A survey of strategies for feedback and assessment in engineering subjects : Discussions and examples

Andrew Ooi
The University of Melbourne, Melbourne, Australia
asho@unimelb.edu.au

Gavin Buskes
The University of Melbourne, Melbourne, Australia
buskesgj@unimelb.edu.au

Abstract*: One of the most often quoted statements in educational circles is that "assessment tasks drive student learning". Assessment practices in engineering have changed markedly over the years. With the explosion of Problem Based Learning (PBL) styled courses, increased focus on group work, the building of generic skills linked to graduate attributes and more widespread use of online tools, methods for assessment and opportunities for feedback have widened increasingly. In this paper, we survey several experienced engineering lecturers from around Australia and their approach to assessment in their subjects – varying from institution, content, size and year level. Student focus groups are also drawn upon to provide the other side of the picture. It is observed that there is a large diversity in both assessment and feedback practices that may warrant a more comprehensive study.*

Introduction

Classifying work completed in a subject as a piece of assessment is a strategic tool for creating student engagement and provides a mechanism for driving student learning (Ramsden, 2007); while also making it clear to students that the completed work is a valued and important record of their learning (James, McInnis, & Devlin, 2002). As educators, we all use assessment tasks to motivate students to learn and acquire new knowledge through a demonstration of their level of understanding. However, how we go about it differs in that there is no "one size fits all" assessment practice – we must conform to the pressures of constraints such as subject content, class sizes and available learning environments, budgets, availability of staff and deadlines for results processing.

In order to be classified as a "good" assessment, it must be consistent with the intended learning outcomes, and it must be "authentic" to the discipline; in other words the assessment tasks need to "represent the knowledge to be learned in a way that is authentic to real life" (Biggs & Tang, 2007; Torrance, 1994). For engineering, this could be as simple as tailoring assessment tasks to actual tasks performed in the engineering industry or simply applying an engineering context on the assessment.

Assessment tasks are usually classified into the two categories – formative, where feedback is provided during learning, and summative, where feedback is provided after learning (Biggs & Tang, 2007). Both types of assessment are intended to match performance as it is versus performance as it should be. Formative assessment is employed to encourage students to attempt tasks without fear of making errors – in fact, these errors can be used as a basis for correction and more focussed learning on the student's behalf. Summative assessment is used to judge how well students have learned what they are supposed to learn and is the more feared of assessments due to its impact. Typically, subjects will require an appropriate amount of both formative and summative assessments, providing different levels of feedback at differing times. It is how the assessment is performed and how this feedback is conveyed to the students that varies with subject lecturer, subject content and institution; indeed the authors' experiences through discussions with people at multiple institutions across Australia show that the variation can be quite large. This paper surveys the assessment and feedback practices employed at several institutions and reveals a diverse amount of approaches.

Trends in assessment and feedback strategies

Assessment

Assessment varies in terms of desired format, frequency and permissible duration. Tests, exams or quizzes are the likely types of assessment that most commonly spring to mind when mentioning assessment; all in some way measure the length of time that students can retain information in their memory. At the University of New South Wales (UNSW), assessment in a first-year mechanics subject consists of a series of quizzes which only test students on material covered since the previous quiz. The quizzes are short in duration, about 45-50 minutes, as they are done in lectures. As such there is only a small amount of content that can be examined each time. In contrast, a first-year programming subject at UNSW examines students with workshop tasks that progressively assess what has been learnt since the start of the subject. The final assignment covers all of the material from the entire semester. The failure rate for follow-on subjects from the programming subject is low while the failure rate for follow-on subjects from the mechanics subject is high. While firm conclusions cannot be drawn from making a comparison between different subjects, it could be possible that the quizzes in the mechanics subject may only be assessing short term memory and not encouraging students to progressively build upon their knowledge.

Both of these subjects display a trend towards a decrease in the weighting of the final exam and greater importance placed on continuous assessment. From visiting multiple institutions, it was observed that it is now uncommon for subject coordinators to weight the final semester exam more than 60%, especially in light of subjects that involve large amounts of project work. In addition, a survey taken by engineering students UNSW indicated they generally find exams "non-authentic". In real life, engineers are typically not given only three hours and are allowed to consult a reference text in order to obtain a solution to a problem. They also usually do not work as an individual; tasks are completed in groups and require the application of generic skills such as team work, communication and time management.

