

Assessment of Final Year Engineering Projects – an AQF8 perspective

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CONTEXT

In undertaking the Office for Learning and Teaching (OLT) Project, Assessing Final Year Engineering Projects (FYEPs): Ensuring Learning and Teaching Standards and AQF Level 8 Outcomes, the project team identified three key areas which were common and most pertinent in the survey data: curriculum, supervision and assessment. This paper describes a set of assessment guidelines that were developed as a key outcome for the OLT Project in addition to the supporting body of knowledge, good practices and data collected.

PURPOSE

The first phase of the broader project identified a need for greater consideration of how final year projects demonstrate Level 8 learning outcomes required by the Australian Qualifications Framework for 4-year Bachelor of Engineering (Honours) degrees. The purpose of the second phase was to develop and disseminate guidelines that assist academics to create and assess FYEP tasks in relation to the learning outcome areas of knowledge, skills and application. These guidelines are accompanied by exemplar practice as identified from the review of survey data and are designed to assist academics in the design, assessment and moderation of tasks associated with FYEP work.

APPROACH

The wider project methodology was largely qualitative, adopting a case study approach. Data was gathered from 16 universities across Australia (from all states and territories) and included university documentation such as subject outlines, rubrics and student guidelines. Additionally, interviews were conducted with coordinators of final year project subjects. Within these interviews participants were asked specifically about their assessment practices and AQF level 8. Additional data was gathered from participants during a conference workshop designed to explore their understanding of the AQF Level 8 learning outcome descriptors. The guidelines were developed after mapping this data against the sections of knowledge, skills and application described in the Level 8 learning outcomes.

RESULTS

The dissemination of the Assessment Guidelines and exemplar practice is designed to both capture some of the complexities around assessment of FYEPs and progress practice towards AQF8 compliance. It is anticipated that the adoption of the guidelines within institutions will lead to higher quality assessment practices and delivery of AQF level 8 outcomes.

CONCLUSIONS

Assessment practices in FYEPs vary considerably across institutions and this variance is seen in both the types of tasks set for students and the ways in which they are marked and moderated. The project team has sought to delineate good practice in this area and disseminate guidelines designed to assist in careful thinking about the high standards implied by AQF level 8.

KEYWORDS

Assessment, Final Year Engineering Projects, Australian Qualifications Framework

Introduction

In undertaking the Office for Learning & Teaching (OLT) Project: *Assessing Final Year Engineering Projects (FYEPs): Ensuring Learning and Teaching Standards and AQF8 Outcomes*, the project team identified three key areas which were common and most pertinent in the survey data collected. These were: curriculum, supervision and assessment. This paper presents the set of Assessment Guidelines that have been developed as part of the deliverables for the OLT Project and they are based on the supporting body of knowledge, good practices and data collected. The assessment guidelines typically apply to four year undergraduate engineering degrees with embedded Honours. Such qualifications are designed to support achievement of the Level 8 learning outcomes of the Australian Qualification Framework (AQF, 2013). The skills and application of knowledge outcomes most relevant to final year engineering projects are shown in Table 1 with the key points of difference between AQF7 and AQF8 highlighted in **bold**.

Table 1: Points of Difference between AQF levels 7 & 8 (AQF, 2013, p.16)

Skills	Graduates will have cognitive skills to review, analyse, consolidate and synthesise knowledge to identify and provide solutions to complex problems with intellectual independence
	Graduates will have cognitive and technical skills to demonstrate a broad understanding of a body of knowledge and theoretical concepts with advanced understanding in some areas
	Graduates will have cognitive skills to exercise critical thinking and judgement in developing new understanding
	Graduates will have technical skills to design and use research in a project
	Graduates will have communication skills to present a clear and coherent exposition of knowledge and ideas to a variety of audiences
Application of knowledge and skills	Graduates will demonstrate the application of knowledge and skills to plan and execute project work and/or a piece of research and scholarship with some independence

In line with the scope of the OLT project, these points of difference were the focus for the project team. The learning outcomes described in Australian Qualification Framework (AQF, 2013) for Level 7 were assumed as these describe 3-year bachelor degrees (non-honours awards).

Further to this point, it is acknowledged that institutions have well established final year project requirements embedded in their engineering courses, and that these afford useful capstone learning opportunities (readiness for graduation) for students as well as demonstration of EA Stage 1 Competencies and accreditation requirements (Engineers Australia, 2011). The introduction of AQF and the uptake by the majority of institutions to ensure their courses will reflect Level 8 learning outcomes, provides a valuable disruption to practice and an excellent opportunity to reflect on and improve current practice.

Methodology

The OLT Project was undertaken in two phases. In phase one, data was collected from 16 universities around Australia including examples of curriculum material and interviews with FYEP subject coordinators. Contributing Universities were from the Australian Technology Network, the Regional Universities Network and the Group of Eight and data was provided from several different engineering disciplines, including: mechanical, aerospace,

mechatronics, electrical, civil, chemical and mining. The data sources therefore represent a wide range of University type and a wide range of engineering disciplines. However, because the skill set which demonstrates AQF 8 (see Table 1) is generic in nature, no distinction was made between the different disciplines of engineering.

Analysis of the data identified three key areas: curriculum, supervision, and assessment as key themes. In phase two, the project team attempted to synthesise the data into a set of draft guidelines to be used by FYEP curriculum designers, supervisors and assessors. A series of workshops were held across Australia as part of the national dissemination strategy (Lawson, 2014a) to seek feedback on the draft guidelines. The feedback (still in progress at the time of writing this paper) will inform the final guidelines (Rasul, et al, nd). The focus of this paper is on the development of the draft assessment guidelines.

Given the significant task for the project team, three subgroups were formed to progress work in parallel. In the early stages it became apparent that it would be difficult to write guidelines that were only about assessment, without engaging areas of curriculum or supervision. This was reconciled by each group focussing on the points of difference between AQF7 and AQF8 (highlighted in bold in Table 1). It became clear that all institutions already had FYEP project subjects that were likely to be at least compliant with AQF Level 7. The guidelines point to key areas needed to meet AQF Level 8 outcomes. Other papers on Curriculum (Howard, et al, 2014) and Supervision (Martin, et al, 2014) present equivalent guidelines.

The research approach undertaken by the assessment group was iterative. In the early stages we noted project process (how the student went about delivering their project) was important and this could be evident in (say) reflective journals, student/supervisor discussion. The draft guidelines presented in this paper represented a shift in focus towards outcomes – those components of a FYEP which may provide evidence of learning such as deliverables and artefacts (Nouwens, et al, 2013). Based on dissemination workshop feedback (still in progress), it is likely that the final guidelines will recapture a focus on process as critical in affording a student the opportunity to demonstrate AQF Level 8 outcomes.

Results and Discussion

A brief overview of the data collected in phase one of the OLT project indicates there is considerable language variation in the tasks/outcomes expected of the FYEP – ‘design’, ‘implement’, ‘perform’, ‘prepare.’ Some institutions attempt to qualify outcomes – ‘produce high quality’ ‘apply original thinking.’ Few institutions use the terminology used in AQF Level 8 in their course or subject documentation, but when interviewed most feel that their current practices reflect AQF Level 8. Final year engineering project deliverables include final report/thesis, progress documents, presentations/seminars and/or exhibitions. In terms of assessment, weightings for the thesis (final report) were observed to vary between 40% to 100% and the number of assessment tasks from 3 to 7. There is considerable variation in marking and moderation practices with many coordinators expressing concern about supervisor bias. Close attention is paid to formative assessment in many project courses and the use of peer and self-assessment in some. The following sections present three areas that were considered noteworthy.

Assessment Practices

It is apparent that assessment practices in FYEPs vary considerably across institutions. This variance is seen in both the types of tasks students undertake and the ways in which they are marked and moderated.

However, variance per se between institutions is not viewed as a concern. Participants in the dissemination workshops have indicated the most important issue is quality or working towards high level learning outcomes. This aligns with accreditation requirements, including

EA Stage 1 outcomes. For example, there is agreement that an annotated bibliography would not be appropriate at AQF Level 8 outcome.

In addition, the group noted synergy between the AQF Level 8 outcome 'Graduates will have communication skills to present a clear and coherent exposition of knowledge and ideas to a variety of audiences' and the (best) practice of a few institutions conducting open/public exhibitions of student work. In short, the use of public presentations or exhibitions is supported in the literature as enhancing engagement and learning outcomes (Schmid, et al. 2012; Kar, et al, 2013). There is merit in institutions introducing or improving their practice in this area.

Supervisor Marking

There was some contention regarding the role of the supervisor in marking of FYEP. In part, this contention may stem from "the subjectivity to be found in the supervisor-student relationship" (Lawson, 2014b). Further, the supervisor will have a far greater understanding of the process of undertaking the work compared to the outcome or final product or artefact alone, and literature points to this formative assessment as critical in scaffolding student learning (Gardner & Willey, 2012). As one of our workshop participants commented:

It's interesting that we seem to making a point about supervisors assessing the project themselves as an owner and yet they are quite capable of assessing everything else up that point. Why is this final year project so wonderful that they can't make a good, you know, decision on that sort of thing and so I think, I personally think that the supervisor should be involved in it...You're OK all the way up to the report but then you can't do it anymore... (Person A)

In writing the guidelines, the assessment group noted the AFQ Level 8 outcomes listed in Table 1 *may* be identifiable in project products such as artefacts and reports, but also in reflective journals and discussions with supervisor where process could be evaluated. Feedback from the dissemination workshops is highlighting the need for institutions to consider carefully their FYEP assessment practice, and rather than mitigate against potential subjectivity, consider a means by which the professional judgement of the supervisor is included in evaluating how the student has undertaken their project as critical component of demonstrating AQF Level 8 outcomes.

