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Towards Authentic Assessment – an Evaluation of Assessment in a Postgraduate Engineering Asset Management Course

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BACKGROUND

An evaluation of assessment of the University of Southern Queensland postgraduate engineering management course ENG8104 *Asset Management in an Engineering Environment*, which is taught in a number of Faculty of Engineering and Surveying programs, is discussed. This evaluation considers the way in which participants in this course are assessed in relation to the authentic assessment of the sustainable life cycle management of engineering assets. Current assessment is by a mid-semester assignment and an end of semester examination, each worth 50 per cent of marks in the course. The question is raised whether this assessment is an authentic approach to evaluating whether learners both understand the course material and can apply it in a way that meets current and emerging professional engineering requirements.

PURPOSE

The following research question is addressed:

To what extent does the assessment of this course meet the requirements of professional engineers in undertaking sustainable life cycle management of engineering assets, including contemporary and emerging professional issues?

DESIGN/METHOD

The research method adopted for this study used the following steps to meet the research objectives:

- Review sustainable life cycle management of engineering assets.
- Review course assessment methodologies, including authentic assessment.
- Apply program evaluation principles to assess issues and develop options.
- Evaluate how assessment for the course compares with advantages claimed for good assessment practice.
- Develop conclusions with respect to course assessment

Research is primarily based on evaluation of course assessment from the point of view of the author as an observer participant examiner. Other research inputs include review of professional practice requirements, analysis of past assessment results, and anecdotal information.

RESULTS

The study has shown that the assignment in this course partially authentically assesses the requirements of professional engineers undertaking sustainable life cycle asset management. It has also shown that the examination is not a good instrument for authentic assessment of these requirements.

CONCLUSIONS

While current assessment for this course tests learner knowledge and is aligned with course objectives, it is considered that it may not provide the best approach for assessing professional engineering practice in sustainable life cycle asset management. This paper addresses the assessment process in this course from this point of view.

KEYWORDS

Asset; management; authentic; assessment; evaluation.

Introduction

The postgraduate course ENG8104 Asset Management in an Engineering Environment (Thorpe, 2012), is offered by the Faculty of Engineering and Surveying at the University of Southern Queensland in both on-campus and distance education (external) modes. It is primarily taught in the Master of Engineering, Master of Engineering Technology and the Master of Engineering Science programs, and in other postgraduate programs in the Faculty as well as to some advanced undergraduate students.

Assessment in this course is by a mid-semester assignment (Assignment 1), which assesses learner progress in the first three modules of the course, and an end of semester examination, which assesses the whole course. In the current offer of the course, each of these assessment items has a weighting of 50 per cent of the overall assessment.

While the assessment process has so far appeared to achieve the goals of assessing the extent to which learners understand the course material, and while assessment in this course aims at constructive alignment (Biggs, 1999, 2001) of course objectives, teaching and learning, and assessment, the question remains as to whether the assessment in this course best meets the goals of the learners, and of their industry and profession.

The changing nature of both engineering and asset management is also an important consideration in the delivery of this course, including its assessment. Managers of engineering assets have a complex task. As noted by Lutchman (2006, p. 18), they are required to optimise the life cycle of an asset to meet performance requirements in a safe and environmentally sound manner through smart planning, investment financing, engineering, operations, maintenance, refurbishment and replacement. Such a definition requires them to consider many professional issues, including life cycle project management, sustainability and risk management.

Professionals and their employers are now expecting postgraduate courses to be more relevant to the needs of professional practice. While some of these changes can be made through updating course material, there is a significant issue in making assessment relevant to the needs of professional practice. For this reason, a major component of improving relevance of this course for the professional engineering asset manager would be focused on the assessment process, which is a significant goal for learners and is important in providing learners with a realistic understanding of the content of the course and the extent to which they meet professional requirements in the management of engineering assets.

