Bridging the gap between learning and teaching in engineering

Overcoming barriers to learning: A guide for academics

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ALTC 2007 Associate Fellow
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# Contents

**Introduction**  
Overview  
Using this guide

**Barriers to student learning**  
Educational environment  
Behaviours and actions  
Individual attributes  
Which barriers?

**Practical strategies for overcoming barriers to learning**  
When learning seems like a ‘spectator sport’  
When students are isolated and you need them to work together  
When students experience a ‘chilly climate’ in the classroom  
When students struggle with the big ideas of the discipline  
When students don’t know how they are going  
When students don’t know how to learn  
When students don’t know where to get help  
When things are moving too fast for students to learn them  
When students are losing interest and don’t see the connection

**Concluding remarks**

**Glossary**

**References**

**Appendix**
INTRODUCTION

Overview

Learning can often be like an obstacle course for students. For some, this is an exciting challenge leading them towards the finishing line of graduation and achievement of their career aspirations. But this is not always the case. Sometimes the obstacles can become such large challenges that students fall by the wayside, either failing or choosing to leave their engineering course. The question that those who teach engineering may ponder is what factors contribute to students not making it or performing at less than their best? And are there strategies that we can use to ensure that students can and do navigate the obstacle course successfully?

This guide is one of the outcomes of the investigations and research conducted as part of an Australian Learning and Teaching Council (ALTC) Associate Fellowship program titled ‘Bridging the gap: Matching students and staff through discipline-based self-evaluation and co-creation of more appropriate pedagogies in engineering’. Other guides and resources can be found at the ALTC Exchange Group titled ‘Bridging the gap between learning and teaching in engineering’, available at http://www.altcexchange.edu.au/group/bridging-gap-between-learning-and-teaching-engineering.

The guide is designed for teachers of engineering—those who lecture, tutor or present labs or practical classes either online or on campus. The guide is formulated to help you to make decisions about what you can do in your classroom to try to maximise learning outcomes for your students. It draws upon a review of the literature in educational research and, in particular, engineering education research to provide practical suggestions for how you can implement a teaching approach that will provide students with the opportunity to learn. It is organised into two main sections. The first introduces some of the barriers that students face and the second provides strategies that you can implement in your teaching, curriculum and learning environment to help students overcome these barriers.

There is not a one-to-one relationship between barriers and strategies because often one strategy addresses a number of barriers. There are also barriers that cannot be overcome through teaching alone. Throughout the guide you will be introduced to a number of anecdotes about mythical students. These anecdotes are used to provide you with a picture of how students experience barriers and hopefully demonstrate the difference you can make by modifying your teaching approaches and styles.
Using this guide

To help you make the most of this guide, each broad topic includes strategies that teachers of different teaching styles can make use of. This recognises that you will have your own style and approach, and what might be a comfortable choice for you may not suit other teachers. The teaching style framework that is used is that of Grasha’s teaching styles clusters (Grasha, 1996). The styles are listed below along with a coloured dot that has also been placed beside text throughout the guide to indicate that a strategy may be suitable for this style:

1. The **expert/formal authority** cluster
2. The **personal model/expert/formal authority** cluster
3. The **facilitator/personal model/expert** cluster
4. The **delegator/facilitator/expert** cluster

The Appendix provides a link to a website that has a brief overview of each of these clusters and provides a link to an online questionnaire that will allow you to reflect on your own style.

Student learning styles are also explicitly addressed throughout. The Index of Learning Styles (ILS), based on the Felder-Silberman model, has been used extensively with engineering students. The ILS assesses learning preferences on four dimensions (Felder & Soloman, n.d.):

1. Active/reflective
2. Sensing/intuitive
3. Visual/verbal
4. Sequential/global.

The Appendix contains a link to the ILS questionnaire and to material that you can use with your students to help them reflect on their learning styles.

A word about terminology

In discussing students and their experience and behaviour in learning, terminology is important. When a term is introduced in the guide that may be new to engineering academics or may have a number of interpretations, it will appear in italicised blue like *this*. Definitions of these terms are provided in a glossary at the end of the guide.

Australian institutions differ in the way in which they describe units of study. For the purpose of this guide, we will use the term *course* to describe what is generally a single, semester-long area of study (sometimes called subject or unit) and *program* to describe an overall degree (sometimes called course).
As part of the Australian Learning and Teaching Council (ALTC) program that has developed this guide, an extensive literature review has been undertaken to investigate what barriers students face in learning at university and, in particular, those that are experienced by engineering students. This guide includes a summary of those barriers. For a more complete description you can read *Barriers to student learning in engineering: A literature review*, available at [http://www.altcexchange.edu.au/group/bridging-gap-between-learning-and-teaching-engineering](http://www.altcexchange.edu.au/group/bridging-gap-between-learning-and-teaching-engineering) under ‘Resources’.

Barriers to learning may be understood to fall into three broad, but intersecting categories. They are:

- **Educational environment**—external influences on the students due to the educational environment.
- **Behaviours and actions**—what behaviours and actions the student demonstrates in a learning situation.
- **Individual attributes**—both the internal and external attributes that the student brings to their learning.

