

What can we do to better support students in Thesis?

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

CONTEXT Thesis units are often considered the culmination of an undergraduate engineering degree and play an important role in addressing extra-institutional requirements, including aspects as broad as developing/assessing communication skills (EA Stage 1 Competency) and increasing student exposure to research (AQF requirements). However, even within a single institution, different schools can have markedly different approaches to these common requirements and there can be substantial variation in supervision practices even within a single school. Variations in the student experience of Thesis units have the potential to undermine the achievement of the aims of these units. To better understand the current learning & teaching practices and create consistency across different Thesis units at The University of Sydney, the Faculty of Engineering & IT has been conducting a review of Thesis units in its schools. This paper outlines the aim of the review, the review process and the recommendations of the review, particularly with regard to approaches that are most likely to ensure the achievement of the intended learning outcomes.

PURPOSE The aim of this study is to better understand the views and requirements of Thesis coordinators, supervisors and undergraduate students, and identify ways to address issues with consistency in areas such as student experience, supervision, and assessment of undergraduate theses, whilst also coping with academic workload requirements.

APPROACH A review of the current Thesis programs in the Faculty of Engineering & IT at The University of Sydney has been undertaken. Strengths and weaknesses of the current structures and practices have been identified from the perspective of Thesis coordinators and supervisors; from this, techniques and tasks that could be used to better scaffold the research experience for undergraduate have been identified. Surveys of recent past undergraduate students are being used to identify where students themselves believe that changes are necessary.

RESULTS A list of tasks that supervisors and students have found effective in supporting the undergraduate Thesis learning process will be outlined. Furthermore, both supervisor and student perspectives will be integrated into recommendations, which will include a general structure that Thesis coordinators will be able to tailor for implementation within their own schools and will identify areas where Faculty-wide initiatives have potential to further enhance student learning outcomes.

CONCLUSIONS This review's recommendations will aim to provide structure and guidance to students so that they are better equipped to gain a greater appreciation for research. Nevertheless, it is widely acknowledged that the workload of both students and supervisors is already high, so measures that will achieve this without substantial increases in workloads will be identified and prioritised in the recommendations.

KEYWORDS undergraduate Thesis; research training; surveys

Introduction

Thesis units are often considered the culmination of an undergraduate engineering degree (Holdsworth et al., 2009; Ku & Goh, 2010) and play an important role in addressing extra-institutional requirements, including aspects as broad as developing/assessing communication skills (Engineers Australia, 2017) and increasing student exposure to research (AQF, 2013). Both internal policy and external accreditation requirements often go further, and mandate a 'capstone' project experience of some form: e.g. "It is expected that programs will embody at least one major engineering project experience" (Engineers Australia, 2008).

The existing literature on final year engineering theses (e.g. Wisker, 2012, Lawson et al., 2014) highlight some areas of concern, mainly with consistency in supervision and marking. In addition, undergraduate thesis units are often students' first major experience of undertaking research, so undergraduate students often need more structure and guidance (Wisker, 2012). Lawson et al.'s (2014) interviews noted that marking consistency is a significant issue with undergraduate theses, with some interviewees arguing that supervisors can be biased or have a conflict of interest in relation to assessing students they have supervised and others arguing that supervisors must be involved in marking as they have a holistic view of a student's work. While rubrics can help with marking consistency, they also need a degree of tailoring to the project (Littlefair & Gossman, 2008). Overall, variations in the student experience of Thesis units have the potential to undermine the aims of these units (Lawson et al., 2014; Rasul et al., 2015).

This paper outlines the results of a review undertaken by the Faculty of Engineering & IT at The University of Sydney to better understand the current learning & teaching practices and make recommendations that aim to create consistency across the Thesis units run by the four different schools within the Faculty.

Overview of the Thesis Program

Engineering students at The University of Sydney undertake the thesis as 12 credit points (0.25 EFT) over two semesters during which they undertake a project. In line with AQF requirements, the thesis units aim to expose students to research as well as to have them connect their technical and design skills to broader professional capabilities within the context of a major individual project.

The thesis research process is organised into a number of sequenced assessment tasks which introduce students to different aspects of research, such as the literature review and progress report. In the literature review or proposal components, students are exposed to the existing research on their topic through identifying and analysing existing literature, interpreting the findings and evaluating the quality of the research. In the progress report or participation components, students are assessed on the process of performing research e.g. planning the research and implementation. In the presentation/seminar or thesis components, students communicate their research to peers and academics.

There are different approaches to the kinds of project students undertake and may for instance include:

- Design and construct/implement
- Collection and analysis of survey data
- Experimental tests
- Numerical simulations
- Analysis of case studies

Overall there are differences across the Engineering Schools at the University of Sydney in the assessment tasks undertaken by students. As can be seen in Table 1, there are substantial differences in terms of the timing and weighting of assessments, in spite of a relatively similar structure (proposals and literature reviews in first semester; presentations and final submission of thesis in second semester). Chemical and Biomolecular Engineering (CBE) assess each semester separately, whereas the other schools assess across both semesters and apply the same mark to both units. Additionally, Civil Engineering (Civil) and Electrical and Information Engineering (EIE) have participation components of 15% and 20% respectively, which reflect the management aspect of the thesis. Compared to other Schools, Aerospace, Mechanical and Mechatronic Engineering (AMME) give more weighting to the final Thesis submission.

Table 1: Summary of Thesis assessments

Week	Civil	AMME	CBE	EIE
Semester 1				
3			Online Quiz (5%)	Proposal (0%)
5		Proposal (0%)		
7			Literature Review/ Plan (45%)	
10	Literature Review (10%)			
13		Progress Report (10%)	Presentation/ Seminar (50%)	Progress Report (0%)
Semester 2				
7			Progress Report (20%)	
11			Thesis (70%)	
12	Presentation/ Seminar (15%)	Presentation/ Seminar (10%)	Presentation/ Seminar (10%)	
13	Thesis (60%)	Thesis (80%)		Thesis (60%)
StuVac				Presentation/ Seminar (20%)

In terms of marking, each of the schools has a policy that the final submission of the thesis is assessed by two markers, namely the supervisor and a second marker, but if the marks differ by 15% or greater, a third marker is required. A common rubric is used across the Faculty for the marking of the final submission. Presentations are also assessed by two markers, but each school has its own criteria. The marks for the other components (e.g. literature review, participation) are determined by the supervisor alone.

Depending on the nature of the project, as well as on student needs and the style of supervision, support from supervisors can include: weekly meetings with students; directing students to library resources; discussion of the requirements and expectations of the thesis unit; showing and reviewing exemplars or the provision of a thesis template; creation of project plans; provision of feedback on written submissions; and introduction to industry contacts.

Review Methodology

Information for this research was collected through discussions and an online survey. Discussions were held with the unit of study coordinators from the thesis units who identified areas which were of concern. These included: variations in quality of supervision; inconsistency in marking; and the difficulty of project assignment. Approximately 130 past graduates of the Bachelor of Engineering degree at The University of Sydney were emailed a link to an anonymous online survey to which there were 16 responses. Study data were collected and managed using REDCap (Research Electronic Data Capture) electronic data

capture tools (Harris et al., 2009) hosted at The University of Sydney. The ethical aspects of this study were approved by the HREC of The University of Sydney 2017/483.

Survey

The following questions were asked in the survey:

1. What did you enjoy most about Thesis?
2. What do you think needs improvement?
3. How useful would the following have been during your Thesis?
 - a) Online modules to guide you through Thesis
 - b) More tasks to support communication skills
 - c) More opportunities to present work throughout the year
 - d) Changes to the marking rubric
 - e) More assessments/deadlines
 - f) Standardisation of marking/marks better linked to WAM
 - g) Group discussions
 - h) Clearer expectations from your supervisor
 - i) A project with strong links to industry
4. What other techniques and tasks do you think could have been used to improve your learning experience during Thesis?

Survey Results

The survey responses were received from students who had received marks of 65–91 for the Thesis units. Despite substantial differences in their Thesis marks, many students made similar comments in response to the survey and there did not seem to be correlation between their marks and the ratings on proposed changes.

What did you enjoy most about Thesis?

Many responses indicated that the topic was one of the highlights of the Thesis experience, commenting positively on “learning about things that I am really interested in” and the “[a]bility to research a fascinating topic”. Furthermore, the autonomy to work on the topic was clearly a positive experience, with a number of comments about the independent nature of the research project, e.g. “I really enjoyed the independence” and “[t]he opportunity to do individual research into a topic outside of lectures. The ability to take research into own direction”. This also had the additional benefit of giving students the “flexibility to do more work in the weeks that I didn't have much on”. Some responses also highlighted a positive experience with supervision, e.g. “relationship with my supervisor” and “[w]orking with a really good supervisor. He was really supportive”.

What do you think needs improvement?

Many of the responses commented on varying quality of supervision, with “some people hav[ing] fantastic experiences whilst others poor experiences”. Some responses commented on the availability of the supervisors, e.g. “[s]upervisors should try to make themselves available to thesis students in a reasonable capacity” or “[s]upervisors need less students each so they actually have time for their students”, whilst others added that the quality of the time with the supervisor was important, e.g. “more constructive sessions with Supervisors are required for a successful thesis”. These comments contrast with the positive comments on supervision in the previous section and clearly highlight the inconsistency between the student experience of supervision. Some students have pointed out that their supervisor (as an individual) was excellent, but also acknowledge that this is not necessarily the case across the spectrum of supervisors.