Research was therefore undertaken to explore options for improving the relevance of assessment of this course to professional and industry needs. It particularly focuses on authentic assessment, which is stated to be criterion based, aligns the task performed with professional practice, meets the physical and social contexts of the task, and achieves outcomes that demonstrate the attainment of required professional competencies (for example, Gulikers et al., 2004). This research addressed the following main question:

- To what extent does the assessment of this course meet the requirements of professional engineers in undertaking sustainable life cycle management of engineering assets, including contemporary and emerging professional issues?

The research also considered options to improve the assessment of the course. Such options are briefly discussed in the conclusion.

It did not address any potential future realignment and change in course objectives and content as a result of assessment changes.

Overview of the Course

Course Description

ENG8104 Asset Management in an Engineering Environment primarily addresses strategic engineering asset management, and was primarily developed for the coursework Master of Engineering program, where it is a core course in each of the Majors in this program (advanced structural engineering design, engineering management and engineering project management). It has a companion course, ENG8206 Whole of Life Facilities Management, which focuses on the more detailed aspects of asset management and maintenance.

The course is delivered in the first semester of the academic year and has a total nominal workload of 165 hours. The current objectives to be attained by learners are as follows:

- demonstrate an understanding of the role of asset management;
- apply cost effective whole of life financial planning for engineering and technological assets;
- critically evaluate and apply options for asset replacement, rehabilitation or upgrading;
- evaluate and manage the application of computer based asset management systems.

Teaching is delivered through seven modules, divided into the two streams of asset management theory and applications of that theory.

Learners in this course, who are primarily engineers, either attend on-campus classes at the Toowoomba, Queensland campus of the University or study it through distance education. All learners receive a course study package consisting of an Introductory Book, Study Book and List of Readings (Thorpe, 2012), and have access to an electronic Study Desk for interaction with academic staff and discussion about the course.

Current Assessment

Learners in ENG8104 undertake two pieces of assessment: a mid-semester assignment and an examination at the end of the course. At the moment, each assessment item is weighted at 50% of course marks. In some past offers of the course, the assignment was worth 40%.

Assignment

The assignment covers the theoretical material delivered in the first half of the semester, and is a summative assessment instrument designed to both assess the knowledge of students of the asset management theory section and provide learners with feedback about their performance to date. It aims to achieve the principles of constructive alignment (Biggs, 2001) through addressing the first two course objectives, and consists of the following components:

- An essay question, of 3000 to 4000 words in length, worth 30% of course marks, which asks learners to develop an asset management strategy for an engineering asset system of their choice. They are challenged to identify and address those matters that they would address in taking over an aged, poorly managed system, and improving it so that it meets world best practice in 10 years
- A mathematical question, worth 5% of course marks, that requires learners to apply the principles of depreciation to the cost of asset ownership.
- A second mathematical question, worth 15% of course marks, which requires the application of discounted cash flow principles to the comparison of the net life cycle benefits for the two options of rehabilitation or replacement of an aging asset.

Examination

A two hour examination at the end of the semester, which is worth 50% of course marks, is designed to test learner knowledge of the whole course. It is conducted in a closed

environment in which no reference materials or calculators are allowed, and consists of five questions, all drawn from the course Study Book, of which four are to be answered.

Professional requirements of engineering asset managers

Asset managers are required to implement a sound and sustainable asset management program, minimise ownership costs, involve staff, incorporate performance measures, plan for funding, improve the safety and environmental aspects of asset management, and ensure safe operation of the asset (Lutchman, 2006, p.9).

They are also required to understand and apply the asset management life cycle of planning, developing and maintaining the asset, and in doing so are required to undertake strategic management, risk management, safety management (Queensland Government, 2007) and life cycle sustainability. In addition, they should consider emerging asset management issues, such as data quality (Lin et al., 2007) and the social considerations of asset development, operation and management. They also are required to optimise the asset life cycle to meet performance requirements in a safe and environmentally sound manner.

Most asset managers are professional engineers, and are therefore bound by a Code of Ethics (Engineers Australia, 2010) that defines the values and principles that shape the decisions made in engineering practice. In particular, as professional engineers, they are required to demonstrate integrity, practise competently, exercise leadership and promote sustainability. The definition of “sustainability” in the Code of Ethics includes the traditional concept of balancing the needs of the present with the needs of future generations (Brundtland, 1987), but also includes community and stakeholder engagement; and the health, safety and wellbeing of the community and the environment.

