Towards the development and delivery of sustainable assessment in foundation engineering studies

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C3: Integration of teaching and research in the engineering training process

CONTEXT Boud (2000) has argued that higher education assessment must be sustainable so it "meets the needs of the present and prepares students to meet their future learning needs". Within engineering education, sustainability means tasks should have real-world currency and encourage lifelong learning and self-regulatory competence. Portfolios are a widely adopted assessment practice in engineering which aligns well with understandings of sustainable assessment; however, many students have not experienced this assessment before entering higher education. Mismanaging the implementation of these assessments at critical times such as first encounters can often result in student bewilderment and frustration, potentially leading to increased attrition.

PURPOSE The study aimed to develop effective scaffolding and supports for introducing portfolio assessment to first-year engineering students in response to student voice data.

APPROACH An action research approach was adopted to examine the implementation of portfolio assessment with a cohort of Engineering students from diverse backgrounds. Students' experiences of this portfolio assessment were gathered via surveys where they were asked to rate assessments on the 'value' of their learning, how much 'effort' was required to complete them and how 'difficult' they were to complete. These investigations, along with student satisfaction and results, informed significant revisions to the assessment structure of the unit in 2016 and further refinements in 2017; while the largely cross-sectional design means that such data cannot establish that one approach was more effective, they can provide some anecdotal evidence of improvements in the student experience.

RESULTS Data indicated that unit revisions might have improved both students' experiences and their academic achievement. For example, Absent Fail grades fell in 2017 to only seven down from 17 in 2015. Also, the 2017 cohort achieved an increase in grade point average of 4.91 up from 4.27 in 2015. Improvements in student satisfaction in areas of assessment tasks, learning resources and Moodle navigation were also noted.

CONCLUSIONS These data suggest that not only could students see the benefit of portfolio assessment, but that introducing it in a structured and scaffolded way potentially improves the student experience and also their academic results.

KEYWORDS Portfolio assessment; Student success; Foundation studies

Introduction

Boud (2000) has argued that higher education assessment must be sustainable so it "meets the needs of the present and prepares students to meet their future learning needs" (p. 151). Furthermore, sustainable assessment creates learners who are more able to cope with the changes they will experience in their working life (Boud & Soler, 2016). Adaptability is especially critical for graduate engineers, who must quickly come to terms with and continuously stay abreast of rapid and frequent change in the sciences and technologies which underpin their field (Engineers Australia 2013).

Unlike many commonly used higher education assessment genres (e.g., exams, traditional essays), which are primarily used to measure learning, sustainable assessment tasks become learning pathways for students to develop intricate knowledge, skills, and dispositions. Developing and implementing such sophisticated assessment is challenging for institutions with a range of study modes (online, blended, and on-campus) and diverse students who vary widely in demographic characteristics such as age, socio-economic status, and ethnicity. Furthermore, sustainable assessment should have real-world currency and encourage students to develop lifelong learning skills and self-regulatory competence to perform in complex and rapidly evolving environments.

To develop these skills, students must often engage with pedagogies and assessment genres they may not have previously encountered. Project-based learning contextualises the curriculum via inquiry around complex and current project scenarios and is often assessed through portfolio assessment, self- and peer-assessment and in some cases, reflective writing. These assessment genres, implemented effectively, can foster lifelong learning and self-regulatory competence.

The use of project-based learning and novel forms of assessment is not new to engineering education but students can react negatively on their initial encounter when they are placed outside of their comfort zone, or they do not understand what to do to be successful (Struyven & Devesa, 2016).

The study aimed to develop effective scaffolding and support for introducing portfolio assessment to first-year engineering students in response to student voice data. It was thought that portfolio assessment would provide students with a sustainable assessment experience that would help them develop not only engineering content knowledge and skills, but also improve their self-regulation and abilities to act as self-directed learners.

Methodology

The study reported here was part of the larger Higher Education Participation and Partnerships Programme (HEPPP) funded Supporting Student Assessment Success (SSAS) Project (Dargusch & Harris, 2015-2017), investigating students' perceptions of the assessment supports provided in first-year university courses. Ethical clearance was obtained (H15/02-024) to gather data on student experiences of assessment supports within the unit. All data were collected by the second and third authors who were not involved in teaching into the unit.

An action research approach was adopted to examine implementation of portfolio assessment in a project-based learning core unit (ENEG11001 – Engineering Skills 1, superseded in 2016 by ENEG11005 – Fundamental of Professional Engineering) offered to first-year students in several engineering courses at CQUniversity. Data for this paper were primarily collected via the university higher education dashboard and student surveys. Students were provided details of the study and ethical safeguards, giving consent by choosing to complete the instrument. Students' value perceptions were obtained from the 2015 cohort by 42 participants representing a 27% response rate. In 2017, 37 participants returned valid surveys representing a 26% response rate. Participants were asked to rate

assessments on a six-point scale in terms the ‘value’ of their learning, how much ‘effort’ was required to complete them and how ‘difficult’ they were.

Several interventions were conducted with the aim of better preparing students for portfolio assessment. Feedback from staff and students were used to make improvements to the unit (Table 1). Interventions were implemented over the 2016 and 2107 offerings of ENEG11005.

Table 1: Interventions to assessments and supports

2015	2016	2017
Portfolio Assessment: 100% Individual Portfolio due in Exam Week. Comprising Grade Nomination (self-assessment against the marking rubric), Personal Reflective Journal, Individual Workbook, Individual Reflective Paper (encouraged to submit early to obtain formative feedback by Week 6), Individual Drawing Folder (formative feedback offered in Week 9), Self and Peer Assessment results, and a Viva Voce. **Other Assessment:** Four team projects with formative technical reports or presentation to create scenarios for students to compile evidence in their portfolio of meeting the marking rubric and unit learning outcomes. A**ssessment Supports:** • Reflective writing guide • Referencing guide • Basic examples of Grade Nominations and entries in Workbooks and Reflective Journals • Portfolio Marking Rubric • Technical Report Template	**Portfolio Assessment:** 30% Individual Portfolio due in Exam Week similar to 2015 but without Reflective Paper and Drawing Folder to allow separate assessments which scaffold skills for creating the portfolio. **Other Assessments:** 10% Individual Reflective Paper due in Week 4, to scaffold reflective writing. 30% Individual Sketching and new AutoCAD drawing activities due in Week 7, to scaffold the development of technical skills for the team project. 30% Project Action Plan and Individual Reflective Paper due in Week 9 to prepare students for addressing the portfolio marking rubric. One team project with formative technical report and presentation, in response to students’ requests to limit the number of project investigations. **Assessment Supports:** • As with 2015 plus … • Instructional videos for drawings activities as they are highly valued by students (Taylor, Harris, and Dargusch 2015) and they flip the classroom making assessments a learning pathway (Brown 2005). • Reflective Paper exemplar	**Portfolio Assessment:** As with 2016 but Viva Voce removed because it required substantial staff effort, yet had limited value by students (Taylor, Harris, and Dargusch 2015). **Other Assessments:** As with 2016 but second reflective paper replaced with a summative Team Technical Report in response to student feedback regarding excessive assessment on individual reflection and not enough emphasis on team project outcomes. This structure promotes completing all aspects of the team project to ensure adequate evidence is obtained for addressing the portfolio marking rubric. **Assessment Supports:** • As with 2016 plus … • Portfolio exemplar as students requested additional exemplars when queried on how unit resources could be improved (Taylor, Harris, and Dargusch 2017). • Additional instructional videos comprising preparing the report introduction, locating data sources and performing a literature search, and completing several technical tasks for the team project and individual portfolio.

Also in 2017, to help students perceive the importance of mastering skills being taught at the foundation level, a framework was introduced for progressive development of professional skills based on critical aspects of employability for engineers (Nair, Patil & Mertova 2009; Trevelyan 2014; Willmot & Colman 2016; Dowling et al. 2016).

Results and Discussion

Results are presented by comparisons over the three-year period to 2017 being offerings of ENEG11001 – Engineering Skills 1 in 2015 superseded by ENEG11005 – Fundamental of Professional Engineering in 2016. Key areas analysed include student satisfaction; unit grade distribution; and students' perceptions of assessment task 'value' to their learning, how much 'effort' was required to complete them and how 'difficult' they were to complete.

Student Satisfaction

The response rate for the student satisfaction surveys over the three years remains reasonably constant (approximately 60%), indicating that comparisons between the cohorts can be made and that in these units, the students remained reasonably engaged (Figure 1).

