

## Authenticity in assessment: reflecting undergraduate study and professional practice

STUART PALMER<sup>†</sup>

The literature suggests that assessment is a powerful tool for influencing student study habits. It is also recognized that there is a tension between traditional forms of assessment and newer forms of assessment that offer a more authentic representation of practice, but are more complex and expensive to administer. The international trend in undergraduate engineering course accreditation to move to demonstration of attainment of graduate attributes poses new challenges in assessment of learning. A case study based on integrating assessment practices across the year levels of an engineering management studies stream in an undergraduate course is presented. Key features of the assessment portfolio include: the use of assessment in the first year as a foundational tool to establish student study habits and skills; the evolution of assessment tasks by the fourth year to reflect the world of professional practice and to allow students to demonstrate their integration of knowledge and skills; the weighting of assessment tasks to indicate the value attached to particular tasks; the structured inclusion of group work; a concern for student and staff workloads; the recognition of student diversity, in particular the needs of off-campus and mature-age students; and the matching of assessment tasks to professional accreditation requirements.

### 1. Assessment in engineering education

It is recognized that the form and content of student assessment strongly influence students' attitude to study and their ways of working (Berglund *et al.* 1998). This implicit role of assessment is recognized along with the explicit 'audit' function of student assessment:

Authorities agree that assessment has two main roles. It warrants or certifies achievement... It also influences learning, partly by signalling what is really valued... (Knight 2001: 1–2).

A recent Australian review of assessment in higher education identified that academic staff and students often view assessment from opposite ends of the curriculum. It is suggested that academic staff consider first what is to be taught, how it is to be taught and then how learning can be assessed. While students first identify what is going to be assessed, what they need to learn and then what study approaches to adopt (James *et al.* 2002). It is further suggested that:

For university teachers, recognising the potent effects of assessment requirements on student study habits and capitalising on the capacity of assessment for creating preferred patterns of study is a powerful means of reconceptualising the use of assessment (James *et al.* 2002: 8).

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<sup>†</sup> School of Engineering and Technology, Deakin University, Geelong, Victoria 3217, Australia. e-mail: spalm@deakin.edu.au

That is, student assessment can be viewed as a strategic tool for enhancing teaching and learning.

Berglund *et al.* (1998), reporting on engineering education in Sweden, identify that industry considers the technical subject knowledge of graduates as 'quite satisfactory', but that university education should place more emphasis on communication skills and the ability to make good presentations and reports. This same result has been reported elsewhere, including Australia:

The majority of employers judged as 'satisfactory' the emphasis given to the basic sciences, the skills, knowledge and practice of the particular discipline of engineering studied . . . But they judged as unsatisfactory the emphasis given to oral and written communication skills . . . and . . . engineering as part of a broader business context . . . (Williams, 1988: 31).

More recently in Australia:

The deficiencies identified to Williams by employers are confirmed by critical feedback from young engineers . . . Australian engineers are well prepared in engineering technology, but not well prepared for the full practice of engineering in its managerial and business dimensions (Bates *et al.* 1992: 8–9).

It is argued that certain skills required by engineering graduates (such as communication skills, creativity, etc.) are not effectively assessed by traditional assessment methods, such as examinations and/or solution of problems of a standard form, and that these traditional forms of assessment can encourage surface learning rather than deep learning (Berglund *et al.* 1998). More 'authentic', or performance-based, assessment techniques that demonstrate student mastery include oral presentations, debates, written portfolios, exhibitions, videotapes, etc. (Burtner 2000). However, it is recognized that more authentic assessment does not come without costs, including 'an extraordinary time commitment' (Burtner 2000), additional financial costs and increased possibility for plagiarism when they replace individual tests and examinations (Knight 2001). The use of journals to allow students to reflect on the applicability of theory in a practical application is noted in the literature. Students were generally positive in their evaluation of journals, reporting that journals had helped them in the learning of their course material. It was identified that the quality of student journals entries did vary, and ongoing feedback was essential to ensure students were using the journals as intended and getting the most benefit from the exercise (Lundström and Booth 2002).

More generally, a 1999 Société Européenne pour la Formation des Ingénieurs (SEFI) (European Society for Engineering Education) working group seminar addressing the topic of assessment produced a list of characteristics of 'fair' assessment that included the following points (Vos 2000):

- 'open'/transparent/predictable criteria;
- related to genuine learning achievement;
- gives feedback/encouraging/guides learning;
- reliable;
- accurate, unbiased, objective;
- relevant and appropriate to content/level/objectives;
- comparable to previous/consistent;
- adheres to rules—punishes plagiarism but has an appeals process;
- continuous/timely;
- accounts for mitigating circumstances and special cases;
- reviewed and changeable—so that improvement is possible.

It is acknowledged that engineering educators are not necessarily experts in educational theory, including assessment of learning; ‘... wanting to do assessment and knowing how to do assessment are two different issues’ (Burtner 2000: 4).

Establishing measurable objectives and evaluating their outcomes are sophisticated activities which most engineering educators have had little or no experience (Peterson 1998: 7).

In Australia, the engineering professional association with responsibility for accrediting undergraduate engineering programmes, the Institution of Engineers, Australia (IEAust), notes the following in its accreditation policies:

It is appreciated that the pedagogies and measuring techniques appropriate to the broader graduate attributes are not widely known in engineering, and it will take time to acquire experience in them (Institution of Engineers Australia 1999: 16).

Engineering educators should seek assistance from experts, where required, to help in the development of appropriate student assessment.

It was suggested earlier that academic staff develop assessment according to the sequence: what is to be taught? How is it to be taught? Then how can learning be assessed? (James *et al.* 2002). But, how is the question ‘what is to be taught?’ answered for engineering education? A systems approach to education suggests that the requirements for engineering education are determined by the requirements for a ‘good engineer’, and that these in turn are determined by a number of stakeholders, including the university, engineering employers and society at large (Rompelman 2000). Obviously, a central stakeholder in determining the content and assessment of undergraduate engineering education is the relevant accrediting professional body, as engineering programmes must, at the absolute minimum, satisfy the requirements of the accrediting body.

In the UK, the undergraduate engineering accreditation function is distributed amongst a range of discipline-based chartered institutions, under the oversight of the UK Engineering Council (Ramsay 2002). To assist in bringing consistency to graduate attributes attained by students in undergraduate programmes accredited by the various discipline institutions, the Engineering Professors’ Council (EPC) has developed The EPC Engineering Graduate Output Standard (Engineering Professors’ Council 2000). This document articulates the desired output standards for all engineering graduates, regardless of discipline, in the form of 26 generic ‘ability to’ statements based on procedures carried out by professional engineers. In the UK it is recognized that ‘The development of output standards... signals the need for intensive thinking about assessment systems and purposes’ (Knight 2001: 1). It is argued that the UK output standards imply an approach to assessment with the following characteristics:

A systematic, programme-wide approach to assessment... Summative, grade-bearing assessment of those outcomes that can be reliably and affordably assessed... Greater use of formative assessment... The orchestrated use of a range of assessment methods... progression in learning and assessment such that... the later stages of programmes set authentic and substantial assessment tasks... (Knight 2001: 3).

It is acknowledged that such an approach presents a challenge to find a practical compromise between the complexity of the output standards and the need for an affordable assessment system that provides summative measures of student performance.

In the USA, the Accreditation Board for Engineering and Technology (ABET) is the principal accreditation body for undergraduate engineering programmes. In 1996, ABET accreditation requirements changed from being prescriptive about programme content and ensuring that students passed their studies, to focusing on ‘demonstrated

student outcomes in actual performance' (Schachterle 1999: 122). This new set of accreditation requirements was entitled Engineering Criteria 2000 (EC 2000). It is acknowledged by many that EC 2000 significantly influences the assessment of undergraduate engineering education, requiring many engineering educators to re-examine the methods they employ to measure student performance and the attainment of required graduate attributes (Schachterle 1999, Burtner 2000).

