Best Assessment Practices of Final Year Engineering Projects in Australia

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ABSTRACT

Purpose:
The focus of the paper is to explore the best practices for the delivery of final year engineering project. Students use their own initiatives to accomplish practical design projects in their final year of engineering. Each academia proposes different ways of project approaches that should satisfy engineering accreditation requirements for capstone projects. This paper analyses and compares various undergraduate final year engineering project approaches of different universities in Australia. From this case study analysis, this research will explore the best assessment practice for the delivery of final year project.

Design/Methodology:
Through desktop analysis methodology, this paper will analyse six universities in Australia who are practicing different approaches in their undergraduate final year engineering project. This analysis will look in to the various types of final year projects undertaken, their learning outcomes, teaching methods and assessment measures.

Findings:
From these 6 case studies, this paper will provide a report on its implementation and assessment impact on final year projects based on the analysed results of qualitative review of course units in undergraduate programs.

Conclusions:
This paper shows the desktop analysis data and compared the six case studies of Australian universities. The above-summarized different final year engineering project approaches were extremely successful in identifying and promoting

creativity and innovation through final year projects. From the comparison, it is clearly shown that Deakin University practices one of best assessment methods for the delivery of final year engineering project.

Keywords: *Final year projects, learning outcomes, teaching methods, assessment measures.*

INTRODUCTION

Students in the final years of their Bachelor of Engineering program are required to work independently to manage and implement a project. Final year project is an integral part of the BE (Hons) programme, successful completion of which is necessary to satisfy the award of the degree. Project allows students to demonstrate professional capabilities expected of graduating as professional engineers. Students are required to conduct research, demonstrate critical thinking and document sound analysis and judgement to support project decision-making. Students define and scope their project, apply technical knowledge, assess safety and risks and prepare a feasible plan and schedule for implementing the project in the following project implementation phase. It is required to work and learn autonomously, prepare and adhere to work and reporting schedules, communicate progress, and prepare reports and presentations. It may provide useful evidence and opportunity to a prospective employer of your involvement and competence in areas of mutual interest.

The focus of this paper is to explore the best practices for the delivery of final year engineering project. This paper analyses and compares various undergraduate final year engineering project approaches of different universities in Australia. From this case study analysis, this research will explore the best assessment practice for the delivery of final year project.

FINAL YEAR ENGINEERING PROJECTS

The purpose of all engineering degrees is to provide a strong grounding with the principles of engineering science and technology. By learning the engineering methods and approaches in an academic environment, graduates are enable to enter the world of work and tackle real world problems with innovation and creativity. The accreditation bodies such as Engineers Australia also recommended about the final year projects in 'Stage 1 competencies and elements of competency for professional engineers'. It states that 'Application of systematic approaches to the conduct and management of engineering projects' as one of most important engineering application ability for professional engineers. Engineers have the responsibility to conduct their project with all fundamental knowledge and understanding, which contributes to their continual improvement in engineering practice (EA, 2012).

Effective final year projects are mostly got high interest to the employers that which brings success to their companies (Ward, 2013). The evidence of effectiveness and standards of a program for accreditation and the professional capabilities of individual students is assessed through final year engineering projects (Rasul, 2009). To re-incorporate the generic skills in to the curriculum, the employers and professionals have their attention to final year projects as a major vehicle (McDermott, 2006). The final year projects are considered as a completed learning experience of the engineering programs. The quality of student output from the final year projects are used as an indicator for the quality of the engineering programs (Jeff, 2002).

Different Project Approaches

Problem based learning

Problem solving is a component of the problem-based approach. Problem based learning (PBL) focuses around problem scenarios rather than discrete subjects and the selection of the problem is essential in PBL. In this type of learning and teaching, students are usually presented a situation, a case or problem as a starting point. The role of the teacher is to be a supervisor of the learning process. The teacher acts to facilitate the learning process rather than to provide knowledge and solving the problem may be part of the process. Here the problem scenarios encourage students to engage themselves in the learning process. The learning process is the central principle, which enhances student's motivation, and is a common element in problem and project-based learning. Students become independent inquirers. PBL is an approach to learning that is characterised by flexibility and diversity, which can be implemented in a variety of ways in different subjects and teachers support their learning. In this approach, students learn how to learn. Using problems or cases from real life in teaching is effective for motivating students and enhancing learning and development of skills. Students need to learn how to get the information when needed, as this is an essential skill for professional performance (Du, 2009; Qvist, 2006; Stojcevski, 2008).