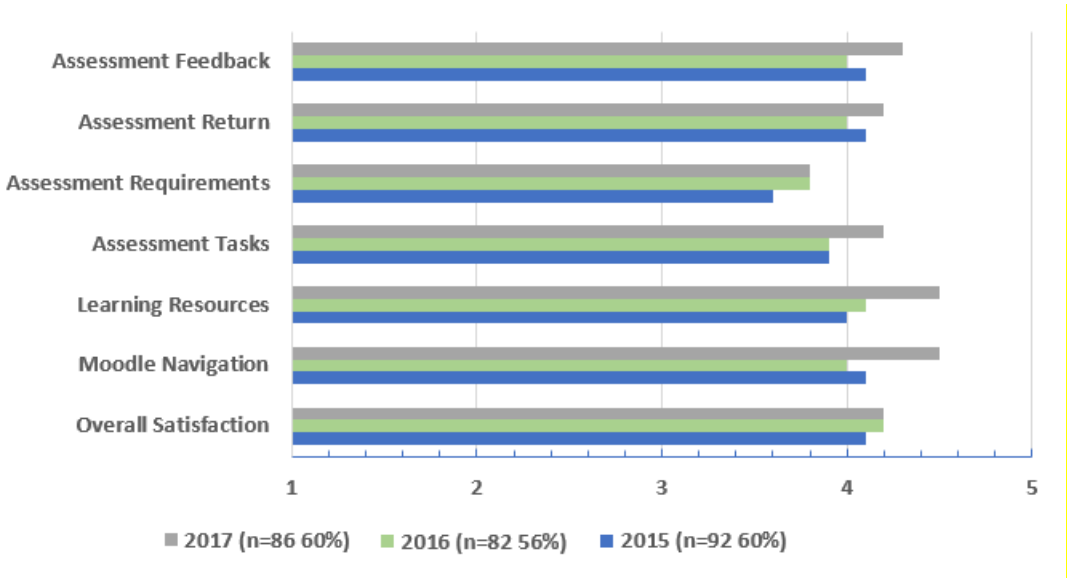

Figure 1: Student satisfaction trends in ENEG11001 (2015) & ENEG11005 (2016 & 17)

The 2017 offering achieved or equalled the highest student satisfaction across all key performance areas, suggesting that the interventions have overall achieved a positive outcome for the students' experience and satisfaction.

The satisfaction score for assessment requirements remains consistently below the university average despite focus by the teaching team on thoroughly introducing and preparing students for the assessment (Portfolio, Reflective Paper, Self-and Peer Assessments). This result confirms reports in the literature that students may react negatively to new forms of assessment (Struyven & Devesa, 2016).

Assessment tasks, learning resources and Moodle navigation (Web-based learning management software) all show significant improvements in student satisfaction. Interventions which focused on improving these aspects of the unit appear to have been successful; it appears that having a structured approach to introducing assessment was appreciated by the students.

Grade Distribution

Minimal changes were made to the standard, type and level of assessments over this period, yet the grade point average has been steadily increasing with more students now able to achieve exceptional results and higher attainment of the unit learning outcomes (Figure 2). This indicates the approaches used to introduce new assessments may effectively reduce the negative reactions to first encounters of foreign assessment types, at least in relation to student grade concerns.

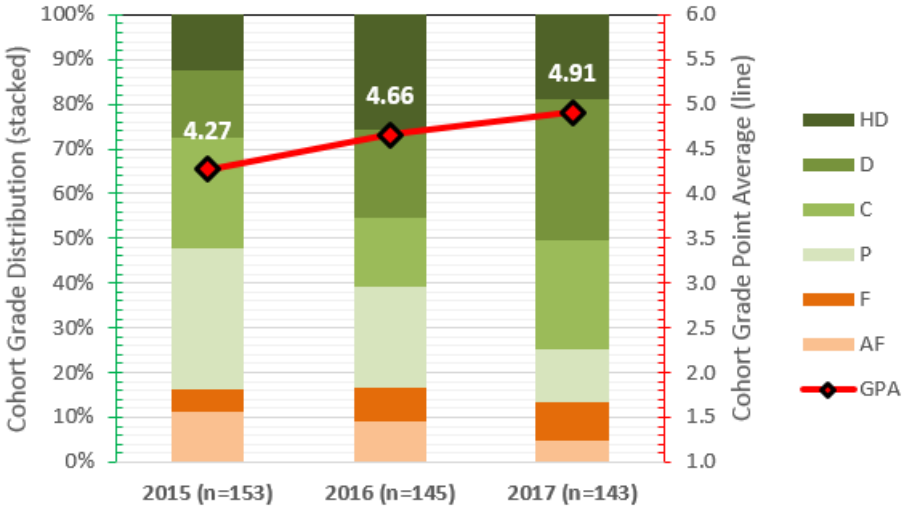

Figure 2: Grade trends in ENEG11001 (2015) & ENEG11005 (2016 & 17)

Student numbers are slightly reducing in line with current trends in engineering enrolments across Queensland. An increasing completion rate has enabled the number of students passing the unit to be maintained.

Absent Fail grades are steadily decreasing, suggesting that students are increasingly feeling capable of attempting these forms of assessment. Managing attrition at CQUniversity is challenging owing to servicing regional centres in Queensland which have some of Australia's highest representations of students with low socio-economic status. Furthermore, many students are the first in their family to higher education, and/or of Aboriginal or Torres Strait Islander descent. Considering this context, these interventions have achieved encouraging results for student retention.