In 1996, a major review of engineering education in Australia was published (Johnson 1996). This review proposed more freedom for, and scope for innovation by, individual engineering schools in determining their course content and modes of delivery, moving from a prescriptive system of accreditation to one focusing more on demonstrated outcomes and graduate attributes. In response to the recommendations of the review the IEAust issued a revised framework for the accreditation of engineering undergraduate courses (Institution of Engineers Australia 1999). This change brought the Australian accreditation regime into alignment with changes occurring elsewhere in the world, and posed the same questions and challenges to engineering educators about how to measure reliably and cost effectively the required graduate attributes.

## **2. Case study in assessment from Deakin University**

### *2.1. Context*

The Deakin University School of Engineering and Technology offers 3-year Bachelor of Technology (BTech), 4-year Bachelor of Engineering (BE), Masters and Doctoral engineering programmes in flexible delivery mode. The undergraduate programmes contain at least one 'engineering management' unit per year. The author has academic responsibility for first year/first semester unit SEB121 Fundamentals of Technology Management, and the fourth year/second semester unit SEB421 Strategic Issues in Engineering. The stated aims and content for SEB121 are as follows.

This unit aims both to develop the basic skills you will need as an independent, adult learner, and to build up knowledge in several areas of engineering, technology and society. It is also an introduction to modern practices in the engineering workplace. The unit has four modules:

- (1) Technology perspectives.
- (2) Communication skills.
- (3) Introduction to management concepts.
- (4) Quality management concepts.

The stated aims and content for SEB421 are as follows.

This unit consists of three modules:

- (1) Technological forecasting and assessment.
- (2) Policy design in engineering organizations.
- (3) Issues in productivity improvement.

The technological forecasting and assessment module discusses methods for long-term forecasting, factors in technological innovations, and the impact of technological changes on business and society. The topics in the policy design in engineering organizations module are policy structure, designing organizational structure to support policy, and modelling and analysis of policy alternatives. The issues in productivity improvement module focuses on labour productivity, productivity improvement techniques, benchmarking and the changing nature of work practices.

The author's approach to assessment for these two units is founded on a number of principles. These are presented in the following sections.

### 2.2. *Clear aims and objectives*

Aims and objectives can come from many sources, including institutional policy, course accrediting bodies, industry groups, professional bodies and academic staff. Aims and objectives inform the syllabus for a unit and, by testing the student mastery of the syllabus, the assessment indirectly tests achievement of the unit aims and objectives. Within strands or major streams in a course there should be vertical integration of assessment, and across an entire course there should be horizontal integration of assessment. The author has some scope to address integration within a stream, as he has academic responsibility for the 'top and tail' of the management studies strand in the undergraduate course.

### 2.3. *Authenticity and value*

Assessment tasks should reflect and develop the skills that students will need in their university studies and their professional practice. If assessment is perceived by students to be authentic, it is more likely to be valued. If not, it is likely to be confusing and irrelevant to students.

### 2.4. *Fairness and objectivity*

The author finds that marking schemas are a valuable aid in the speedy and consistent marking of student work. They also form a permanent record that can be retained in case of student queries or challenges regarding assessment. If students' work is to be assessed against objective criteria, then it is important that these requirements be clearly spelled out in the assessment details given to students.

### 2.5. *Efficiency and practicality*

The author prefers a series of smaller valued assessment tasks across the semester, rather than a small number of highly valued tasks that may promote crisis-mode student work as the submission due dates approach. However, there is a need to balance the amount of assessment with the real issue of student and staff assessment exhaustion. Practical options for increasing the 'efficiency' of assessment include:

- teamwork/group assignments: this can be made optional, with a word limit that increases with team size;
- peer/self-assessment;
- auto-marked computer-based testing: supported by most modern online course management systems, and can be a valuable part of a portfolio of assessment types.

### 2.6. *Exams versus assignments*

In science and engineering it is not uncommon to find the assessment for a unit consists of two assignments plus an exam, where the exam may count for 70% of the final unit mark. While an exam provides some measure of 'quality assurance' that students have attained a basic familiarity with the topic, such a skewed weighting on an end-of-semester exam is not representative of real engineering practice. Where an examination is required, it can be given a less than traditional weighting, making more room for a range of semester assignments, but with a hurdle requirement added that students must pass the exam to pass the unit overall.

