their professional judgement and to support them when they implemented or chose to not implement a change in teaching practice.

> I don't know if this is anything to do with your research but it would be good if we had more voice in the system that someone would actually listen to us and my experience is they tend not to. They just dismiss you.
> [Q. More voice in terms of being able to direct how you want your teaching to go?]
> A. Well things like converting 30 rooms around the campus to this sort of thing [collaborative learning spaces]. Well, no, no-one ever asked.

Unit coordinators placed student success at the heart of their teaching endeavours, modifying their practices in response to student need. They were also cautious about introducing any teaching change which would not be of benefit to the students.

Recommendation 6: In a trend towards more tutorial classes, investigate a pipeline of and sustainable supply of suitable tutors who may or may not be PhD candidates.

Recommendation 7: Clarify the role of the teacher in an online environment / MOOC.

5.3.4 Collegiality

Colleagues had both a formal and informal influence when unit coordinators were considering a change to teaching practice. Formally, the Head of School proved to have a significant influence on changes to teaching practice. Less experienced teaching staff sought a consultation with the Head of School to discuss teaching changes they were considering. The Head of School endorsed the teaching change, as well as ensuring that the change was in line with Engineers Australia's accreditation requirements, a role I had expected to be with the Associate Dean (Teaching and Learning). The Head of School was acknowledged to be supportive of teaching staff and teaching initiatives.

Informally, when unit coordinators were considering a change to teaching practice, the informal conversation proved to be vital. The informal conversation (in a tea room, in a corridor, in a department meeting, over lunch) provided a way hear about the success, failures, and challenges of teaching engineering or implementing a teaching change in the engineering context. An engineering colleague's teaching experiences carried legitimacy and authority, and a change in teaching practice was likely to be viewed more favourably if it had been shown to be successful in a colleague's class. Colleagues also shared their experiences of new technological products such as tablets, laptops and Blackboard.

Recommendation 8: Retain informal communal staff spaces such as tea rooms. When matched with a culture that values and encourages tea breaks and lunch breaks these spaces provide a safe and effective environment for sharing of teaching and learning experiences (informal conversations). Informal conversations are not as easily fostered when informal spaces are not readily accessible.

A second informal collegial influence was around team teaching. Some units are taught by a teaching team – a number of lecturers as well as tutors. Less experienced lecturers noted how much they learnt from their more experienced lecturers on the teaching team, and how the teaching team formed an informal community of practice. The teaching team was formed a natural environment for more senior lecturers to share their teaching experiences.

Recommendation 9: Establishing teaching teams for a unit proved to be a natural and non-threatening way to facilitate change in teaching practice. The team could even include specialists such as programmers or non-engineering teachers. Ensure the teaching team is adequately resourced (for example, if someone on the team is creating videos).

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Appendix 1: Human Research Ethics Approval

Curtin University

Memorandum

To	Jolanta Szymakowski, Nicoleta Maynard, Jonathan Paxman, Civil Engineering
From	Pauline Howat, Administrator, Human Research Ethics Science and Mathematics Education Centre
Subject	Protocol Approval **SMEC-38-13**
Date	3 October 2013
Copy	SMEC

Office of Research and Development

Human Research Ethics Committee

Telephone 9266 2784
Facsimile 9266 3793
Email hrec@curtin.edu.au

Thank you for your "Form C Application for Approval of Research with Low Risk (Ethical Requirements)" for the project titled *"Understanding the Impact of Teaching and Learning Innovations in Civil and Mechanical Engineering"*. On behalf of the Human Research Ethics Committee, I am authorised to inform you that the project is approved.

Approval of this project is for a period of 4 years **3rd October 2013** to **2nd October 2017**.

Your approval has the following conditions:

(i) Annual progress reports on the project must be submitted to the Ethics Office.

(ii) It is your responsibility, as the researcher, to meet the conditions outlined above and to retain the necessary records demonstrating that these have been completed.

The approval number for your project is **SMEC-38-13**. Please quote this number in any future correspondence. If at any time during the approval term changes/amendments occur, or if a serious or unexpected adverse event occurs, please advise me immediately.

Pauline

PAULINE HOWAT
Administrator
Human Research Ethics
Science and Mathematics Education Centre

Please Note: The following standard statement must be included in the information sheet to participants:
This study has been approved under Curtin University's process for lower-risk Studies (Approval Number xxxx). This process complies with the National Statement on Ethical Conduct in Human Research (Chapter 5.1.7 and Chapters 5.1.18-5.1.21). For further information on this study contact the researchers named above or the Curtin University Human Research Ethics Committee. c/- Office of Research and Development, Curtin University, GPO Box U1987, Perth 6845 or by telephoning 9266 9223 or by emailing hrec@curtin.edu.au.

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CRICOS Provider Code 00301J

Appendix 2: Participant Information Form

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7 October 2013

Understanding The Impact Of Teaching And Learning Innovations In Civil And Mechanical Engineering

PARTICIPANT INFORMATION SHEET

The Project team: who are we?: Associate Professor Nicoleta Maynard, Dr Jonathan Paxman and Ms Jolanta Szymakowski.

Who will conduct the research? Ms Jolanta Szymakowski, a research assistant, has been hired for the project. She will arrange to meet with staff and students for discussions.

How will participants be recruited? Engineering students will be invited to participate through in-class announcements (with teachers' prior permission) and by email. Engineering staff will be invited by telephone, email, or through the unit coordinator. E-mail lists will not be accessed directly by the researchers.

What happens to the data? Interviews, focus groups and workshops will be audio recorded. Notes from the interviews and focus groups will be analysed, along with the transcripts from the audio recordings. These notes, recordings, and transcripts are the property of the researchers. Recordings will be stored securely and will not be accessible to teaching staff.

Is the anonymity of participants protected? All data are anonymous, that is, no data released to other people will enable you to be identified either during the research or in resulting publications or presentations. No audio recordings will be released to teaching staff or anyone else.

Can you withdraw from the project? You are free at any time to withdraw consent to further participation without prejudice in any way. You need give no reason or justification for such a decision. In such cases, your records are destroyed, unless otherwise agreed by you.

What are the risks and inconveniences of the project? There is no health risk involved and the only inconveniences are volunteering your time for either an interview or participation in a focus group or workshop. If you are a student, your participation or choice not to participate in this research will not influence your participation in your course or your grades, except that it might help you reflect on your learning.

What are the long term outcomes? This research project will investigate staff and students' experiences of changes to engineering education practice and help make educational change easier. Your participation is therefore highly valued.

This study has been approved under Curtin University's process for lower-risk Studies (Approval Number SMEC-38-13). This process complies with the National Statement on Ethical Conduct in Human Research (Chapter 5.1.7 and Chapters 5.1.18-5.1.21). For further information on this study contact the researchers named above or the Curtin University Human Research Ethics Committee c/- Office of Research and Development, Curtin University, GPO Box U1987, Perth 6845 or by telephoning 9266 9223 or by emailing hrec@curtin.edu.au.

Any person considering participation in this research project, or agreeing to participate, may raise any questions or issues with the researchers at any time. In addition, any person not satisfied with the response of researchers may raise ethics issues or concerns, and may make any complaints about this research project by contacting the Curtin University Human Research Ethics Committee.

All research participants are entitled to retain a copy of any Participant Information Form and/or Participant Consent Form relating to this research project.

Kind regards

Jolanta Szymakowski

1 of 1

Appendix 3: Participant Consent Form

Curtin University

School of Civil and Mechanical Engineering

GPO Box U1987
Perth Western Australia 6845

Telephone +61 8 9266 4538
Facsimile +61 8 9266 2681
Email jolanta.szymakowski@curtin.edu.au
Web curtin.edu.au

13 September 2013

Understanding The Impact Of Teaching And Learning Innovations In Civil And Mechanical Engineering

PARTICIPANT CONSENT FORM

I (the participant) have read the participant information sheet and any questions I have asked have been answered to my satisfaction. I agree to participate in this activity, knowing that I may withdraw at any time without reason and without prejudice.