There were also comments on assessment, mainly regarding the “[i]nconsistency in marking and lack of transparency in the marking process”. This is further reflected in comments regarding the lack of feedback from the thesis submission, e.g. “presentations were done and we received final mark, but no breakdown into components or feedback on research itself - what could have been done better”.

The thesis units are typically taken across two semesters, with most schools weighting the assessments in the second semester much higher than the first semester. Some responses commented on the subsequent lack of incentive to work in the first semester, e.g. “[t]here could be more incentive to start your experimental work/conduct interviews earlier” and “[h]aving more presentations during the year (eg 2 min q&a) to encourage people to work through year”.

Interestingly, there is a clear alignment in the concerns of unit of study coordinators and the students, especially in the areas of supervision and marking. This is likely a reflection of the fact that unit of study coordinators receive feedback from students (in the form of Unit of Study Survey results), and oversee the marks finalisation process, where significant differences in mark allocations between markers are most obvious.

How useful would the following have been during your Thesis?

Figure 1 shows the number of responses that agreed or disagreed with each proposed change listed in the survey. It can be seen that there is general agreement with the usefulness of the potential changes that were listed, with the clear exception of strong disagreement with e) more assessments/deadlines. Interestingly, the respondents who commented that there was a lack of incentive to work in first semester also disagreed with the usefulness of more assessments or deadlines.

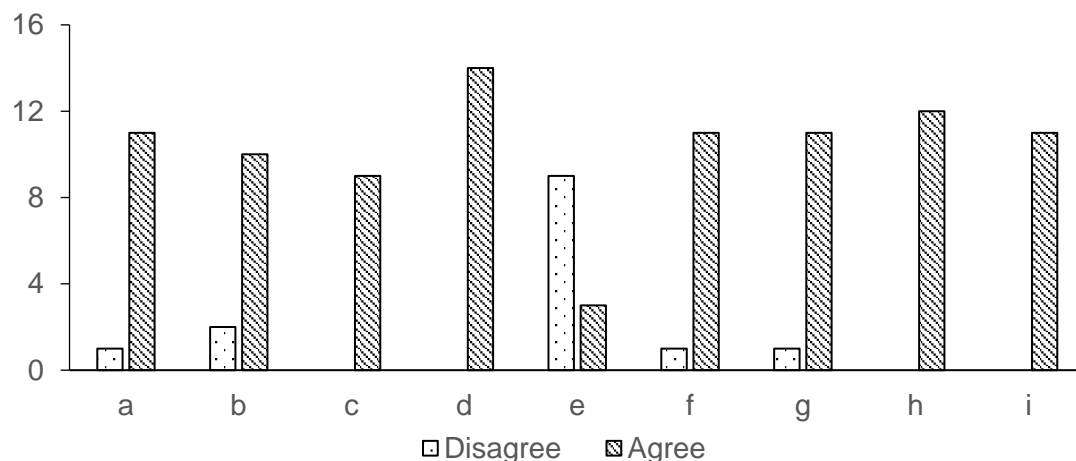


Figure 1: Agreement and disagreement with the utility of a) online modules, b) communication tasks, c) more opportunities to present work, d) rubric changes, e) more assessments, f) standardisation of marks, g) group discussions, h) clear supervisor expectations, i) project with industry links

What other techniques and tasks do you think could have been used to improve your learning experience during Thesis?

A number of respondents commented on the lack of training in how to write a thesis, e.g. “[a] presentation or a tutorial of how to write a thesis before it is written” or “some organized learning materials or workshops in using better tools (for example, LaTeX) for both word processing and citation management.” This also reflects an improvement suggested by a respondent that, “a lecture when thesis starts about what a literature review is, then a

separate lecture on what methodology should entail etc.” should be offered. Currently, Civil and EIE organise literature review writing sessions in conjunction with the Library in first semester. According to the thesis coordinators from the respective schools, the Literature Review sessions that are run by the Library specifically for engineering thesis students are well-attended by the Civil and EIE students. Furthermore, some respondents commented on the usefulness of exposure to other students’ research, e.g. “communication with other groups” and that “a mixture of group discussions and one on one feedback sessions and review” was helpful when organised by their supervisor.

Recommendations

The aim of this review is not to homogenise the thesis experience, but rather to support the improvement of the student experience and learning outcomes of the Thesis unit. Based on the data collected, the following recommendations aim to minimise structural changes to the existing units by focusing on the introduction of new elements and promoting “best practice” from across the different schools’ existing units.

Conduct End-of-Thesis Student Survey on Supervision

Issues with variability in supervision quality should be assessed via an end-of-thesis survey where students can provide feedback on their supervision experience. Currently, the Unit of Study Survey provides feedback from students on their overall experience of the thesis unit, and Thesis coordinators often have a general idea of which supervisors are providing adequate supervision; however, a survey specifically on supervision would create greater accountability for individual supervisors and allow Heads of School to make an assessment on which supervisors are performing well and which need further support, scrutiny, accountability or training.

Ensure Consistency of Marking

The mandatory use of third markers was noted by the thesis coordinator to have been effective in the past; however, this is a resource-intensive practice and is not practical with the growth in student numbers that the Faculty has recently seen. Furthermore, there is general agreement from supervisors that the use of external markers for across-the-board marking would not be ideal as theses should be marked by someone with experience in the research area. There is no immediate solution to the issue of consistency of marking between two markers; however, monitoring of supervisors who consistently give high or low marks relative to the second marker or who consistently give their students marks much higher or lower than a student’s Weighted Average Mark (WAM) should be undertaken. Using this information, supervisors with unusually generous or harsh assessment practices can be identified and steps can be taken to either normalise marks or to discuss the marking with the supervisor.

Provide Feedback to Students

The process of giving feedback to students at the end of the thesis should be formalised so that students receive information on their performance in the thesis unit. Currently, this process is dependent on the supervisor and internal requirements, with many schools not necessitating any feedback beyond the final mark. Feedback will provide students with further insight into their own strengths and weaknesses, as well as increase student confidence in the marking process. This could simply be in the form of checked boxes in a rubric and a mandatory one-paragraph comment from the marker, as is current practice in EIE.

Provide Thesis Writing Resources

There are a number of resources available to students at The University of Sydney to help them with their thesis writing, such as the Library and Learning Centre resources. In general, however, guidance on writing is often not considered to be the responsibility of the supervisor, but rather the responsibility of the student, and students may be reluctant to access general resources that are not tailored to engineering students.

The Literature Review sessions that are run by the Library for engineering thesis students are tailored to help students find scholarly resources and evaluate the quality of the information within the resources. Some sessions also introduce the use of reference managers, such as Endnote. The Learning Centre also runs sessions on how to write a Literature Review, but the focus tends to be on postgraduate research students, as noted by one of the survey respondents, "They have these for postgrads but I don't understand why they don't do it for undergrads". Further discussion with the Library and Learning Centre is required regarding resourcing; however, these programs should be expanded across all the schools so that all students are aware that there are Library and Learning Centre resources available to them and, if organised across the Faculty, there would be greater flexibility in the timing of sessions that can be run.

Provide Templates and Exemplars

Templates and sample submissions of past student work could be provided in each school as a guide to students. Ideally, a variety of past submissions would be included to account for the differences in types of projects offered by the school. Currently, this is done at the supervisor level, resulting in situations where some students have a much clearer idea of the expectations than others. If introduced at a school level, all students would have the same base level of support and supervisors who may wish to build on the provided resources (by providing their own exemplars or by analysing the template and submissions with their students) may do so.

Encourage Video Presentations

To create incentive for students to work throughout the year (and particularly, in first semester which generally lacks assessments), students should submit a video submission of their progress and expected findings. The videos could be distributed across the Faculty for peer review and this could also be used as an opportunity to expose students to research outside of their own project. Although the student survey suggested that more assessments would not be beneficial, a first semester, low-weighted assessment would alleviate some of the concern with the additional workload. Furthermore, this cross-School initiative would align with The University of Sydney's Strategic Plan, which includes a greater focus on multidisciplinary activity.

Include Poster Presentations

An unassessed poster presentation session is another way in which students can be exposed to research outside of their own project. Both staff and students would have the opportunity to interact with poster presenters and, would have the opportunity to learn more about projects on offer and about potential supervisors. This would benefit penultimate-year students as well. In the past, poster presentations have also been attended by industry representatives. Coordination across the Faculty to run poster presentation events on the same day would give students the opportunity to see research outside of their own school.

Conclusion

This research identified issues mainly concerned with supervision and marking, but also feedback, resources and exposure to the research being undertaken by their peers. Positive

aspects identified from student surveys suggests that the respondents generally agree that, aside from additional assessments, the provision of additional structure and support during the thesis unit would be beneficial to them. This review recommends that support for students be provided by better promotion of thesis-writing resources and the provision of templates and exemplars. Furthermore, consistency of supervision and marking should be addressed via an end-of-thesis student survey on supervision and monitoring of lenient markers. More opportunities to present their projects and, conversely, gain a better understanding of research outside of their own project should be given to students, as well as better feedback on their final submission.

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Acknowledgements

We are very grateful to Deborah Rodrigo for her help with the student perspective and identifying approaches that link with the postgraduate research experience and Vaiju Deb for her help during the survey process. We would also like to thank the Thesis Coordinators within the Faculty of Engineering & IT—Luming Shen, Yash Shrivastava, Rod Fiford & Yuan Chen—for their time in discussing the Thesis units and for their help in the initial identification of the key issues.