These categories are represented in Figure 1. As is clear from this visual representation, they are not independent—the environment that a student experiences can influence their behaviour and their perceptions of themselves and their capabilities (for example, receiving no feedback on their learning can lead students to assume that they are doing well when they aren’t, leading to failure and a drop in academic confidence). Each category is explained on the following pages.

**Figure 1:** Barriers to student learning
Educational environment

Educational environment is perhaps the most obvious area of academic influence. It may be understood to encompass the following areas:

- **Teaching styles** and educational choices that academics make in the design and set up of classroom experiences. In particular, a clash between a teacher’s teaching styles and the learner’s learning style may be a barrier to student success.

- **The classroom climate**, which includes the nature of teacher–student interaction, the teaching/learning activities and student learning feedback. Students feeling that teachers are unavailable or unapproachable has been shown to impact on their *academic confidence* and in turn to influence their academic performance (GPA) (Vogt, 2008). The extent and nature of feedback is known to influence the quality of student learning (Ramsden, 2003).

- **The curriculum**, including the design of the program and course and, in particular, the extent to which students can see relationships between courses and across programs. It also relates to the way in which the course is organised, including the time devoted to particular subject areas.

- **Assessment**, which might logically seem to fit with curriculum but is separated here to provide emphasis to the high priority that students put on assessment as a ‘driver’ of their learning and hence the barrier that it may become.

- The provision of **academic or learning support**.

- The provision of institutional support for issues beyond the academic, including **counselling, careers advice and financial advice**.

- The **campus environment** and whether or not it supports student engagement with the physical or virtual location of their learning. This also includes the extent to which the campus or online environment supports students to work together or form *learning communities*.

- The nature of the **institutional context**, including the type or style of institution (rural/regional versus urban, research intensive versus technological, etc.).

A number of these factors influence students’ sense of *academic integration* and *social integration* or, conversely, can contribute to *academic isolation*. 
Behaviours and actions

Behaviours and actions refer to what the student actually does about their learning. While it may seem that this is solely in the control of the student, it is important to remember how our decisions in the classroom, in the curriculum and in our interactions with students directly influence these actions. They include:

- How much effort students put into their learning and how much of their time is on task. This has the dimension of both the quantity of time and effort and the quality. Sometimes students spend a lot of time on worthless activities which can be a barrier to their achievement of effective learning outcomes.

- Whether students are willing to seek help when they are in difficulty. Not understanding or struggling with what you are learning does not have to be a barrier if students have the confidence to seek help with their problems.

- How engaged students are in both individual learning and peer learning. While it is true that learning requires individual effort, learning is being seen more and more as a social activity. One of the obvious ways in which having peer support is advantageous is in allowing students the opportunity to try out their ideas and understandings and to get help to understand what they are learning.

- Whether students are self-regulated in their learning. Self-regulated learners are strategic in their approach to learning—they use appropriate process to plan, implement and monitor their actions in learning and are driven in this by their own internal motivation and through engaging in a process of metacognition. Many studies have shown that self-regulated learners are much more successful than those who rely on outside influences to show them what they should be doing and when.

Individual attributes

Individual attributes refers to those attributes and capabilities that we associate with an individual student. Broadly speaking, this area fits into three categories:

- Personal environment and background, including work commitments, finances and resources available to the students, previous educational experiences (which can determine a students expectations and attitudes to learning in a new context), family background (for example being the first in a family to attend a university) and social capital.
• **Commitment, beliefs and perception of self**, which includes motivation, *aspiration*, academic confidence, *self-efficacy* and individual perception of challenge.

• **Academic capabilities**, which refers to background knowledge and skills that may prepare students for learning in this context. In engineering education, much focus in this domain is on mathematical ability.

**Which barriers?**

The original proposal for this ALTC Fellowship program proposed three categories of barriers—personal, institutional and intellectual. The reasons for a change to this model are a reflection both on the literature and on the separation of barriers into those that are under the direct influence of the institution and teachers and those that are not. The original categories have been subsumed into the broader categories above.

Irrespective of how barriers to student learning are categorised, they cannot all be changed or influenced by academics, but some can be—either directly or via changes to those things under our control. The next section of this guide provides you with practical strategies that can be implemented to overcome or prevent barriers from arising.
When learning seems like a ‘spectator sport’

... “learning” is not a passive, knowledge-consuming and externally directed process, but an active, constructive and self-directed process in which learners build up internal knowledge representations that are personal interpretations of their learning experiences.

(Vermunt & Verloop, 1999)

In engineering, we sometimes think that what we have to learn is clear—there is a body of facts and standard processes that students need to acquire to become good engineers. However, thinking in these terms often leads us to believe that teaching is about transmission only, the transferral of these facts and standard processes into a students’ brain without change or challenge. But the reality is that what we are asking is for students to change the way they view the world. I am not a structural engineer, but I have many friends who are and I have never met one who does not view public infrastructure in a way that differs markedly from your average member of the public. They ‘see’ bridges and large buildings with amazing detail about the design and construction decisions made. Thinking about our students as future engineers requires us to make sure that this shift in how they view the world is part of what we make happen by our teaching. Simply transferring facts is not enough. We must engage them in actively making new mental models for themselves. So how do we do this? Some simple suggestions that you can implement to get your students involved in their learning (sometimes referred to as active learning) include:

- Providing some open ended challenges at the end of each lecture that link the theoretical material that you cover to the real world of engineering (which, lets face it, is the entire real world). You can pick these up at the start of the next class to link across lectures.
Anecdote

Brad was pretty excited. They’d been talking in their materials class about different classes of materials and the lecturer had set them a challenge. Apparently the light pole outside their lecture hall contained more than six different materials. They had to identify as many classes of material as they could and give a quick explanation as to why each part was made of that sort of material. The first one to email a correct response with five or more would get a prize. Everyone of course guessed metals for the pole but after that they were all a bit vague. Brad was determined to win.