A key motivator for students is when they can clearly see that the theory they learn can be applied in practice and when there is no clear connection between theory and practice it increases frustration. Some students in a focus group commented directly that the theory appears pointless in itself when it does not appear to resemble what they see in practice. To alleviate this, it has been recognised by the authors that more and more institutions are making students work on projects that are relevant to the industry in order to improve the authenticity of the assessment. Where the real shift appears to be is that industry projects are being undertaken as a form of assessment by students earlier in their degree program, rather than solely in their final year. While students in their early years of study may not have the maturity and necessary knowledge of a fully-fledged graduate it is felt that they can still positively contribute towards an industry project. In order to ensure positive outcomes for both the students and the industry partner, care must be taken to ensure that the expected outcomes are consistent with the capability and knowledge of the students at the level of their course.

Online assessment

Online assessments are generally acknowledged to offer benefits in administration, flexibility and student convenience (Watson & Angus, 2008) and while they are often lumped together in the same basket, there is a myriad of different types available. The traditional online assessment tool is the online quiz. Typically a staff member will set up the questions, students will enter their answers and then receive a mark. Over the years, small (although sometimes quite sophisticated) variations have appeared such as the ability to randomise parameters to create individualised tests, improved usability and the addition of mathematical engine back ends, but the basic structure has largely remained the same (Allen, 2003).

It is observed that the main uses of online assessment at present are to give students rapid feedback on the progress of their learning and to give lecturers an idea as to how well the class is progressing as a whole. Therefore any gap in lecture content or delivery can be identified immediately. The University of Queensland (UQ) have used an online approach for their Preparing for First Year (PFFY) subject. The idea of this test is to find out what first year students know and for lecturers to use this information when they design their subjects. It also allows lecturers to quickly identify students at risk. This information is now becoming very important to lecturers for students coming in with different backgrounds; in particular overseas students with a different high school education. Additionally for institutions that have moved to a common first year engineering course, local students are now admitted with very different maths and science backgrounds and this sort of online assessment helps identify strengths and weaknesses of individual students and the cohort as a whole.

At the Dept of Mechanical Engineering, University of Queensland, online assessment is performed quite routinely in many subjects. It is commonly accepted that online problems must be relatively simple since students typically attempt this type of question when they are in the comfort of their own home and help is not readily available (unlike problems attempted in a tutorial setting). The use of online assessment is to encourage students to learn and give them confidence by getting them to do problems that are simple and only involve one or two engineering concepts. The idea is to use it as an illustrative tool, getting students to attempt a question to reinforce concepts in engineering. However, this does not mean that online assessment can only be used for simple or easy questions. In a subject on acoustics at the University of Queensland, relatively complex online problems have been designed where a question is divided into smaller parts. Each of the smaller parts are relatively simple and answers from a preceding question will give students hints on how to answer the following question. It is a guided approach and the idea is to teach and reinforce ideas introduce in lectures in an online system.

At the University of Melbourne, several engineering subjects have adopted online assessment using the Maple TA system as a form of teacher-centred assessment. Here also a general first year engineering subject uses both teacher-centred and student-centred forms of online assessment (Buskes, Evans, Ooi, & Shen, 2010) in order to give the students experience of both answering student and teacher created questions and posing the questions themselves.

Feedback

Feedback is regularly at the top of the list of those factors leading to good teaching (Black & William, 1998). Feedback improves accessibility and helps improve the level of staff-student interaction, which can lead to improved learning outcomes (Ramsden, 2007). Assessment provides feedback to students about their learning and how to improve knowledge and develop their skills. The form, depth and structure of the feedback can vary significantly as the assessment varies.

In a focus group consisting of mainly 3rd and 4th year engineering students conducted at the Mechanical Engineering Department, UNSW, students commented that a typical turnaround time of two weeks (after they submit their assignment and when they are returned) is too long when compared to the pace of the course. Usually after two weeks, they would have forgotten what the assignment is about and would have already moved on to a different assignment. In one particular subject, to improve the speed of delivering feedback on an assignment, it is given to students in the form of a "tick or a cross". No commentary or any other form of detailed feedback is given. The students suggested what would be useful would be for the lecturer to "review" the assignment after it is has been submitted; to show what is expected for each question in the assignment in terms of the actual sample responses. Other students have commented that this review process takes away valuable lecture time which they could use to cover the material in more depth.

