EURECA: A UNIQUE APPROACH FOR FINAL YEAR PROJECT AT TAYLOR'S UNIVERSITY

Abdulkareem Sh. Mahdi Al-Obaidi, Douglas Tong Kum Tien, Mushtak T. Al-Atabi

Department of Mechanical Engineering, School of Engineering, Taylor's University,
No. 1 Jalan Taylor's, 47500 Subang Jaya, Selangor DE, Malaysia

ABSTRACT

In an Engineering undergraduate program, the final year project covering two semesters is a compulsory requirement mandated by Engineering Accreditation bodies worldwide. The final year project tends to be research intensive compared to the design and build projects prior to the final year. It builds upon the foundational knowledge and skills attained in the earlier undergraduate years. Engineering educators and accreditors consider the learning experience obtained by the students in successfully undertaking the final year projects as essential in contributing towards their development in becoming competent and sought after entry level engineers. It also plays a part in laying the foundation for future success in an engineering career through both the hard and soft skills attained. There are many approaches in assessing a student in the final year project. However it must be borne in mind that appropriately designed assessments contribute towards effective learning and development. Therefore the final year project assessment must be aligned with the learning outcomes identified by the faculty. Here at Taylor's University School of Engineering, in addition to the standard assessment components, a new approach is adopted to include a participation in a conference. Engineering Undergraduate Research Catalyst Conference (EURECA) is a unique approach to assess final year project students. It aims to expose the student in a real environment of a conference to gain further skills. Participation in a peer reviewed conference, assessment by external reviewers, oral defense of thesis, anonymous assessment coupled with prompt feedback to students are some of the approaches implemented to deliver the learning outcomes. This paper shares successful engineering education experience to further enhance the final year project component for engineering undergraduate students.

KEYWORDS

Final year project, Conference, Undergraduate programme, CDIO Standards: 2, 3, 8, 10

INTRODUCTION

There is an increasing need for employment-ready engineering graduates who posses a wide array of personal, interpersonal, and system building knowledge as well as skills that allow them to perform in real engineering teams, to conduct researches, and to produce real products and/or systems that meet both enterprise and societal needs. To achieve this, the educational institutes need to continuously revise the engineering curriculum and adopt non-traditional approaches. The core paradigm shift required is the move from the lecturer-centred

learning environment to a student-centred one. A number of these non-traditional approaches are adopted by different institutions, including Problem-based learning, Project-based learning, Problem-based learning, CDIO initiative (Conceive-Design-Implement-Operate), etc. (Mills and Teagust (2003), Crawley (2002), Chadrasekaran et al. (2013), Al-Obaidi et al. (2013), Al-Atabi and Al-Obaidi (2011), Al-Atabi et al. (2013), & Shamel and Al-Atabi (2013).

The accreditation bodies and engineering councils around the world have a duty to ensure that the quality of engineering graduates and programmes. For example, in Malaysia, Engineering Accreditation Council (EAC) is the body delegated by Board of Engineers Malaysia (BEM) for accreditation. The objective of accreditation is to ensure that graduates of the accredited engineering programmes satisfy the minimum academic requirements for registration as a graduate engineer with BEM (EAC, 2012) [4].

In most of the engineering programmes, Final Year Project (FYP) is the milestone and one of the compulsory subjects in the undergraduate engineering programme for students to graduate. As defined by EAC the final-year project can provide one of the best means of introducing an investigative research oriented approach to engineering studies. It is a requirement of the programme to include a significant project in its later stages. The final-year project is required to seek individual analysis and judgement, capable of being assessed independently. The student among others is expected to develop techniques in literature review and information processing, as necessary with all research approaches. It is recommended that final-year projects should also provide opportunities to utilise appropriate modern technology in some aspects of the work, emphasising the need for engineers to make use of computers and multimedia technology in everyday practice. (EAC, 2012) [4].

It is clear from this definition that the successful FYPs rely heavily on the researches. Actually, the FYP is the screen which shows how well the students possessed and achieved the personal, interpersonal, and practical skills to approach engineering challenges by research and find solutions or design systems that meet both enterprise and societal needs.