Engineering asset managers are also required to address the competency standards of Engineers Australia (Engineers Australia, 2011). Such requirements include, in addition to technical engineering competencies, other skills such as business management and sound asset management practice.

It would therefore be expected that the primary considerations in assessing the learning of the modern asset manager would be centred around sustainability, and related areas like strategic asset life cycle management, sound business management, risk management including safety management, and emerging areas, such as data quality.

Principles of Good Course Assessment

According to Boud (1998), the two key purposes of assessment are to certify and prompt learning, or formative and summative assessment. Good assessment tends to be criterion-referenced (Connoley, 2004) and meets the principles of constructive alignment (Biggs, 1999, p. 64; Gulikers et al., 2004). Quality student assessment should also support the interrelated objectives of guiding and encouraging effective approaches to learning, validly and reliably measuring expected learning outcomes (and in particular higher-order learning), and defining and protecting academic standards (James, McInnis and Devlin, 2002). It also assesses learning, identifies knowledge gaps in students, encourages student learning and builds on the learner’s confidence (Christie and Stehlik, 2006).

According to Connoley (2004), good criterion-referenced assessment requires clarity about what learners should be learning in terms of qualities or performance criteria, and assessment tasks that advise the assessor with respect to how well students meet the criteria. This process commences with setting learning objectives.

Other considerations in good assessment include challenging learners to achieve deep learning, or going below the surface of the study material to understand its meaning, as opposed to shallow, or surface, learning (Biggs, 2001). Such assessment is not only aligned with course objectives and instruction, but also to provide challenging, realistic tasks that motivate learners to meet higher order objectives in the cognitive domain.

In summary, good assessment at the postgraduate level should be criterion referenced, meet the principles of constructive alignment, and challenge learners to fully understand the material being taught and meet high level objectives in the cognitive domain.

Authentic Assessment

One of the key challenges in teaching professional learners is to cross the gap between teaching and professional practice, such as in the professional management of engineering assets. An approach to achieving this goal that also meets the principles of constructive alignment between instruction, learning and assessment is authentic assessment (Gulikers et al., 2004), which can be defined as a form of assessment in which students are asked to perform real-world tasks that demonstrate meaningful application of essential knowledge and skills (Meuller, 2005).

Gulikers et al. (2004) observe that while opinions differ on what constitutes authentic assessment, it is clear that it is a form of performance assessment and accordingly links closely with criterion-referenced assessment. They note that to positively influence student learning, authentic assessment should be aligned to academic instruction, and that it requires students to demonstrate their competencies in a situation that resembles professional practice. They also state that authentic assessment is subjective, thus making it important to take account of student perceptions when designing an authentic assessment. They also argue that the two most important reasons for choosing authentic assessment are construct validity (related to whether an assessment measures what it should measure) and consequential validity (which describes the intended and unintended effects of assessment of instruction on teaching). In addition to validity, good assessment should also have reliability, which may be described as reliability the degree to which test scores are free from errors of measurement (American Psychological Association as cited in Killen, 2003). It should also be fair.

Gulikers et al. (2004) define authentic assessment under five elements (task, physical context, social context, assessment form and criteria), each divided into a set of elements, with which existing assessment can be compared. In evaluating the assessment used in *ENG8104 Asset Management in an Engineering Environment*, the research extended this basic framework through the addition of an extra element titled “current and emerging professional issues”, in order to include comparison of course assessment with items such as sustainability, risk, safety and other professional issues.

Evaluation Methodology

While there are a number of approaches to evaluation, that of Owen (2007), modified for evaluation of this course, was used for the research. Owen (2007, p. 1) states that evaluation may be seen as a process of knowledge production, which rests on rigorous empirical enquiry. He defines three steps in the evaluation process:

- developing an evaluation plan
- implementing an evaluation design to produce findings
- disseminating findings to interested audiences (Owen, 2007, p.63).