Project based learning

Project Based Learning is perceived to be a student centred approach to learning. It is predominantly task oriented therefore the facilitators often sets the projects. The students need to produce a solution to solve the project and they are required to produce an outcome in the form of a report guided by the facilitators. Teaching is considered as an input directing the learning process. The problem is open ended and the focus is on the application and assimilation of previously acquired knowledge. Engineering students require the opportunity to apply their knowledge to solve problems through project-based learning rather than problem solving activities that do not provide a real outcome for evaluation. One of the greatest criticisms of traditional engineering pedagogy is that it is a theory based science model that does not prepare students for the 'practice of engineering'. Self-directed study is a big part of a student's responsibility in a project based learning module (Vere, 2009).

Design based learning

Design based learning (DBL) is a self-directed approach in which students initiate learning by designing creative and innovative practical solutions which fulfil academic and industry expectations. Design based learning is an effective vehicle for learning that is centred on a design problem solving structure adopted from a combination of problem and project based learning. Design projects have been used to motivate and teach science in elementary, middle, and high school classrooms and can help to open doors to possible engineering careers. Design based learning has been implemented more than ten years ago, however it is a concept that still needs further development. Therefore it is very important to characterise DBL as an educational concept in higher engineering education (Hung., 2008) (Wijnen, 1999). Integrating design and technology tools into science education provides students with dynamic learning opportunities to actively investigate and construct innovative design solutions. A design based learning environment helps a curriculum to practice 21st Century Skills for students such as hands-on work, problem solving, collaborative teamwork, innovative creative designs, active learning, and engagement with real-world assignments.

Scenario based learning

In Scenario based learning (SBL) students are provided with real-life scenarios. SBL is a student centred approach where students are considered as active participants' of the process. The role of the academic is changed as a facilitator to guide and support the students in their learning process. The word scenario is used to denote the several distinctive aspects of SBL learning mechanism (Doppelt, 2009; Dopplet, 2008). Through this type of learning, students got the opportunity to expose and apply their acquired experiences, knowledge and skills to realistic situation. Here the problem is fairly open and as such the outcomes are undetermined.

Inquiry based learning

Inquiry based learning begins with students being presented with questions to be answered, problems to be solved, or a set of observations to be explained. It is usually used in laboratories based on scientific methods. The learning process is student centred while teachers' function as facilitators. Students observe a selected task or phenomenon, develop a proposal and experimental procedure for the observed task, perform their experiments, evaluate their results, and reflect on their learning. This provides excellent training in design of experiments and scientific methods (Thomsen, 2010).

Traditional teaching is often considered to be subject-based learning, where students learn specific information and are then given a problem to apply what they have learned. Inquiry-based learning in some ways is similar to problem-based learning in the sense that students are first given the problem to be solved and then must determine the information needed to fully address the problem before learning specific information and solving the problem. This type of learning is meant to encourage high-level thinking and collaboration.

Action based learning

Action based learning is a structured method that enables small groups to work regularly and collectively on complicated problems, take action, and learn as individuals or as a team while doing it (Malicky, 2006). Interrelationship of learning and action, learning occurs through a continuing process of reflecting and acting by the individual on their problem. Action based learning is typically characterised by certain key components such as problem as content, learning through teamwork, time for personal and group reflection on lessons learned. Action based learning emphasis on self-reflection and real-time lessons makes it a particularly powerful vehicle for achieving student understanding of social and environmental issues while students undergo any project (Malicky, 2006).

Action based learning is an educational process by which students learn through their actions and experiences to improve performance. It helps students work on a problem through supportive but challenging questions. It encourages a deeper understanding of the issues involved, a reflective reassessment of the problem and an exploration of ways forward. By following this process, action based learning allows for a structured way of working that provide the discipline students often need to learn and improve practice (Malicky, 2006).

FINAL YEAR ENGINEERING PROJECT ASSESSMENT CRITERIA

The students are expected to demonstrate a number of elements when they complete a project. Students have to clearly meet the course graduate profile or the programme outcomes. The graduate profile must be closely considered when designing assessments criteria for a final year project. The establishment of transparent learning outcomes together with appropriate assessment criteria is also becomes a key requirement of it (Malicky, 2006).

The following case studies show us how the final year engineering projects are implemented and assessed through different approaches. The following engineering projects in different universities are practiced in final year undergraduate engineering programs.

Deakin University

At Deakin University, the general aim of a final year engineering project is to provide you with the opportunity for integrating and extending knowledge relating to your undergraduate programme of study by exercising skills of initiative, resourcefulness, creativity, analysis and communication (Deakin University, 2013).

Engineering project A – this final year project that is an elective unit of Bachelor of Engineering (all major disciplines) offered in trimester 1, 2 and 3. It enables students to conduct and construct an engineering research project with prior knowledge attained in their disciplines. By using the concept of research methodology as a vehicle, it allows students to practice self-directed learning approach. The students get their opportunity of learning and solving design problems through design based learning approach.

Table 1: Final year project overview

Teaching Methods	Learning outcomes	Assessment breakdown
Active learning, teamwork, support materials, peer discussions and weekly lectures	Project planning, engineering design, poster and progress report.	Research proposal – 20% Project report – 60% Presentation – 20%

Engineering project B – this capstone project is offered to on/off campus students enrolled in Bachelor of Engineering. It incorporates a number of skills such as problem solving, self-directed learning, Analytical, teamwork and communication. It provides the opportunity for the students to develop skills in applying engineering related knowledge and skills in planning, managing and implementing a wide range of project types in the workplace.

Table 3: Final year project overview

Teaching Methods	Learning outcomes	Assessment breakdown
Active learning, teamwork, support materials, peer discussions and weekly lectures	Project planning, engineering design, poster and progress report.	Oral poster presentation –20% Final year Project report –60% Supervisors Mark– 20% With logbook

The University of Newcastle

At the University of Newcastle, the aim of final year engineering project is to provide students a way to enhance and demonstrate their knowledge and skills.

The final year projects represent the completion stage of student study towards the Bachelor of Engineering degrees (The University of Newcastle, 2013).

Final year engineering project – this course consists of a combination of final year engineering project part A and final year engineering project part B. It is a single course which act as a vehicle for students to consolidate, enhance and demonstrate the knowledge and skills gained from their prior years of their engineering studies.

Table 4: Final year project overview

Teaching Methods	Learning outcomes	Assessment breakdown
Individual supervision, self directed learning, seminar	Progress report, deliver a seminar, prepare a interim report, poster presentation	Presentation – individual (seminar/presentation/ interview) Presentation – individual reports (final thesis report) -100%

Engineering Project – The students need to complete both part A and part B in a sequence within a twelve months timeframe to meet the requirements of this course. It provides the opportunity for the students to apply their skills attained over the previous years. A staff member supervises the projects. The students get their own space to develop project planning and time management skills, teamwork and communication skills.

Table 5: Final year project overview

Teaching Methods	Learning outcomes	Assessment breakdown
Problem based learning and lectures	Project management skills, written and oral communication skills, Analytical	Oral presentation Progress report – 100%

University of Southern Queensland

At University of Southern Queensland, the final year project is a combined course of research project part 1 & 2 that gives students an opportunity to do a professional level technical project work (University of Southern Queensland, 2013).

Research project part 1 – Students undertakes this individual project. Through this research project, students can define and analyse the problem and develop a solution to the problem. Students got the opportunity to make necessary decisions, convert their ideas in to innovative outcomes, test and evaluate the solution for open-ended problems. The students need to finish this research project part1 and intend to do the research project part 2 as a part of completion of their final year study.

Table 6: Research project overview

Teaching Methods	Learning outcomes	Assessment breakdown
Lectures, Project work, Private study, Report writing, supervisor consultation	Critical thinking, Analytical learning, project planning, communication	Project work -30% Project work tasks- 50% Report writing – 20%

Research project part 2 – After the completion of research project part 1, students will continue the research project part2 with the guidance of supervisors. Here students have to take responsibility of this major individual technical task and establish, manage, maintain the whole project progress.

Teaching Methods	Learning outcomes	Assessment breakdown
Lectures, Project work, Private study, Report writing, supervisor consultation	Critical thinking, Analytical learning, project planning, communication	Project work -60% Project work tasks- 10% Report writing – 30%

Central Queensland University

At Central Queensland University, the Final Year Engineering Project (FYEP) is an individual project. To complete the project, students must successfully complete the project-planning course, and then complete the implementation course. In order to finish a project-planning course, students have to pass all the courses in their prior year (Central Queensland University, 2013).

Engineering project planning and engineering project implementation – Students work independently in the Bachelor of Engineering to manage and implement a final year project that allows them to establish their professional capabilities. Students work and learn through self-directed learning approach. This is an individual project. By doing this research project, students can demonstrate project planning, document analysis, decision-making and critical thinking. Written assessment (project folder) consists of following compulsory items such as thesis, technical paper, oral presentation, technical poster, reflective paper and self-assessment to Engineer Australia Stage 1 competency standards.