Different universities around the world have different approaches to ensure that FYP meets the minimum requirements of the accreditation bodies and produce engineers who are able to apply the research components to conduct a successful research. This depends on approaches adopted by the educational institutes. To meet the increasing demands from the industry and other stockholders for “employment-ready” and “engineers who can engineer” engineering graduates, and also to meet the minimum requirements set by the accreditation bodies, the educational institutes need to adopt innovative approached for final-year projects.

This paper shares successful engineering education experience to further enhance the final year project component for engineering undergraduate students. At Taylor’s University School of Engineering, in addition to the standard assessment components, a new approach is adopted to include a participation in a conference. Engineering Undergraduate Research Catalyst Conference (EURECA) is a unique approach to assess final year project students. This approach aims to produce engineers who are able to address the grand challenges.

FYP APPROACHES

In most of the universities final-year project is a subject offered in the final year; for example Year Four in a four-year engineering degree programme. Usually, FYP carries a considerably high number of credit hours upon graduation. It is therefore a crucial component

in the quality of the engineering graduates. The learning outcomes of this subject are crafted and mapped to include almost all the outlined programme outcomes. The practice to achieve the learning outcomes is almost common or similar in the universities. However, the quality of the achievement might be different. It depends on the approaches adopted by those universities. The following part of this paper sheds the light on some published literature which attempts some different approaches for the final year projects.

Popov (2003) presents strategies for improving the quality of student learning in the context of the final undergraduate project in mechanical engineering. The results obtained show that a deep approach to learning can be fostered in students by a careful selection of project topics, together with a good balance of group and individual tutorials which can stimulate significant peer interaction.

Thambyah (2011) utilised the revised Bloom's taxonomy table to design new learning outcomes for the final year project course in engineering education. It is envisaged that the present taxonomy table contribute positively to not only FYP courses but also to the quality of many research projects, where, more often than not, such guidelines are not available or remain ambiguous. Dahari et al. (2012) implement the CQI process in an electrical & electronic engineering final year project implementation to address the uprising issues during the accreditation process.

Ortiz-Marcos et al. (2012) indicate the importance of the Final Year Project (FYP) in the strengthening of competences of engineering students. The paper shows which personal competences of students are reinforced most during the FYP process, including the preparation, elaboration, presentation and defense stages. The conclusions drawn will permit the design of new study plans to cope more effectively with the challenges of the FYP.

Ward (2013) identifies and analyses common elements of the capstone programmes implemented in mechanical and aerospace engineering undergraduate programmes in the world's top-ranked engineering universities to determine established best practices. These practices can be modelled and applied to the pedagogy of engineering programmes at universities around the world to improve the development of professional skills of future graduates.

Chandrasekaran et al. (2013) analyse and compare various undergraduate final year engineering project approaches of different universities in Australia. In this paper different approaches of learning such Problem-based, Project-based, Design-based, Scenario-based, Inquiry-based, and Action-based learnings, are discussed and analysed. The purpose is to explore the best assessment practice for the delivery of final year project.

Kim (2013) develops a quantitative method for estimating an expected uncertainty in assessment results arising from the relativity between four variables; examiner's expertise, examinee's expertise achieved, assessment task difficulty and examinee's performance for the complex assessment applicable to final year project thesis assessment including peer assessment. The continuum model consists of assessment task, assessment standards and criterion for the transition towards the complex assessment owing to the relativity between implicitness and explicitness and is capable of identifying areas of expertise required for scale development.

It is fair to say that attempts have been tried and are being tried by different universities to enhance and improve the FYP assessment components and syllabi. Taylor's University School

of Engineering in its endeavor to use the best assessment practice for the delivery of final year project, introduces Engineering Undergraduate Research Catalyst Conference (EURECA) as innovative approach for is a unique approach for this purpose. Surveying the available published literature, the authors believe that this approach with its unique component has been not used before neither by local universities nor by international universities.

The experience of participating in a research conference and having their papers reviewed by external reviewers who are experts in their respective fields becomes a motivating factor for the students to produce quality work. The entire process of submitting an abstract, followed by the conference paper, receiving reviewers' feedback, using the feedback for improvement, presenting the "improved work" at the conference before an audience which included industry participants and in some cases the same external reviewer provided the students with a complete cycle of learning experience and an overall feel of the academic research culture.

FYP AT TAYLOR'S UNIVERSITY

The final year engineering project at Taylor's University is offered over two semesters. FYP1 is offered in the first semester of the final year while FYP2 is offered in the second semester. Table 1 and 2 show the learning outcomes for FYP1 and FYP2 respectively. These outcomes are intended to address the high level cognitive domain of Bloom's Taxonomy.

Table 1. FYP1 Learning Outcomes

No.	Learning Outcome
LO1	Formulate the scope and objectives of a particular research project
LO2	Organize critical literature review
LO3	Build a research plan using project management tools
LO4	Design and Prepare research methodology
LO5	Compile the findings in both written and verbal form

Table 2. FYP2 Learning Outcomes

No.	Learning Outcome
LO1	Evaluate results using research based knowledge and research methods which include experiment design, data analysis and the synthesis of information to provide conclusions.
LO2	Compile and present a final year project thesis and a peer reviewed conference paper.
LO3	Apply project management tools to execute the research plan.

Students are expected to meet with their project supervisor(s) at least once a week for guidance and to update on their progress. In addition there is a module coordinator who handles the administrative matters of the module, keeps staff and students well informed of deadlines and other requirements and organizes the lecture series for the FYP modules. Students are required to attend weekly lectures by different staff members on various topics related to the FYP. These topics are intended to help the students develop the necessary capabilities for undertaking the FYP including research skills.

To ensure that the learning outcomes are achieved, the FYP is assessed through various assessment components aligned with the learning outcomes. Tables 3 and 4 provide details of the assessment for FYP 1 and FYP2 respectively.

As outlined in Table 2, Learning Outcome 2 (LO2) for FYP2 requires the student to participate in a conference where their papers are reviewed by academics from other universities. This participation begins prior to FYP2. During the first weeks of FYP1 the student is required to submit an abstract containing the Background, Purpose, Methodology, and Expected Results of the work to be carried out. This abstract is considered as a submission to the conference and also as an assessment component for FYP1 as shown in Table 3.

A two page conference paper would then be required in the middle of the second semester during FYP2. The student will present the paper at the conference scheduled at the end of the second semester. Both the paper and the conference presentation are assessment components for FYP2 as shown in Table 3.

Table 3. Assessment Details for FYP1

Assessment Details	Mark
Meeting Record	15%
Initial proposal	15%
Abstract for EURECA Conference	10%
Oral Presentation and Viva	15%
Interim Project Report	35%
Engineering Fair Poster	10%
Total	**100**%

Table 4. Assessment Details for FYP2

Assessment Details	Mark
Meeting Record	15%
PO Portfolio 2	10%
EURECA Conference Paper	10%
Thesis	40%
Oral Defence of Thesis	10%
EURECA Paper Presentation	10%
Engineering Fair Poster	5%
Total	**100**%

WHAT AND WHY EURECA?

The conference is called Engineering Undergraduate Research Catalyst Conference or EURECA. The purpose of EURECA is encapsulated in the following excerpt from its website (EURECA (2013): "With the ever-increasing expectations of graduates to be ready to address a variety of new world challenges, the requirements to equip the graduates, especially those in the field of engineering, science and technology, with research skills are more pressing. EURECA 2013 aims at providing undergraduate engineering students the opportunity to experience a research environment. This is expected to prepare them not only for careers in research but also to provide a precursor for them use the developed research skills in their future endeavors."

The conference participation is not limited to Taylor's University final year engineering students but is also open to engineering students from other universities. To the knowledge of the authors, this is the first time that participation in an externally reviewed conference is made a compulsory requirement in an FYP module besides also contributing to students' grades as an assessment component.