I agree that research data gathered for the study (with the exception of audio recordings) may be published provided my name or other identifying information is not used.

I have also been told the steps that will be taken to ensure confidentiality of all personal information.

I am aware that if I have any questions about this project I can contact Jolanta Szymakowski on 9266 4538.

Participant's Full Name: _____

Participant's Signature: _____Date: _____

Please delete appropriate words below.

I *do / do not* agree to being audio recorded (when necessary for this research).

I *do / do not* agree to being approached for a follow up interview (when necessary for this research).

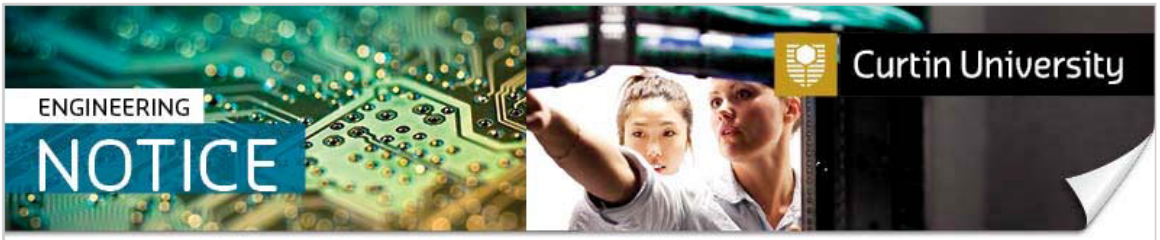
Kind regards
Jolanta Szymakowski

1 of 1

Appendix 4: Units in Civil and Mechanical Engineering

SPK	Title of Unit
12907 v.3	Design For Manufacturing 431
12911 v.2	Automatic Control 432
12925 v.2	Fluid Mechanics 433
302784 v.2	Structural Design 266
302802 v.3	Sustainable Development in Civil Engineering 465
302807 v.1	Integrated Design and Construction 464
302810 v.3	Water Engineering 466
302811 v.1	Geotechnical Engineering 466
302812 v.1	Structural Engineering 462
302866 v.1	Noise 432
308800 v.1	Thermodynamics 236
308803 v.1	Mechanical Design 337
308804 v.1	Mechanical Design 238
308806 v.2	Manufacturing Processes 233
308809 v.1	Engineering Graphics 232
308810 v.1	Fluid Flow Modelling 332
308815 v.1	Automatic Control 333
308822 v.1	Mechatronic Modelling 231
308823 v.1	Linear Systems Modelling 232
308825 v.1	Mechatronic Project 332
308826 v.1	Manufacturing for Mechatronics 332
308883 v.2	Water and Environmental Engineering 362
308884 v.2	Civil and Structural Design 366
308886 v.2	Geotechnical Engineering 368
308887 v.1	Transportation Engineering 366
7601 v.3	Structural Mechanics 262

Appendix 5: Invitation Email



TL@C: Understanding the Impact of Teaching and Learning Innovations in Civil and Mechanical Engineering

One of our School's responses to the TL@C program is to methodically examine the process of changing teaching patterns and chronicle the impacts on our staff. The School has thus secured funding for a research project in this area. Jonathan Paxman, Nicoleta Maynard and Jolanta Szymakowski form the research team.

The research project unfolds over three stages:

Stage 1: Collate past, present and intended teaching practices employed in Civil and Mechanical Engineering units. Units across three Semesters - Semester 2 2012, 2013 and proposed for 2014 - will be studied.

Stage 2: Interview unit coordinators and teaching staff of the units in Stage 1 to understand the experiences of the teacher implementing changes to teaching practice.

Stage 3: Investigate how students experience the changes to teaching practice.