The feedback methodology mentioned above is "reactive" in that students have to perform the piece of assessment first before they are given feedback on what they have done is good or bad. But must all feedback be "reactive"? One other way of providing feedback that is becoming more prevalent is to give "active" feedback. An example would be to let students know the mistakes made by the previous student cohort on a similar assignment. That way, students know what is expected of them even before they commence doing the assignment and can avoid any potential pitfalls. Showing students what a good assessment or a bad assessment is and requiring them to mark an example one and compare to a staff member's judgement is also becoming common and assists in developing critical judgement skills. This sort of active feedback can also be provided almost instantaneously in lectures via the use of Electronic Voting Response Systems (EVRSs) (Fies & Marshall, 2006), or “clickers”, which give students the opportunity to interact both with the lecturer and their peers.

Subject specific case studies

The authors have summarised some of the differing strategies of assessment and feedback in subjects at various institutions across Australia. While by no means comprehensive, it does offer a snapshot into what is currently being done in terms of engineering education and could serve as the impetus for a more in-depth study and summary to be completed in the future.

Case 1

University of New South Wales

Department of Mechanical and Manufacturing Engineering

Subject: 1st Year Design (ENGG1000)

The first year design subject consists of about 1000 students. There is no exam for this subject. Assessment consists of peer assessment and marked assignments/report/gantt chart by tutors/course coordinators. The assessment for the design proposal and report is typical of what many lecturers do. Students work in group of about seven individuals and the work is marked by a tutor or subject coordinator. The groups have been randomly selected in the past but in 2010 the Belbin (Belbin, 1993) and Meyer-Briggs (Myers, 1995) models were used to allocate students into groups. The coordinators in each department are responsible for marking the pieces of work generated by their students. At the end of a certain period, all coordinators get together and compare their results to ensure that the marking is consistent across the departments. It is reported that there are usually no problems with this approach.

A peer assessment task is performed in the form of learning portfolio where students are asked to reflect on what they have learnt from the subject. This assessment component is 20% of the overall assessment for this subject. Students are asked to do this three times per semester. Their peers are asked to mark their assignment and comment. Students need to explain why going through this process is good for them. This method appears to work well in practice, with the only intervention by the lecturer being required when student’s complain that they have been given a particularly low mark.

In order to judge if students have the ability to provide good peer assessment and improved critical judgement skills, students are asked to do a “Calibrated Peer Review” (CPR) ("Calibrated Peer Review: A Writing and Critical-Thinking. Instructional Tool," 2005) exercise in week 12 of the semester. The CPR is an open source software system developed at UCLA and the process is as follows

- The lecturer will write three different (good, mediocre and bad) pieces of work on an online system.
- These reflective reviews are randomly distributed to students but they are not told whether the article given to them are good, mediocre and bad.
- Students are then asked to rate and write comments on the article that they have been given. These can be electronically marked because the quality of the work that is given to each student is known a priori.

Case 2

University of New South Wales

Department of Mechanical and Manufacturing Engineering

Subject: 2nd Year Fluid Mechanics

There are 370 students in this subject. There are two mid-semester tests worth 15% each and end of semester exam worth 60% and the students also have to do laboratory sessions (four in total) with a total of 10%. In the lab sessions, students are examined on the spot. At the moment, the mid-semester tests are manually marked but these tests may be placed online with randomised variables to ensure that all students do problems that are slightly different to each other to prevent collusion.

Case 3

University of New South Wales

Department of Mechanical and Manufacturing Engineering

Subject: 3rd Year Heat Transfer

There are about 130 students in this subject. With smaller class sizes, every week students complete particular tutorial problems based on that week's topic for a total of 15%. An assignment (mid semester) which they have to submit is worth 10%, a lab report handed in the last week of the semester comprises 15% and the exam is worth 60%.

Case 4

The University of Sydney

School of Aerospace, Mechanical and Mechatronic Engineering

Subject: 3rd Year Fluid Mechanics

There are about 150 students in this class. Every week, for 12 weeks, students are required to submit a short homework piece. They are worth 1% each. There are also three quizzes worth 6% each (for a total of 18%). Students are required to perform a lab which is worth 10% and 60% of their total mark is based on the final exam.