- Students often expect a copy of the PowerPoint® slides you use in a lecture. Instead of just giving them the ones you use for your presentation, produce a second set with some gaps in it. Take regular breaks in class and prompt students to take notes to fill the gaps. If you want to make this collaborative, ask them to swap notes and see if they missed anything that the person beside them noted.

- Ask questions in your lecture and wait for students to answer. This sounds fairly simple but it requires you to be able to set up an environment where students feel comfortable to answer (and maybe get it wrong!). One way to do this is to ask open-ended rather than closed questions. And if you are greeted with silence, you can choose a non-threatening way to call on students. For example, choose someone you think may be brave enough to say something and then check out the colour of the shirt they are wearing (red, for example). While glancing around the room, say ‘Let’s get a suggestion from someone wearing a red shirt’. Then you can look back at that student without appearing to have singled them out.

- Your institution may allow you access to an audience response system. These allow you to ask questions of your students and then to poll them for their responses using a small handheld device. Asking multiple choice questions in this way can be a good chance for students to test their understanding and for you to modify your approach on the run to ensure that students are keeping up. This technique often makes use of concept tests to check student understanding. To see a more complete description, have a look at the (University of Wisconsin-Madison based) National Institute for Science Education web page titled ‘Classroom assessment techniques conceptests’, available at http://www.flaguide.org/cat/contests/contests1.php. This resource also contains links to existing tests in a number of subject areas (National Institute for Science Education, n.d.).
Practical strategies for overcoming barriers to learning

- Expect students to be prepared for your classes and communicate this to them. You can use the course website to provide them with activities they have to do in preparation for the next class. It is now relatively easy to make a video of yourself, for example either talking to the students or showing them something and then asking them to answer some questions or do some research. Younger students in particular may be familiar with this form of communication and you can pique their interest.

A group of Finnish researchers studied engineering students and the factors related to study success in engineering education. A summary of one of their findings suggests that:

... students who thought that learning requires active effort on their part succeeded better than students who considered learning to be the passive reception of information.

(Tynjala, Salminen, Sutela, Nuutinen, & Pitkanen, 2005)

**When students are isolated and you need them to work together**

_The message is clear: What students learn is greatly influenced by how they learn, and many students learn best through active, collaborative, small-group work inside and outside the classroom._

(Springer, Stanne, & Donovan, 1999)

There are so many ways to introduce cooperative learning and collaborative learning into your classroom. Here are just a few suggestions:

- **In class activities:** Something as simple as asking students to turn to the student beside them and discuss a concept or a problem can connect students to their peers and help them to explore their own understanding. If you pose a quick closed question (like ‘What’s the next step in this problem/solution?’, ‘Which equation would we use to cover this situation?’, ‘Will this piece of code compile without errors?’) then you can keep students focused and let them know whether they are right or wrong immediately. Try to take the time to listen in on conversations to gauge whether the students are on track or discussing last night’s party.
**Anecdote**

Ted had taken over lecturing the introductory programming course. Even he was getting bored with standing out the front and talking about code! Then he discovered that he could insert a ticking clock into a PowerPoint slide and he decided to try an experiment. In introducing recursion, instead of just talking about it and showing bits of code, Ted inserted a question part way through the lecture. He was a bit nervous but at the appropriate time he turned to his class of 200 students and said, ‘Given what I’ve just said, turn to the person next to you and discuss what you think this piece of code does.’ The students looked a bit stunned at first that they were actually being asked to do something active in class but after a while, a lively discussion sprung up. Over the next few weeks, Ted did this regularly in classes and the students started really getting involved. He found it led to them talking to each other more and asking him more questions.

- **Online**: The online environment provides many opportunities for students to work together and younger students are often very comfortable doing so here. Many learning management systems have tools you can put into students’ hands to do this. If they are working together on a project, they may like to set up a dedicated discussion forum, a wiki or just co-create a web page to explain their design or solution.

- **Projects or assignments**: Introducing cooperative or collaborative projects or assignments is becoming a common occurrence in undergraduate engineering classes. But not everyone is enamoured of the idea. It’s something that is easy to get wrong—students not contributing, one student doing all the work, teams falling apart before the end of the project and so on. Careful planning and design of assessment is required to get this sort of collaborative learning right. Things to think about include:
  
  a. Ensuring that there is a team’s worth of work to be done—if one person can do it alone then you might argue that they’re just being an efficient engineer to do so.
  
  b. Working out early ways that the team will manage the work. Tracking progress through reports and team meeting minutes can keep them on track.
  
  c. Deciding in advance a strategy for managing lack of contribution from a team member. Martin Murray, a civil engineering academic at Queensland University of Technology, implemented an industrial relations policy to cover first-year teams. It set out how teams could raise valid complaints so everyone knew where they stood.
  
  d. Determining how final marks will be decided. Is it a team mark or an individual mark? This will send a powerful message to students about what you think is important so you need to have decided that up-front.
• **Outside the classroom**: You can provide students with support or encouragement to set up informal learning communities beyond their timetabled classes. Studying together provides students with both social and academic opportunities and the research clearly shows that students who are connected to the academic and social life of their institution are more likely to be retained. This may be as simple as making some suggestions that students study together.