Our people already do an extraordinary job of ensuring our students have the best possible teaching and learning experience, and the process of educational change requires significant amounts of time and resources. I invite you to work with the research team so that your efforts are captured, acknowledged and used as input to later educational change. Do take this opportunity to express your views.

Teaching Practices Overview

Over the next four weeks you will be contacted by Jolanta Szymakowski as she collates each unit's teaching practices. Jolanta is an experienced engineering educational researcher, an electrical engineer and a qualified educator. Please make her welcome.

Approval to conduct this research has been provided by Curtin University's Human Research Ethics Committee, in accordance with its ethics review and approval procedures (Approval Number SMEC-38-13).

Appendix 6: Interview Protocol (Stage 1)

Survey

Date: …… Time: …… Location: ……

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Unit Code: _____ Unit Name _____

Unit Coordinators: **2013 Sem 2** _____
2012 Sem 2 _____
2014 Sem 2 _____

Unit Structure (classes):

L1 Lecture 1 T1 Tutorial 1 CL1 Computer Lab 1 SL1 Science Lab 1 W1 Workshop 1 Sem1 Seminar 1
L2 Lecture 2 CL2 Computer Lab 2 SL2 Science Lab 2 P1 Practical 1
SL3 Science Lab 3 IS Individual Study
Proj1 Project

** *labs: frequency /sem*

2013

Unit Structure in 2013

Activity	L1	L2	T1	CL1	CL2	SL1	SL2	SL3	W1	Sem1	P1	IS	Proj1
(length)													
(frequency)													

2013: What takes place during classes?

Didactic Instruction
Worked Examples
Student questions and answers
Student problem solving
Peer discussion
Feedback

2013: Did UC also teach a tutorial? ❒ Yes ❒ No ❒ n/a

2013: Any change in the use of technology?

Tablets (and pen)?	❒ Yes	❒ No	
Recorded lectures?	❒ Yes	❒ No	
Collaborative learning spaces?	❒ Yes	❒ No	Which room?

2013: Timetabling and venues?

How satisfied are you with the timetabling process?	Very satisfied	4	3	2	1	Very dissatisfied	n/a
How effective was the timetabled room in supporting your teaching and learning activities?	Very effective	4	3	2	1	Very ineffective	n/a
How effective was the timetabled room in supporting your teaching and learning activities?	Very effective	4	3	2	1	Very ineffective	n/a

2013: Notes

Survey TL Stage 1 v4.docx Page 1 of 2

2012 – last year

Unit Structure in 2012

Activity	L1	L2	T1	CL1	CL2	SL1	SL2	SL3	W1	Sem1	P1	IS	Proj1
(length) (frequency)													

2012: What took place during classes?

Didactic Instruction	
Worked Examples	
Student questions and answers	
Student problem solving	
Peer discussion	
Feedback	

2012: Did UC also teach a tutorial? ❒ Yes ❒ No ❒ n/a

2012: Notes

2014 – next year

Unit Structure proposed for 2014

Activity	L1	L2	T1	CL1	CL2	SL1	SL2	SL3	W1	Sem1	P1	IS	Proj1
(length) (frequency)													

2014: What will likely take place during classes?

Didactic Instruction	
Worked Examples	
Student questions and answers	
Student problem solving	
Peer discussion	
Feedback	

2014: Will UC also teach a tutorial? ❒ Yes ❒ No ❒ n/a

2014: Any changes planned in the use of technology?

Tablets (and pen)?	❒ Yes	❒ No	
Recorded lectures?	❒ Yes	❒ No	
Collaborative learning spaces?	❒ Yes	❒ No	Which room?

Stage 2

Would you be interested in Stage 2 of this research, where you are interviewed to explore your experiences of changing teaching patterns? ❒ Yes ❒ No ❒ Maybe

Follow Up / Interviewer Notes

Appendix 7: Interview Protocol (Stage 2)

Stage 2 – Interview Protocol

Date: …… Time: …… Location: ……
Interviewer: JHS Interviewee: …… Position of Interviewee:……

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Questions: