Improved Alignment Of Project Management Assessment In Engineering Final Year Projects With Industry Practice Through A Task-Oriented Eportfolio

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CONTEXT

A recent review of Deakin University's engineering final year project (FYP) units highlighted that project management was not being rigorously assessed. While invariably being required to manage their projects, students were not necessarily required to employ professional project management tools or techniques, and marks were often correlated with student engagement and project success rather than awarded for use of project management tools and techniques. Similarly, student feedback indicated that they didn't perceive themselves to be undertaking much project management, even when they were.

PURPOSE OR GOAL

The intention behind the change to project management assessment was two-fold: 1) To bring the project management activities and their documentation into closer alignment with industry practice, and 2) To reinforce in the students the importance and value of project management as a learning outcome and professional competency. Project management is increasingly a substantial part of engineering roles, and is, in itself, a common role for graduate engineers. As the most substantial project most undergraduate engineers will take on, the FYP presents a key opportunity to develop and reinforce good project management.

APPROACH OR METHODOLOGY/METHODS

The unit team worked closely with an industry-based project manager (IBPM) to understand both the common activities and documentation processes expected in industry. These were then embedded across three assessment tasks, two of which were task-oriented project management e-portfolios created in PebblePad. We provide our reflections, as well as those of the IBPM, on the impact of the intervention on student learning and outcomes.

OUTCOMES

Review by the IBPM confirmed that the new assessments are in much closer alignment with industry practice, and require students to show proficiency in the project management tools and techniques used in industry. Staff reflections indicate increased student engagement with and demonstration of project management tools and techniques, knowledge areas and skills.

CONCLUSIONS & RECOMMENDATIONS

Assessment redesign has given unit staff greater assurance that students are competent in the breadth of project management areas consistent with intended learning outcomes and professional competencies. However, qualitative and quantitative student feedback is required to better understand the extent of the improvement. In alignment with industry practice, the creation of a unit-wide lessons learned register is recommended.

KEYWORDS

Engineering project management, ePortfolio

Introduction

Project management has long been acknowledged as an essential skill for engineers. The Washington Accord, an international agreement between accrediting bodies for tertiary-level engineering programs, defines as one of its graduate attribute profiles the ability to: "Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects in multidisciplinary environments." (IEA, 2021) Similarly, Engineers Australia, responsible for accrediting Australian tertiary-level programs, defines "Application of systematic approaches to the conduct and management of engineering projects" as one of the sixteen compulsory elements of competency (EA, 2019).

However, surveys of recent engineering graduates, as well as those who employ recent engineering graduates, have consistently highlighted 'business skills/approach' as the major skillset lacking amongst the cohort (e.g. Male et al., 2010; Palmer, 2002; WCEC, 2004). This invariably includes more specific skills related to project management such as quality management (WCE Council, 2004), time-management (Nair et al., 2019; Panuwatwanich et al., 2011), stakeholder communication (Nair et al., 2019; WCE Council, 2004), planning, scheduling, budgeting, and risk management (Male et al., 2010), scope management, cost management and reporting (Panuwatwanich et al., 2011).

This body of research suggests that despite the requirement to teach and assess project management as part of engineering tertiary programs, there is either a gap between the project management skills taught at university and those required for professional engineering practice, or there is a gap between the skills taught and the skills developed by students.

Engineering employers have acknowledged the challenges in effectively teaching the necessary project management skills, seeing direct professional experience as a vital mechanism through which these skills are developed (Panuwatwanich et al., 2011). Students have also noted the study of project management at university as "dry and tedious" (Tuladhar et al., 2014), with recent graduates suggesting real-life examples of engineering project management, such as case studies and industry presentations, would have benefited their learning (Male et al, 2010). These suggestions are in alignment with teaching practices such as project-based learning, where learning activities as well as assessment are designed to enable students to experience what it is like to think and act as a practitioner (Uziak, 2016). Indeed, Palmer (2007) identified that by the fourth year of an engineering program, assessments should reflect the world of professional practice, with their content signalling to students what is really valued by their profession. Ultimately though, the teaching of project management to engineering students is an under-researched area of engineering education, with clear opportunity for development.

Alternative assessment strategies have seen success in developing students skills in areas that typically benefit from authenticity of experience. Cain et al. (2017) employed a task-oriented portfolio approach to an engineering programming unit, through which learning activities and assessment tasks were structured to optimise the likelihood of students engaging appropriately with the tasks and achieving the desired learning outcomes (Biggs, 2012). A key feature of this assessment style was the use of regular formative feedback from the teaching team, encouraging students to develop their understanding and improve the work in their portfolios to reach the expected standard (Cain et al., 2017).

As the culmination of every Australian-based engineering 4-year degree program, the final year project is often the first substantial (or if not the first, likely the largest) engineering project undertaken by students. As the ultimate project-based learning experience of their degrees, it therefore presents an obvious opportunity to engage students in an authentic project management professional practice experience, while also representing the final chance for students to develop and demonstrate professional competencies prior to graduation.

This paper seeks to explore the development of an improved regime of project management assessments and teaching and learning activities within the engineering final year project units at

Deakin University with the intention of bringing students skillsets into closer alignment with those sought by industry.

Background and context

Engineering Final Year Project Structure

The engineering final year project at Deakin University consists of two units, each worth two credit points (where one year of study is eight credit points), that are usually taken in consecutive trimesters. Every student has an academic supervisor, whose role is clearly defined to students as a technical expert, and not a project manager. Broadly speaking, SEJ441 Engineering Project A involves project design. Students are required to read widely on their topic, define a project aim and objectives, develop a method, prove the feasibility of their project, and provide a detailed plan for project implementation. The assessment task due dates are spread across the trimester and tasks are scaffolded to help students design a well-justified and achievable project. SEJ446 Engineering Project B involves project implementation and delivery, and the assessment tasks are all due at the end of trimester. Prior to the changes implemented in 2024 and discussed below, in each of the final year project units, there was a single project management assessment due at the end of trimester, which consisted of a short, reflective report (500-1000 words) supported by a series of appendices containing evidence of project management (such as emails to stakeholders and meeting minutes). These assessments were designed to assess the learning outcomes: "Demonstrate effective management of an engineering project, including (but not limited to) considerations such as project scheduling, risk management, stakeholder engagement, professional conduct, safety, sustainability, and ethical contexts" (SEJ441), and "Exhibit autonomy in conducting and managing a substantial project using formal project planning methods to a professional standard while accommodating stakeholder safety, risk and ethical requirements" (SEJ446).

Issues with Project Management as part of Engineering Final Year Projects

High variability in baseline skillset and lack of formalised teaching of project management

Previously, there was little active teaching of project management within these units. As capstone units, it was expected that students would draw on project management skills developed in their preceding three years of study. However, with a student cohort representing five engineering disciplines, each with their own curricula, and a diverse student body, the range of project management skills displayed by students was large.

Poor understanding of what constitutes project management

Previous students frequently communicated to unit staff (informally and formally through anonymous unit feedback) that they felt there was an imbalance in the weightings of the assessment tasks in SEJ446, where project management is worth 30 %, the thesis worth 40 % and the exhibition presentation worth 30 %.

This indicated that some students didn't recognise the value or significance of the project management they were inherently doing to keep their projects on track, to ultimately have project outcomes to present via the thesis and exhibition assessments. This may have been reflective of the lack of use of formal project management tools and techniques by some students. It may also have been reflective of the nature of the project management assessment, which consisted only of a short report with appended evidence of project management, and was often completed by students in matter of hours in the last week of the trimester. Further, while not the core focus of the assessment, the rubric enabled supervisors to award substantial marks for student engagement and supervisor satisfaction with project outcomes.

Intended Outcomes

By revising the project management assessments, the unit team aimed to achieve two primary outcomes: 1) To bring the project management activities undertaken by students and their documentation into closer alignment with industry practice, and 2) To reinforce in the students the importance and value of project management as a learning outcome and professional competency.

Assessment redevelopment

Consultation with an Industry-based Project Manager

To bring the assessments into better alignment with industry practice, the unit team first consulted with an industry-based project manager (IBPM) working at an Australian municipal council to deliver engineering and construction projects. The IBPM was approached for this role as they have an undergraduate qualification in an engineering-adjacent field (materials science) but a series of postgraduate qualifications in project management and have worked as a project manager across a number of industry sectors. The consultation involved a series of semi-structured interviews, via online and telephone meetings from August 2023 to February 2024, during which the IBPM outlined the common processes and documentation associated with the establishment, running and close-out of a project, allowing us to view typical documentation templates and providing rationale for the design of templates and the sequencing of reporting.

In particular, they highlighted stakeholder management and risk management as areas that are often poorly understood by people without formal project management training, and therefore as highly beneficial skills to develop in students. They also reinforced the need for project managers to be aware of the legal, ethical and sustainability implications of their projects, in addition to the more commonly considered aspects such as resourcing, scheduling, scope and quality.

The unit team identified four key project management activities described by the IBPM that aligned with the parts of the project lifecycle covered by the final year project units, and that could be incorporated into the current assessment regime to bring greater alignment between students work and industry practice. These were 1) the development of a business case, which was similar in intent to the initial proposal assessment that students completed at the mid-point of SEJ441, but with a greater focus on strategic alignment and anticipation of risk to project success, 2) the development of a project plan, which was similar to the final proposal completed in SEJ441, but from consultation with the IBPM it was clear that the existing assessment missed a suite of project management considerations, 3) the completion of regular status reports, designed to provide stakeholders with a broad overview of project progress, including successes and risks as the project progresses, and 4) the completion of a project close-out report, that serves to document legacy considerations, and importantly, provide a reflective record of lessons learned.

Review of Professional Competencies

As highlighted previously, both the Washington Accord (WA) and Engineers Australia (EA) define core professional competencies (or elements of competency) expected of graduate engineers related to project management, WA10 and 2.4, respectively (IEA, 2021; EA, 2019). In consultation with the IBPM, all the EA stage 1 competencies were reviewed in detail and other indicators of attainment that were deemed in alignment with project management professional practice were identified, and the underlying knowledge and skillsets synthesised (using Edum-Fotwe and McCaffer's (2000) characterisations of the generic knowledge areas of project management for guidance).

It was found that each of Edum-Fotwe and McCaffer's (2000) generic knowledge areas (integration, cost, time, procurement, quality, communications, risk, scope and human resources), as well as their four essential project management skills (leading, communicating, negotiating and problem solving) was represented by at least one indicator of attainment from EA's Stage 1

competencies (EA, 2019), although it was notable that the depth and breadth of knowledge expected of graduate engineers was reduced as compared to the knowledge required by practising project managers (Edum-Fotwe & McCaffer, 2000).

In addition to the required knowledge identified by Edum-Fotwe and McCaffer (2000), the EA Stage 1 competencies also highlighted knowledge related to contextual risk (specifically safety, ethical conduct, legal, environmental protection, intellectual property) as well as sustainability. These had been previously acknowledged by the IBPM as important aspects of project management, and so they were added to the list of generic knowledge areas of project management that should be included as part of the assessment redesign, which are hereafter referred to as 'competency-informed knowledge areas'.

Design and Implementation of the New Assessment Regime

One issue identified with the assessment of project management in these units was that in SEJ441, the unit learning outcome associated with project management was assessed only once across the four assessment tasks, and associated with an assessment with a low weighting (10 %). To rectify this, elements of project management, especially those related to scope, time, quality and contextual risk, were embedded within the first assessment task, the initial proposal, and the weighting of this assessment increased from 20 % to 25 % (Table 1). This in turn brought this assessment into closer alignment with the industry practice of preparing a business case, as described by the IBPM.

For the main project management assessments in each unit, we combined fortnightly status reports (identified by the IBPM as a key project management process) with a final report: In SEJ441, a final project plan, and in SEJ446, a project close-out report. The structure and content of both reports were designed to reflect those completed in industry, as much as possible. Between the status reports and final reports, all of the core knowledge areas are assessed, and supervisors assess students on the core skill areas. A greater depth of knowledge is required in the status reports in SEJ446 than for SEJ441, reflecting both the scaffolding of knowledge across the two units, and the greater weighting of the project management assessment in SEJ446 (30 % vs 20 % in SEJ441) (Table 1).

A task-oriented portfolio approach (Cain et al., 2018) was adopted for the main project management assessments in each unit. The assessment (for each unit, a series of status reports and a final report) was broken into a series of well-defined tasks, each achievable in a short period of time. Each task had a suggested due date that spread the work across the trimester, and scaffolded knowledge development. Formative feedback was provided to students at regular intervals to promote reflection and improvement. Students adjusted their work to correct issues or misunderstandings, and resubmitted it for reassessment. This process continued until the work achieved the required standard, at which point it was acknowledged as complete. The portfolio served as a mechanism to perform summative assessment at the end of the unit, but focusing staff and students on formative feedback during the teaching period (Cain et al., 2018). This approach had already been successfully employed in the 3rd year Deakin engineering unit SEV301 Water Engineering Design, and we benefitted from the knowledge and experience of this unit chair in our assessment redesign.

Like Cain et al. (2018), we adopted a differentiation between pass tasks and graded tasks, where pass tasks were designed to scaffold student learning, with the aim of building core knowledge. These tasks were designed to cover all competency-informed knowledge areas, but only to a minimum acceptable standard of understanding. Rather than specifying additional tasks rated as credit, distinction and high distinction tasks, requiring increasing depth of understanding (as per Cain et al., 2018), we designed a series of (optional) graded tasks, also covering the competency-informed knowledge areas, and provided rubrics detailing the criteria for all grades from pass to high distinction for each task. Additionally, there were a further three graded competencies (covering the four essential project management skills) that required no formal

tasks to be completed as part of the portfolio and that were marked by supervisors rather than the unit team.

Table 1: SEJ441 and SEJ446 assessment tasks before and after the new assessment regime

Unit & Assessment task	Assessment weighting & project management content - Before	Assessment weighting & project management content - After
SEJ441 – Engineering Project A		
Initial Proposal (due week 5)	20% - Resources, project schedule	25% - Strategic alignment, legal and ethical considerations, sustainability, risk, schedule
Oral Presentation (due week 9)	20% - Project schedule	Unchanged
Project Management (due week 12)	10% - 500 word reflection on organisation & autonomy, planning and professional conduct. Supporting evidence, including safety risk assessment and budget. Supervisor assessment of effort, autonomy and professionalism.	20% - Structured portfolio: fortnightly updates; project plan with safety/project risk, project schedule, resourcing, budget and communication plans. Optional legal and ethical considerations, governance and sustainability. Supervisor assessment of professionalism, leadership & stakeholder satisfaction.
Final Proposal (due week 13)	50% - Project schedule	35% - None
SEJ446 – Engineering Project B		
Project Management (due week 11)	30% - 1000 word reflection on organisation & autonomy, planning, stakeholder requirements and professional conduct. Supporting evidence, including communication with stakeholders and final project schedule. Supervisor assessment of effort, autonomy and professionalism.	30% - Structured portfolio, including detailed fortnightly status reports covering project status, risk and schedule, with evidence of progress, and a closeout report covering handover of deliverables and assets, and project management lessons learned. Optional reflections on learning outcomes and engineering competencies. Supervisor assessment of professionalism, leadership & stakeholder satisfaction.
Project Exhibition (due week 12)	30% - None	Unchanged
Final Thesis (due week 13)	40% - None	Unchanged

The software chosen for the task-oriented portfolio was PebblePad (https://pebblepad.com/), which is described as a "flexible ePortfolio, workbook and assessment platform for unparalleled learning experiences". It was chosen over other alternatives because it had been employed previously by one author for portfolio-based assessment in other units and had been used successfully for the task-oriented portfolio assessment in SEV301.

The new assessment regime was implemented in Trimesters 1 (March – June) and 2 (July – October) 2024 in both SEJ441 and SEJ446. The IBPM provided feedback on the industry alignment of the assessment changes via an online meeting in July 2024.

Results and Discussion

Alignment with industry practice

The perhaps more straightforward aim of this assessment redesign was to bring project management activities, tools and techniques used, and documentation of project management by students into closer alignment with industry practice. By replicating the structure and style of typical industry documentation for status reports, project plans and project close-out reports within the PebblePad portfolios, the IBPM confirmed that both the activities undertaken by the students, and the documentation mechanisms, were in alignment with industry practice. They observed that the depth of status reports developed for SEJ446 was somewhat greater than would be typically seen in industry but didn't recommend that this be adjusted as the structure and processes contained within the status reports would promote good practice. This is consistent with Palmer's (2007) assertion that assessment content should be reflective of what industry values.

The IBPM had noted during initial consultation that an area that, in their experience, people working in project management roles but without formal training typically struggle with project risk identification and management, confusing it for contextual risk, typically safety risk. Our observation was that while the students were competent at using the risk documentation strategies (rating likelihood and consequence to prioritise risk mitigation), they too at first struggled to differentiate safety risk from project risk, and a substanital proportion of the formative feedback provided related either to supporting students to differentiate the types of risk, or encouraging them to think both more broadly and deeply about project risk.

An area of opportunity identified by the IBPM was that the lessons learned table that forms part of the SEJ446 close-out report should be consolidated into a lessons learned register, organised by project type, that would be accessible to future students undertaking a similar style of project, and added to after each subsequent trimester. This is standard practice in industry to allow project managers to learn from the past experiences of others, and ultimately better manage project risk. Fortuitously, the PebblePad platform makes this process relatively straightforward, and this will be implemented going forward.

The benefits of a task-oriented portfolio assessment

With the previous versions of these project management assessments, it was possible for the students to only consider project management (beyond project scheduling) right at the end of the trimester, when the assessment was due. Indeed, in our experience, this was how many students approached the assessment. While this promoted reflection on project management, it did not promote the development (through practice) of project management skills. However, with the task-oriented portfolio, on-time completion of the regular progress updates/status updates was >50 % in SEJ441, and in SEJ446, where there were penalties for late completion, >95 %. This promoted the regular consideration of important aspects like project risk, scheduling and stakeholder engagement during the project, rather than just at the end. A number of students communicated to us that this helped them to anticipate issues and deal with them efficiently when they arose, evidence of them beginning to think and act as practitioners (Uziak, 2016).

Students also communicated that they appreciated the breaking up of a large assessment into smaller tasks with staged due dates, noting that this took the pressure off towards the end of trimester when other larger assessments were also due. The unit team did reflect however, that while this benefited the majority of students (who completed the majority of tasks during the trimester), there were a minority who left all tasks until the end, leaving themselves a substanital amount of work. Further, we acknowledge that for some students, having multiple due dates for small tasks is a more daunting prospect than a single due date for a large task.

The positive role of formative feedback

Similar to the findings of Cain et al. (2018) a number of students acknowledged to the unit team the benefits of receiving regular feedback on their tasks, both for keeping them accountable, and for enabling them to reflect and act on that feedback prior to any summative assessment.

Throughout the course of the trimester, it became clear that the formative feedback was also bringing equity to student outcomes: While some students were very familiar with basic project management concepts like scheduling and stakeholder management, others acknowledged having no prior experience of project management. The nature of the task-oriented portfolios, with a series of repeated tasks (status reports) in the early part of the trimester and provision of regular feedback, allowed students to 'catch up' to their peers without the unit team having to dedicate considerable contact hours to delivering project management theory to the whole cohort with their diverse range of skills. This cycle of attempting authentic project management tasks, receiving feedback, and reflecting on feedback before trying again, could be considered an example of successful experiential learning (Kolb, 1984).

Project management as a learning outcome and professional competency

With students now required to complete two structured, multi-component, task-based, project management portfolios as part of their final year project, the unit team feels we now have greater assurance and stronger evidence that all students who pass these units have demonstrated at least the minimum standard across the breadth of competency-informed knowledge areas and key skill areas of project management. As such, our confidence that they have met the unit learning outcomes and professional competencies related to project management is also high. In reality, through these assessments, we are assured that the majority of students have far exceeded the minimum standard in these areas.

The degree to which the aim of reinforcing in the students the importance and value of project management as a learning outcome and professional competency has been met is harder to appraise without qualitative or quantitative evaluation from students. Interestingly though, a significant proportion of the student reflections on project management lessons learned (part of the SEJ446 close-out report) were focussed on risk management, despite, as acknowledged previously, this being a challenging concept for students and industry-based project managers alike. This perhaps demonstrates that this type of assessment, encouraging regular reflection supported by formative feedback, has been effective in developing this particular skill.

Conclusions and Future Work

This paper presents reflections on a redesign of the project management assessments within the engineering final year project units at Deakin University. Following consultation with an IBPM and review of the EA stage 1 competencies, the assessments were redesigned to bring them into greater alignment with professional project management practice while ensuring they addressed key competencies. Task-oriented portfolios were created for the main project management assessments, making use of formative feedback to facilitate development of project management skills prior to summative assessment at the end of trimester. Portfolio tasks were divided between pass tasks that assessed all key competencies to a baseline level, and optional graded tasks that assessed competencies at higher levels of attainment. Feedback from both the IBPM and reflections from the unit team suggest the aims of the project have at least been partially achieved. The next stage of this project is to use student's feedback to assess whether their perceptions of project management as a valuable professional competency has increased.

To continue to reflect industry practice, an improvement recommended by the IBPM was that the responses within the lessons learned table that forms part of the SEJ446 close-out report should be consolidated into a rolling lessons learned register, to allow future students to learn from the experience of their peers. This will be implemented ahead of the 2025 unit offerings.

In the medium term, the priority is seeking ethics approval to access student feedback provided through the university's standard end of trimester anonymous online evaluation surveys. This will allow for a more in depth quantitative and qualitative evaluation of student perceptions of the value of project management as a professional competency and their learning in this space.

References

Biggs, J. (2012). What the Student Does: Teaching for Enhanced Learning. *Higher Education Research & Development*, 31(1), 39–55.

Cain, A., Grundy, J. & Woodward, C.J. (2018) Focusing on learning through constructive alignment with task-oriented portfolio assessment, *European Journal of Engineering Education,* 43(4), 569-584.

EA (2019) Stage 1 Competency Standard for Professional Engineer. Engineers Australia. https://www.engineersaustralia.org.au/sites/default/files/2022-07/stage-1-competency-standard-professional-engineer.pdf

Edum-Fotwe, F. T. & McCaffer, R. (2000). "Developing project management competency: perspectives from the construction industry", *International Journal of Project Management,* 18(2), 114-124.

IEA (2021) Graduate Attributes and Professional Competencies – Version 4: 21 June 2021. International Engineering Alliance. https://www.internationalengineeringalliance.org/about-us/gapc

Kolb, D. (1984) *Experiential Learning as the Science of Learning and Development*. Englewood Cliffs, NJ: Prentice Hall.

Male, S.A., Bush, M.B. & Chapman, E.S. (2010) Perceptions of Competency Deficiencies in Engineering Graduates. *Australasian Journal of Engineering Education,* 16**,** 55-68.

Nair, C.S., Patil, A. & Mertova, P. (2009) Re-engineering graduate skills - a case study. *European Journal of Engineering Education,* 34 (2), 131 - 139.

Palmer, S. (2002) An Evaluation of Undergraduate Engineering Management Studies. *International Journal of Engineering Education,* 18(3), 321-330.

Palmer, S. (2007) Authenticity in assessment: reflecting undergraduate study and professional practice. *European Journal of Engineering Education*, 29(2), 193-202.

Panuwatwanich, K., Stewart, R.A. & Nepal, K.P. (2011) Project management skills for engineers: industry perceptions and implications for engineering project management course. Proceedings of the 2011 AAEE Conference., Fremantle, Western Australia, 569-575.

Tuladhar, R., Pandey, G.R., Turner, P., Christie, D. (2014). Turning Tedious to Terrific: An Authentic Learning Experience to Engage Engineering Students in Project Management. Proceedings of the 2014 AAEE Conference, Wellington, New Zealand.

Uziak, J. (2016) A project-based learning approach in an engineering curriculum. *Global Journal of Engineering Education, 18*(2), 119-123.

WCE Council (2004) *How does chemical engineering education meet the requirements of employment?* Frankfurt: W.C.E. Council.

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