For some very detailed advice on how to implement cooperative learning in your classroom, see the website *Active/cooperative learning: Best practices in engineering education* by the Foundation Coalition in the United States, available at [http://clte.asu.edu/active/main.htm](http://clte.asu.edu/active/main.htm).

For advice on using student teams, the Foundation Coalition also has the following site: [http://www.foundationcoalition.org/home/keycomponents/student_teams.html](http://www.foundationcoalition.org/home/keycomponents/student_teams.html)

**When students experience a ‘chilly climate’ in the classroom**

... ongoing educational reform efforts must encourage engineering faculty to understand the significance of their student/professor relationships and seriously undertake measures to become personally available to students.  

(Vogt, 2008)

Some academics feel that there should be some distance between lecturers as experts and students as novices but the research clearly shows that when students feel like they are actually interacting with those that teach them (not just passively listening), their academic confidence increases as does their academic achievement. This does not mean that you personally need to shake hands with all your students and know their names! But you may want to consider ways in which you can show students that you are concerned about them and aware of them as people.
Anecdote

Marcus was bored. He’d done well in first semester but somehow he was just not connecting with the stuff that they were studying. It seemed so dry and theoretical, nothing like he expected when he came to study engineering. He didn’t really know anyone in his class and he certainly didn’t know any of the academics. Then in semester 2 he started a course in dynamics. The lecturer was great. He interspersed all the theoretical knowledge with stories about his job as an engineer and his research. Marcus also felt that he cared about how students were going. He often stopped in class to check everyone was following and not just in a cursory way, he always studied their faces. Every third class he actually finished 10 minutes early so anyone could come down the front and ask him questions. Marcus had never actually spoken to his other lecturers but when he was struggling a bit with one of the concepts, he felt confident to go down and ask his lecturer for some help. It turned out Marcus wasn’t the only one and the lecturer then spent some time with all of them making sure they understood.

Strategies that you can either implement individually or in collaboration with colleagues to create academic integration include:

- Organise one or two small group sessions with a peer mentor or tutor so that someone knows each student’s name. This doesn’t have to be costly if you work with other academics teaching in your year level and is particularly effective for first-year students to meet higher-year students.
- Suggest a department or faculty social event so that even if there are many students, they get to meet some academics on neutral, social ground. You could work with your professional association to host such an event and invite some industry speakers or include the local chapter.
- Include some stories from your own experience into your lecture material (either your research or industry practice). This helps to also make the material that you are teaching more relevant to students.
- Be aware of the structure of the program that most students are enrolled in. If you can mention in passing that you realise they have a major assignment for another course so you understand they may be distracted, it shows that you understand that the students experience a program and not just your course.
- Students report positively on teachers who are enthusiastic about what they are teaching. Your passion for a subject can be infective so don’t be afraid of showing your excitement, sharing what you’re reading or talking about the conferences you’re attending. Your enthusiasm will draw them into the subject.
• Find out what your teaching style is (see the Appendix for a link to an online questionnaire you may like to try). If you feel comfortable, discuss this with your students to let them know that you have a preference and that you are aware that there are other ways to approach teaching.

• Set up a process for students to ask questions easily and make sure you answer them. You could set up a standard email address so that you don’t have to be the one to always check it, and work out a standard response. Make sure that no student is made to feel silly for asking a question. This is also a great way to get feedback on your teaching—it’s good to know if no-one is actually following what you are doing in lectures even if you think you saw them nodding in class! If you have consultation times, make sure you are there.

When students struggle with the big ideas of the discipline

A student experiencing difficulty in grasping a particular concept can lead to an apparent ‘blockage’ in their learning, which is only cleared when the student finally gains the necessary understanding to proceed. With some concepts this can be a fairly straightforward process, requiring only an alternative explanation or carefully worked example to smooth the way for continues learning. With other concepts, however, the clearing of this mental blockage has a much more significant and fundamental impact, with the resulting understanding or ‘insight’ opening up a while new way of thinking and practising in a discipline.

(Stokes, King, & Libarkin, 2007)

The first step in focusing on those things that are problematic for students is to identify what they are. If you’ve taught a course a number of times, you may already know this—what was the most common area of questions from students? What did they get wrong consistently on the assessment tasks? If you are more of a newcomer, you may still remember from your own learning experiences what was challenging. But perhaps the best way to find out where to start is to have a conversation with your colleagues. Those teaching in higher-level courses or who have taught similar courses before could be a good source of conversation.

Once you’ve identified the challenging areas for students, the next step may be to observe two things:

1. The strategies that students who do get it use to learn it.
2. The ways in which the majority of the students approach learning it.
If you've got a very large class, enlisting the help of tutors or even videoing students in a practical class to see what they do (with their permission of course) can allow you to see what thought processes they currently use.

Anecdote
Jiang was teaching first year and she noticed that every year, students made some silly errors in rearranging equations and solving fairly simple problems. She just didn’t understand how they could come up with answers that were so obviously ridiculous and not question themselves. So she decided to introduce some new exercises. Students had to use a log book and to estimate a ballpark figure for their answers before they did a calculation—just something simple like would the answer be in pascals or megapascals? Jiang challenged the students with in class activities that helped them to see the meaning of such quantities. She found that with a consistent approach across the semester there was a marked improvement in the answers students gave—when they got something ridiculous they at least commented that they could see it was on the wrong track.

Some other suggestions for action include:

- Meet with your tutors regularly or, if you are a tutor, talk to others in the same class. Work out together what aspect of the subject matter is most troubling students and focus your teaching attention (and students learning) on those aspects.

- Over time refine the plan for your course to get the balance right in terms of time spent on tasks—communicate to students those areas that they need to get right and which are in the critical path to understanding. Design your curriculum around these areas.

- Ensure that you communicate the ‘inner logic’ of the subject (Entwistle, 2005) and return to it regularly. That is, how does each element of the course fit together? One way to communicate this is to represent the subject matter or the course itself using a concept map. As you move through different areas of the course, show the concept map to the students and highlight which areas you are currently concentrating on. As an undergraduate and later as a tutor, I experienced a powerful example of this. In materials engineering, a particularly effective lecturer let us know that the entire course could be summarised by a representative equation:

  Properties + Situation = Behaviour

So if we could analyse the situation that a material was in (for example, the forces or stress that the material was subjected to) and know the properties of that material (for example, the yield strength) we could predict how it would behave (for example, deform catastrophically). It really helped to clarify and put into perspective the various concepts that we were learning (and later I was teaching).
• Ensure that you model ‘ways of thinking’ about problems or projects in the course. Seeing the steps an expert takes to solve a problem gives students a road map for approaching it themselves. Take care to give varied examples to ensure that students are able to extract the generalisable approach rather than a recipe that may not succeed in all situations.

• Link across courses so students do not compartmentalise their knowledge or approach. This requires having conversations with colleagues and being aware of the overall program design. Let students know they are on a learning journey—it’s not enough to ‘learn’ something only to pass this course because the next one will build on it.

When students don’t know how they are going

In a comprehensive review of 87 meta-analyses of studies of what makes a difference to student achievement, Hattie (1987) reports that the most powerful single influence is feedback.

(Gibbs & Simpson, 2004–2005)

Eleven conditions under which assessment supports student learning were identified (Gibbs and Simpson, 2004-05): They relate to:

• The quantity, distribution and quality and level of student effort;
• The quantity, timing and quality of feedback; and
• The student response to that feedback.

(The Open University & Sheffield Hallam University, n.d.)

Anecdote

Michel handed in his assignment and breathed a sigh of relief. It was all over! A few weeks later, he got his marks back with some comments but he didn’t really pay much attention other than to register that he had passed. Now to move on to the next assignment. But he just didn’t know where to start. He thought that the two assignments were supposed to be related but somehow they just didn’t seem to fit. Michel approached his tutor and to his surprise, his tutor suggested he go back and look at the comments on his first assignment. When he did, he suddenly realised that the mistakes he had made in the first assignment had got him off track. After checking with the tutor to make sure he had understood correctly, Michel was able to see exactly where he had to put his efforts for the second assignment.
For students, understanding how much effort to put in and whether their efforts are effective is often a challenge, particularly for students who are new to university and who may have had little contact with university environments and study before (for example, those who are the first in their family to attend university). Providing them with opportunities to get feedback on their learning is vital. Providing feedback when you have a class of over 200 students can appear daunting but here are some suggestions:

- Provide students with some quick quizzes in class and get them to swap with each other to mark them. Give the worked solution on a PowerPoint slide and get them to talk about where they went wrong. This can be a bit daunting for students, but if you warn them up-front and explain why you are doing it, it can provide them with some useful feedback.

- Use an audience response system to ask multiple choice questions of students in class. This way their responses are anonymous but you can immediately see if they are on track and so can they.

- Define criteria and standards for each criterion for all assessment tasks. These define the quality of work that students need to produce to achieve a certain grade. Criteria and standards can provide focus for students on what is important as well as being a means to communicate feedback effectively. You can even ask students to contribute to producing criteria and standards for a particular task. For example, you could have an in-class discussion about what makes a good design report. Engaging students in talking about the qualities they would look for will help them to clarify where to put their efforts.

- Use tutors to provide feedback and tell students when that feedback will come. Sometimes students are getting feedback when they don’t realise it.

- Ask students to address the feedback from their first assessable task on their second. This ensures that students actually have to pay attention to what’s been said.

- Develop a bank of standard feedback for tutors marking lots of assessable work. If you want to, you can actually give this to students before they submit their assessable work. This is a form of feed forward that helps students to focus on what’s important.
When students don’t know how to learn

*In the models, it was also found that students’ marks could be improved by seeking help in the university’s mathematics learning support centre.*

(Lee, Harrison, Pell, & Robinson, 2008)

It is dangerous to assume that students know how to study or learn in the university context. Our expectations of them are much greater than they may have encountered at high school or in other learning experiences. However, this should not be a mystery to them. By making explicit expectations for HOW they might learn in the course as well as WHAT they might learn, we can help them to begin to self-regulate their learning. Many academics fear that this is a form of ‘spoon-feeding’ that will lead to lots of work for academics. Obviously the amount of support or ‘scaffolding’ that you provide will be dependant on the level of the students. First-year students will need much more guidance on how to learn than final-year students (hopefully) but it may be worth a discussion with some fellow academics across your program to see what stages students are at. You can also connect with learning support or academic skills professionals in your institution who may be able to provide advice (to both you and your students) or even some materials that you could customise to give students about studying and learning effectively.

Anecdote

Jon was loving the freedom at uni. Having scraped through first year, he really felt like now he’d worked out how to succeed. The key in most of the courses was to make sure you got the solutions to problems as early as possible. There was no point struggling with the set questions on your own, better to wait until the lecturer posted the answers online and then you could learn them ready for the exam. And then Jon started having some difficulties. In his second-year exams, there were problems that he hadn’t seen before and no matter how hard he wracked his brain he just couldn’t remember how to do the questions. He felt like he was heading for failure and just couldn’t understand why.

Some practical strategies for supporting students to develop their learning abilities include:

- Ask students to fill in a learning styles questionnaire (such as the Index of Learning Styles) and provide them with some suggestions that are particular to your course that will both allow them to capitalise on their strengths or preferences and to also mindfully address non-preferences. You may also like to share your own learning style or teaching style.
• Remind students of the support services that are available to them. You could do this by providing a link on your course website to the relevant areas in your institution or perhaps making mention of these services at a relevant time in the semester (for first-year students this might be around week 5 when the information from orientation week is receding in their memories but the need for learning support is increasing).

• Include on your reference list for your course some books about learning or some of the skills that are required to complete the unit beyond just technical ones. For example, the book *Communication skills: A guide for engineering and applied science students* (Davies, 2001) contains lots of good suggestions for how students can write reports, organise technical information, give presentations and so on. It is aimed at engineering students so is very relevant to our context. There are many other texts that you can either find in your library or request your library to purchase for student use. If you teach a first-year course, you may even want to consider prescribing such a text for your course.

• Be organised and present a united front. If you have tutors, ensure that everyone is giving the same answer to questions or if students are asking questions that only you can answer, let tutors know that they should send such questions on to you. Also ensure that you have spent some time prior to the start of semester organising your course and, in particular, your website so students can find the information and support they need to complete the course. Changing requirements can add to student confusion and be a significant barrier to student success for students who might otherwise be quite capable of meeting the intellectual requirements of the course. Spend some time thinking through the pathways that students will follow through the website, course material and assessment tasks so that you can provide what is needed at appropriate times and in the appropriate format. If you have the time, you could do this with tutors or, even better, previously successful students.

• Make use of the learning support services available at your institution. In some cases learning support services staff (sometimes called academic advisers) may be willing to work with you to embed some learning support into your curriculum. For example, if you are setting students an assessment task to do an oral presentation, learning support staff may be able to provide you or your tutors with some good generic resources that you can modify and use to teach your students about oral presentations. In some cases they may even be able to take a class for you or with you to enhance students’ generic skills.
When students don’t know where to get help

McInnis, James and McNaught (1995) carried out extensive research into the FYE [first year experience] at university and one of their findings was that students now require assistance beyond what was the norm, that student support services were often under-utilised and that many students were unaware of their existence. McKavanagh, Connor and West (1996) found that students often only sought help at a crisis time, and that many students did not know of the existence of these services or how they might be assisted by them. McInnis and James (1995) stress the need to look at the marginalisation of the support services and the desirability and means of integrating support services into the academic mainstream.

(Taylor, McCowan, & Baguley, 2002)

As an academic we can only do so much to support students in their learning but all universities provide a range of support services that can help students beyond what we can do in the classroom. While it might be too time consuming to keep yourself completely up-to-date with every question that students might want answered, in most institutions there is one contact (email, phone or physical location) that can get students some much-needed help. Often this information is given out in orientation week to first-year students and by the time students need it, it has long receded into their memory. A reminder in week 5 or so about what’s available or the occasional news announcement online can place the information in students’ memories when they need it and give them the chance to deal with whatever issues are bothering them outside their studies, leaving them free to focus on learning.

Anecdote

Peta had been really looking forward to getting into uni. Finally a chance to focus on what she really enjoyed and not have to do all that peripheral stuff! But just as she started out, her mum had her hours dropped at work and she really couldn’t afford to pay for too much of Peta’s stuff. So Peta got a job. The only problem was no-one at work really cared when she was supposed to be at lectures so she was missing heaps of stuff and she really didn’t know how to catch up or what she could do about it. After all if she didn’t work, she couldn’t even get the bus to uni, let alone afford the text books. She remembered someone in O week saying there was help if you were in financial difficulties but she couldn’t remember where and didn’t really know who to ask.
Suggestions for supporting students to get help include:

- If you have a large class, track down some useful support information and hand it out to your tutors. Ask them to remind students regularly that there are support services available and encourage them to keep an eye on any students who may be struggling.