The review of the conference papers are conducted by external reviewers who are staff of other universities locally and abroad who are experts in their respective fields related to the research focus of the FYP. The reviewers not only reviewed but also assessed the papers by giving marks according to a rubric provided to them and gave written feedback to the students. The reviewers' comments and feedback were communicated to the students

through their supervisors. With the reviewers input about their project the students are able to enhance their work, the final conference paper and their thesis. Samples of the review form, assessment rubric and feedback form can be found in Appendix A.

The benefit derived from having this conference is that the students' papers are assessed independently by external experts. This assessment can be used to gage the quality of the students' work benchmarked against that of other universities. The feedback received from the external reviewers cum assessors is communicated to the students through their supervisors. The supervisors also gained as a result of having the work peer reviewed and through the feedback they received from the reviewers.

Academics from other universities including some of the reviewers of the papers, engineering professionals from the industry and staff of Taylor's School of Engineering participated as judges/assessors at the conference. The students are required to present and respond to questions from the judges and from the audience. The feedback from the judges/assessors is communicated to the students and hence the students' learning cycle is complete.

CONCLUSIONS AND FUTURE PLANS

EURECA 2013 was a success by the metrics we set for it, mainly the number and quality of the students' publications. All graduates managed to author and present conference paper. This was a great introduction to research for these graduates. 15% of the 2013 graduating cohort are currently doing postgraduate studies, this being the first graduating cohort. The conference received positive responses from the employers as well and we currently plan to open the EURECA 2014 to contributions for other universities final year students. The effectiveness of such new approach for FYP students will be further assessed after having more graduating cohorts, where the comparison between two or more cohorts may suggest whether EURECA opened students' eyes to research as a career path. This can be done by tracking the number of students going for further research.

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BIOGRAPHICAL INFORMATION

Abdulkareem Sh. Mahdi Al-Obaidi, Ph.D. is a Chartered Engineer (IMechE) and Senior Lecturer in the Department of Mechanical Engineering at the School of Engineering, Taylor's University. He is the Head of the Engineering Education Lab Research Group at Taylor's University and the Executive Editor of Journal of Engineering Science and Technology. His current scholarly activities focus on the Engineering Education, Aerodynamics of Supersonic Flying Bodies and Thermodynamics and Heat Transfer.

Douglas Tong Kum Tien, is a Chartered Engineer (IMechE) and Senior Lecturer in the Department of Mechanical Engineering at the School of Engineering, Taylor's University. He is also serves as the Programme Director for Mechanical Engineering and module coordinator for the final year projects. He is currently pursuing his PhD in the Engineering Education.

Mushtak A. Al-Atabi, Ph.D. is a professor and dean of the school of engineering at Taylor's University. A mechanical engineer by training and Fellow of the IMechE, Mushtak has pioneered CDIO and Project Based Learning at Taylor's University. He continues to explore new innovations to improve students' experience and recently he developed and deployed the first Massive Open Online Course (MOOC) in Malaysia.

Corresponding author

Dr. Abdulkareem Sh. Mahdi Al-Obaidi
Department of Mechanical Engineering,
School of Engineering, Taylor's University,
No. 1 Jalan Taylor's, 47500 Subang Jaya,
Selangor DE, Malaysia
+60173955578
abdulkareem.mahdi@taylors.edu.my

Appendix A

EURECA 2013 Student Paper Assessment Rubric

Title: An Application of Research Methodology Framework Relating Cognitive Ergonomics to Sport Science

Author: Terence Foo Kai Wai

Examiner: Professor Keith Case

Organization of Paper, Grammar, Usage of Language, and Spelling	5	4	5	Information is very organized with well-constructed paragraphs and subheadings. There are few or no errors. Word choice is precise and appropriate.
			3-4	Information is organized with well-constructed paragraphs. Few errors in grammar, usage mechanics and/or word choice
			1-2	Information is not well organized and paragraphs are not well-constructed. Numerous errors in grammar, usage mechanics and/or word choice.
Objectives	10	8	8-10	Objectives are clear and motivate paper content.
			5-7	Objectives are clear.
			1-4	Objectives exist but may not be clear.
Theoretical Framework	20	14	16-20	Theoretical framework is clearly defined, connected to the paper content, and is used throughout the paper to guide the reader.
			10-15	Theoretical framework is clear and its connection to the paper content is defined.
			1-9	Mention of theories, but unclear how they relate to paper content.
Methodology and Data	20		16-20	Methodology and data are clearly defined. Data and analysis described in a format that can be replicated by others. Offers clear rationale for methodological choices.

