Marcus Wilson. Student ID 1143457

PROF531-11B  Tertiary Teaching: Research and Development

Personal Portfolio

Note: This portfolio is based heavily on the portfolio entered for the University of Waikato Teaching Awards in October 2010.
Introduction

I commenced my formal teaching journey in 2004, although I had had plenty of exposure to teaching as a student. As a post-doctoral worker, who had spent a semester in the university system as a researcher, I was asked to teach a third-year physics paper. I was duly furnished with the previous lecturer’s notes, shown what the timetable was, and left to it. No indication of learning outcomes, no guidance on how to write decent assessments, no knowledge of teaching strategies – and not the slightest idea that there was even help available for such things – I was just expected to teach, and so I did. Since then I have come to realize that the ability of an individual to teach should not be assumed; rather it needs developing through practice and guided study.
As I look back on that initial experience, I can see I wasn’t entirely in the dark. I had already begun to apply some critical analysis to my teaching. I quickly grasped that lecturing from someone-else’s notes was not the way to go, but, being focused on the need to teach the ‘curriculum’ (which as far as I knew was the lecturer’s notes), I didn’t have the confidence to deviate from them. In fact, being able to do that, took a couple of years. Then there were the assessments. The previous lecturer had supplied me with the assignments from the last few years, and the exam questions, but to me they didn’t look as if they were assessing the appropriate things. I had a go at re-writing the assignments to assess what I thought the students should be learning (though sticking rigidly to the curriculum). I didn’t know it, but I was already thinking about what the learning outcomes should be and how assessments could play a role in encouraging students to meet them; however, I was not yet in a position to start applying my insights in a systematic way.

Furthermore, I did not yet have the confidence to change the way that papers were taught. There was some irony here – I have been very keen on communicating science to the general public, and have happily taken on organization of public events such as ‘Café Scientifique’ where science is discussed in non-specialist language in a café environment. Also, with schools, I was eager right from the outset of my time at The University of Waikato to contribute to outreach events such as the Osborne Physics Days; as part of this I’ve put together entertaining talks full of unconventional demonstrations. Yet, when it came to university teaching, my false perceptions of the constraints on me prevented me from following my natural instincts. I still clung the idea that university lectures had to be done in a particular manner (the way I was taught); with the ‘curriculum’ being of primary importance. I was slow to grasp the fact that it doesn’t have to be this way.

Suitably enlightened, thanks to numerous sessions with the Teaching Development Unit (TDU), conversations with colleagues, and my own background reading, I now see teaching as something less restrictive. Whatever the subject, I am free to guide the students to do things that help them learn. That has opened up a range of possibilities, such as planning innovative assessments (e.g. presentations, posters, student-designed experiments), focusing a lecture session around a formative assessment task and encouraging conversation about learning. I’ve now jumped into the role of ‘teaching advocate’ for the Faculty of Science and Engineering and am enthusiastically undertaking the Postgraduate Certificate in Tertiary Teaching (PGCert).

**Design for learning**

My experience has shown that good papers don’t just happen – they need careful consideration and planning. My most significant paper is 2nd year ‘Experimental Physics’, PHYS204 for which I
have been the sole teacher since 2005. At the end of 2008, I undertook a major review of this paper, involving people external to the university and students who had undertaken the paper. The paper as I had inherited it was old (dating from around 1993), though it clearly had been tweaked since its inception. Pulling it apart and rebuilding it, starting with the learning outcomes, was a major effort. For example, the aim of the paper is to give students a reasonable ability to do experimental physics work, in a broad context. This paper is about what the students can do experimentally, rather than specific content, and the outcomes now reflect this - the first learning outcome is now ‘The students who successfully complete this paper will be able to plan, carry out, and document experiments’.

“I think the course [PHYS204] provides a very good foundation for a second year experimental physics.”
Gideon Gouws, Lecturer in Physics, Victoria University of Wellington

“The experiments were well set-up and worked well.”
A 2009 student on the Experimental Physics PHYS204 appraisal form

“Thanks, I learned heaps today.”
A 2011 student, at the end of a laboratory session in PHYS204

Moreover, in 2010 have changed further some of the PHYS204 assessments as part of my PGCert work. In the new approach, students are left to design experiments themselves, rather than follow a traditional ‘cookbook’ in which detailed instructions are given. This directly addresses a learning outcome indicating that students should be able to plan experiments. It gives more freedom to the student to take the initiative. The ability for a student to drive his or her learning is a key principle that I now try to build upon in my papers. Initial results suggest that students do engage more deeply with the experiment, and I await with interest the more detailed results at the end of the semester.

A further example taken from the paper on Computer Aided Engineering, ENEL503. Here, I designed and teach half the paper, looking at electromagnetic effects, drawing heavily from my time in industry when I used these skills. The key point here is that there are many different techniques available in industry, and we cannot teach them all in detail, but a student arriving in industry should be able to come to a conclusion about the best way to solve a particular
problem. With this in mind a learning outcome is ‘A successful student should be able to recognize the major modelling techniques when they come across them in industry’, and an associated assignment has the students looking at the scientific literature and identifying specific examples of different modelling approaches and commenting on why the approach is (or isn’t) well suited to the problem.

Sometimes small changes can be productive. After two years of teaching PHYS301 Biophysics, with student feedback to draw from, I felt that there was simply too much in the paper. Students were struggling because they didn’t have time to grasp biological applications of physics that were new to them. In 2007 I introduced two simple introductory lectures at the start of the paper (dropping other material) which has made the course more accessible.

Not all students fit the same mold. I have been continually challenged by my first year classes, which contain a wide array of students from different schools and backgrounds. I have found that the use of formative assessment strategies, such as quick multiple-choice questions, really helps in determining what students grasp and what works for them.

Physics and engineering students as a whole tend to be introverted and not keen to talk; however, they will answer multiple choice questions in class. Moreover, I have learned that Chinese students are extremely reluctant to speak in class – either to myself or to other students. However, that does not mean they are not engaged with the class – they will frequently come to see me one-to-one. Being approachable is absolutely necessary to help here.

I also recognize that engineering students (as a group) think differently to physics students – the former being the more focused on applying formulae to problems, the latter having a deeper level of enquiry into the subject (Gire et al., 2009). As a physicist myself, teaching a physics class with both groups of students, there is a strong temptation to neglect the needs of the engineering cohort. For example, in my teaching of a dynamics paper (ENME351) in 2011, I used physics terminology rather than engineering terminology for several weeks, which possibly confused students, until being corrected by another staff member. Being part of the School of Engineering helps me here to recognize what the specific needs of the engineering students are. Well defined learning outcomes relevant for engineers, gives me direction in my teaching here. An example is from my Solid State physics teaching (ENEL285) in which an outcome is targeted at electronic engineering students – ‘Students who successfully complete this paper should be able ... to explain qualitatively the key electronic properties of semiconductors (including pn junctions).’ In 2009 I introduced an assessment in which the students presented a poster on pn junction diodes; a task rather more relevant to the engineer than the physicist.
An unusual experience has been teaching a man in his seventies. This proved challenging – he was learning for his own interest and not interested in landing a degree *per se* – so the traditional lecture and assessment style did not motivate him at all. He found a directed study paper enlightening as it gave him freedom to explore the avenues he wanted to follow.

One of the most inclusive strategies I have found is to be approachable – no matter who the student is or what their preferred method of learning is, I try to make myself readily available to discuss their learning with them.

“*Marcus always has time for his students... Every Thursday afternoon, I can go to that lab expecting that if there is anything that I don’t understand Marcus will thoroughly explain it.*”  
Anonymous comment on University of Waikato Teaching Award nomination

“*He is very co-operative...*”  
Anonymous comment on University of Waikato Teaching Award nomination

*Using a PHYS301 Biophysics experiment which I designed (drawing from literature) to teach students about dimensional analysis in physics*
Facilitating learning

In the last two years I have begun to use a variety of methods to help students learn. I have been strongly motivated by the work of Wieman (2005) and Mazur (1997), who shockingly demonstrated that an average physics lecture achieves nothing by way of student learning. Rather, physics students learn best from each other.

I have tried to exploit this in my teaching. My tutorials are now focused on having students discuss and explain ideas to each other (peer instruction). In 2010 and 2011, I have structured parts of my lectures like this as part of my PGCert (Tertiary Teaching) work. This showed a good improvement in appraisal score for Solid-State Physics, ENEL285 (rising from 1.6 to 1.1), which has been the paper for which I have usually had the poorest scores. I have also introduced assessments that are not the traditional pen-and-paper style. In Solid State physics I now require the students in small groups to put together a poster about a specified electronic component; this gives freedom to them to explore the concepts in their own preferred manners. In Biophysics, PHYS301, I ask the students to give a presentation as an assignment. This is a new thing to most physics students, and doesn’t come naturally to many, but is a skill that they need to learn.

Relevant examples can help students grasp concepts. In the Electromagnetic Waves class (ENEL312) in 2010, I illustrated used a mobile phone in salty water to illustrate the fact that conductors absorb electromagnetic energy. However, this illustration went beyond a demonstration – the preceding week I asked the class to estimate just how much water and salt would be needed to shield the phone. This enabled them to try out their learning from this paper, and assess for themselves how good that learning was. I recorded this example on my blog; this led to it being reported in the Waikato Times.

Mathematics plays a key role in the expression of physics; in a sense, mathematics is the language of physics. However, I have found that it can get in the way of student understanding. Students can easily fall into the trap of thinking that solving equations is what physics is about. Tuminaro and Redish (2007) provide an excellent discussion of this phenomenon. Unfortunately many physics courses at school and university, including some of mine, strengthen this perception. I am now much more conscious of this issue, and actively try to play down (but not necessarily remove) the mathematics.

“I … think your emphasis on the physics rather than the math that describes it approach is really good, my problem solving approach has changed from wondering what equations I have at my disposal to what’s actually going on.”

3rd year physics student, 2010
I try to adopt an informal style of teaching. This is both to allow students to feel comfortable and to mirror the practices that they are likely to find in the workplace. Students need to feel comfortable with asking questions and challenging what I say. My Teaching sessions are now as much driven by the students as they are by me.

“One thing I’m noticing as I sit in these labs is that students seem very relaxed. There is no obvious tension, either between them and you, or between members of a team. They seem to approach the labs as a developmental process, being prepared both to challenge and to be challenged without any rancor.”

Pip Bruce Ferguson, Teaching Developer, University of Waikato

“I’ve had Marcus for three papers so far and I’ve enjoyed all of them. He has a really good teaching style.”

Anonymous comment on University of Waikato Teaching Award nomination

Changing the way classes are taught can be uncomfortable to students, particularly the introverted male stereotype of the physics and engineering class. I have found that explaining why the changes are there has been empowering; instead of hiding out of fright and responding with a wall of silence and inactivity, as has happened in the past, students feel more comfortable engaging with something new. By demonstrating that I am taking risks in trying new approaches, a student can feel that it is safer for them to take a risk too. I can thank my TDU colleagues for bringing that to my attention. Students appear to appreciate the opportunity to discuss learning theory.

“Your genuine and innovative ambition to improve the learning of your students has made this paper equally challenging and exciting. More specifically your obvious willingness to constructively experiment with modern cognitive strategies (e.g. student orchestrated experiments) is a quality that I feel appropriately separates teaching competence from excellence.”

3rd year physics student

Finally, I try to instill in a class a sense that they can be “sources of solutions” to their own problems (Turpen & Finkelstein, 2009). One student can help another student. This encourages students to engage more deeply with an area of learning, rather than simply turning to me when they think they need help.
When students encounter a problem, they are never simply told how to fix it. Instead, ... they are given just enough assistance to find their own solution to the problem.”

1st year physics student.

Assessing student learning

Assessment I see as the key to learning, and therefore drives how we teach. It cannot be separated from course design. It is intensely motivating to students, whether they wish to beat their peers, please other people, demonstrate their own learning, or simply to pass (Biggs & Tang, 2007). Assessment tasks that are aligned to the learning outcomes, supported by appropriate teaching strategies, will maximize the chances of students learning what we wish them to.

As I have developed as a teacher, I have given assessment a greater priority. My exam questions and assignment tasks are now prepared before a semester’s teaching commences, rather than being quickly written in an *ad hoc* manner to meet the most pressing deadline. With these in place, I can teach to the assessments, knowing that by doing so I am teaching to the intended outcomes. An example is from the Experimental Physics paper, where a learning outcome is ‘A successful student will be able to plan an experiment’. Planning an experiment has proven hard to teach in lectures or even in the laboratory; however, what has worked is giving the students opportunities to do planning in the lab, by not providing them detailed instructions. I now use such experiments as assessment tasks. Previous work on this suggests that students spend more time in sense-making tasks, conducive to physics learning (Karelina & Etkina, 2007), and my experience supports this.

“*[The assignment] showed me how much I have learnt about experimental practices from this course.*”

3rd year student in 2010, talking about his second year experimental physics PHYS204 in 2009

“They give you freedom. You have to think about it and decide what’s important. You learn more by doing it.”

2nd year experimental physics PHYS204 student, talking about experiments that he is required to plan himself
Also, as part of my PGCert work, I have looked at formative assessments. I have used multiple choice questions at the start of a lecture (be it first, second or third year) to tease out the manner in which students think about a problem. This enables me to guide my teaching appropriately, and also helps my students know if they are meeting their objectives and helps them to learn.

“Keep the multiple choice questions – they really help”

2nd year student in 2010 on Solid State Physics ENEL285 appraisal form

A further aspect of assessment is the giving of feedback. I have found that giving feedback at the time of the assessment is very valuable. With many assessments I now return them to students during laboratory sessions, where I can spend time talking to the individual student about the work; or even marking the assessment with the student during the laboratory session.

Within the School of Engineering, where physics lies, there is not a formal procedure for the review of physics assessments. However, assessments for the core engineering papers are reviewed periodically by the Institute of Professional Engineers New Zealand. This input from professional engineers is extremely valuable in ensuring the papers are focused towards the needs of the profession. With no such review in physics, I am eager to talk about ideas for assessments within the school whenever possible – for example in the staff tearoom or on my blog.

Evaluating learning and teaching

Talking about my teaching is a great way to ensure that it improves. I often put up my thoughts about teaching on my blog ‘PhysicsStop’. Although this isn’t specifically a teaching-related blog, it is a good place to offer up my opinions and invite comment. I have also contributed to a blog ‘Talking Teaching’, co-authored with Alison Campbell (University of Waikato) and Fabiana Kubke (University of Auckland). The blog gives me chance to reflect and formulate my own thoughts. Posting experiences and opinions for all to see is a scary experience, but feedback is almost always valuable.

Frequently (& publicly – on his blog!) reflects on his own teaching & on ways to improve it.

Anonymous comment on University of Waikato Teaching Award nomination
A good example is my reflection after a difficult first-year tutorial. My major theme was that first year teaching is more difficult (for me) than third year teaching because of the gap between my understanding and the students’ is larger\(^1\). The comments have helped me think on what I do carry out well, and where specifically issues might lie. Generally, I have found those who comment on the blog posts tend to do so very constructively and give useful encouragement and advice.