- Keep a track of any students whose results fluctuate from one assessment piece to the next. While it would be easy to assume that this was caused by some form of dishonest approach, it could actually be from a change in personal circumstance. A quick email to ask if there are any issues that are impacting negatively on the student may be a lifeline to a student in crisis. Be prepared to advise the student of appropriate support services. You cannot be expected to be a counsellor or financial adviser but you can point the students in the direction of these services.

- Think carefully about your choice of resource needs for your course (such as text books). Would a student who is struggling to make enough money to feed themselves be able to afford this? Is it absolutely vital and does it provide value for money?

- Only timetable on-campus activities for things that need to be done on campus. If the reality is that students could experience some of your course remotely and learn just as much then you can’t expect them to attend if they have competing priorities. Make use of flexible learning resources if you can—students will always be making choices and if the on-campus experiences you provide don’t prove to be valuable to them then don’t be surprised if they make the choice not to attend.

- Most universities have some form of first year experience (FYE) program that has linked support services to the academic context. If you teach in first year or if you want to see what other support is available, consider tracking down this program at your institution. You may also find some support for your teaching.
When things are moving too fast for students to learn them

_Pragtising teachers in post-compulsory education can often cite aspects of their own subject which seem to be necessarily learned slowly. In my own former discipline, the Second Law of Thermodynamics is one such topic. It has to be ‘lived with’ for quite a while before it begins to make sense. It is often quite some time after being able to use it successfully, and solve problems with it, that the meaning of it gradually dawns._

(Race, 2005)

It is very rare for anyone to learn something simply by hearing it spoken about once, and yet some of our students think that listening to a lecture is enough to understand a concept or idea. Most of the more difficult concepts in engineering (and most other disciplines too) take time and the opportunity to revisit them many times before they are truly understood. Unfortunately, most of our courses last only one semester, which can seem like a very short time for students to be able to learn concepts that we know are very important for their engineering career.

_Anecdote_

Chang-yi was glad he’d survived the first-year exam in electrical principles and could move on. He was surprised on entering his second-year electronics course to find his first-year lecturer there. The lecturer gave a quick highlights lecture of what they had done in first year and told them that these ideas were important to build from in the electronics course. Chang-yi realised that he should probably get out his first-year notes again and have a look over them or he’d be left behind. He was surprised how much he had forgotten but it didn’t take long to get himself up to date again and it certainly made the first tutorial a bit easier to start.

What can we do about getting students to take the time to learn things properly and design our courses and programs to allow this to happen? Strategies you may consider are:

- Make explicit to students the need to revisit things. You might do this by providing reminders of topics you have already covered later in the semester and suggest they go back and look at them again. Remind them that while it might take an hour to go through something the first time, the second and third time you revisit it will be much quicker and each time you do so, you are cementing your understanding for the future.
• Suggest students keep a logbook of their learning. This could be a book not only for notes on particular areas of learning but also for ‘meta-notes’, that is, messages to themselves about what they understood, what questions they had, peers they have shared ideas with, problems that address this topic and so on.

• Try to organise your curriculum so that maximum time can be devoted to things that are difficult for students to learn and keep revisiting them. This might be a course- or a program-wide activity. Working with lecturers in the courses that come before and after yours may allow you to provide some continuity in the way you talk about particular topics, which can help students to realise that they need to keep thinking about a topic even though they may have completed a semester-long course.

When students are losing interest and don’t see the connection

Three quarters or more of students rate ‘studying in a field that really interests me’, ‘improving my job prospects’, ‘developing my talents and abilities’ and ‘getting training for a specific job’ as important (ratings of 4 or 5 on a scale of 1–5). The most prominent item is perhaps ‘studying in a field that really interest me’; 78 per cent of first years rate it as ‘very important’ in their decision-making. The other three items did not attract such a strong response. ‘To improve my job prospects’ is very important for 54 per cent of respondents and the other two items are very important for 40–45 per cent of respondents.

(Krause, Hartley, James, & McInnis, 2005)

As the above quote suggests, students have aspirations to be studying something really interesting and important to them at university. Unfortunately, the ideas students have about what is interesting and important may be very different to what we know they need in order to become excellent engineers. But it is possible to keep them engaged and interested by ensuring the relevance of what we are teaching and what they are learning. Linking our courses to graduate outcomes—to being a successful engineer—should not be too difficult given that the push in most institutions is to ensure that degree programs have defined graduate outcomes and that their development is mapped across the curriculum.
Practical strategies for overcoming barriers to learning

Anecdote

Yan was bored. She’d come to the end of the second year of her program and she still didn’t see where it was going. She went to the final class of one of her courses just to get some revision notes. There was a guest speaker, however, and she recognised him as a lecturer that some of the third-year students had said was pretty good. It turned out that he had come to their final class to give them a taster of next year’s course that built from this one. It looked pretty interesting and Yan was actually feeling quite inspired when he showed them the projects they’d be working on and some of the designs that the current year’s cohort had produced. So this course really was relevant! Now Yan had something to look forward to through the holidays and maybe she wouldn’t throw out the notes just yet—they might help her get a head start on next year’s project!