		14	10-15	Methodology and data are described and are appropriate to answer the questions.
			1-9	Methodology and data are mentioned but may be confusing.
Reported outcomes	20	15	16-20	The research or assessment is presented in a clear and concise manner. Benchmarks, success indicators and outcomes are clearly defined.
			10-15	Outcomes are quantifiable and research or assessment is included.
			1-9	Outcomes are reported but not substantiated by research.
Educational or Field Significance	15	13	12-15	Significance of results clearly articulated, paper covers new territory and could have important impact on the field.
			8-11	Significance of results discussed and work covers new territory.
			1-7	Significance of results discussed but work seems to be re-hashing of prior work.
Use of relevant literature citations	10	7	8-10	Citations are included, clearly support the paper content, and articulate the premise regarding the implementation of the project/model discussed.
			5-7	Citations are included and they support the paper content.
			1-4	Citations are included but do not support the paper content.
		75		

Please fill in the marks for each Criteria into Actual Marks column as guided by the Rubric and sum up the Total Marks into the bottom cell

(Please note that these marks will not be revealed to students. Only your comments given in the next page will be given as feedback to the students.)

Author:

Please Write Your Comments for Feedback to the Student:

Organization of Paper, Grammar, Usage of Language, and Spelling **I assume that the paper was restricted to be two pages long. It is always difficult to organize a paper to fit a particular page length and I think a good job has been done. The English is generally very good with only occasional, minor lapses.**
Objectives **This is a difficult topic to tackle. i.e. trying to find objective measures in cognitive ergonomics is always difficult and probably even more so in the field of sports. Nevertheless, trying to quantify ergonomic/emotional characteristics is extremely valid and a very current field of academic endeavor.**
Theoretical Framework **The theoretical framework in terms of the likely factors influencing performance is good – given more space in the paper this could have been developed further through references.**
Methodology and Data **The use of questionnaires has its difficulties but is probably the only realistic way of tackling this area given your circumstances.**
Reported outcomes **The data collected and analysed produced significant results. Interpreting these results can be difficult and a reasonable attempt has been made here.**
Educational or Field Significance **As I have already mentioned, the issues raised in this paper are very current and relevant as we try to gain a better understanding of human behavioural/cognitive/emotional characteristics.**
Use of relevant literature citations **Within the limitations of the paper this was good, but there must be a very extensive literature in the sports psychology field.**

Appendix A

EURECA 2013 Conference: Paper Review Form

Title: An Application of Research Methodology Framework Relating Cognitive Ergonomics to Sport Science
Author: Terence Foo Kai Wai

Reviewer: Professor Keith Case

Overall Recommendation	
Strong Accept	X
Weak Accept	
Weak Reject	
Strong Reject	

Extent of Required Changes	
Minor	X
Moderate	
Major	
Excessive	

General comments:

A complex issue of cognitive/behavioral/emotional ergonomics that makes a very interesting paper.

I assume that there is a two page limit which causes problems, but the paper would have been improved with more description of the questionnaire (number of participants, their backgrounds, etc). Reference to studies in sports psychology would have been useful and perhaps a little more discussion on the validity of the results.

However, I feel that this is an excellent attempt at a research study and paper from someone not experienced in such things.

Required changes before publication:

There are a few minor problems with the English that could be improved but they do not spoil understanding of the paper.

The points mentioned in the second paragraph above could be tackled but this is not essential

Comments NOT forwarded to the author:

I think that this is an excellent attempt at research and a paper. My marking (attached form) gives it 75% which under our marking schemes would be an excellent mark representing work up to the standard of a first class honours degree. If this needs moderating to reflect the marks given to such an achievement under your system then I am happy for you to do it.