Turning Tedious to Terrific: An Authentic Learning Experience to Engage Engineering Students in Project Management

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Structured Abstract

BACKGROUND
Project management is often perceived as "a boring and tedious subject" by undergraduate engineering students as the traditional ways of teaching the subject often lack context and relevance to practice. Nevertheless, soft skills such as project management, leadership and communication are very important graduate attributes which are often a core part of the duties performed by graduate engineers. Non-traditional teaching pedagogies such as project and problem based learning are found effective in developing such competencies.

PURPOSE
This paper discusses an innovative approach to enhance student engagement in an engineering project management subject by using mixed-mode teaching which includes face to face lectures and active student-centred project-based learning through an authentic industry project. The main objectives of embedding an industry-based project in the subject are to give students an exposure to real world challenges and opportunities to implement the project management skills and tools they learnt in the classroom in a real-life scenario. Having a real industry project also helps to add context and authenticity, which in turn helps to keep students engaged and motivated.

DESIGN/METHOD
As a part of the project management subject, an industry project based on an actual ongoing project was embedded in EG3000 (Engineering Project Management) at James Cook University. The class was divided into groups of 9-10 students, each group consisting of students from different engineering disciplines. Each group of students represented a project management team to manage and execute the project. As a part of this project, student teams were required to conduct planning and feasibility analysis and define project scope, liaise with key stakeholders to identify their needs and to report status of the project; conduct risk analysis; consider sustainability aspects during the project delivery; and apply appropriate project management tools and concepts for performance evaluation, budgeting, auditing and successful delivery of the project.

RESULTS
Mixed-mode teaching which included face to face lectures plus project-based learning through an authentic industry project significantly improved student engagement in the undergraduate third year engineering project management subject. Involvement of industry in delivering the project briefing and a site visit added authenticity and context to the project.

CONCLUSIONS
Instead of the traditional "chalk and talk" pedagogy, a mixed-mode of delivery was successfully trialled in the undergraduate project management subject using a combination of in-class lectures and student-centred project-based learning. An authentic large scale industry project used in the subject gave students invaluable opportunities to apply project management knowledge and skills in a real-world scenario and to appreciate the challenges they will face as graduate engineers.

KEYWORDS
Project based learning, authentic industry project, project management

Introduction

Project Management involves planning, organizing, monitoring and controlling all aspects of a project to safely and successfully deliver project goals within a specified time, budget and resources. Project management tools and knowledge are increasingly used to execute engineering and scientific projects due to growing focus on sustainable and customer oriented results, increasing constrains in budget and resources, and compression of product life cycle (Larson and Gray, 2011). The importance of project management education in undergraduate engineering programs is, therefore, well recognized both by the academic institutions and professional engineering bodies (Male et al., 2009, Winter et al. 2006).

Engineers Australia (EA), which controls the accreditation of engineering programs in Australia, requires that engineering graduates meet the prescribed Stage 1 competencies to enter engineering practice as professional engineers (EA, 2013). The EA Stage 1 competency standard requires graduates to have not only sound technical abilities in their respective disciplines but also soft skills such as leadership, communication, and project management. Driven by the accreditation requirements and industry feedback, current engineering curricula across the nation incorporates project management subjects in addition to traditional technical subjects (Male et al., 2009; Panuwatwanich et al., 2011). Male et al. (2009) conducted a comprehensive survey of 300 established engineers in Australia which identified that along with technical skills, communication, teamwork, professional attitudes, business skills and problem solving are perceived as highly important skills for graduate engineers. While the importance of project management studies in undergraduate engineering curricula is widely recognized by the industry, undergraduate students do not immediately appreciate the value of management studies and often find it dry and tedious. This is mainly because the traditional ways of teaching project management concepts and theories often lack context and relevance to practice (Winter et al., 2006 and Palmer, 2001). Furthermore the traditional methods of delivering management subjects do not reinforce the breadth of skills necessary for engineering practice. Engineering business competencies which include planning, specification, estimation, project management, cost control, risk and maintenance management are still identified as one of the key competency deficiencies in our graduate engineers (Male et al., 2010). Project and problem based learning pedagogies are better suited for achieving these engineering business competencies. Survey of recent graduates suggested the inclusion of more real-world examples such as case studies; hands-on activities, industry visits, and industry presentations help undergraduate students to appreciate the value of management studies (Male et al., 2010; Mills and Treagust, 2003; Palmer, 2001). Recently published “Best practice guidelines for effective industry engagement in Australian engineering degrees” by Australian Council of Engineering Deans (ACED) (Male and King 2014) strongly advocates enhancement of student engagement through authentic engineering problems and practices which will not only improve their understanding of the concepts but also help the students comprehend the relevance of socio-technical competencies.

With this in mind, this paper discusses an innovative approach taken in an undergraduate engineering project management subject at James Cook University to enhance student engagement and understanding of project management concepts. The approach is based on implementing a meaningful industry partnership to develop and embed authentic industry based project in a third year engineering project management subject. The project was conducted as a part of the ACED initiative to enhance industry engagement in engineering degree programs through the Workplace Innovation Program (WIP) funded by Australian Government Department of Industry.

Background and methodology

EG3000: Engineering Project Management is a compulsory third year engineering subject taken by students from all the engineering disciplines at James Cook University. A typical class size in the subject is around 80 to 90. The subject used to be delivered in a traditional content driven approach until 2011. However, there were ongoing issues related to lack of student engagement in the subject as the theoretical concepts taught in the classroom were often perceived as “boring and tedious” and disconnected from the real world. Hence from 2012, in conjunction with the in-class lectures, project-based learning was introduced into the subject to give students an exposure to a real and current problem from industry and give them opportunities to implement the project management knowledge and tools they are learning in the classroom in real-life scenario.

Subject learning outcomes (SLOs) for this subject were also rewritten to align the course contents, assessment items, teaching and learning strategies with the expected graduate attributes and EA Stage 1 competencies.

SLOs for the subject claim that students who successfully complete this subject will be able to:

1. Effectively communicate, including written and oral and other forms, in a professional environment
2. Define a scope, identify resources, produce cost estimates and budgeting for a project
3. Use risk management analysis to identify risks, assess their effects on a project timeline and implement appropriate intervention plans
4. Apply appropriate project management tools and concepts for performance evaluation, auditing and successful delivery of projects
5. Consciously apply systems thinking, approaches and concepts in a range of engineering management problems including dealing with complexity and uncertainty
6. Appreciate and apply sustainable practices while planning, designing and managing projects
7. Appreciate professional and ethical responsibilities and abide by them while delivering projects

The use of the embedded industry-based project aims to address each of the subject learning outcomes for EG3000 and is therefore an integral part of the subject.

In 2013, Semester 1, Phase I of the WIP project involved the development and implementation of a hypothetical, yet a real-life based project developed in collaboration with Rockfield Technologies as the theme of the student group project. The majority of the student feedback clearly showed that even though students appreciated the inclusion of an industry project, they would prefer to work on a real project with tangible outcomes rather than working on a hypothetical scenario.

Taking the student feedback into account, a group student project based on an actual ongoing project of our industry partner Glencore was developed and embedded in the subject in Semester 1, 2014 as Phase II of the WIP project. The aim of using a real industry project was to give authenticity and realism to the student project and give students an exposure to the different aspects of project management concepts through a real multinational industrial project in the region. This also gives students invaluable opportunities to engage with and learn from the industry experts.

Details of the student project (Phase II)

The student project was based on a relocation and expansion project currently underway at marine Berth 8 (Figure 1a) at the Port of Townsville. Glencore, one of the world's largest international resource companies, have invested in a high throughput ship loader as well as associated bulk materials handling infrastructure for this berth (Figure 1b). The new facilities are expected to be operational by the end of 2014. Technical details of the ship-loader and supporting infrastructure were prepared by the project managers from Glencore and handed over to the students as a project overview. This project was strategically chosen because of the following reasons:

a) The project is quite unique and is large enough to have components from Civil, Mechanical, Electrical and Electronics and Chemical Engineering disciplines.
b) Students can relate to this project as it is directly linked to the region.
c) The construction site is nearby, to allow student site visits.
d) It is a large scale ongoing project which helps to add authenticity to the student work. And the industry representative can provide relevant information readily.

The EG3000 class was divided into groups of 9-10 students, with each group including students from different engineering disciplines. Working in a multi-disciplinary team helped students to appreciate their different backgrounds and to develop cooperative team-building skills. Students were also required to differentiate roles within their team. Each group of students represented an international project management team to manage and execute the Berth 8 development. As part of this project, student teams were required to conduct planning and feasibility analysis and define the project scope; liaise with key stakeholders to identify their needs and to report status of the project; conduct risk analysis; consider sustainability aspects during the project delivery; and to apply appropriate project management tools and concepts for performance evaluation, auditing and successful delivery of the project.

Technical details of the ship-loader and supporting infrastructure were handed over to the students during the initial project briefing by the project manager from Glencore. During the semester, the students were also taken to the construction site at Port of Townsville so that students could appreciate the magnitude of the project. This also added authenticity and context to the student project. Students were required to submit two status reports, a final report of the project and do a final presentation. The final presentations were assessed by the project managers from Glencore. Apart from this project-based learning, four guest lecturers, all experienced project managers working in different engineering disciplines, were also invited to give an overview of project management in large international projects.

