

Enhancing Cap Stone Projects' Assessment and Teaching

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CONTEXT

A University internally funded Teaching Excellence Development Fund teaching and research project was initiated in 2015 aimed to enhance student engagement and satisfaction outcomes in the Bachelor of Civil and Construction Engineering cap-stone research project units. Historically the units had low student satisfaction rates, and were criticized by the lack of transparency and consistency with evaluation across discipline specialist areas and campuses (onshore and offshore). The aim was achieved through the enhancement of teaching resources and renewal of delivery, new assessment rubrics and marking schema, and scholarship of teaching and learning.

PURPOSE

The purpose is to enhance student, staff and industry satisfaction and engagement with the final year project units, enhance teaching delivery and evaluation, and ensure alignment of the units with Australian Qualifications Framework level 8.

APPROACH

Lecturer and supervisor reflections and student evaluation data were used to assess the influence of changes to the units on students' satisfaction and agreement with unit-based evaluative items addressing teaching quality. Mixed mode research methods will be used with a variety of data collection to enable greater validity, reduce pre-existing assumptions and assess the impact from a number of perspectives.

Quantitative data will be the satisfaction data of students both prior to changes (historical data) and after changes (post 2015 data). Qualitative data analysis will be conducted to gain more insight into the experience of engineering students who experienced both the former and renewed units for their project e.g. transitioned from the old units for one semester to the new unit for second semester of their project.

RESULTS

The satisfaction data in the first semester of implementation for those students who were completing their final year projects (thus, experienced the old and new units) spiked at over 90%. Currently the satisfaction rate is on average 80%. The teaching and research project impact has extended beyond the Department of Civil Engineering with the Unit Learning Outcomes and Marking Rubrics currently being shared across all disciplines of Engineering in the Faculty. It is anticipated that this will enable consistency of final year project evaluations and outcomes. This action is currently being accomplished with representatives from all Departments working collaboratively on fine-tuning rubrics. Semester 1, 2017 implementation is planned for uniform Unit Learning Outcomes and rubrics across all engineering disciplines.

CONCLUSIONS

The outcome of this research will be a contribution to the teaching and learning discourse on final year project assessment, teaching and standards. The author and collaborator, Kerri Bland, continue to refine the rubrics and seek collaboration to benchmark the standards across other Universities and share experiences of Unit Co-coordinator successes and challenges in managing large cohort, multi-supervisor final year project units

KEYWORDS

Research projects, competencies, learning outcomes.

Context

A University internally funded Teaching Excellence Development Fund teaching and research project was initiated in 2015 by the author and Kerri Bland which aimed to enhance student engagement and satisfaction outcomes in the Bachelor of Civil and Construction Engineering cap-stone research units; Civil Engineering Research Project 1 and 2. The teaching and research project was started with a review or 'audit' of the current state of student and staff satisfaction and concerns. Historically the units had very low student satisfaction rates, particularly in regards to feedback to help students achieve the learning outcomes, which were consistently below 60% satisfaction with a low of 29% in semester 1 2014 (normal university rates around 80%), and were criticized by academic staff for a perceived lack of transparency and inconsistency with evaluation across discipline specialist areas and campuses (onshore and offshore). An appraisal by the author and collaborator, Kerri Bland, found the practices of research data management, human research ethics and intellectual property agreement records compliance required improvement. It was thought that explicit teaching and professional development was required to safeguard compliance with University policy and legislative requirements.

The aim was achieved through the enhancement of teaching resources and renewal of delivery, new assessment rubrics and marking schema, and scholarship of teaching and learning. The aim was aligned with the School Plan for continued improvement of Units delivered in the School (with a goal for unit satisfaction rates to exceed 80%). The project was implemented in Semester 1, 2015, and reflective practice by the implementers over three semesters has led to refinements in the marking rubrics and resources provided to students and staff. The implementation of significant changes in Project 1 and Project 2 units in semester 1, 2015 (February – July) was monitored carefully with faculty and student feedback sought via: interviews; focus groups; and survey (in addition to University-system student evaluation measure eVALUate). This research indicated enhancement of teaching and learning, and collegial relationships were strengthened.

Purpose

Teaching Excellence Aims

The purpose is to renew the final year cap stone project units (research based individual projects that are conducted over two consecutive semesters) in order to enhance student satisfaction and engagement with the final year project units, enhance teaching delivery and evaluation, and ensure alignment of the units with AQF level 8 which stipulates graduates of a Bachelor Honours Degree demonstrate the ability "to plan and execute project work and/or a piece of research and scholarship with some independence." (Australian Qualifications Framework Council 2013). The renewal of the cap stone projects was undertaken to ensure continuing accreditation of the Degree course by Engineers Australia which demands graduates are capable of "application of systematic approaches to the conduct and management of engineering projects" and a range of professional and personal attributes (Engineers Australia nd). These attributes relate to students' English language capabilities and graduate competencies of Curtin University, Engineers Australia and the Board of Engineers Malaysia (which is of relevance to the offshore campus degree program). Prior to the start of the renewal, a need to teach University and legislative requirements regarding the management and conduct of undergraduate research projects was not anticipated. However, the initial audit of the 'state of affairs' revealed this would be a necessary aim of the renewal. Some issues, confined to undergraduate projects, had arisen due to the historical perception that undergraduate cap-stone projects may not fall under the umbrella of research.

Strategic Alignment of Aims

The research projects' renewal was supported by an internal University teaching excellence development fund due to the alignment of the purpose to School, Faculty and University priorities: 1. The Bachelor of Engineering program renewal outlined in the Proposal for Major Change document in April 2014. The renewal is to meet AQF Level 8 requirements, making the curriculum more research-informed and include Research Methods and Engineering Leadership. 2. Faculty priorities to deliver graduates who meet contemporary and future engineering requirements of complex engineering problem solving and effective oral and written communication in professional and lay domains. 3. University Vision to have highly satisfied students and employers. Improved teaching and assessment delivery will enhance unit satisfaction rates. Improved communication and engineering application skills will help maintain industry satisfaction which currently results in 80-90% graduate employment within 2 months. 4. University Strategic priority of development of English language proficiency and University Learning and Teaching Vision for converged teaching, that is strengthening development of online and face-to-face mixed modes of delivery, and teaching excellence development strategic priorities :Improvement of assessment practices, development of English language proficiency and development of engaging, interactive and personalised approaches to learning.

Approach

Overview – Teaching Enhancement and Scholarship

The approach was dual-fold with strategies targeting research teaching-delivery and evaluation enhancements. The teaching enhancements were via the development of engaging and personalised teaching delivery in research methodology and thesis writing. This was implemented through online and face-to-face lectures in research methodology and on-line professional engineering English writing skills development complemented by student engaged workshops. The evaluation enhancement was undertaken through professional development of supervisory academic staff and development of evaluation rubrics to ensure consistency of assessment and bench marking of theses. Innovation in assessment was undertaken to ensure industry engagement and participation in the process and lay the foundation for future work integrated learning options for the research units. Scholarship of Teaching & Learning was undertaken for exploration of current engineering education pedagogy regarding research projects and for dissemination of findings from the Project.

Teaching Enhancement

The teaching enhancement began with an evaluation of the current state of practice of final year projects which was assisted by professional workshop attendance (AaeE 2014) and a literature review. The literature of significance includes identifying the nature of engineering competencies in Australia and ensuring generic competencies of communication, professionalism, self-management, problem solving, critical thinking and creativity were expected and assessed along with engineering technical and practical skills (Male, Bush and Chapman 2011(a); Male, Bush and Chapman 2011(b)). Review of final year engineering projects highlights similarities in assessment and processes and endorses the importance of projects to education of engineers (Ku and Goh 2010). From this, the unit learning outcomes were developed and are now articulated as the following for Project 1:

- Identify, plan and commence a project that leads to the solution of an authentic civil engineering problem
- Deploy an appropriate combination of research, design and analytical methods in the solution of engineering problems

- Apply and integrate advanced communication and interpretative skills, knowledge and creativity in the solution of a novel and complex engineering problem
- Reflect upon and critically review project work and apply advanced communication skills to convey progress
- Interpret and apply selected research literature in the solution of engineering problems

And for Project 2:

- Manage the continuation and completion of a project that leads to the solution of an authentic civil engineering problem.
- Deploy and integrate an appropriate combination of research, design and analytical methods, cross-disciplinary learning skills, knowledge and creativity in the solution of engineering problems.
- Apply advanced communication and interpretative skills able to justify engineering approaches and evaluate project outcomes comprehensively in written and oral forms.
- Interpret and apply selected research literature in the solution of engineering problems.
- Investigate complex problems using research-based knowledge and research methods.

The Unit Learning Outcomes were articulated into assessment items and marking rubrics were developed for all assessment items aligned with the unit learning outcomes, Engineers Australia attributes and University Graduate Attributes. Identifying and embedding the key attributes of top-ranked universities' cap-stone projects which include a design-test-build programme philosophy and industry engagement (Ward 2013) was also an important consideration in the redesign of the units. To this end, the assessment of projects included a cycle of propose, present and reflect assessment items throughout the two semesters to encourage reflective practice and engagement in the research with the goal of 'useful and usable' outcomes. Industry engagement has been an element of the projects for many years with projects arising from industry sponsorship and/or initiation however this was enhanced with industry sponsored work experience and mentoring for project students. In addition, industry engagement with the Projects was spearheaded with the introduction of a marketed, professional bi-annual conference promoted through LinkedIn and the Industry Advisory Board resulting in industry feedback and benchmarking. The conference was enhanced by alumni who presented key-note opening and closing addresses.

Teaching resources were developed for research methods, ethics, intellectual property, statistics, reflective practice, report writing and oral communication skills. A collaborative and University-wide approach was taken with academic, technical and professional staff from across the University engaged in the development, delivery and refinement of resources. The partnerships developed for the research project units now span Human Research Ethics Office, Office of Research and Development, Science and Engineering Library team, English Language Development, Health and Safety, and Data Management. Collaborative learning spaces were utilised to engage in joint campus workshops with our offshore campus students and unit co-coordinator, Associate Professor Lau.

Key outcomes from this cross-disciplinary and diverse collaboration, in addition to the development of teaching resources and explicit teaching of key research skills and legislation, have been a template for intellectual property agreements covering student projects when sponsored by industry, standardised risk assessment processes, job safety analysis templates and online laboratory booking systems, library workshops and resources

targeted for engineering students and bespoke training modules for nVivo, EndNote, database searching and statistical analysis.

Changes to teaching delivery were implemented by maintaining face-to-face contact with the Unit Coordinators weekly via a project briefing followed by group discussion and consultation time in which bespoke training and assistance was provided or developed with colleagues. Changes to the unit were communicated to supervisory staff via staff meetings, a start-up workshop, weekly updates and quality unit review meetings.

Scholarship - Data Collection and Analysis

Lecturer and supervisor reflections and student evaluation data was used to assess the influence of changes to the units on students' satisfaction and performance. Mixed mode research methods were used with a variety of data collection to enable assessment of the changes via a number of perspectives.

Quantitative data was the satisfaction data of students both prior to changes (historical data) and after changes (post 2015 data). Qualitative data analysis was conducted to gain more insight into the experience of engineering students who experienced both the former and renewed units for their project e.g. transitioned from the old units for one semester to the new unit for second and final semester of their research project.

Criteria for Evaluation of Success

The success of the innovation to the Project units was measured on the following criteria which were outlined at the time of the internal scholarship funding application (2014):

1. Improved student engagement and satisfaction outcomes as measured by the University's online system for gathering and reporting students' perceptions of their learning experience (eVALUate) in S1 2015
2. Successful continuing accreditation of the Degree course by Engineers Australia in 2015
3. Enhanced Scholarship of Teaching & Learning as measured by the range and frequency of dissemination of information, positive feedback from staff professional development activities and applicants' reflection.

Results

Summary

The satisfaction data in the first semester of implementation for those students who were completing their final year projects (thus, experienced the old and new units) was over 90%. Currently the average satisfaction rate for quantitative criteria is exceeding 82%. The project impact has extended beyond the Department with the Unit Learning Outcomes and Marking Rubrics currently being shared across all disciplines of Engineering at Curtin University to provide consistency of final year project evaluations and outcomes. This action is currently being accomplished with representatives from all Departments with Semester 1 2017 implementation planned for uniform Unit Learning Outcomes and Rubrics for common assessment items of Thesis and Presentation.

Results against Criteria

1. Improved student engagement and satisfaction outcomes as measure by eVALUate S1 2015. The data is shown in Table 1 for the research project units across 2014-2015. Project 1 is the new unit replacing Project 461 and Project 2 is the new unit replacing Project 462. The shading highlights the progression of most students through the two consecutive project units; progression from Project 461 to 462 or Project 2 (as of 2015).