The interactive form of evaluation (Owen, 2007, p. 39) was used for the evaluation of assessment in *ENG8104 Asset Management in an Engineering Environment*. This methodology is based on the assumption that people with a direct vested interest in interventions should also control the evaluation of these interventions. It aims to improve a program that is already being delivered, and has a focus on program delivery. In this particular evaluation, the author acted as participant observer.

The questions in the evaluation were based on questions proposed by Owen (2007, p. 93) for interactive evaluation. The questions focused on what happened in the assessment, what was working well and not working well, how learners were affected by the assessment, how the assessment met the individual goals and needs of students, and how it could be improved.

The primary assessment process was comparison of existing assessment compared with the advantages claimed for good authentic assessment. In addition, there was a comparison of results, over the time the course has been offered, in the assignment compared with the examination. The author's experience and learner comments on assessment (where available) were also used. This range of approaches was aimed at improving triangulation of data and evidence (Bryman, 2004; Martineau and Hannum, 2004).

Results

Assessment of results against authentic assessment

Each question in the assignment, and the examination as a whole, was compared against the five elements of authentic assessment listed by Gulikers et al. (2004) - task, physical context, social context, assessment form and criteria - each of which was divided into sub elements. As previously discussed, an additional element – current and emerging professional issues - was added to this assessment in order to make it relevant to the previously discussed desired goals of the course. Formative assessment tasks (such as tutorials and formative questions and exercises in the study material) were not assessed for this evaluation.

The comparison used a five point Likert scale, in which a score of 1 was a very poor fit to the element, a score of 5 a very good to excellent fit to the element, and scores of 2, 3 and 4 were allocated to intermediate fits. A rationale was given for each score allocated. For example, a score of 3 was allocated to the sustainability aspect in the Professional Issues element for Question 1 on the assignment, as this question contained some sustainability requirements related to life cycle asset management. Table 1 shows a summary of the fit of each assessment item to the six elements of authentic assessment compared.

Table 1. Comparison of Existing Assessment of ENG8104 with Authentic Assessment

Authentic Assessment Element	Score - Assignment Question 1 (Strategy)	Score - Assignment Question 2 (Depreciation)	Score - Assignment Question 2 (Economics)	Score - Examination
Task	4	3	3	3
Physical Context	4	3	3	2
Social Context	3	3	3	3
Result/form	4	3	3	3
Criteria	4	4	4	4
Professional Issues (added by the author)	3	2	2	2

Table 1 shows that, according to the elements for authentic assessment defined by Gulikers et al. (2004), supplemented by consideration of professional issues, all existing forms of summative assessment in this course have both strengths and weaknesses. Thus, all summative assessment tasks evaluated were strong in assessment criteria, and were of medium strength in the social context of authentic assessment results and form of assessment. The first question in the assignment (a searching essay question on strategic

asset management) was quite strong in result and form of the assessment and of medium strength in professional issues, while the other assessments were of medium strength in result and form and did not address professional issues well. While the first question in the assignment was strong in task and physical context, the other two (numerical) questions in the assignment were of medium strength in this element. The examination was of medium strength in task, but poor in physical context.

The author has kept to a similar basic format for each form of assessment with incremental annual changes aimed at making the assessment more relevant to current educational practices. Changes to assessment in recent years have included the use of more reflective questions in both forms of assessment, and the use of rubrics for marking (introduced in 2011).

Additional Approaches to Evaluation of Assessment for the Course

In addition to the comparison of the assessment process against authentic assessment, the consistency, over the period of offer of the course, of each type of assessment (assignment and examination) was estimated through comparing the percentage results in the assignment and examination over the period of offer of the course. Learners who did not attempt both the assignment and the examination were omitted from this study. Percentage results were used, as the proportionate value of the assignment and examination varied between different years varied over time (the assignment was worth 50% of course marks in some years and 40% of course marks in other years). The percentage of marks obtained by the learners was therefore a common measure of the achievement in each method of assessment.