### 2.7. *Meeting the needs of on-campus and off-campus students*

Many off-campus engineering students (who at Deakin are primarily of mature age) come to their studies with significant work experience in the engineering workforce, often with supervisory or management experience, and are generally highly motivated to succeed. Some assessment activities may cause difficulties for off-campus students, such as arranging an oral presentation or group work. Group work can be made optional for off-campus students, as many will already be experienced in group work from their employment. For oral presentation off-campus students can organize a small audience, videotape their presentation for submission and ask the audience to provide an evaluation of their presentation skills.

### 2.8. *Assessment for first year: SEB121 fundamentals of technology management*

The assessment portfolio for SEB121 is presented in table 1. This is a first-year/first-semester unit. There is a portfolio of assessment types including developing basic competencies with university systems, foundation skills such as information literacy and investigation, some tests of discipline knowledge, and some generic skills such as written and oral communication. There is an exam with a ‘must pass’ hurdle requirement, but it does not dominate the assessment. There is a relatively large number of smaller assessment tasks, the aim being student engagement with the course content across the semester, starting small and simple, and building up in size. Continuous assessment starting early in the semester has the benefit of quickly identifying those students falling behind and perhaps at risk of dropping out, so remedial action can be taken.

The majority of assessable items in this unit are submitted online via a course management system (CMS). To build student familiarity with the system and to ensure that any problems are flushed out early in the semester, assignment 1 is a minor exercise, requiring students get online in the first two weeks of semester, to access the CMS system and to introduce themselves in an online discussion forum.

Assignment 2 involves students attending a library information literacy session where information resources related to engineering and technology are presented. To encourage student attendance the library has developed an exercise to test students on the resources and search strategies presented, and the completed exercise is submitted and marked. Attaching marks to this exercise means that most students will complete this important foundation skill-building activity.

Assignment 3 looks to extend the skills developed in assignment 2, and to tie in with related class material addressing written communication, plagiarism, etc.

Item	Description	Marks
Assignment 1	Introduction to CMS online system	4
Assignment 2	Information literacy and the library	5
Assignment 3	Referencing	6
Assignment 4	Professional ethics report	15
Assignment 5	SEB121 multi-choice test 1	9
Assignment 6	SEB121 multi-choice test 2	9
Assignment 7	Major report and presentation	22
Examination	Must pass!	30

Table 1. Assessment portfolio for SEB121.

Students use the library to locate and produce formatted references for a number of each of the following information sources—textbooks, journal papers, conference papers and websites.

Assignment 4 aims to exercise the skills developed in assessment tasks completed so far and to tie in with class work dealing with professional practice and ethics. Students have to locate a published case study relating to the failure of technology, assess the ethics of the parties involved, and submit a written report professionally presented with appropriate graphics and referencing.

Assignments 5 and 6 are similar, being multi-choice, auto-marked tests completed online in the CMS. The questions relate to the course material being studied at the time and form a mini-bracket of continuous assessment for a 2-week period. The multi-choice format is used to vary the range of assessments in the unit and to reduce the overall marking effort required.

The final major assignment for the semester seeks to integrate the skills and knowledge gained throughout the semester in the context of a real-world case study. Students, working in groups of up to three, identify and investigate a real organization via published literature and/or visit to interview a manager. In a written report they document and analyse the organization's approach to a number of technology management issues. Based on this work, the group then prepares and delivers a 10-minute oral presentation to the class.

#### 2.9. Assessment for fourth year: SEB421 strategic issues in engineering

The assessment portfolio for SEB421 is presented in table 2. This is a final-year/final-semester unit and the next stop for many students is professional practice. Emphasis is now placed on discipline and practice skills and knowledge, and advanced conceptual topics. There is a smaller number of more significant assessment tasks, with a focus on practising generic professional skills in the context of discipline area case studies. There is an exam with a 'must pass' hurdle requirement.

