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Learning and Teaching Approaches and Methodologies of Capstone Final Year Engineering Projects*

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The capstone final year engineering project (FYEP) is the culminating learning experience of engineering programs. It requires students to demonstrate that they can integrate knowledge, skills and professional graduate attributes developed during the program and perform at a standard expected of graduates. This paper reports on insight into the approaches and methodologies used for learning and teaching of the capstone FYEPs. National and international literature outlines a variety of information regarding the capstone FYEPs structures, elements of its assessment criteria, and methodologies of learning and teaching. More specifically, the study seeks to map processes, assessment and supervision practices of capstone FYEPs and to provide a set of guidelines and tools to ensure quality outcomes of capstone FYEPs. This study is intended to promote quality practice amongst supervisors and academics involved in learning, teaching and facilitating capstone FYEPs. A questionnaire was conducted to answer a broad research question: What is the current approach used in learning and teaching of capstone FYEPs? The questionnaire outcomes and a number of common issues, discrepancies and inconsistencies found are outlined in the paper. In supporting its claims, the paper offers some qualitative data to explore contentious issues around capstone learning and teaching. This is pertinent to those involved in the design and teaching of capstone projects.

Keywords: final year engineering projects (FYEPs); learning and teaching; assessment

1. Introduction

Accreditation requirements for undergraduate programs for professional engineers require final year students to complete capstone projects but literature shows that currently there is no guarantee of consistency. Practices differ greatly between universities and little work has been initiated that seeks to identify good practice, highlighting the need for the development of guidelines for learning and teaching of capstone FYEPs. The literature on learning and teaching methodologies of capstone FYEPs are derived from both national and international levels.

The literature on learning and teaching approaches used for FYEPs has pointed to the importance of having well defined projects, good communication of expectations with students and clear guidelines for assessment by staff [1, 2]. Some studies report that academic staff generally adopts different approaches to assess tasks [3, 4]. Generally, a broad range of practices and a lack of consensus about what constitute a legitimate assessment task, what assessment criteria are appropriate or what level of formative assessment and support is legitimate are found in the literature [5–9]. These variations appear to be due to insufficient preparation of and academic isolation of academic supervisors, a general lack of discussion about project expectations among faculty and lack of agreement about issues of educational task design and assessment.

The assessment process should be coherent and consistent in light of good education practices. The literature also reports that there are no definite or guaranteed assessment criteria for assessing FYEPs highlighting the need for the development of guidelines for the FYEPs and assessment criteria [5, 10–13]. Practices differ greatly between universities and limited work has been initiated that seeks to identify good practice. Although some research exists on group work and peer assessment, further investigation into the methodologies behind individual project work is required [11, 12].

A nationwide survey was done 2005 in USA on capstone design courses for understanding, assessing, and ultimately improving engineering capstone education in USA [14–18]. The areas they focused on were course logistics, faculty involvement, project coordination, funding details, and industry sponsorship. Their findings suggest uncertainty on the part of many faculty members concerning sound assessment practices including writing objectives and appropriate assessment strategies. The survey also indicated that the competencies articulated in ABET criteria 3 and 4 should be evaluated more extensively than current practice [16]. However, they recommended further study to understand and realize full potential of capstone courses [15].

Academic supervisors and others involved in teaching and facilitating FYEPs have not yet man-

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aged to develop productive dialogue relating to assessment and learning and teaching methodologies. There is some consensus about the place and purpose of a FYEP as a means for students to demonstrate technical and professional knowledge and skills, and its place as an integrated and authentic learning opportunity that encourages independent, self-directed and higher order learning. However, there remains a need for further collaboration around consolidating the paradigm of capstone projects and the ways in which they might be assessed. The need for this consolidation is highlighted by Rasul et al. [5] who note the ill-defined paradigm of capstone engineering projects means that students are often uncertain of their academic expectations, leading to confusion and miscommunication.

This paper presents a detailed review of literature on practices used worldwide for learning and teaching of capstone FYEPs first, then reports practice amongst supervisors and academics involved in teaching and facilitating FYEPs. Finally, the paper outlines the typical responses received from a questionnaire conducted on learning and teaching methodology of capstone FYEPs in Australia which has not been done earlier nationally. The discussion is based on the capstone FYEP done individually. It also presents some of the issues and conflicts that were identified from the conduct of questionnaire.

2. Learning and teaching practices of FYEPs

Literature reveals that the FYEP or capstone course is designed as an integrated and culminating learning experience for students with significant assessment purposes [10, 19]. For example, Jawitz et al. [19] reported that in the Built Environment program at the University of Cape Town, South Africa, FYEPs were used as a pointer of the quality of the program overall. In another study in Spain, Valderrama et al. [10] presented that the engineering curriculum includes the development and assessment of FYEPs that represents the culmination of the student learning process from previously learned engineering and personal skills. Valderrama et al. [10] investigated the complexity of the assessment process and its influence on the decision making regarding students' readiness to graduate. So projects are seen as vehicles by which students are given the opportunity to apply and demonstrate what they have learnt to this point in their degree through enabling critical and reflective thinking and the deployment of professional skills.

In New Zealand, Universities establish link with local industries for encouraging professional development of students. Auckland University of Technology (AUT) traditionally focuses on students utilizing techniques learned throughout their course to produce real outcomes for industry sponsors through FYEPs [8]. These capstone FYEPs are an important opportunity for students to establish links with industry, providing them not only with professional experience but also exposure to prospective employers [2].

At AUT students are prepared for their final year undertaking throughout their whole engineering program where project work is first introduced in year 2 of the program, and is continued in year 3 with a semester length project and in year 4 with a yearlong project [8]. It is therefore recommended that preparing students adequately to undertake their capstone FYEPs is essential for their success.

A number of engineering schools use team based projects in their undergraduate programs and some use interdepartmental teams from different disciplines. Capstone FYEPs may be presented as either a group or on an individual basis. Many universities are beginning to undertake FYEPs in a group setting. By grouping less experienced undergraduate students with postgraduate students in a non-hierarchical situation, it is also possible to both minimise project scoping and provide preparation and support for final year students by exposing them to an established research or design process [8].

At the University of South Australia, group FYEPs are presented in the format of an entire design process undertaken by the entire group working as a design consultancy. This group method is similar in principle to that of the Australian Maritime College, where real industrial design problems are undertaken by teams of three or four students, grouped by lecturers without student input. The interface with industry ensures a good grounding in professional engineering abilities. In the case of FYEPs conducted at the University of South Australia, students are encouraged to assess team members' performance within the group with respect to a number of key identifiers of work quality. Moreover, the accepted aim of a Bachelor of Engineering course is to produce graduates who are ready to use learned skills and attributes to succeed in the professional arena.

In assessing FYEPs, the group dynamic supported in some universities may lead to subjectivity when assigning individual grades to students. Due to the necessity of dividing labour amongst team members, it may be the case that the work produced by each team member will address quite different outcomes from one another. It is also necessary to consider the collective outcomes of the FYEP as a whole, as the success of an engineering project is of

great importance within an industrial context. Therefore it is necessary to conduct individual assessment of members of an FYEP group with consideration of both external factors and individual contribution [11].

3. Methodology and approach

For the development of learning and teaching methodology of capstone FYEPs, the following areas should be highlighted: Support for students, selection of projects, preparation for academic staff, preparation of industry clients and supervisors, project assessment, standard of project reports, curriculum integration and coordination and supervision of projects. A questionnaire was conducted to address the current approach to learning and teaching of capstone FYEP courses. The universities selected for the questionnaire were based on the disciplines and types of program offered (such as Bachelor of Engineering (BE), Bachelor of Engineering Technology (BET) and BE Co-op programs), mode of program (such as internal and external) and location of university (such as regional location and CBD area). An effort was made to capture the wide variety of programs offered across Australia and to include both metropolitan and regional universities. A sample of questions to students and supervisors along with assessment and research aspects is given in Table 1. Thirteen universities were selected for survey based on the criteria mentioned above which represent majority of the universities of these categories in Australia. In some occasions the responses were received from more than one coordinators of the same university as there are different approaches used in different disciplines of engineering within the same university.

4. Results and discussion

The responses to questionnaire in Table 1 from thirteen universities from all states and territories of Australia are discussed in this section. These responses are summary of responses which are generally applicable to most of the universities surveyed. These responses have been published in 2014 Capstone Design Conference, 2–4 June, Columbus, Ohio, USA [20]. This paper is an extended version of [20]. The responses have been presented in a way that it appears in Table 1 such as aspects of students, supervisors, assessment and research quality. These are described below. For your information, the issues and concerns identified during the course of this study are presented in Section 5.