I try to take the class appraisal forms beyond just the use of the standard university-wide Likert questions. These, on their own, I find not particularly helpful. I usually add my own questions to the list, particularly if I have been trying something out in class, to ascertain what my students thought. Reading free responses is useful too, and I take time to analyze these and draw out the main themes. These have fed into course re-design – e.g. the review of the Experimental Physics paper which was viewed by students as containing too much and being too difficult.

I have engaged substantially with TDU during my time at Waikato, and have always found them very helpful. I have much appreciated the many workshops that have been run.

Asking for feedback from physics-teaching colleagues is something that I’ve never found easy to do, though I’ve greatly appreciated it when it happens. I had my first ‘formal’ classroom observation in 2010. This I found useful in highlighting things I do well, such as developing a good atmosphere and relationship with the students. Also, it drew my attention to some of the advantages and disadvantages of my practices. For example, marking students work in a lab session with the student allows the student to benefit from one-to-one feedback and teaching, but it also may be too open and uncomfortable a situation for them.

I’ve had plenty of informal feedback from colleagues who have heard and seen me teach, particularly for non-tertiary events such as visits from school groups. My blog also supplies me with feedback from teachers at other institutions. This is something I reflect on.

I have been proactive also in seeking external comment on the papers I teach – I have had the Experimental Physics paper reviewed externally in 2008.

Despite my best intentions, things can go spectacularly wrong sometimes, and I have recently learnt from that. An example is from 2009, when I was asked to cover a 3\(^{rd}\) year engineering paper (ENME352) for a colleague on study leave. This was not a subject area I was greatly familiar with; nor had I taught most of the students before. I should have known better, but I lapsed into teaching from my colleague’s notes, some of which I could not follow myself. The resulting mess earned me my first ‘two point something’ score for teacher effectiveness, a

\(^{1}\) http://sciblogs.co.nz/physics-stop/2010/07/21/aaaarrrrh-first-year/#comments
paper-satisfaction score of 2.7 (very poor indeed) and some cutting comments on the appraisals. When I was asked in 2010 to cover for an absent colleague, my intended approach was very different – giving much more responsibility to the students to find and present information to each other – however, another colleague jumped in to take the course and I didn’t get chance to try out this strategy. In 2011, I again covered part of a paper for an absent colleague, and I was much more flexible in my approach to teaching.

**Professional development and leadership**

After being a keen attendee at a variety of TDU sessions since joining the university, I finally enrolled in a Postgraduate Certificate in Tertiary Teaching in 2010. This has encouraged me to try out new teaching initiatives, evaluate them systematically, and to reflect on my teaching experiences. In December 2010, I presented work undertaken in my PGCert to the Australian Institute of Physics Congress. Research into the teaching of physics marks a new and exciting research path for me.

I am an active participant in the University of Waikato teaching network. Being able to discuss ideas and experiences across subject areas is valuable. I provided an article on formative assessment to the TDU Talk magazine in June 2010 (Wilson, 2010). This drew heavily on the literature survey I undertook as part of my PGCert work.

Also in 2010, I agreed to take on the role of Teaching Advocate for the Faculty of Science and Engineering. I am pleased that the University of Waikato has allowed these roles to exist. As a teacher, I feel I have a responsibility to facilitate the development of teaching, and so I was very willing to take this role when it was offered to me by TDU and my Faculty. This involves communicating the importance of good teaching practice to the Faculty, as well as being a point of contact for teaching enquiries. I have run a series of small workshops looking at different areas of teaching, which encourage conversations between teachers. Many have found these enjoyable and helpful. However, one (not entirely unanticipated drawback) is that they haven’t had wide appeal – those who have come are mostly those who generally work hard on their teaching – others have held back. I will be expanding this role over the summer break by working with other Faculty teachers to develop appropriate Learning Outcomes for their papers – this practical help might have wider appeal.