Assessing the Process

Further to Supervisor Marking above, the group identified that there is typically a significant amount of formative assessment provided by the supervisor which scaffolds student learning throughout the project. As noted by interviewees:

I make a huge emphasis to students what we assess is the process. We don't care what you are doing really. I mean I am very cynical and I tell them, tell it like this to make an impact: "We don't care what you are doing, what we care is how you do it...How you make your decisions, how you make your assumptions, how you select components, what do you see as constraints, how do you plan, how do you follow your plan, how do you reflect on your plan, how you can say 'oh, I underestimated this activity' or 'I thought I had to do this.' (Person B)

Actually, coming back to the challenges, probably that's one of the challenges that we've faced, the fact that sometimes...particularly with the implementation part we see the thesis as the lasting artefact. So when Engineers Australia comes to accredit us, that's what they see. That's what we show them and that's what they see. So they can't see the other bits. So we are always a little bit conflicted, I think, about the difference between the fact that thesis is the artefact and it's the lasting artefact of the student's work and yet sometimes there are other things that may impact on the grade you want to give the student and that can be a little bit of a tension sometimes I think. (Person C)

Well, I think the emphasis on the process. It is not about what they do. It is not about getting a dancing robot at the end of one year. It's about what you did and what you thought and what you learned, why you doing the dancing robot. And if the robot doesn't dance at the end, it doesn't matter. What matters is that you did it correctly or you tried to do it correctly. I think that's a great thing that students are getting into the idea that engineering is about the how, it's not about the what. (Person B)

For institutions planning to improve their FYEP assessment practice, the importance of these comments was reinforced during the dissemination workshops, emphasising the process of the student planning and executing the project, their research methodology and intellectual independence. However, the summative assessment of the product or deliverable appears to 'count' most toward the final subject mark. This is evident in some institutions weighting the final report at 100% of final mark/grade. Arguably, here the process is indirectly assessed as it is implied within the product, but there is also some concern that it may be possible to 'fake' evidence of process in final report.

(Draft) Assessment Guidelines

There is broad consensus amongst the higher education sector that assessment plays a critical role in the provision of high quality teaching and learning and many universities have guiding principles underpinning faculty or school assessment work. The general principles below are taken as necessary but not sufficient for the provision of quality assessment of FYEPs. The more specific guidelines may assist in designing FYEPs that demonstrate AQF Level 8 learning outcomes.

As overarching principles, assessment must be authentic; encourage student involvement in peer and self-assessment; be tightly and constructively aligned to outcomes and curriculum; and enable opportunities for formative feedback (Boud, 2003; Gardner & Willey, 2012; Hattie, 2008, Biggs, 1996).

All assessment practices associated with FYEPs should be considered in light of AQF Level 8 outcomes. This means that tasks themselves and how they are marked should reflect the higher order requirements of the skills and application of knowledge as described in AQF Level 8. The FYEP is a unique undertaking in that it usually spans a year, requires students to work in largely autonomous ways -though under supervision, and engage in a research and/or design project of high intellectual quality. Therefore FYEP assessment should be cognisant of these unique demands and might look qualitatively different from other undergraduate assessment practices.

Primarily, given the length and nature of a FYEP course, assessment should be seen as a dialogue, a conversation that is focused on the development and improvement of a student's capacity to undertake a project. These guidelines posit that formative, peer and self-assessment are critical components of the assessment program and must occur early and frequently in the FYEP student journey. The guidelines also assume, given the principle of constructive alignment, main assessment items should be taught, scaffolded and practised prior to demonstration. In the case of FYEP, such scaffolding and practice might take place in preceding subjects.

The following guidelines identify points of differentiation between the skills and applications of AQF7 and AQF8 and the ways in which associated assessment of learning outcomes might be considered. The guidelines acknowledge that the FYEP is an ideal place to look for AQF8 outcomes, but it may not be the only place in an institution's curriculum. Further, FYEPs vary across institutions in terms of individual versus group projects, how projects are developed or allocated to students, and what tasks are set and assessed. It should be noted that these six (A)ssessment guidelines have been written to directly align/reflect with the six AQF8 learning outcomes described in Table 1.

- A1. When assessing for this skill look for evidence of the student's individual capacity to synthesise knowledge to identify and provide solutions to complex problems

- A2. When assessing for this skill look for evidence of the student's broad understanding of a body of knowledge and theoretical concepts with advanced understanding.
- A3. When assessing for this skill look for evidence of the ways in which the student is moving beyond what is locally known and described and towards what is critical and new. This suggests a requirement for the assessor to have relevant discipline related expertise.
- A4. When assessing for this skill look for evidence of use of specialist bodies of knowledge and skills as applied to a new problem. This guideline suggests ideally, students should develop their own projects rather than be allocated one.
- A5. When assessing for this skill look for evidence of student communication skills with more than one audience. Include opportunities for students to communicate with peers, academics, industry or general public.
- A6. When assessing for this skill look for evidence of students' individual capacities to develop and implement projects and/or a piece of research relevant to the practice of engineering.

The guidelines above are not provided in isolation. Table 2 lists typical FYEP assessment deliverables as well as examples of the student activity which may provide an opportunity for demonstration of AQF Level 8 learning outcomes. The following scenario represents how the guidelines might be used by an institution:

A curriculum designer determines that their FYEP subject is an ideal opportunity for students to demonstrate the AQF learning outcome "Graduates will have cognitive skills to review, analyse, consolidate and synthesise knowledge **to identify and provide solutions to complex problems with intellectual independence**". The guideline linked to this outcome is "A1. When assessing for this skill look for evidence of the student's individual capacity to synthesise knowledge to identify and provide solutions to complex problems." When assessing (say) the project proposal, the assessor might look for evidence of "Review, critique and synthesise knowledge and demonstrate the space for project/problem including cross-disciplinary fields".

Table 2 shows multiple project deliverables (e.g. proposal, progress report) that provide opportunity for multiple activities likely to support demonstration of learning outcomes. Equally, the activities are likely to contribute to more than one project deliverable. Elements within the table are not intended to be linked in a prescriptive manner. Further, while the assessment deliverables and example activities in Table 2 have an emphasis on deliverables/products, it is not difficult to identify where process is evident. The real value of Table 2 is that it can be adapted and improved at the (local) institutional level as needed.

Table 2: Typical FYEP assessment deliverables and examples of student activity providing opportunity for demonstration of AQF8 outcomes

Assessment deliverables	Examples of student activity leading to demonstration of outcomes	
Project proposal	Develop a project proposal independently including problem identification	Present a clear statement of the shortfall of knowledge and how the project addresses this, or, in the case of a design prototype, the unique design elements are identified
Literature Review		
Progress Reporting	Review, critique and synthesise knowledge and demonstrate the space for project/problem including cross-disciplinary fields	Design activity that involves critical thinking, evaluation and judgement with demonstrated development of new understanding
Reflective journal or logbook or portfolio	Discover and document the state of the art	Choose relevant research methodology, explain relevant theoretical approaches
Model/artefact, simulation, design, proof of concept	Systematically investigate, distillate and apply engineering theory and practice to an engineering problem	Demonstrate understanding within a specific topic area beyond those from coursework experiences
Final Report/Thesis	Value add to (local) knowledge by adding commentary or evaluating or comparing or summarising or drawing new ideas or identifying patterns or trends	Provide material to a publishable standard
Poster sessions, exhibitions, oral defence, interview	Understand context, need, benefit, requirements, uncertainty, value of intended outcome and to whom	Write and/or present coherently, succinctly, with logical development of ideas and clarity
Peer review	Critically analyse quantitative and/or qualitative data	Incorporate appropriate text, calculations, drawings, images. Represent data appropriately
Publishable material	Interpret results with appropriate engineering decision making and reference to body of knowledge	Make logical and accurate conclusions and recommendations
	Apply appropriate technical engineering tools e.g. design, experimental work, analytical, statistical, computing, simulation to provide solutions	Use suitable language for various audiences and appropriate presentation methods and techniques
	Be autonomous and demonstrate self-management including applying project planning regularly to report progress and direct/guide project work and decisions, evidence of adapting/changing planning as needed, including response to disturbances.	Use innovative or creative approaches to engage audience and seek audience confirmation for understanding Collaborate with broad stakeholders

Conclusions

The introduction of Australian Qualifications Framework has presented institutions with an opportunity for change, with the majority aiming to have their 4-year engineering courses meet the Level 8 learning outcomes. The development of the (draft) assessment guidelines described in this paper aim to assist institutions in achieving this aim through FYEPs. Further, the paper presents three areas identified from data collected from institutions across Australia related to FYEP assessment practices which are noteworthy for institutions to consider. These include: the use of public presentations or exhibitions to enhance

engagement in learning outcomes; incorporation of the professional judgement of the supervisor in evaluating how the student has demonstrated outcomes; assessment of the process of student planning and execution of the project (such as research methodology) in addition to the summative assessment of the project product or deliverable and; adoption of the full suite of curriculum, supervision and assessment guidelines.

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