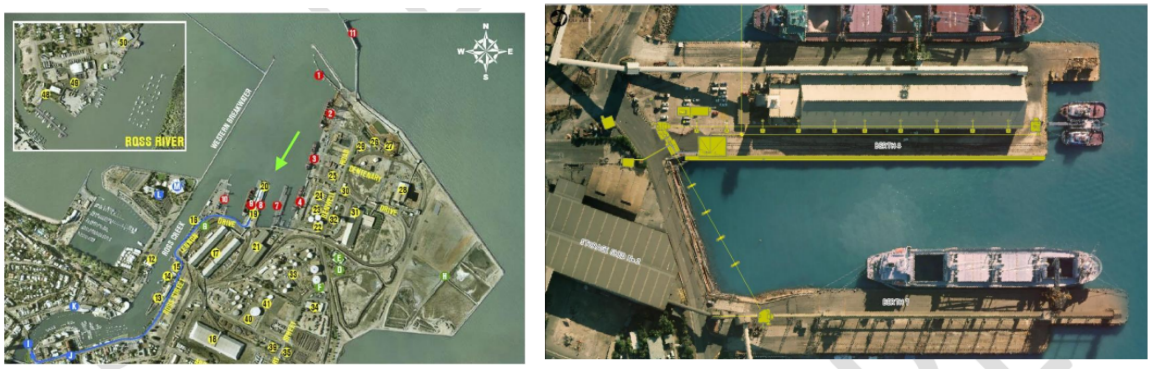

Figure 1(a) Port of Townsville showing location of Berth 8 (b) Details of proposed new infrastructure at Birth 8

Project Timeline

The project is delivered to the students early in the semester so that the students have adequate time to understand various elements of the project and to get familiar with their team mates. This was an ideal time for the students to demonstrate effective teamwork and leadership skills. Half an hour lecture time was allocated every week during the semester to give adequate time for the students to discuss the project within their respective groups. An industry based lecturer was available during the discussion time to answer students' queries. The project timeline is given in Table 1 highlighting the key milestones of the project.

Table 1 Student project timeline

Item Description	Week No.
1. Team allocation – Teaching staff to allocate	2
2. Project briefing from the industry representative	3
3. Submission 1: Status Report at 30% project completion	7
4. Site Visit to Port of Townsville and mid-semester consultation with industry representatives	9
5. Submission 2: Status Report at 75% project completion	10
6. Submission 3: Final Project Execution Report	13
7. Submission 4: Group Seminar – Glencore representatives as well as the lecturer were on the examination panel	13

Key aspects of the student project

Constructive comments from the students and feedback received during the WIP progress meeting on Phase I Project were used in designing Phase II of the project. The key aspects of the Phase II project were:

a) The use of an actual ongoing industry project from our industry partner Glencore: The use of a large scale ongoing project added authenticity to the student project and helped students to better understand the application of project management concepts they learnt in class room and appreciate the complexities involved in professional practice. This open ended project required students encouraged self-directed learning which also help them develop essential skills like organization, communication and team work.

b) Authenticity: Initial project briefing was done by the project manager from Glencore. Technical details of the actual project were also supplied by Glencore. Technical details from the industry and site visits added authenticity and realism to the project. An industry based lecturer was available to answer students' queries. Final project presentations were also assessed by the project manager from the industry.

c) Socio-technical elements: Socio-technical elements were explicitly included in the assessment criteria of the project to motivate students to have a broader perspective of social, environmental, economic and other contemporary engineering issues in engineering projects.

Feedback

Use of mixed-mode delivery of the subject which included face to face lectures and project based learning significantly improved student feedback. Feedback was obtained at interim student-staff feedback meetings during the semester and also through the formal subject feedback mechanism at the end of the semester. In the semester-end student feedback survey, 71% of the student agreed that the assessment activities helped them understand the subject material. 60% of the students agreed that they were overall satisfied with the subject with 31% students remaining neutral. From these figures, it may appear that the student response has not improved dramatically. However, by digging into the written student comments, it was evident that students appreciated the learning through the industry project which is demonstrated by student remarks (Student Feedback of the subject, 2014) like:

> *"The group assignment was good, especially tying to a relevant project which was actually happening in the real world."*
>
> *"The inclusion of actual industry representatives and a look into what can be expected outside of university was good."*
>
> *"The group project developed the use of the skills and techniques taught in the subject."*
>
> *"The group project and having a sort of real world application with the berth upgrade definitely made things more interesting."*
>
> *"The subject was good in the fact that it provided exposure to engineering and kind of gave you an idea of some of the things to expect when you leave university, things I previously was not aware of."*
>
> *"The big group project was based on a real life project. Field excursion was also quite good. Industry speakers were also really good to have as a part of the subject."*
>
> *"Leaning about what is required in a real world engineering projects."*

Students have also consistently admired the wealth of practical knowledge guest speakers brought into the class room.

In 2015, considering the students' constructive feedback, the delivery of the theoretical concepts of project management is recommended to be done via screencast videos which will allow lecture time to be more effectively used for cooperative learning through project discussions. The flipping of the classroom will provide a blended learning experience for the students and will further strengthen the project based learning environment.

Conclusions

Instead of the traditional "chalk and talk" pedagogy, a mixed-mode of delivery was successfully trialled in a third year project management subject using a combination of in-class lectures and student-centred project based learning. An authentic and current large scale industry project used in the subject gave students invaluable opportunities to apply project management knowledge and skills in a real world scenario and to appreciate the challenges they will face as graduate engineers. The site visit, project overview and design briefing from the industry gave an authenticity and realism to the project which helped boost student motivation and engagement. Furthermore, students working in heterogeneous groups with students from multiple engineering disciplines helped develop cooperative team-building skills through shared learning experiences. Active and self-directed learning using an authentic industry project was found very effective in developing breadth of project management skills in engineering students. This framework of industry engagement can be adopted in other universities for similar subjects like asset management or capstone design subjects.

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