In 2017, 75% of students achieved a grade of Credit or higher suggesting the new methods of introducing assessments and other interventions are allowing most students to achieve good results and to accomplish the unit learning outcomes confidently.

Students' perceptions of value, effort and difficulty of assessment tasks

The range in task value perceptions of students analysed in the 2015 and 2017 offerings is very similar with upper and lower means approximately at 4.1 and 5.2, where 'Moderately Valuable' was coded 4.0 and 'Valuable' was coded 5.0 (Figure 3). This consistency suggests that direct comparisons of task value rankings between the two cohorts could provide an insight into changes in students' perceptions of assessment tasks resulting from the interventions.

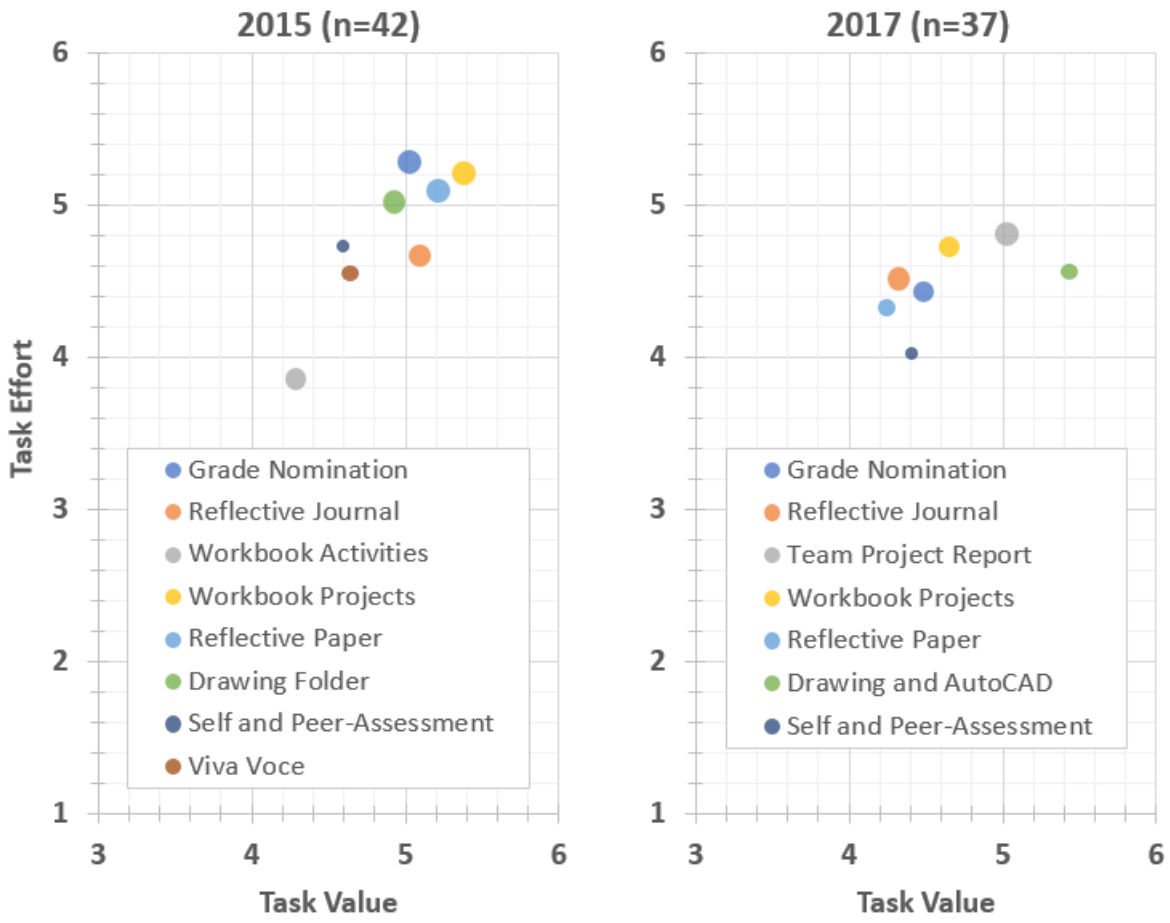

Figure 3: Students' perceptions of task value, effort and difficulty (denoted by marker size)

The 2017 cohort thought assessment tasks required less effort to complete but, as stated earlier, this cohort also achieved a higher grade point average. This is consistent with indicators that task difficulty also reduced marginally in 2017 (Figure 3). The reduction in effort by students was intentional as interventions included better preparing students for the assessments and reducing the number of projects. Enabling students to achieve higher grades with less effort has introduced learning efficiencies, and has also reduced instructor workloads with fewer projects to facilitate and responses needed for assessment queries and to correct students' misconceptions.