In addition to estimating the consistency of the assessment process, this method also aided in comparing the percentage marks received for the assignment and the examination. If there was not a significant difference in favour of the assignment, then there would be a fairly low risk of a learner gaining higher marks in the course through modifying the course to include two assignments rather than the traditional examination and assignment. If there was a significant difference in favour of the assignment, then any option to replace the examination with an assignment would require further investigation.

Average percentages in the assignment, examination and for the while course for the 255 learners (132 learners studying by external student and 123 learners studying on campus) undertaking the course over its period of offer of 2004 to 2012, were as shown in Table 2.

Table 2. Average Percentages for ENG8104 – Period 2004 to 2012

Factor	Assignment	Examination	Total for Course
Mean	70.9%	66.6%	68.5%
Standard Deviation	13.4%	12.3%	10.4%
Standard deviation/Mean	18.5%	18.9%	15.2%
Maximum	98.8%	95.8%	94.7%
Minimum	30.0%	25.0%	38.9%

In summary, Table 2 shows that over the period of offer, percentage marks over the period of offer of the course tend to be reasonably consistent, with a with a ratio of standard deviation to the mean of 18.5% (assignment), 18.9% (examination) and 15.2% for the course as a whole. The mean percentage for the assignment tends to be slightly higher than the mean mark for the examination.

A further analysis was also undertaken of the difference between percentage marks received in the assignment and the examination to see if there was any significant difference between them. A standard confidence interval estimating approach for larger samples, using the mean

and variance of the probability distribution of the percentage marks for the assignment and examination as inputs, was used for this calculation. The results showed that the estimated confidence interval of the difference between the mean (average) percentage marks of the assignment and examination was between 2.1% and 6.5% at the five per cent level of significance. Such analysis shows that while there is a measurable difference between the two forms of assessment, it is not high. Therefore, it is concluded that the examination, which is not considered an authentic assessment instrument, could be replaced by an assignment that mirrors professional practice, provided the assignment was made sufficiently rigorous.

From the point of view of the author as observer participant, learners have not had significant difficulty with Question 1 (essay type of question) of the assignment, which is considered the most authentic current assessment process. They have had some difficulty with the numerical questions. There have been few difficulties reported with respect to the examination, apart from its length.

There are few learner comments with respect to the level of difficulty with respect to the assignment and the examination. The main comments, some of which are posted on the course Study Desk and some of which have been received by the author anecdotally, are that the examination is long. This comment may at least partially explain why examination marks tend to be lower than assignment marks.

Conclusion

The existing summative assessment for *ENG8104 Asset Management in an Engineering Environment* meets the requirements of constructive alignment, construct validity and consistency. While all items meet the requirements of authentic assessment with respect to the criteria used for assessment of learner performance, only the first question on the assignment achieved a score of 3 or more out of 5 on all elements of authentic assessment. Therefore, the remaining questions in the assignment and the examination require further review, an important question being whether to retain the existing examination or to replace the examination with a revised assignment that truly evaluates whether learners have achieved the required competencies relevant to the sustainable life cycle management of engineering assets, including current and emerging issues.

The examination, which is considered the least authentic of assessment approaches, is unlikely to be able to be improved from this point of view because of the time constraints in which to complete it. A different form of assessment, such as a challenging assignment, is likely to be suitable for this purpose provided it is of sufficient challenge and difficulty, and marking is sufficiently controlled and rigorous (for example, though the use of detailed rubrics).

All summative assessment items should include activities or questions that assess how well learners are able to meet current and emerging professional issues like sustainability and risk management.

Therefore, there are a range of options available for improving course assessment. Such options include modifying the numerical component of the existing assignment to make it more relevant to the needs of the profession and industry; and replacing the examination with a rigorous authentic assignment that mirrors work conditions (for example, presentation of the solution to a challenging problem, or a timed assignment reflecting professional work conditions). The option implemented would be likely to be relevant to the professional needs of industry and the learners, meet professional requirements including current and emerging professional issues, and challenge the learners to achieve at a high level of performance. It would also meet the principles of good assessment.

The next step in such a process, which would complete the evaluation process, is to disseminate findings of the research to all stakeholders in the course, including industry, learners and academics, and obtain their feedback, possibly in a stakeholder workshop.

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