Table 7: Final year project overview

Teaching Methods	Learning outcomes	Assessment breakdown
No face to face lectures or tutorials, self – directed learning	Communication, Problem solving, Critical thinking, Team work	Presentation and written assessment – 100%

RMIT University

At RMIT University, this final year engineering project is a major individual project. The below listed are some of the common final year engineering projects practiced in Bachelor of Engineering courses.

Engineering Design – Student can develop their advanced technical design skills together with integrated personal skills. This project will demand students to have high level of technical competence. Academic staff acts as a facilitator for the students to promote successful completion of the project. Students also got an opportunity to have this project as industry based.

Table 8: Final year project overview

Teaching Methods	Learning outcomes	Assessment breakdown
Design lectures, workshops and reflective discussions	Project based learning activity, theory with practice	Major project and designated assessment task – 100%

Professional engineering project – It provides students to learn about engineering projects and engineering research projects. It's a team project activity. With the guidance of an engineer mentor, students will complete a team-engineering project.

Table 9: Final year project overview

Teaching Methods	Learning outcomes	Assessment breakdown
Guided laboratory, project work, team presentation	Project management, problem solving, self directed learning, report writing	Presentation and project report – 100%

Swinburne University of Technology

At Swinburne University of technology, the final year project is mandatory unit for the students in all disciplines of Bachelor of Engineering. The below listed are some of the common final year engineering projects practiced in Bachelor of Engineering courses.

Research project –The students have to identify a question or project problem or objective and they have to use their pre-attained knowledge of engineering methods. The students in their area of interest propose the project that involves technology research and development, experimental work, computer analysis and industry relationship. This research project allows students to practice research practices such as report writing, poster presentation, oral presentations, and creativity and communication skills.

Table 10: Final year project overview

Teaching Methods	Learning outcomes	Assessment breakdown
Lectures and tutorials, Oral presentations and project based learning	Professional practice, problem solving, project managements, communication	Group assignments -25-40% project reports - 50-60% individual Presentations - 10-15%

Design and development project – This final year project helps students to know about system engineering concepts for planning, design, analysis, evaluation of complex systems considering economic, social, sustainable, ecological, human factors and ethical issues. It encourages students to learn about the sustainable development practices and to develop leadership and professional qualities.

Table 11: Final year project overview

Teaching Methods	Learning outcomes	Assessment breakdown
Lectures, tutorials, seminars, face-to-face discussion with supervisor	Professional practice, problem solving, project managements, communication	Class activity (I) -15% Requirement Analysis - 10% Literature review (I) – 10% Design, Project plan – 15% Oral presentation (I) -15% Peer evaluation (I) – 10% Final report (I) – 25%

CONCLUSION

This paper shows the desktop analysis data and compared the six case studies of Australian universities. The above-summarized different final year engineering project approaches were extremely successful in identifying and promoting creativity and innovation through final year projects. From the comparison, it is clearly shown that Deakin University practices one of best assessment methods for the delivery of final year engineering project.

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Appendix 1

Table 2: Assessment criteria

Mark Out of 10:	0-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10
General	Completely unsatisfactory. Almost nothing to show for any work that has been put in.	Unsatisfactory. Aims not met. No evidence of any real progress. Nothing worthwhile produced, although evidence of some work, albeit unsuccessful.	Satisfactory. Progress towards meeting most aims. No evidence of independent thought or much initiative. Could readily be completed by any student.	Good. Aims mostly met. A competent technician could have done most of the work.	Very good. Reasonably ambitious aims met fully or less ambitious aims exceeded. Required both ability and application to complete	Excellent. Only a few students could have completed. Contains "something extra". Ambitious aims met fully or reasonably ambitious aims exceeded.	Outstanding. A member of staff would not be ashamed of this work. No student could reasonably be expected to achieve much more or present it better with the time and resources available.	
							In the top 5% of projects.	Clear candidate for best project of the year.
Preparation and literature review	Unsatisfactory report.		Satisfactory report.			Good report.		
	Little or no evidence of any research whatsoever.	One or two sources (probably books or magazine	Several sources of information used, but research not	Systematic literature survey attempted, but incomplete or	Competent literature survey carried out.	Comprehensive literature survey, sound base for project and further	Literature survey very systematic and comprehensive, student able to talk with confidence about other work in the field.	