Case 5

The University of Sydney

School of Aerospace, Mechanical and Mechatronic Engineering

Subject: 1st Year Programming

There are about 700 students in this subject. Assessment consists of workgroup tasks which are broken down into weekly submissions worth a total of 10%. Students submit small pieces of assessment at the end of every workgroup session and the assessment is done electronically. Students are also required to do one assignment individually (15%) which is electronically assessed. Students are also required to submit a major report which is done in groups of two and this major project is manually marked. The final exam is worth 50%. Note that 25% (10% workgroup tasks and 15% assignment) of the total assessment for this subject is electronically marked.

Discussion

From the small cross section of assessment practices provided in the case studies above, it can be seen that several trends have emerged. Firstly, a shift away from a large weighting of the exam in the final subject mark is clear, with more emphasis being placed on to continuous assessment. Indeed, a 60% weighting on the final exam appears to be a common figure across year-levels and institutions. This might be due to the shift towards providing more "authentic" forms of assessment, which it can argued that an exam fails to qualify as.

Secondly, larger subjects appear to have more in the way of electronic assessment, likely due to the increased overheads involved in assessing large numbers of students and providing adequate and timely feedback. These subjects also tend to be more project-based, with a larger emphasis on group work. However, only one subject in the case studies presented in this paper actually includes elements of peer assessment incorporated in the continuous assessment. This is additionally the only subject where students critically reflect on their work and provide feedback to other students.

Finally, the timing of assessments is quite varied, with some subjects preferring a weekly submission, and others with submissions spread further apart over the semester. It appears that this is heavily based on the preference of the lecturer / subject coordinator and timetabling and staffing constraints. A further study on the reasons for the timing of assessments would be required to determine why this is the case.

Conclusion

In this paper we have investigated different approaches to assessment and feedback in engineering subjects by surveying subjects at several tertiary institutions in Australia. While a more comprehensive study would be useful to compare more approaches and provide a guide to other educators alike, this small cross-section of engineering subjects in Australia has indicated that there is a large amount of diversity in both assessment and feedback practices. The reasons for this appear complex and could warrant further investigation in the future, including a study into the outcomes of these practices on student learning.

References

Allen, G. D. (2003). A Survey of Online Mathematics Course Basics. *The College Mathematics Journal, 34*(4), 270-279.

Belbin, R. M. (1993). *Team Roles at Work*. Oxford: Butterworth-Heinemann.

Biggs, J., & Tang, C. (2007). *Teaching for quality learning at university* (3rd Ed. ed.). UK/New York: McGraw Hill.

Black, P., & William, D. (1998). Assessment and classroom learning. *Assessment in Educatuion: Principles. Policies & Practice, 5*, 5-74.

Buskes, G., Evans, J., Ooi, A., & Shen, B. (2010). *Teacher- versus student-centered approaches to online assessment: experiences in a first year engineering subject*. Paper presented at the 21st Annual Conference for the Australasian Association for Engineering Education 2010, Sydney.

. Calibrated Peer Review: A Writing and Critical-Thinking. Instructional Tool. (2005), from http://net.educause.edu/ir/library/pdf/ELI5002.pdf

Fies, C., & Marshall, J. (2006). Classroom response systems: A review of the literature. *Journal of Science Education and Technology, 15*(1), 101-109.

James, R., McInnis, C., & Devlin, M. (2002). Assessing Learning in Australian Universities. Melbourne, Australia.

Myers, I. B. (1995). *Gifts Differing: Understanding Personality Type*: Davies-Black Publishing.

Ramsden, P. (2007). *Learning to Teach in Higher Education*. London ; New York, NY: RoutledgeFalmer.

Torrance, H. (Ed.). (1994). *Evaluating Authentic Assessment : Problems and Possibilities in New Approaches to Assessment*. Buckingham: Open University Press.

Watson, J., & Angus, S. D. (2008). Does regular online testing enhance student learning? Evidence from a large first-year quantitative methods course. *The quantitative analysis of teaching and learning in higher education in business, economics and commerce : forum proceedings*, 139-159.