Table 1: Student Unit Satisfaction Survey Responses 2014-2015

Quantitative items surveyed and Agreement Rates (%)	Semester 1, 2014 Project 462	Semester 1, 2014 Project 461	Semester 2, 2014 Project 461	Semester 2, 2014 Project 462	Semester 1, 2015 Project 1 (replaced Project 461)	Semester 1, 2015 Project 2 (replaced Project 462)
1. The learning outcomes in this unit are clearly identified.	43	75	75	74	81	90
2. The learning experiences in this unit help me to achieve the learning outcomes.	57	75	75	74	85	70
3. The learning resources in this unit help me to achieve the learning outcomes.	33	75	66	69	88	70
4. The assessment tasks in this unit evaluate my achievement of the learning outcomes.	71	63	72	79	77	100
5. Feedback on my work in this unit helps me to achieve the learning outcomes.	29	71	75	69	72	70
6. The workload in this unit is appropriate to the achievement of the learning outcomes.	29	75	66	77	69	90
7. The quality of teaching in this unit helps me to achieve the learning outcomes.	29	75	81	77	85	80
8. I am motivated to achieve the learning outcomes in this unit.	57	63	66	91	88	90
9. I make best use of the learning experiences in this unit.	71	100	84	89	96	90
10. I think about how I can learn more effectively in this unit.	71	100	94	97	92	90
11. Overall, I am satisfied with this unit.	43	88	88	74	73	80
Response Rate (%)	16	22	21	28	18	21
Enrolment count (number of students enrolled)	45	144	38	127	147	34
University suggested min response rate for 95% confidence agreement $\pm 10\%$	64-70	37-46	70-77	37-46	37-46	70-77

The data shown in Table 1 for the initial 2015 'start up' semester unit of the new research project unit Project 2 indicates that an (on average) improvement in all evaluation criteria was experienced for those students enrolled in the initial semester of the research project when compared to previous semesters of Project 462 satisfaction data. The satisfaction score for item 5, feedback, whilst enhanced when compared against 2014 data for Project 462, was still below the University and School expectation of 80%. This may be attributed to the

nature of the final semester of research project as only a small percentage (15%) of assessable items are given feedback during semester. The bulk of the assessment (70%) is allocated to the thesis and oral presentation which are submitted or presented at the end of semester. For all items surveyed, the satisfaction rates for the final project unit (Project 462) in Semester 1, 2014 are lower than any other year (including older historical data for overall unit satisfaction not presented in this paper). It is uncertain why this occurred. The response rate is low in a small enrolment group, albeit not much lower than other response rates. This highlights the difficulty of interpreting quantitative statistical data without access to qualitative student responses describing their experiences and perceptions which help with understanding and interpreting satisfaction data (which is not available to subsequent unit coordinators; hence not accessible to the author).

The data shown in Table 1 for the initial 2015 'start up' semester unit of the new research project unit Project 1 indicates that an improvement in most evaluation criteria was experienced for those students enrolled in the initial semester of the research project when compared to previous semesters of Project 461 satisfaction data. The satisfaction score for learning resources and quality of teaching was significantly increased by over 20% to reach excess of the University normal 'green light' expectation of 80%. The agreement rates for workload appropriateness for the unit degraded by almost 10%. This was expected due to the introduction of assessment items in the initial semester of the research project; a major change to previous years.

Of particular interest is comparing Semester 2 2014 Project 461 (initial semester of Project work) and Semester 1 2015 Project 2 (final semester of Project work) as this data is from the same cohort progressing from the initial semester (under the old unit management) to their final semester (under the renewed units and teaching) of their project. These students rated the new units favourably as seen in Tables 1 and 2, with an increase of 25% agreement with 'the assessment tasks in this unit evaluate my achievement of the learning outcomes.' and 15% increase in agreement with 'the learning outcomes in this unit are clearly identified' and 14% increase in agreement with 'the quality of teaching in this unit helps me to achieve the learning outcomes.' All other criteria, in which agreement rates decreased or increased, were only nominal changes of within -8 to +6%. With response rates of 21% for these units, with around 36 students enrolled, the confidence level is only 80%.

Table 2: Selected Satisfaction Survey Responses 2014-2015

eVALUate quantitative items	Semester 2 2014	Semester 1 2015	Change in agreement rate (%)
	Project 461	Project 2	
	% agreement	% agreement	
1. The learning outcomes in this unit are clearly identified.	74	90	16
4. The assessment tasks in this unit evaluate my achievement of the learning outcomes.	72	100	28
6. The workload in this unit is appropriate to the achievement of the learning outcomes.	66	90	24
8. I am motivated to achieve the learning outcomes in this unit.	66	90	24

Qualitative data was obtained from a student survey and interviews with this cohort in addition to University managed evaluations of student feedback. The research and survey qualitative data was mostly positive with comments including the following:

- The class tutorials were most helpful as well as the recommended textbook for this unit.*
- Lecturers are willing to take time out of their schedule to sit down and provide feedback in the form of forcing us to self-evaluate.*
- This unit in comparison to the first one is more organized; more defined, and has more resources to aid the students. It was a near perfect unit but the adjustment from one unit style to another took quite a bit of time but well done to both the coordinators for a good semester.*
- The feedback and support are certainly improved and students are far less intimidated by the unit coordinator.*
- All the changes were very very very good (apologies for repetition but in comparison to the previous Project unit, this one was by far better in terms of magnitude) as everything was organized and useful. The resources and workshops actually motivated me to go as opposed to the previous unit*

Continued monitoring of student satisfaction and feedback is occurring. The trend is for a continued positive agreement rates as recorded by eVALUate to Project 1 and Project 2 units. As seen in Figure 1 (which shows the average of agreement rates for the project units for each year 2014-2016) the new units implemented in 2015 and refined in 2016, record higher average rates of agreement to all quantitative evaluative items.

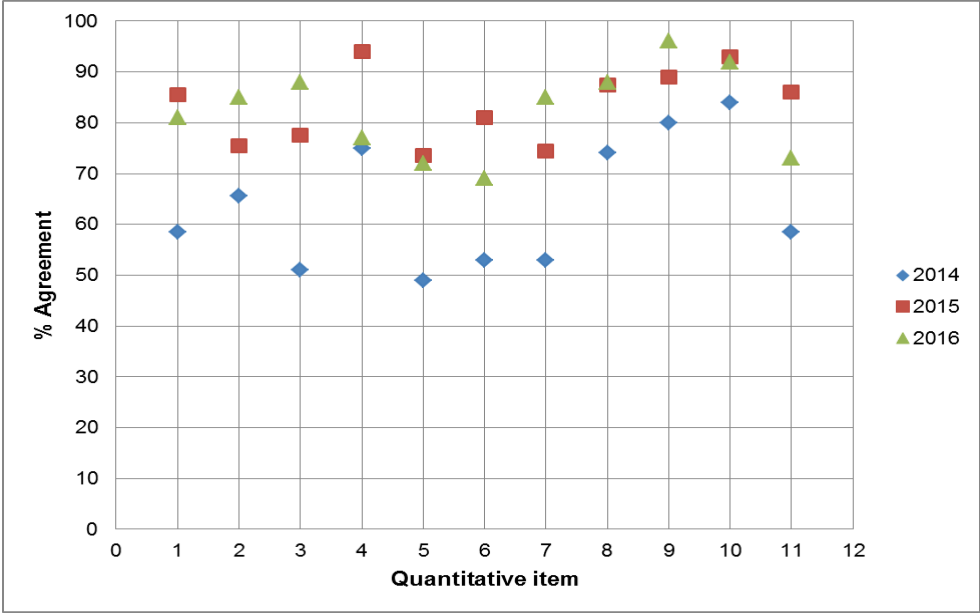


Figure 1 Average Agreement Rates over All Teaching eVALUate Items 2014-2016

2. Successful continuing accreditation of the Degree course by Engineers Australia in 2015. This measure was attained at both the onshore and offshore campus (Engineers Australia being the accrediting body onshore and offshore, and the Board of Engineers Malaysia, an additional accrediting body for offshore). The recommendation by Engineers Australia to move towards unifying the final year project across disciplines of Engineering is currently being undertaken with the Unit Learning Outcomes from Civil and Construction Engineering being adopted by all engineering disciplines. The assessment rubrics for Thesis and Presentation are similarly being used as a template for other disciplines.

3. Enhanced Scholarship of Teaching & Learning as measured by the range and frequency of dissemination of information, positive feedback from staff professional development activities and applicants' reflection. This is an ongoing process. The outcomes of the unit renewal have been disseminated within the University as 'best practice' for cross disciplinary engagement via internal Teaching and Learning forums, in addition to dissemination via an international engineering education conference workshop and collegial visits to the offshore campus. This has led to a School wide uptake of the renewed units' learning outcomes and a sharing of the evaluation rubrics and templates to increase consistency within the School of Civil and Mechanical Engineering, and across the Faculty encompassing all disciplines of engineering. The next phase of adoption will be a cross-discipline moderation team to for Projects. To be implemented in 2017 this moderation extends the usual practice beyond the School of Civil and Mechanical Engineering.

Conclusions

The outcome of this research is a contribution to the teaching and learning discourse on final year project assessment, teaching and standards for research based cap stone projects. The implementers continue to refine the rubrics and teaching resources. Collaboration to benchmark the standards across other Universities and share experiences of Unit Co-coordinator successes and challenges in managing large cohort, multi-supervisor final year project units is welcomed.

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