My blog has also enabled me to communicate with others about good teaching practice and enables us to learn from each other. My teaching-related posts take several forms. Perhaps the most useful and most frightening is when I record my own thinking about an area. This can
provoke comment. An example is the post “For Example...” in which I thought about whether I should supply a relevant exemplar of an assignment to a student who asked for one\(^2\). This post created significant discussion on Sciblogs in which the merits and drawbacks of such a process were debated, and thoughts were aired on how to emphasize the former while avoiding the latter. I hope that by exposing my thinking to the world other teachers will be encouraged to share their thoughts and experiences with others.

Some posts can be more direct – for example I wrote a post about the NIWA Science Fair at which I have been a judge for several years. I made the decision to record my thinking publicly – partly in the hope that it would reach the people who need to know (primarily school teachers and then school students) – but also to open up discussion on what goes on at a Science Fair and how this is part of a teaching process. The blog post, to my surprise, got picked up by the New Zealand Herald, and published in their ‘Opinion’ Column.

I’ve also been keen to teach and facilitate teaching beyond the tertiary environment, particularly to children and a non-expert audience about science matters. I particularly enjoy seeing the open discussion of science occurring – I believe that highlighting relevant real-world applications is a powerful tool for helping people to develop science-based understanding.

From 2006 through to April 2011, I ran Café Scientifique, an initiative to bring science discussion into an accessible environment, namely a café. In a typical event, I would facilitate the interaction between a scientist and the public. This involves guiding the scientist in terms of what styles and content are appropriate, and sometimes guiding the discussions. This event isn’t immune from being appraised, and I appreciated the opportunity to work with a summer student in 2008/2009 to unravel people’s experiences of it.

I provide interactive talks to numerous school groups throughout the year, both on and off campus. The highlight is organizing and contributing to the annual Osborne physics lectures in which applications of year 12 and 13 physics is discussed.

*Photograph: Demonstrating Faraday’s law of electromagnetic induction at the Osborne Physics lectures in 2010*

I have also particularly enjoyed helping school students tackle the NZ Scholarship Exam, and have done several scholarship preparation sessions in Hamilton and New Plymouth.

“I found today much more helpful that other scholarship tutorials I’ve been to! Thankyou.”

Anonymous comment on 2010 Hamilton Physics Scholarship Preparation appraisal form

I’ve also contributed towards discussing science on radio and television. My blog plays a large role here. I was honoured to be a finalist in the ‘Science Communication’ category in the 2010 Kudos awards.

**Conclusion**

As I’ve travelled on my teaching journey, I have grown in my realization that good teaching isn’t something that happens by accident. At the start, I had only my own experiences as a student to draw from, now I see that the resources available are far greater. Literature, documenting and drawing from my experience, and conversations with others, are all valuable. I have needed to use those resources wisely to improve as a teacher, and now feel I have the potential (and duty) to contribute to them. That said, there is still huge scope to grow more.

In the future I would like to pay more systematic attention to recording my thoughts about teaching and my experiences, in a way that I can draw maximum learning benefit from them. I would like to see the status of teaching grow throughout the university, and, as teaching advocate for the Faculty of Science and Engineering, that is something towards which I am in a good position to contribute.

My overarching passion is for people to learn and experience physics. As a university teacher, I am privileged to be able to guide my students along this path.

The final word I leave to one of my former students, Bryn Parry, who now is a secondary school physics teacher in Rotorua. After he started teaching, Bryn asked if I’d share some resources on careers in physics that I’d given to him and his peers in their first year at Waikato. He realized that these would be valuable for his students too. It was great to hear that my enthusiasm for physics and its teaching has now been passed to someone else.

“[Marcus’s] resources will certainly be handy for inspiring the new generation, hopefully there will be some future physicists and engineers [in my class].”

Bryn Parry, School teacher (in physics) and graduate of the University of Waikato.
References


Wilson, M.T. PhysicsStop. [http://sci.waikato.ac.nz/physicsstop](http://sci.waikato.ac.nz/physicsstop)