Replacing some freehand sketching activities with AutoCAD tasks has made the drawing assessment the most valuable to students by directly developing skills for their team project and portfolio, where previously it was moderately valuable by comparison to other assessments. The task is now also perceived to be easier through scaffolding with instructional videos which enables students to learn through completing the assessment. Many encouraging comments were received from the students: *"I found the videos extremely helpful as I learn well visually. Being able to rewind and watch again was very helpful."* The change in student perception of this task is a positive indication of benefits that can be achieved through a structured approach to introducing portfolio assessment where suitable resources support students through the learning opportunities.

Replacing the second reflective paper and activities from the textbook with a new summative assessment of a Team Project Technical Report (30%) made this task significantly more valuable to students' learning and marginally more difficult to complete, requiring students to apply a lot more effort. This is a positive change as preparation of technical reports and

working with peers are essential skills that are also now progressively developed using a whole-of-course approach following suggested practices for sustainable assessment. This intervention also allowed students to create many suitable entries for their Portfolio Workbook and to unpack learning scenarios in their Reflective Journal, thus creating a structured approach to introduce the Portfolio assessment. The new iteration of the unit should also prepare students very well for further units that focus on developing these professional skills.

Reducing the portfolio to 30% resulted in a moderate reduction in value, effort and difficulty for the grade nomination (a self-assessment of their Portfolio and nomination of what grade students believe they have achieved against the marking rubric). This result was mostly as intended. The grade nomination should be perceived as an assessment support tool which provides clear instructions for efficiently completing portfolio assessment to their desired level of achievement. Thus, the intentions were to reduce the effort needed and difficulty with the tasks but not to reduce its perceived value towards their learning. Greater emphasis might be needed to link the portfolio activities back to the unit learning outcomes and hence enable students to comprehend that they are beginning their development of skills expected in engineering practice.

Reducing the number of reflective journal entries in response to student feedback (15 down from 25) has devalued the reflective journal task but not significantly reduced the effort required or difficulty. This is not a positive change. Instilling reflective practice is essential for engineering graduates and learning through self-assessing and reflection is a key part of sustainable assessment. As with the Grade Nomination, more emphasis on the link with professional practice might be necessary to increase the perceived value of this task.

The perceived value, effort, and difficulty of the Workbook has reduced by separately assessing the Team Report. This is believed to be a transfer of value perceptions from individual tasks to team-based tasks which is a positive outcome for building professional skills and attaining the unit learning outcomes.

Changing the topic of the reflective paper from 'the history of engineering practice' to 'transitioning to higher education' and making this task a separate summative assessment (10%) has significantly devalued the task and reduced the effort and difficulty. This is also not a positive change. Without a longitudinal study, it is impossible to measure whether the new topic will better prepare students for their future learning needs. Also, without further questioning of students, it is unknown what impact assigning a low summative percentage had on students' perceptions. If something is not highly valued, it is likely to be easily forgotten, which works against the objectives of sustainable assessment.

Self and peer-assessment remained of similar value to the students but required much less effort in 2017. The only change to this assessment was to encourage teams to establish a self and peer-assessment grading rubric as part of their Portfolio assessment. It appears that this has helped students to complete the task allowing them more time to devote to other activities.

Conclusions

Several interventions were developed to better prepare students for new forms of assessment such as portfolios, reflective papers and self and peer assessment in a first-year engineering unit. Student satisfaction and grades were analysed over a three-year period to 2017, along with student surveys and interviews to establish students' perceptions of assessment task 'value' to their learning, how much 'effort' was required to complete them and how 'difficult' they were to complete. It is important to note that relatively low sample sizes were studied providing anecdotal evidence of improvements in the student experience.

These data suggest that not only could students see the benefit of a structured approach to introducing assessment, but that introducing sustainable assessment can potentially improve

the student experience and academic results. Student satisfaction increased across nearly all performance areas. More students attempted assessments, completed the unit, and achieved excellent grades.

Most interventions resulted in a positive impact on students' perceptions of assessment tasks. Introduction of instructional videos, AutoCAD activities and a summative assessment on the Team Project Report was well received by students and created learning pathways, giving students insight into their future learning needs, and skills in self-assessment, self-direction and working with their peers.

Further work remains to increase value perceptions of preparing a portfolio grade nomination, a reflective journal and a reflective paper, all of which are essential skills for practising engineers and key components of sustainable assessment.

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