What can we do to bring our courses to life for students? Strategies include:

- Use industry and research examples to show how theory applies to practice. In particular, design your assessment tasks to be as close as possible to real-world tasks. Obviously first-year students will require much more task definition but as students get to higher-year levels it is important to increase the complexity of the tasks and to expect more of them.

- Provide an overview of your course at the beginning and revisit it as you pass through each topic area. You can do this by developing a concept map or mind map to illustrate the relationship between topics and/or the relationship between different learning experiences. If you put this on a single PowerPoint slide you can show it again and again to highlight where you are focusing in this particular class.

- Incorporate some real-life context into assessable tasks. You can provide background and context to most assessment pieces that make students feel like they are on the path to becoming a professional engineer.

- Organise a social event or professional event that allows students to meet practising professionals. Many academics are members of professional organisations and encouraging students to get involved in events links them to the real world of engineering.

- Be enthusiastic about the course/subject that you are teaching. Keep a refreshed outlook by remembering that you are developing the engineers of tomorrow and be clear about why what you are teaching them is so important.
CONCLUDING REMARKS

It is hoped that individual academics can pick up this guide and find strategies they can try out in their classrooms almost immediately. But there is one final strategy that deserves particular mention. All teachers can benefit from becoming a part of a teaching community. This can be as easy as chatting to a fellow academic or a group of your peers, or it can involve finding your institution’s academic development or teaching support unit and talking to an academic developer about what you are trying to achieve in your teaching or a problem that is challenging you. The Australian Learning and Teaching Council (ALTC) provides further opportunities for academics to become involved beyond their institution and sometimes beyond their discipline. As teachers, we must see ourselves also as learners—constantly seeking a better way to enhance the learning of our students. After all, we are taking on no small task in educating the engineers of the future. It is they who will provide the solutions for our world.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic confidence</td>
<td>Belief in one’s ability to succeed in the academic (university) environment.</td>
</tr>
<tr>
<td>Academic integration</td>
<td>Extent to which one is a part of or engaged in the academic environment. This might include participation in timetabled learning experiences, completion of assessable tasks and also time devoted to academic tasks outside those timetabled (either alone or with peers).</td>
</tr>
<tr>
<td>Academic isolation</td>
<td>The opposite of academic integration.</td>
</tr>
<tr>
<td>Active learning</td>
<td>Refers to designed learning strategies that focus the responsibility for learning on the learner. Rather than being passive recipients of knowledge, in active learning learners are participating and shaping the way in which their learning progresses.</td>
</tr>
<tr>
<td>Aspiration</td>
<td>Cherished wish or desire. Dream of future outcome.</td>
</tr>
<tr>
<td>Collaborative learning</td>
<td>In its simplest form, collaborative learning involves students working together to enhance the learning of individuals. It involves students in combining their individual skills and resources to focus on their learning.</td>
</tr>
<tr>
<td>Cooperative learning</td>
<td>’Cooperative learning, a particular type of active learning, is a formal instructional approach in which students work together in small teams to accomplish a common learning goal.’ (From <a href="http://clte.asu.edu/active/mainde.htm">http://clte.asu.edu/active/mainde.htm</a>)</td>
</tr>
<tr>
<td>Learning communities</td>
<td>According to Wikipedia, ‘a learning community is a group of people who share common values and beliefs, are actively engaged in learning together from each other.’</td>
</tr>
<tr>
<td>Metacognition</td>
<td>Put simply, metacognition is thinking about thinking.</td>
</tr>
<tr>
<td>Motivation</td>
<td>Psychological concept related to a person’s reason or purpose for a particular course of action.</td>
</tr>
<tr>
<td>Self-efficacy</td>
<td>An individuals judgement on their ability to complete tasks to a required level of performance.</td>
</tr>
<tr>
<td>Self-regulation</td>
<td>Learning that engages metacognition to purposefully engage strategies and processes to plan, organise and complete appropriate behaviours and actions to bring about learning.</td>
</tr>
<tr>
<td>Social capital</td>
<td>Social capital represents the active connections between people, including trust, support and behaviours and actions that demonstrate commitment to a social good. When social capital is enhanced, people are more likely to be involved and to benefit both emotionally and materially from being a part of the community.</td>
</tr>
<tr>
<td>Social integration</td>
<td>Extent to which students are integrated into the social aspects of campus life. This might include engagement with fellow students in informal social activities, in clubs and societies or other organised social activities.</td>
</tr>
</tbody>
</table>
REFERENCES


Appendix

Teaching styles

- The following website from the University of Texas at Austin provides a brief overview of teaching styles:
  http://www.lib.utexas.edu/services/instruction/tips/tf/tf_tstyles.html
  (last accessed 7 April 2010)
- A teaching styles survey is available at:
  http://www.longleaf.net/teachingstyle.html
  (last accessed 7 April 2010)

Learning styles

- The following article describes learning and teaching styles in engineering education (last accessed 7 April 2010):
- Felder and Soloman’s Index of Learning Styles (ILS) is available at:
  http://www.engr.ncsu.edu/learningstyles/ilsweb.html
  (last accessed 7 April 2010)