

# Cementing engineering student engagement through early program exposure to industry practice using aligned project case studies presented by industry professionals

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## Structured Abstract

### BACKGROUND

Students entering four year engineering programs often have core first year courses that cover mostly fundamental mathematics, generic skills and engineering principles. Many students entering second and sometimes even third year of their engineering program are still naïve to the projects, roles and responsibilities of engineers within their discipline. There is often little 'big picture' context provided at the start of their engineering program, as to why they need to learn a range of theoretical concepts and generic skills, often leaving them disengaged with their chosen engineering discipline. In some cases, students leave their program due to a lack of motivation stemming from a lost sense of purpose and career conceptualisation. