2019 **Tertiary Teaching Excellence Awards**
General Category

Nomination for Peter Bier

Department of Engineering Science
The University of Auckland

Contents

Teaching excellence

DYNAMIC
- Positive in attitude and full of energy and new ideas
- Characterized by constant change, activity, or progress

Teaching excellence in my context can be defined as *teaching dynamically*, which involves inspiring students to learn, through sharing the passion, energy and new ideas a teacher has for a subject, and supporting effective learning outcomes through a willingness to constantly change one's practice in the pursuit of better ways to teach. As part of my drive to improve I learn from colleagues and share my own experiences. In this way I hope to foster teaching excellence in both formal and informal contexts, within the University and beyond.

As a Professional Teaching Fellow, my focus is on teaching and promoting excellent teaching practice. I teach core compulsory stage one and two engineering courses, including *Mathematical Modelling 1 and 2* (ENGSCI 111 and 211), and *Introduction to Engineering Computation and Software Development* (ENGGEN 131), which enrol around 1,000 students and introduce difficult (but necessary and foundational) conceptual and technical content. I also teach smaller classes, including *Accelerated Mathematics* (MATHS 153), a stage one mathematics course aimed at very able secondary school students.

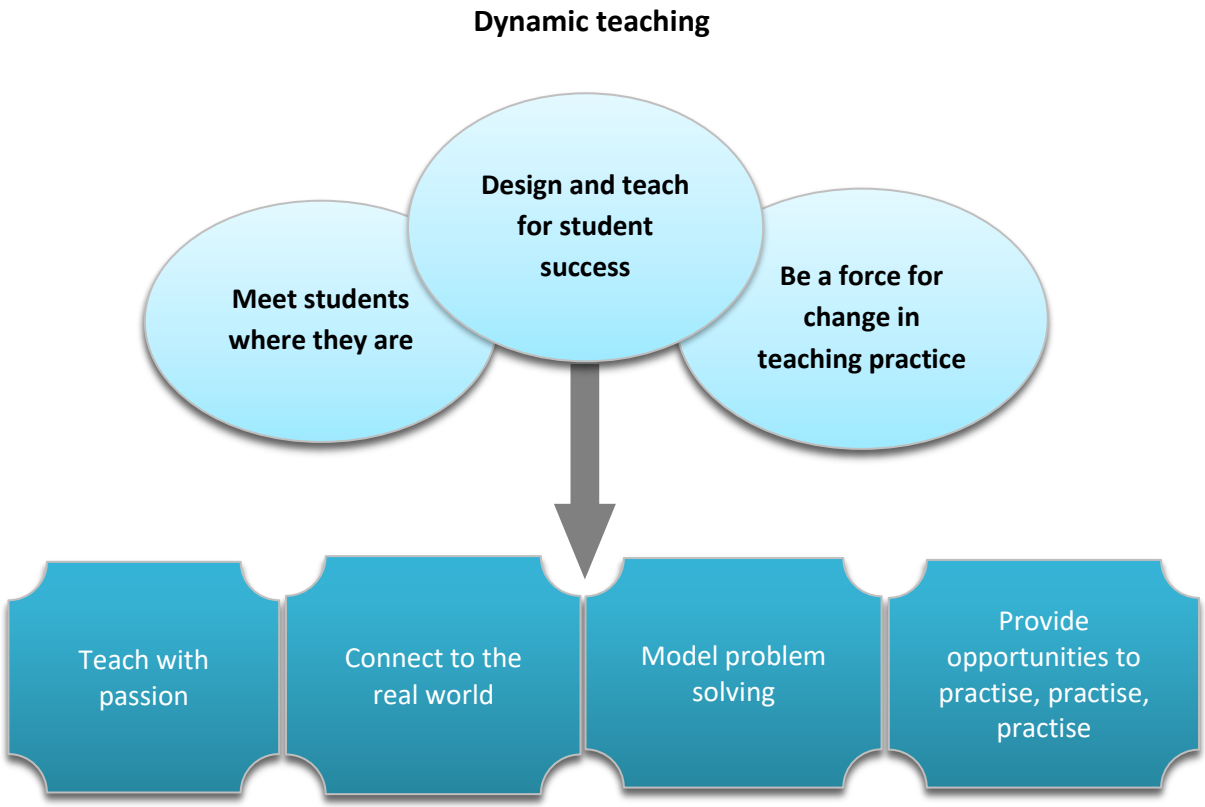
My students have different learning backgrounds and varying interest in the subject matter. Effective teaching in this context must engage and support the learning of the entire cohort of students, from those who lack fundamentals through to those who are already highly skilled.

There is a deliberate element of the performative in my teaching. I use performance to sustain energy and introduce humour. This technique is 'show' in the truest sense – I use it to demonstrate abstract concepts in an engaging way in order to deepen understanding.

Dynamic teachers do more than show and tell. They foster a love for the subject and a life-long love for learning. They are not content to settle for strategies that are adequate, but continually strive to make their teaching ever more effective, always keeping the needs of the learner at the centre of what they do.

Dynamic teaching in the classroom

My approach to teaching dynamically comprises key inter-related factors:



Meet students where they are

I want to take students from 'where they are', to where they need to be. To do this I need to understand their backgrounds and, importantly in my context, support transition into and through engineering courses with foundational and often difficult mathematical content. As I co-ordinate two large stage one courses, I have devoted significant effort to working towards a smoother transition from secondary to tertiary study for our students.

In order to better understand my students' backgrounds, in 2010 I volunteered to teach the year 13 calculus differentiation standard to students at Mt Albert Grammar. Working with secondary students over the course of several weeks gave me valuable insight into the knowledge students bring to university. I was able to tailor my undergraduate teaching to incorporate terminology, notation and concepts more familiar to the incoming students. This experience made me much more aware of the

potential transition gap and the importance of not making assumptions about students' backgrounds.

Since 2009, I have been a regular attender at the biennial NZ Association of Mathematics Teachers' secondary teachers' conference, presenting in 2009, 2013 and 2015. These conferences allow me to keep in touch with what is happening in the secondary sector.

Early diagnostics

For stage one engineering students it is crucial to diagnose gaps in conceptual knowledge as early as possible in a student's first semester, so that students know where they need to develop their knowledge, and so we can be responsive in our teaching. To allow us to more rapidly identify students needing additional support I moved our existing paper-based diagnostic test for first-year students online. We now have an effective tool for identifying at-risk students by the end of the first week of study. To provide further support for these students I oversaw the development of a manual of practice problems and developed video tutorial resources. We have also established drop-in clinics for one-on-one assistance.

Students who take advantage of these opportunities have an opportunity to re-sit the diagnostic test. My analysis has shown that those who improve their score to 75% or more are significantly more likely to succeed in their first-year mathematics course.

Real-time polling and feedback on in-class questions

In class I use multi-choice questions as a way of polling student understanding to check and adjust my teaching in real time. Polling understanding has to be done in a way that allows all students to participate and respond without fear of embarrassment. After trialling various high-tech solutions I have reverted to a simple response system of colour-coded cards printed with A, B, C and D. Students hold up the cards to respond to questions. This solution is less prone to technical problems and still lets me gauge understanding. I provide graphical feedback to the whole class with quick hand-drawn sketches based on rough proportions, without revealing individual responses.

Real-time polling in action

Enhanced preparation: the Genesis Programme - a new path for Māori and Pasifika students

I am particularly interested in the success of our Māori and Pasifika students, who together form approximately 10% of our student cohort. For some Māori and Pasifika students there are barriers to entering engineering studies, as they may not have selected or had access to the necessary subjects at school, or received the support they needed to achieve at the required level in secondary mathematics and physics.

In 2019 I was excited to play a key role in the creation and delivery of our Faculty's Genesis Programme, working alongside a fantastic team of professional staff. Analytics were used to identify a cohort of Māori and Pasifika students who would not normally be able to enter into the engineering programme but showed the potential to succeed. Fifteen of the students invited decided to join the programme and a further five students who were concerned about their mathematical background also enrolled.

Genesis is a four-week, intensive academic programme that aims to build mathematical knowledge and teach the skills to support self-directed learning. We start with a short residential component to build a strong sense of community and belonging for our students. This is followed by several weeks of sessions where students practise the study skills taught and we work together to fill the gaps in their mathematical background. The course also featured practical design challenges and team building events throughout.

The programme was a resounding success for students. From the 20 participants, 16 came directly into Engineering while the remaining four are currently studying Science with a view to transferring into Engineering in the middle of the year. All students from the programme are being closely monitored and supported as they progress through their first year. If the first cohort continue to track well there is the potential to expand the 2020 programme to other equity groups. We are also interested in outreach to younger students in secondary schools to offer advice about subject choice.

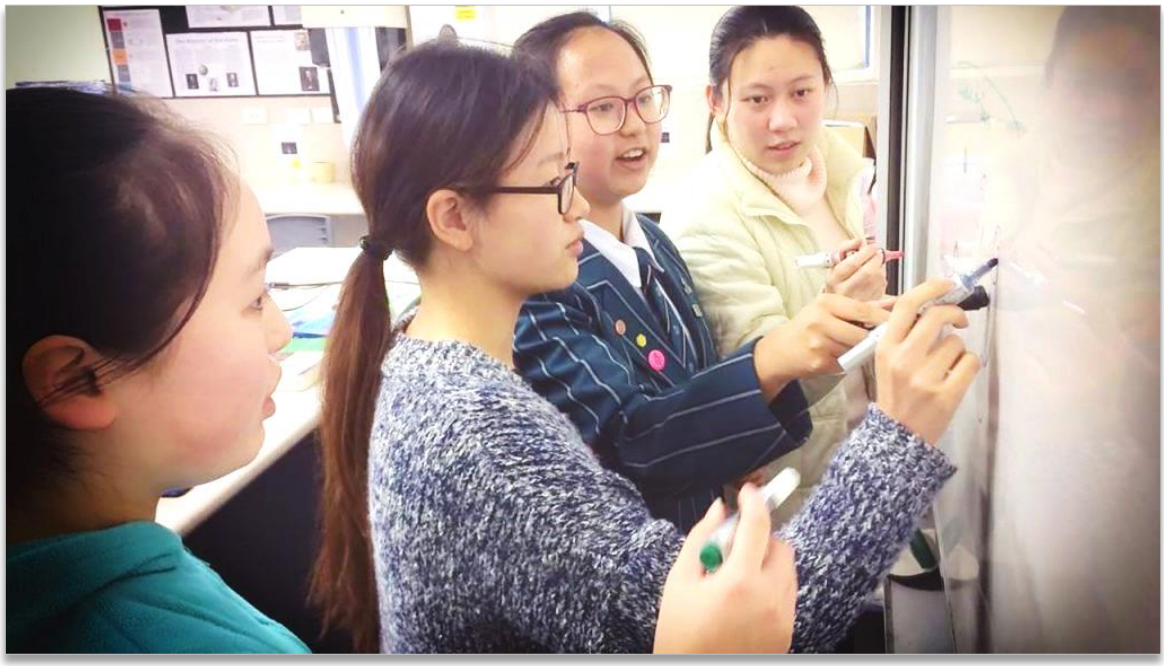
Peter made it all really easy to understand and cared about our learning and improvement
Genesis student survey, 2019

Genesis students (and two of our wonderful support staff)

NZ Engineering Science Competition

Meeting students where they are also encompasses outreach to secondary students. Without a steady flow of capable secondary students who are interested in engineering we will be unable to produce the number of graduates required to grow New Zealand's economy. To this end I help promote secondary student interest in STEM (Science, Technology, Engineering, and Mathematics) subjects through the nationwide NZ Engineering Science competition, which I have run for the last nine years. The competition attracts just under 200 teams of students from schools all over the country, and requires students to devote an entire day to using mathematics to solve the problem posed. Feedback from both students and teachers is that they love the event and the chance it gives students to grapple with real-world mathematical modelling.

> *This competition was a key factor in helping me realise and understand my passion for engineering sciences, and was a major push in encouraging me to pursue this passion.*
> Competition winner, 2018



One of the NZ Engineering Science Competition teams in action

Design and teach for student success

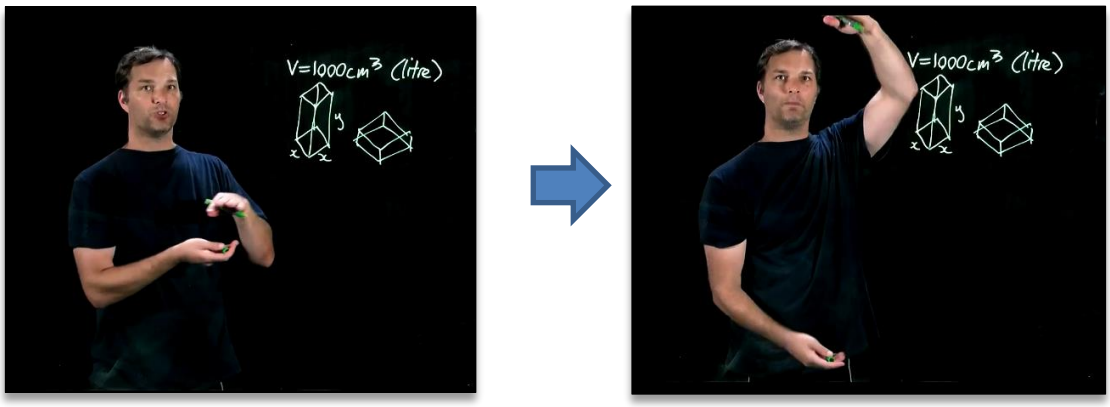
The design of a course, its assessment, and its delivery all have a huge impact on student outcomes. Engaging students is easier when I demonstrate enthusiasm for their learning and passion for the material taught. I design real-world examples and include carefully modelled problem-solving and opportunities for students to practice and reinforce their learning. To ensure that all these elements are working for students I constantly evaluate and review my practice.

Teach with passion

> *Peter Bier's lectures were enthusiastic, interesting and although it may have been the hardest content, it was the easiest to follow as his examples were fully explained and the easiest to understand. It's great to have lecturers that are clearly passionate about what/who they're teaching.*
> ENGSCI 211FC, 2011

I bring dynamism, energy and enthusiasm to my teaching, blending relevant real-world examples, live demonstrations, problem solving, and active learning tasks to create an engaging learning environment. This is of fundamental importance as disengaged students do not learn! Students recognise that I care about **what** I am teaching and, just as importantly, **who** I am teaching.

Teacher enthusiasm is one of the most important factors in motivating students.[1]
I use body language and movement to supplement verbal and written communication.



[1] Edmund J. Sass, "Motivation in the College Classroom: What Students Tell Us", *Teaching of Psychology* 16, no. 2 (1989): 86-88.

Student feedback confirms that enthusiasm, coupled with carefully planned examples and explanations, can help ignite interest in a subject. Energetic lecturing not only engages student interest but helps keep them engaged.

> *… being super engaging and energetic throughout lectures was contagious and made me want to learn, even during topics I was less fond of.*
> *ENGSCI 111AC, 2013*

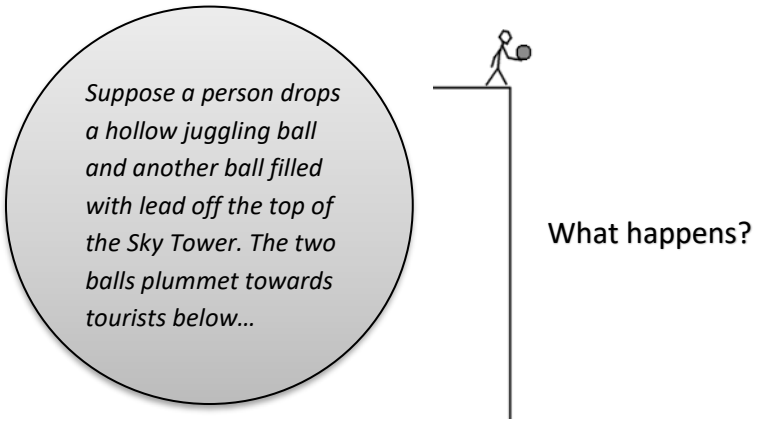
> *… he was enthusiastic about his maths, and teaching. This motivated me to have a deeper interest in mathematics and it helped me to engage myself in more mathematical activities.*
> *ENGSCI 111FC, 2013*

> *Peter made the lectures interesting through his varied cadence and tone, and enthusiasm during lectures.*
> *ENGSCI 211FC, 2017*

Connect to the real world

My teaching is filled with real-world stories, practical examples and live demonstrations. When designing a lesson I begin with clear learning outcomes and then consider what real-life examples would work well within that context to illustrate the concepts students need to understand.

A good story can serve as a great introduction to a problem while also providing the motivation for *why* we care about a particular concept or topic. As Grant explains, people remember stories far better than they do unconnected facts, and those stories provide a hook for knowledge and skills. [2]



[2] Ian Grant, *Communicate: How to speak well in public and private*, Auckland: Random House New Zealand Ltd, 2007.

The scenario above is introduced via props and a story and leads to interesting questions such as 'which ball will hit the ground first?' and 'will either of them injure someone if they hit them on the head?' Students discuss this problem in small groups which is effective for engaging students even in very large classes, and works far better than ploughing straight into the equations of projectile motion.

Only a minority of students correctly identify that the heavier ball hits first, with even fewer being able to adequately explain why. As the students discover, our intuitive guess often proves incorrect – demonstrating the need for the equations.

Topics were covered in depth with good examples of practical situations.
MATHS 153FC, 2008

He teaches relating to the real world all the time, making the learning interesting and attention grabbing.
ENGSCI 111FC, 2018

A lesson on how to represent data graphically becomes much more engaging with a video of the space shuttle Challenger exploding. As I go on to explain, the NASA engineers had compelling data to recommend against launching that fateful morning - but the graphical representation of that data was poor. Students realise the skills being taught could avert disaster.

The space shuttle Challenger exploding

I liked the explanations of how developing good practices can be essential in the real world, such as the example of how the Challenger disaster might have been prevented through better communication of data.
ENGGEN 131SC, 2016

As a student I found live demonstrations were an incredibly powerful teaching tool that created memorable learning experiences. Twenty years on I can still remember those lectures delivered to me that relied on live demonstrations and perhaps more importantly, the concept the lecturer was trying to teach. This has inspired me to incorporate frequent demonstrations into my own teaching.

Using props to bring alive abstract mathematical concepts is a key part of my teaching

I have found that student attention typically increases within the first ten minutes of a lecture and decreases after that point. In order to help students engage for the full length of the class I introduce live demonstrations as breaks from working through problems.

Much of what I teach involves the mathematics of motion, which can be aptly illustrated with juggling. Modelling rotation becomes a much more interesting topic if you are juggling machetes and point out the risks involved in miscalculation. If discussing the calculation of slopes on a three dimensional surface I will move around the theatre, asking people to think about what slope I am experiencing as I climb the stairs. When discussing volume calculations using double integrals I'll use an umbrella to demonstrate an enclosed volume.

> *… running around with an umbrella over his head means I'll never forget the concept of double integrals*
> ENGSCI 211FC, 2015

A mid-lecture break

Peter Bier was great at keeping the attention of the class …he kept morale high throughout the entire lecture and as a result I learnt an awful lot from him.
ENGSCI 211FC, 2008

The use of real life demonstrations or incorporating real life examples into questions helped students visualise the situation presented in the question.
ENGSCI 111FC, 2018

Model problem solving

Modelling problem solving using relevant examples and clear explanations is an essential feature of my teaching. I spend time working through example problems from the course manual that I have crafted carefully, following the principles of constructive alignment. I review and redesign these problems frequently to ensure their continued relevance.

For example, students in ENGSCI 111 have historically found the module on *modelling with uncertainty* far more difficult to pick up than the calculus material, and this was reflected in poor exam performance. To combat this I reshaped the module using the systematic approach outlined by D'Andrea[3].

This entailed detailed planning of learning outcomes and redesign of the module and assessments for alignment. While the same kinds of real-world uncertainty problems still featured in the assessments, I modelled solving them in a completely different way in class, using more intuitive problem-solving methods, as indicated by research.[4] Students were better able to follow this modelling and significant performance gains were made in the final exam; the average mark for the uncertainty question increased from 6.1/20 in 2012 to 15/20 in 201).

Modelling must be rooted in real-world application and as close as possible to how students will actually experience problem solving. While a polished PowerPoint is great for presenting bullet points, engineers do not solve problems by writing PowerPoint slides. To this end, much of my modelling used in class is in the form of 'messy' working, with hand drawn equations and diagrams.

When working problems by hand, mistakes invariably occur. I used to fear making mistakes in front of a class but have come to understand that they present a wonderful learning opportunity. If I make a mistake (planned or not) I ask students to locate it – and as a class we go through techniques for identifying and correcting errors.

Using a tablet allows projection of handwritten material in class

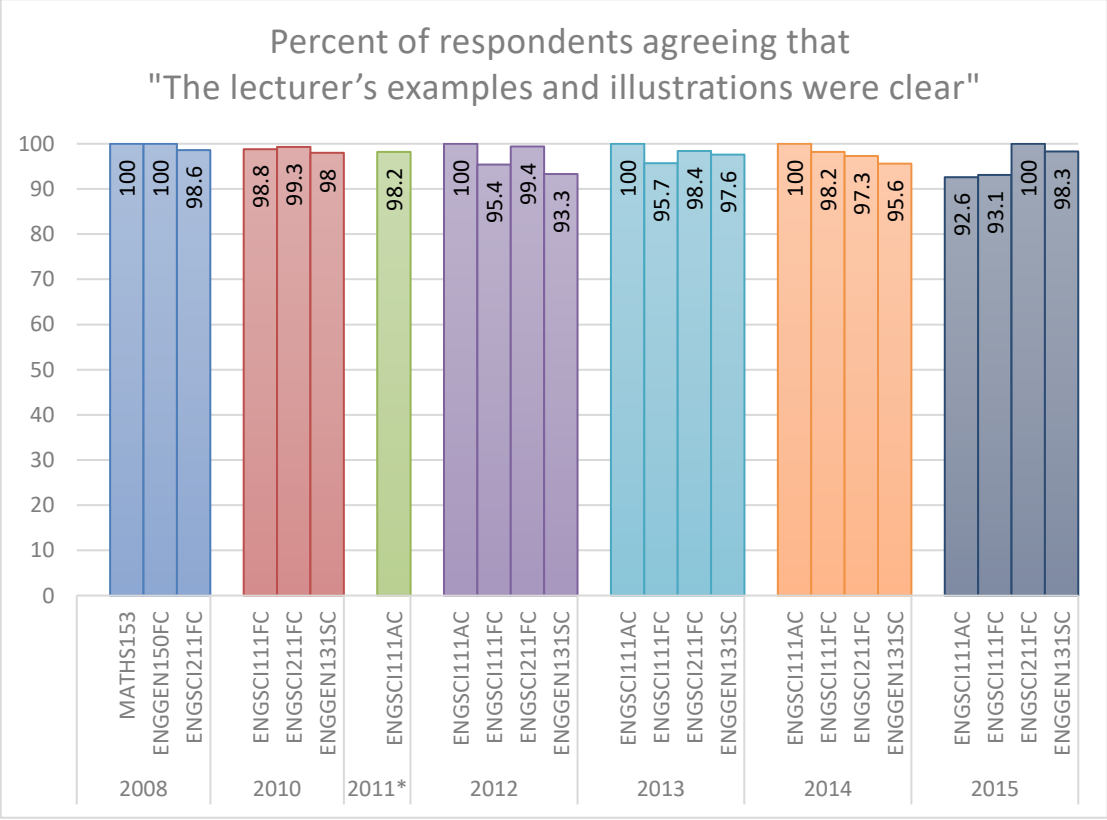
[3] Vaneeta D'Andrea, Organising teaching and learning: outcomes-based planning, in *A Handbook on Teaching and Learning in Higher Education: Enhancing academic practice*, London, Kogan Page, 2003.

[4] Gerd Gigerenzer, *Reckoning with Risk: Learning to live with uncertainty*, London, Penguin Books Ltd, 2003.

… explaining almost every step of his working AS he worked it out showed the thought processes and made it really clear how to figure out a problem and solve it properly.
ENGSCI 111FC, 2011

You take the time to explain things clearly and slowly enough so that I understand and give plenty of examples that we can look at and go through later to get more used to the processes.
ENGSCI 211FC, 2010

He explains the material from the ground up and writes everything in the tablet instead of just speaking off from a powerpoint…being able to see the mathematical process step by step helped my learning and my final grade reflected the latter.
ENGSCI 111AC, 2014

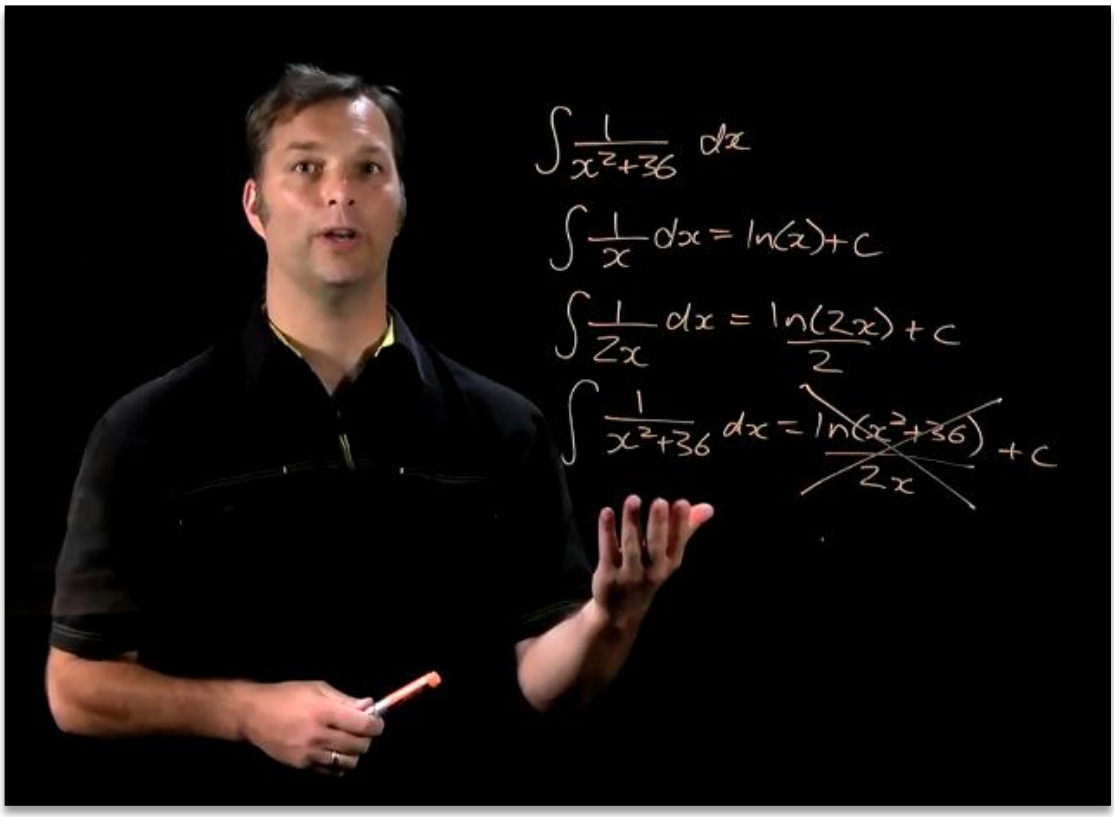


Data for this question is not available post-2015 due to changes to the University's evaluation system

Enable self-paced student review – recognising diverse learning styles

Working a problem live in a lecture is beneficial to many, but it can prove difficult to follow for those who have English as a second language and others who simply require more time to digest the material. Lecture recordings address these issues by enabling students to review at their pace, any points they do not understand. Building on my early adoption of lecture recording, I have started developing supplementary video material to model problem solving beyond the lecture theatre. Typically 10 to 15 minutes in length, these videos are overviews of important concepts and are popular with students.

The additional recordings put up on the knowledge map were SO useful. Easy to learn from and also handy to refer back to without having to rewatch an entire lecture.
ENGSCI 211FC, 2015



Screenshot from a supplementary recording – illustrating a common misconception

Provide opportunities to practise, practise, practise

For students to develop conceptual understanding and the ability to apply problem-solving skills in the real world they must practise these skills. Active practice, spaced out with time between practice sessions, is one of the key strategies that can be used to 'make things stick.'[5]

In lectures I ensure students have that opportunity by using active learning exercises. I get students to work on problems individually and also encourage group discussion. Outside of lectures I use carefully designed weekly formative activities such as assignments, labs, quizzes, tests and tutorials to encourage regular practice. Busy students will often work strategically, only attempting tasks that count towards their final grade. To motivate practice I include a small weighted assessment task, or a tie-in to preparing for test questions. Given that students tend to focus on assessed material, assessments must align with course learning objectives. Feedback on both formative and summative assessment is key so that students may understand their progress and improve their learning.

I liked how the tutorial sheets had questions related to what we learned in the week.
ENGSCI 111FC, 2010

The assignment seemed to be a good representation of what we had learned so far & really let me know what I was good at & what I needed more study.
ENGSCI 111FC, 2010

The weekly quizzes were very helpful in term of testing my learning/understanding of the content delivered in that week. But also it helps in term of preparation for tests and exams.
ENGSCI 111FC, 2016

Assignments as practice

Well-designed assignments can provide an excellent opportunity to practise skills but they need to be accompanied by fast feedback so that students can address gaps in their knowledge and skills. Motivated by the desire to reduce turnaround time to students, in 2015 I trialled the software CrowdMark for online submission and marking of assignments. Although adopting CrowdMark had many benefits in terms of

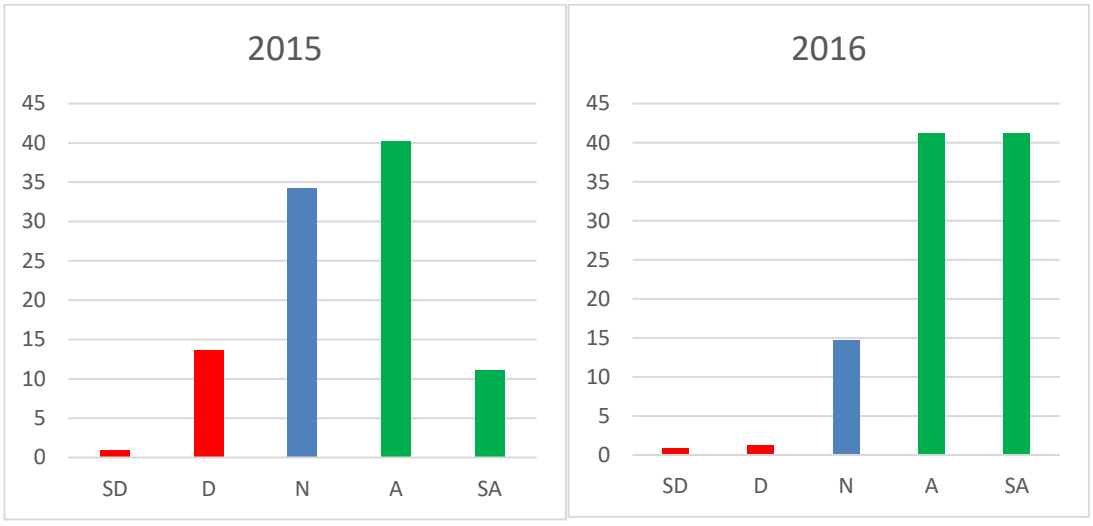
[5] Peter C. Brown, Henry L. Roediger III, & Mark A. McDaniel, *Make It Stick: The science of successful learning*, Cambridge MA, Harvard University Press, 2014.

improved efficiencies and consistency, it failed to significantly reduce marking time. Course evaluation results suggested students felt they were not getting useful feedback on their learning.

We still wanted students to engage in the important practice these assignments provided, but needed to improve feedback time. This inspired me to create weekly worksheets that were assessed via an associated online quiz. Students completed the problems, but rather than the worksheets being hand-marked we then tested their learning through a carefully crafted quiz. I shared my experience of this strategy with others as part of a learning and teaching Fellowship with the University's Centre for Learning and Research in Higher Education (CLeaR). Feedback is received as soon as the quiz is completed, so students can fix misconceptions early before moving on to other areas.

> *… online quizzes were definitely the most helpful resource! Having the availability to such quick feedback turn around has definitely helped me stay on top of understanding ideas and keeping it stored for tests.*
> *ENGSCI 111FC, 2016*

Student feedback on the course evaluation question about helpful feedback on learning dramatically improved:



In addition we saw a significant improvement in student performance on their final grades; the percentage of A grades doubled while the percentage of failing grades halved.

Be a force for changing teaching practice

I continuously reflect on and work to improve my teaching practice. Part of this process is learning from others and sharing the initiatives and techniques that have worked well for my students.

In 2011 I enrolled in the University's Postgraduate Certificate in Academic Practice which was an opportunity to learn from the teaching staff and other students, and share my ideas. As a result of completing the Certificate, I now include more active learning exercises in my lectures and was inspired to introduce group project work into my summer school teaching.

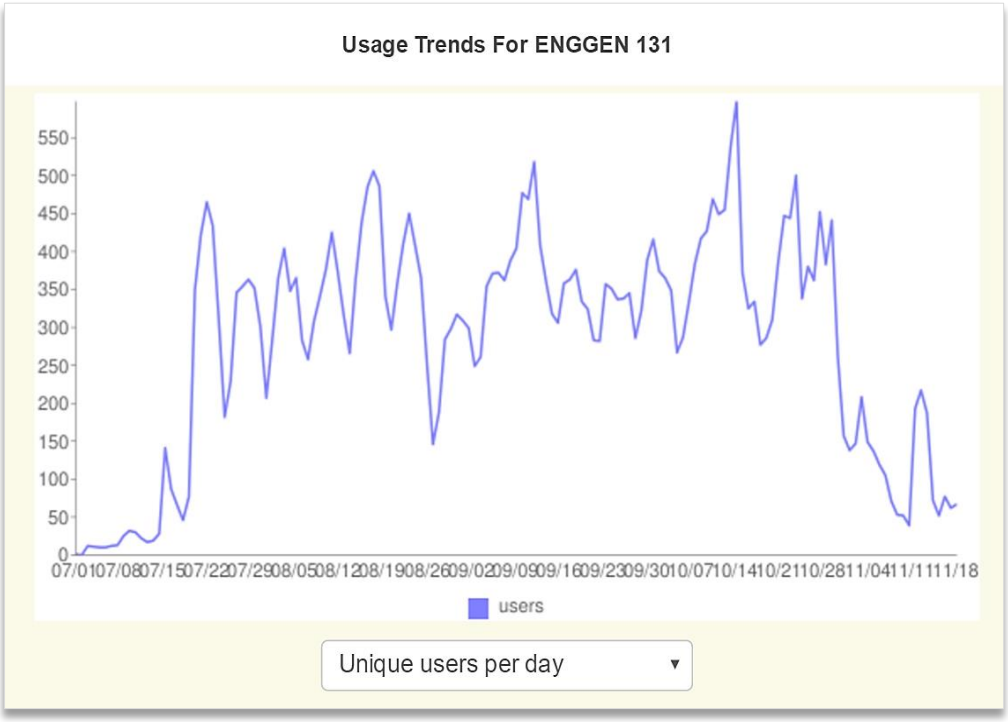
Teaching innovation

Reflection leads to innovation, as problems are identified and solutions sought. I have always tried to improve my teaching in order to enable my students to become more successful learners. I still actively share my older innovations with colleagues as they are new ideas to many.

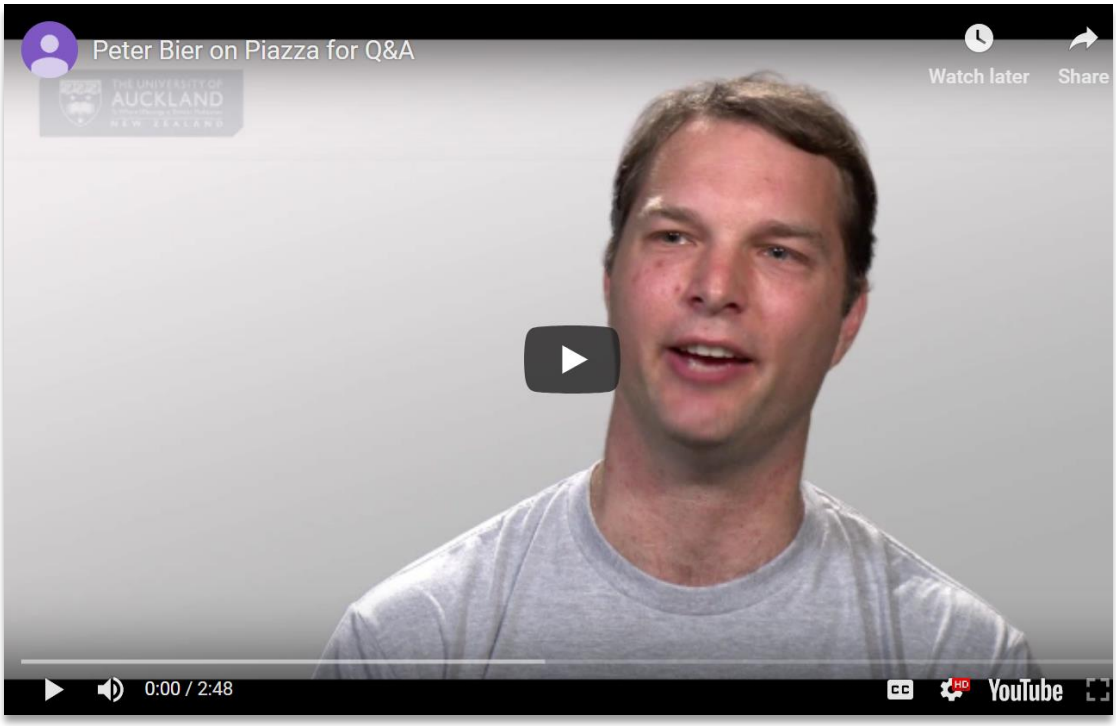
Fast answers to student questions

I wanted students to be able to get fast feedback on the inevitable questions that arise from practising, so I turned to forum software. In 2011 I was one of the first New Zealanders to trial Piazza, a software tool dedicated to running class fora. Piazza has proven incredibly effective with the average response time for a query less than the round trip walk from the library to my office. I answered over 100 queries in the space a few days when I launched the ENGSCI 111 Piazza page. Other students can answer forum queries and I approve their answers, creating a collaborative learning environment. Piazza provides an excellent way to understand the concepts with which students struggle.

In the years since adopting Piazza, my advocacy for it as a useful teaching tool has helped its usage grow dramatically. It is now integrated with Canvas, the University's learning management system, and used in over 160 courses across the University.



This Piazza screenshot shows that the number of daily users on the ENGGEN 131 forum ranges from around 200 to 500 unique students.



Screenshot of an Education Technology Hub video, created to help staff learn about the benefits of Piazza.

Group projects on a tight timeframe

Group projects give students the opportunity to practise large-scale, more complex problems and evaluate their solutions. However, they can be challenging to incorporate in the tight timeframe of summer school courses.

In summer school of 2012 I trialled a day-long group project. Students worked together in teams of four to produce a report that answered an open-ended mathematical modelling question presented on the morning of the day (e.g. 'How deep underwater do you have to dive to be safe from gunfire?' - a scenario familiar to any viewer of action movies).

I collected student feedback and the results of this research were presented at the Australasian Association of Engineering Education conference (2012). The initiative proved successful and in each year since I have worked to improve aspects of the assessment, developing a comprehensive set of resources and more recently requiring students to write self-reflections at key points during the project day. Historically, around 10% of the ENGSCI 111AC class failed. Following the introduction of this initiative I have had only one student fail across the six instances of the course I taught.

Influencing change in teaching practice

I am recognised by the University and wider education community as an advocate for the development of good teaching practices. This has resulted in numerous opportunities to present at training sessions, workshops and conferences, as well as helping steer the direction of education as a member of various working groups and committees. A small selection of these are presented in the timeline overleaf.

A selection of influence milestones from the last decade

2009
- First presented at NZ Association of Mathematics Teachers' conference
- Joined the Australasian Association of Engineering Education (A^2E^2)

2010
- YouTube footage of one of my in-class demos uploaded, it goes on to receive over 35,000 views
- Began running the NZ Engineering Science competition

2011
- Helped organise Delta, the Southern Hemisphere mathematics education conference

2012
- Delivered an interactive keynote at Delta
- Presented at A^2E^2

2013
- Appointed Faculty Learning Management System (LMS) Champion, to help manage the transition to our new LMS
- Joined the NZ Mathematical Society (NZMS) Education Committee to advocate for mathematics education in NZ

2014
- Joined Faculty Teaching Transformation Group

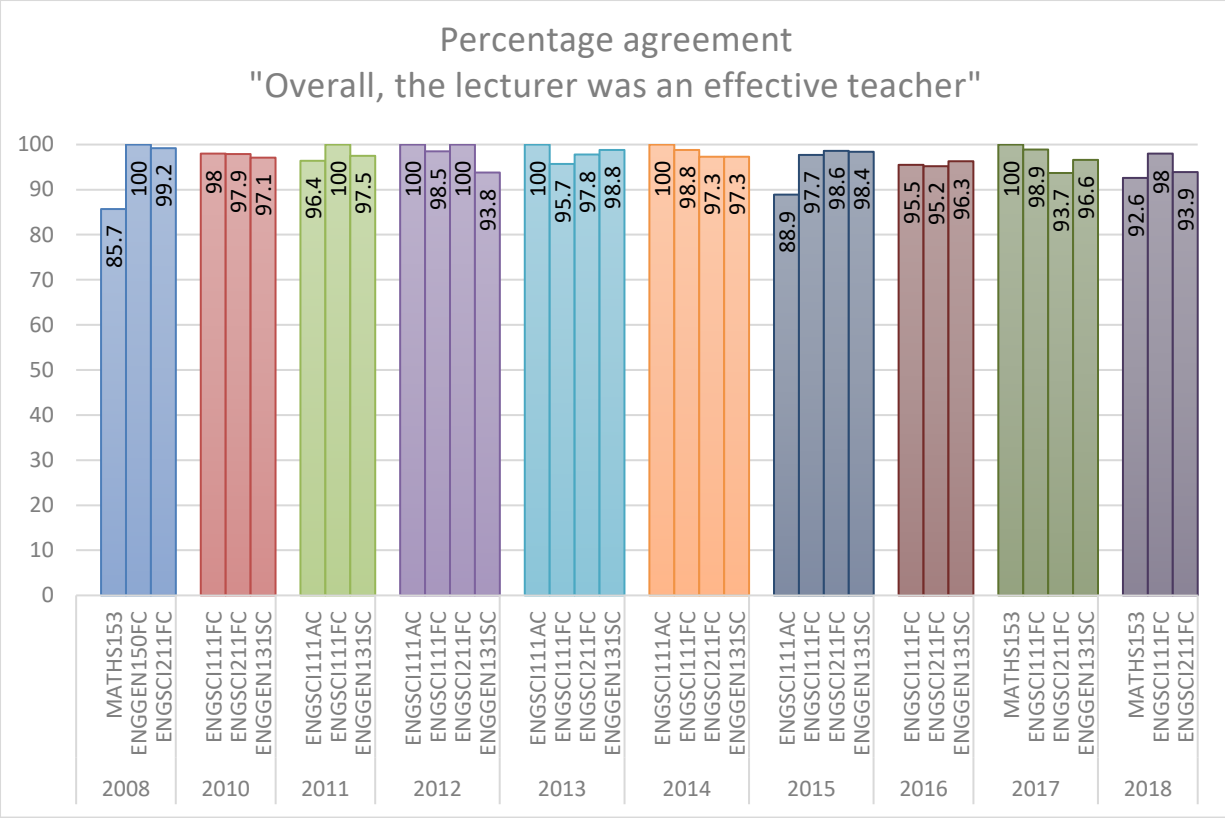
2015
- Teaching featured in NZHerald and on TVNZ's Seven Sharp
- Worked as a CLeaR Fellow, with a focus on e-learning initiatives. Multiple presentations across different faculties.

2016
- Joined University Assessment Working Group, to help draft new assessment policies and procedures
- Joined the Education Technology Hub project, working towards an online repository of teaching technology tools

2017
- First presented at NZMS conference education day

2018
- Joined University Teaching and Learning Quality Committee (TLQC)
- Appointed Faculty of Engineering Associate Dean Teaching and Learning

Evidence of teaching effectiveness



Faculty of Engineering Top Teacher award	2008
(awarded to the top teachers as determined by student votes)	2009
	2010
	2013
	2014
	2016
Faculty of Engineering Early Career Teaching Excellence Award	2011
University of Auckland Early Career Teaching Excellence Award	2011
Auckland University Engineering Association Teaching Excellence Award	2013
Faculty of Engineering Teaching Portfolio Development Award	2015
	2016
Faculty of Engineering Sustained Teaching Excellence Award	2017

Future Directions

I thoroughly enjoyed working closely with Māori and Pasifika students as part of the Genesis programme and saw first-hand the impact that can made by coupling the teaching of study and life skills with dynamic presentation of technical content. I'm keen to expand this model to other groups of students, with a particular focus on other equity groups, such as women in engineering.

To continue to be dynamic I must explore new ways to improve my teaching. In 2017 I enrolled in an advanced stage one physics course to experience a flipped-classroom environment, learning alongside other students. I gained a deeper understanding of the pressures my students face and the strategies they use to cope. I am looking forward to incorporating more principles from the flipped-classroom model into my own teaching and continuing to foster teacher excellence in other educators, as my influence broadens.

I leave the last word to my students:

> *His very evident interest in what he teaches motivates you to learn. The way he approached the class and the course was inspiring.*
> *ENGSCI 111 FC, 2013*

> *Peter is brilliant at explaining things, and it really shows in his lectures. It is often very easy to grasp the more difficult content of the parts of the course which Peter teaches, purely because of the level of detail he goes into when covering relevant examples pertaining to the theory.*
> *ENGSCI 111 FC, 2018*

Peter Bier's teaching technique is outstanding, by far one of the best lecturers I have had. He gives us a clear understanding of what is expected of us in the most effective manner.
ENGSCI 211 FC, 2011

Best lecturer I have had ever. Peter clearly explained everything to do with the content, what is required, why, he emphasised all the critical points and made the lectures interesting and fun.
ENGSCI 111 FC, 2014