		articles) read.	systematic.	inconsistent.		work.	
Project management contact with supervisor(s) and progress, financial awareness	Complete failure in relationship between student and supervisor, likely that the student has effectively dropped out of the course. Shows no financial awareness whatsoever.	Contact with supervisor sporadic. Despite best efforts of supervisor to encourage student, amount of work insufficient. Supervisor has given very clear guidance but student has failed to follow it. Only vaguely aware of costs.	Contact maintained with supervisor, but generally not worked as hard as required. Student needed very clear guidance from supervisor, and has taken advantage of most, but not all, of this guidance. Shows some awareness of cost.	Fairly regular contact maintained with supervisor, Student worked hard. Clear guidance from the supervisor necessary for progress to be made. Could be relied on to keep track of costs.	Regular contact with supervisor. Needed some advice, but worked hard, and demonstrated ability to manage own work. Maintained sound financial record and provided realistic estimate of total development cost.	Maintained regular contact with the supervisor, but needed very little guidance (except in overcoming unusually difficult problems), worked very hard, almost totally self-motivating and self-managing. Meetings with the supervisor very productive and involved a two-way exchange of ideas. Rigorous record of all costs maintained, carefully justified estimate of total development costs provided and, where appropriate, a realistic prediction of further development costs, production costs, product retail price etc.	

Theoretical understanding shown and analytical content	Little or no understanding demonstrated.	Shows little understanding, and cannot relate any of the work to underpinning theory.	Shows understanding of some aspects, at a fairly superficial depth. Unable to present theoretical basis for work, though may, in interview, be able to identify some relation between the work and underpinning theory.	Shows understanding of what has been done, though may not be able to give comprehensive answers to more searching equations. Theory applied but report fails to demonstrate understanding of theory.	Good understanding of what has been done, and can describe theoretical basis, albeit with understanding of theory limited to that used directly.	Thorough understanding of the subject and can apply this understanding to the solution of unfamiliar problems.	Deep and comprehensive understanding of the subject, can answer all questions put accurately and with confidence and apply understanding to the solution of unfamiliar and difficult problems.	The student has evident mastery of difficult material, is able to explain it fluently, and has demonstrated significant original thought.
Design Requirements, analysis, specification, consideration of possible designs, detailed design, verification that specs met, etc.	Little or no evidence of any design whatsoever.	No evidence that the design process is understood.	Design carried out in a way that makes sense, but process has many flaws.	Logical design process followed, but design decisions not justified.	Clear understanding of the design process show. Proceeded in a logical manner and justified most decisions.	Clear understanding of the design process shown. Proceeded in a logical manner and justified all decisions. Design shows flair and innovation.	Very clear understanding of the design process shown. Proceeded in a logical manner, considering all options and fully justifying all decisions. Design shows considerable flair and innovation.	

Experimental work including experimental design, procedure, recording and presentation of results/data, error analysis, data analysis.	Little or no evidence of any experiments (where experiments were required).	No evidence of any data from experiments.	Some appropriate experiments carried out, but with very poor results. Almost no attempt to analyse the results.	Some success with experiments, but reliability uncertain and little attempt to account for errors. Problems, that could have been solved, not overcome.	Work properly planned, carried out carefully and fully documented. Data reliable or unreliability discussed adequately. New techniques applied. Problems overcome by developing equipment or method.	Experiments replicated and errors estimated. Theory developed and applied. Experimental data compared with theory and deviations examined and explained.	As 7-8 plus: experiments very carefully designed, and ingenuity demonstrated in this design. Every reasonable step has been taken to verify the results, and a thorough error analysis has been completed. Results may be publishable.
Practical (construction)	Little or nothing recognisable has been made.	If the project involves making something, it may be recognisable but it doesn’t work.	If the project involves making something, it is unlikely to work very well.	If the project involves making something, it works satisfactorily.	If the project involves making something, it works well.	If the project involves making something, it works well/perfectly and shows real care and craftsmanship.	

Presentation of Final report: adherence to regulations, structure, grammar, spelling, typographical correctness, presentation of graphs tables, etc., use of references, clarity of exposition, clarity of abstract and conclusions	Little or nothing handed in which could be accepted as representing a report.	Quality is low, with little or no structure. Reads like an expanded poor second-year lab report. Report is a rewrite of earlier reports without additional material.	Required components present in recognisable form. Possible to see whats been done from the report. has some results, some explanations & description of work indicates that with some additional application something could be produced.	The report is properly structured and the required components are properly presented, but there are significant flaws. E.g., references, diagrams, and calculations show errors or omissions.	The layout of the report follows the guidance given strictly. It is easy to read with few grammatical or spelling mistakes and gives a clear account of the project.	The report is coherent, follows the guidance given strictly, well structured, easy to read, and few corrections are required. It gives a very clear account of the work that has been done and sets this in the context of other work.		The report is excellent in every way. It needs no corrections, or only a few very minor corrections, and in some cases would be of publishable quality.
	0-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10