Reflective thinking based on experiential learning is a key skill required for the lifelong learner and the socially mature engineering professional (Schön 1995). Assignment 1 aims to develop skills in critical reflection on action, and is completed across the semester by asking students to reflect weekly in short written form on what they learned and of what value it might be in the future. At the end of the semester students are asked to prepare a reflective report that identifies: the important things learned in the unit; insights they have gained into the way(s) they learn; and suggestions for improving the unit.

Assignment 2 requires students, working in groups of three, to locate a published organizational case study relating to the issues currently being studied in class. In a

Item	Description	Marks
Assignment 1	Reflective journal	10
Assignment 2	Technological forecasting and assessment	10
Assignment 3	Policy design in engineering organizations	10
Assignment 4	Major report	20
Examination	Must pass!	50

Table 2. Assessment portfolio for SEB421.

written report they document and analyse the organization's approaches to the issues. Based on this work, the group then prepares and delivers a 15-minute oral presentation to the class. The topic for assignment 2 is technological forecasting. Assignment 3 has identical requirements to assignment 2, except that the topic is policy design.

The final major assignment for the semester seeks to integrate and further exercise the skills and knowledge gained throughout the semester (and across the entire management stream of study), in the context of a real-world case study. Students, working in groups of up to three, identify and investigate a real organization via a visit to interview an engineering manager. In a written report they document and analyse the organization's approach to the range of the technology management issues, contrasting the approaches of the organization to those studied in class. Based on this work, the group then prepares and delivers a 20-minute oral presentation to the class.

### **3. Conclusion**

It is recognized that the form and content of assessment are powerful tools for influencing student study habits. It is also recognized that there is a tension between traditional forms of assessment (examinations, problems of a standard form, etc.) that are easy to administer, but are not a realistic representation of engineering practice and which may promote superficial learning, and newer forms of assessment that offer a more authentic representation of practice and assist in developing desirable student skills, but are more complex and expensive to administer. It is acknowledged that engineering educators may not be expert in the assessment of learning outcomes, and should seek assistance where necessary. Engineering course accreditation requirements strongly influence course content and hence the choice of assessment. The international trend in accreditation to move to demonstration of attainment of graduate attributes poses new challenges in assessment of learning.

A case study based on integrating assessment practices across the year levels of an engineering management studies stream in an undergraduate course has been presented. The portfolio of assessment seeks to recognize the importance of alternative assessment practices across the year levels: from first-year assessment, when students have their entire undergraduate studies before them, to the fourth year, the brink of professional practice. The assessment portfolio was strategically designed to address both student development and teaching and learning goals. Key features of the assessment portfolio included:

- the use of assessment in the first year as a foundational tool to establish student study habits and skills;
- the evolution of assessment tasks by the fourth year to reflect the world of professional practice and to allow students to demonstrate their integration of knowledge and skills;
- the weighting of assessment tasks to indicate the value attached to particular tasks;
- the structured inclusion of group work;
- a concern for student and staff workloads;
- the recognition of student diversity, in particular the needs of off-campus and mature-age students;
- the matching of assessment tasks to professional accreditation requirements.

The approach to assessment described was underpinned by documented educational principles, an appreciation of student motivation and an appropriate degree of pragmatism.

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### About the author

Stuart Palmer graduated in electronics engineering, and worked in private industry for nine years with a consulting engineering firm. Working in electronic design, industrial automation and

process control, he progressed from project engineer to senior engineer to business unit manager. In that time he also completed a Master of Business Administration in Technology Management. In 1995 Stuart joined the School of Engineering and Technology at Deakin University, where he holds the position of senior lecturer, lecturing in Technology Management at undergraduate and postgraduate levels. Stuart has recently completed Doctoral studies in engineering education, and his research interests include frequency domain analysis, engineering education, the use of new media in education and the relationship between technology and society. Stuart is a member of the Institution of Engineers, Australia, a member of the Australasian Association for Engineering Education and a Chartered Professional Engineer.