4.1 Students aspects

In terms of scoping of the project, the kind of project a student selects can influence a student's grade. Routine projects may not provide scope for students to demonstrate high levels of professional capability

Table 1. Sample Questions from Questionnaire

Students
• What foundation are students given before commencing thesis?
• Are projects conducted individually or in groups?
• How do students conduct self-assessment?
• How do students put forward proposals/project scopes?
• What are approved methods of project management?
• How are conflicts resolved between students and supervisors?
• How are external students accommodated for within the course?
• How are these projects managed?
Supervisors
• How do supervisors typically monitor students' progress?
• How are conflicts resolved between industry and academic supervisors (if industry based project)?
• How academic supervisors are currently briefed in their duties?
• When approving projects, what do you use to define an appropriate project scope?
• How much time do supervisors spend on each student? What are workload expectations?
• What are the main project factors you've identified as being related to student dependency?
• What is an unacceptable level of student dependency?
Assessment
• What are the key assessed components for planning and implementation stages?
• How is analytical work validated within projects?
• What descriptors are used for assigning grades?
• How assessment is typically moderated?
Research
• What categories of research sources/information are acceptable?
• How quality of research can be maintained?
• What are the expected outcomes?
• How is confidential issues managed?

and obtain a high grade. There is debate about what kinds of FYEPs are acceptable and the kinds of professional competence that projects should allow students to demonstrate. For example, must all projects allow students to demonstrate knowledge of fundamentals and in-depth technical knowledge, or can projects focus on professional matters such as ethics or social or other impacts of engineering activities? The questionnaire responses indicated that when scoping projects, the academic supervisor serves as a guide for students whether these are industry, university or individually sourced projects. Upon commencement into the final year project, students are required to outline an initial project proposal for their thesis undertaking. The final scope is negotiated at an early stage in discussion with supervisors. Throughout the course of the planning and implementation phases of the project, students must also give progress updates to supervisors, allowing them to refine the scope later if required. In the case of industry project, industry supervisors may also provide their insights into the scoping of the selected project if appropriate.

While the curriculum may scaffold development of students' capacity to undertake projects through project-based learning (PBL) and work-integrated learning (WIL), the FYEP represents a major extension of expectations regarding a student's capacity to conduct a project. Some guidance for students is appropriate, but too much support will fail to extend the student's capacity to deal with complex, real-life professional projects. The questionnaire responses indicated that the students undertaking their project should contact their thesis supervisor at least once every two weeks. Every student (individual student) is provided with a pro-forma that prompts progress to date, self-evaluation, discussion of technical issues, and development of an action plan. It is believed that the students who show due diligence in keeping regular and frequent contact with their supervisor can be expected to have a higher quality submission as a result. Although regular contact with supervisors is compulsory, the nature and frequency may be dependent on the discretion of each individual supervisor.

4.2 Supervisors aspects

Final year project assessment is particularly vulnerable to variation in the quality of supervision because a large number of projects need supervision each year requiring many academics, each of whom may advise students differently about project expectations. Identification and description of good practice would provide academic supervisors with resources for induction and staff development. Guidelines are required to ensure appropriate, consistent support. Students should also be provided with clear expectations about appropriate supervision so they can respond more constructively when expected support is not provided. The questionnaire responses indicated that the academic supervisors should have at least a Bachelor level of qualification and a certain level of prior experience with the requirements for FYEPs. The styles of supervision may vary significantly depending on the student, supervisor and/or the chosen project topic, however thesis efforts are somewhat unified by an interactive forum dedicated to students and supervisors involved with projects. Course materials also include useful information such as course profiles, report writing guides, submission devices and key dates throughout the planning and implementation phases. These materials, whilst primarily designed for students, are also identified as important supports for supervisors. Supervisors may be expected to take from one to ten final year students per year; however the number of projects taken on may depend largely on the number of students in the FYEPs cohort. There is a little regulation to divide the workload amongst supervisors, if more than one supervisor is needed for a multi-discipline project.

4.3 Research quality

In terms of research quality, FYEPs require an extensive quality assurance process at every educational institution and this must be assessed by an appropriate accreditation agency. In the case of a professional qualification, quality assurance procedures have traditionally been conducted by a professional body such as the Engineering Council of South Africa (ECSA) in South Africa [21]. ECSA recently employed an outcomes-based accreditation process in association with several international engineering accreditation agencies in a move to standardize procedures across national boundaries [19]. Engineers Australia, a professional body in Australia has been monitoring the quality of engineering education and expects that graduating engineers will, for example, be able to demonstrate various skills and knowledge; that they will be able to coordinate their work with others and be able to communicate at every stage. Therefore, accreditation guidelines require engineering programs to show that students are capable of 'personally conducting and managing an engineering project to achieve a substantial outcome to professional standards' [22]. These capabilities are also required from international engineering accreditation agreements, Washington Accord, International Engineering Alliance [23] to which Engineers Australia are a founding signatory. For quality assurance of the FYEP, there are two new requirements in Australia for Final Year Projects as follows:

- An Australian Qualification Framework (AQF8) requirement that it demonstrates research capability: Graduates of a Bachelor Honours Degree should have coherent and advanced knowledge of the underlying principles and concepts in one or more disciplines and knowledge of research principles and methods [24].
- A requirement to satisfy the Threshold Learning Outcomes that is used by Tertiary Education Quality Standards Agency (TEQSA). Graduates must demonstrate ability to: identify needs, context and systems of problems; apply problem solving, design and decision making methodologies; apply abstraction and modelling skills; communicate and coordinate proficiently; and manage self in the short and long term.

In order to maintain excellent quality and high standards, the FYEPs should [2]:

- Be a practical problem-solving project that involves an engineering design approach.
- Engage at least 200 hours or more of individual student effort.
- Put the problem in context and review the relevant literature.
- Involve the generation of professional reports on the process, including problem definition and formulation, literature review, design specifications and alternatives, justification of the chosen design, relationship to previous research on the project, analysis, and critical evaluation.

AQF8 [24] states that "Research comprises systematic experimental and theoretical work, application and/or development that results in an increase in the dimensions of knowledge" [24]. Although this definition reflected more of a scientific paradigm, it did not fully capture the work of research in the field of capstone FYEPs. In further work Lawson et al. [25] have developed a detailed definition of research which can apply regardless of the discipline and/or the project type based on the findings of an Australian Office for Learning and Teaching commissioned study on Assessing Final Year Engineering Projects (FYEPs): Ensuring Learning and Teaching Standards and AQF8 Outcomes.

An outcome of a FYEP is an extended report or portfolio. It is important that students receive clear advice about requirements and an appropriate level of support in preparing their reports because the FYEP report will usually be the first extended report students have prepared. If project assessment is based on report moderation (i.e. only on the evidence presented in the report), supervisors and moderators also need shared expectations for assessment, and supervisors must advise students of these expectations. The questionnaire responses indicated that the students write a formal technical report and dissertation describing the project, the issues faced and the choices made in implementing and managing the project, the reasons for making choices, project evaluation and reflection, risk management, and what was learned from the project experience [20]. An oral presentation of the planning stage of the thesis is held at the end of the term studied. This is comprised of a PowerPoint© presentation executed either in person or via prerecording or teleconference. Feedback on the project is provided from a panel of three academic including project supervisors, ideally with a vested interest in the subject matter. The resulting feedback sheet forms part of the compulsory assessment for the planning stage. Presentations are comprised of an A1 size poster, technical paper and ten minutes PowerPoint© presentation.

4.4 Assessment criteria

Assessment can take into account different elements such as supervisor's report, technical report, design portfolio, reflective journal, poster, oral presentations, weightings for technical quality and communication, etc. The criteria for grading projects use various rubrics that influence assessment and benchmarking processes. A particular issue in assessment is the relative emphasis placed on the product or outcome of the project on the one hand, and on each student's thinking, decision-making, management and investigation processes that guided the project on the other.

A pilot investigation of Rasul et al. [5] indicated that the assessment practices must have some common features, such as self-assessment, assessment moderation, assessment criteria, and an assessment component matrix. In other study, Valderrama et al. [10] described the procedure for the outcome-based assessment of FYPs. These studies introduced a user guide which can be implemented for different engineering curricula to help institutions create their own FYEP assessment system. The literature stipulates that assessment criteria should be robust and able to withstand the appeals process if any students claimed that he or she had not been correctly judged. Well-written assessment criteria should allow academics to make assessment decisions benchmarking against standards rather than absolute marking resulting in improved efficiency and greater consistency [2].

There are also other important aspects to be considered in assessing FYEPs for successful completion. Supervisors of FYEPs should be involved in the assessment process. The supervisor should be aware of the students' progress and to encourage and support the students' technical and project management development [26]. Supervisors are to

help answer questions that students have and to challenge students with more difficult concepts that can be incorporated into the project [26]. Therefore, it is recommended that the supervisor should have extensive expertise in the area of the field of the project.

Throughout the course of thesis undertaking, self-assessment is encouraged. A preliminary self-assessment of the student's abilities and project merits is required when they commence their project planning. A further self-assessment pro-forma is to be filled out upon completion of both planning and implementation stages. These are based upon the Engineers Australia Stage 2 Competency Elements. Evaluation of project progress, strengths and weaknesses and project difficulties is prompted throughout the course of the thesis undertaking through progress updates to supervisors.

Moderation is an essential part of marking for both planning and implementation phases of the thesis undertaking and universities maintain this. Students are provided with feedback from a panel of three academic including thesis supervisors following their project planning presentations, which informs both their planning mark and their direction during the implementation phase. Moderation is also carried out following the submission of all elements of the implementation phase.

4.5 Summary of findings

Data was collected from three sources—literature (national and international), university documents and interviews with course coordinators. Documentation includes course profiles, student guidelines, marking rubrics, schedules, and teaching resources. The summary of findings is:

- University coordinators are reflective and committed to improved practice with many course coordinators commenting on changes and improvements made to FYEP courses over time.
- FYEP or capstone courses are often organized as two courses taken over 2 semesters forming a yearlong project. Some universities run single, cross-disciplinary courses with others having discipline or school specific courses.
- Project types generally include university generated, student generated, and industry sponsored, and range from research focused, investigative, experimental, to design and build.
- Most projects require students to work individually. Some allow pairs or groups. Some allow individuals within groups—that is smaller individual projects can contribute to a larger one.

The data can be broadly clustered into four areas of intended outcomes, assessment, curriculum and supervision as shown in Table 2.

5. Issues and concerns

Issues and concerns identified during the course of this study are presented in this section. The study found that there are variations in the way FYEPs are managed and assessed, both in Australia and

Table 2. Summary of findings

Intended or stated outcomes

There is considerable language variation including simple description - 'design', 'implement', 'perform', 'prepare'. Some qualify outcomes: 'produce *high quality*' 'apply *original* thinking.'

Australian Qualification Framework Level 8 (AQF8) thinking ranges from coordinators not being aware of it and having no consideration, to deep consideration and embedding AQF8 language into course outcomes.

Assessment

Tasks include Final report/thesis, progress documents, presentations/ seminars/ exhibitions. Weightings for the thesis vary from 40%- 100%. Volume of tasks varies from 3–7. Sometimes overall competency and project execution are also assessed.

Use of detailed rubrics is widespread (though not always supported in the literature). Standards and guides are sometimes provided for supervisors. There is considerable variation in marking and moderation practices with many coordinators concerned about supervisor bias brought about as a result of the student-supervisor relationship.

Close attention is paid to formative assessment in many project courses. Challenges are around agreement on the what - effort, execution, and artefacts – and the how - best practice moderation.

Curriculum

Overwhelming emphasis on self-directed learning in all project courses. Some offering of workshop support (one-offs) and some offering of regular (weekly or fortnightly) seminars and workshops. There is a provision of parallel project management course to assist students with all aspects of project work. A number of institutions have students (graduates, post-graduates and doctoral) assist final year students through attendance at seminars and so on.

Supervision

There is limited preparation and support given to supervisors with a common idea that skills are learnt 'on the job' and that it 'all works out.' Supports include: comprehensive online and hard copy documentation, co-supervision arrangements and social moderation as a means for supervision advice.

The style of supervision varies and impacts on quality and equity. These however are not necessarily systemic problems, but personal ones and likely to be encountered in any workplace.

worldwide. The issues and concerns identified include:

- Need for agreement about learning outcomes and core requirements for projects for professional programs compared with projects for technologist programs.
- Need for guidelines for students to choose appropriate projects with sufficient scope to demonstrate development and assessment of required graduate outcomes.
- Need for agreement about student/project assessment criteria or what level of formative assessment and support a supervisor can legitimately provide.
- Need to clarify roles and expectations of students, project supervisors, moderators and industry partners where projects are industry based. An initial survey shows that there are universities in Australia who offer about 80% industry based projects [5].
- Lack of clarity about supervision and assessment requirements among teaching staff within and across institutions [19].
- Whether assessment should focus on the students' thinking, motivation and values (process skills) as well as the project outcomes and project reports/presentations.
- How best to assess FYEPs and processes for marking/grading individual project of each student's work and for combining these into a final grade.
- Dealing with conflict between supervisor assessment and moderation assessment.
- How to prepare students adequately to undertake major project work.
- What FYEP evidence would best indicate program standards for accreditation?
- Comparison and grading issues associated in the degree of complexity and scope in various FYEPs and industry collaborations.

In the process of conducting the questionnaire with FYEP course co-ordinators and supervisors a number of more specific issues were identified. The most relevant and recurring of these issues are given in Table 3. Detailed explanation of these issues can be found elsewhere [5].

6. Conclusions and further work

This study has confirmed major discrepancies on learning and teaching approaches and methodologies which are being currently practiced. The study provided shared understandings of requirements of good projects, standards of project work and the processes undertaken that final year students are expected to demonstrate for integrating knowledge, skills and professional graduate attributes developed during the program. This is pertinent to those involved in the design and teaching of capstone projects, both nationally and internationally. The FYEP is a significant part of work that involves creative activity and original thinking. A good engineering project starts with the formulation of a problem, suggests alternative solutions, and then implements one of them.

In general, students can achieve some core fea-

Table 3. Significant/Common Issues within Participating Universities

Issue	Cause/effect	Common Remedial Actions
Detrimental group dynamic	• Poor student motivation • Student personality • Conflicts • Over-dependent student • Domineering students	• Discretion in assigning grades. Head of Department assumes case to assist conflict resolution. • Select student pairs based on prior personal knowledge • Compromise/unofficial resolution where possible • Separate meetings with students • Mark contributions individually
Over-dependence of students	• Lack of ownership over project • Students looking for "soft" supervisor/ topic • International students • Language issues—lack of self- expression • Project topic not aligning with students area of study/expertise	• Supervisors aim to choose students based on application to task • Supervisor assistance given carefully • Emphasis on self-guided work
Conflicting outcomes between industry and university	• Lack of understanding of academic time frame/priority among industry partners • Industry lacks prior knowledge of students' capability • Confusion between roles of consultants and students	• Enhance communication between university and industry • Industry provides thesis topic, academic supervisor tailors scope to suit capabilities of undergraduate thesis student • Ensure all industry requirements are thoroughly understood before accepting the thesis topic • Limit students' contribution to advisory/logical recommendations based firmly in research/experimentation • Establish written agreement/scope negotiation between industry and student/s

tures through completing capstone FYEPs which are to [5]:

- Demonstrate a wide range of the skills learned at the FYEP during their course of study.
- Deliver a product that has passed through the design, analysis, testing, and evaluation stages.
- Perform multidisciplinary research through the integration of material learned in a number of courses.
- Develop problem solving, analysis, synthesis and evaluation skills. Work as a team and collaborate with the academics and other researcher and students.
- Improve communication skills through the generation of the professional reports (thesis) and oral and professional poster presentations.

Discussion to the questionnaire conducted in this study on what is the current approach used in learning and teaching of capstone FYEPs was a scoping exercise for an Australian Government grant on Assessing Final Year Engineering Projects (FYEPs): Ensuring Learning and Teaching Standards and AQF8 Outcomes. This project developed tools and processes to support systematic improvement of FYEPs. These include:

- Tools to evaluate how well students can apply much of the knowledge gained during their university studies in solving a real life problem (i.e. a best practice guideline for assessment of FYEPs based on the Threshold Learning Outcomes for Engineering);
- A clear definition of educational purposes and expectations of FYEP, particularly in the key area of research skills (AQF8);
- Benchmarking of these outcomes based assessment practices with the Stage 1 Competency Standards of Engineers Australia.

The project surveyed and critically reviewed coordination, supervision and assessment practices of FYEPs in Australian universities and different disciplines of engineering. The project also summarized current practices, issues and concerns for learning and teaching of capstone FYEPs through running workshops with stakeholders in all states and territories of Australia. Finally, the project recommended guidelines for good practice in learning and teaching of capstone FYEPs. The reported guidelines apply to four years Bachelor of Engineering Honors Degree, both nationally and internationally. In short, the guidelines reported that Graduates of Bachelor Honours Degree will have cognitive skills: to review, analyze, consolidate and synthesize knowledge to identify and provide solutions to complex problems with intellectual independence; to demonstrate a broad understanding of a body of knowledge and theoretical concepts with advanced understanding in some areas; to exercise critical thinking and judgment in developing new understanding; to design and use research in a project and to present a clear and coherent exposition of knowledge and ideas to a variety of audiences. The guidelines were developed based on documentary materials such as subject outlines, student handbooks, supervisor guides, rubrics and teaching materials as well as 16 interviews with course coordinators and dissemination workshop evaluation and testing across Australia which involved over 100 participants from a total of 26 universities.

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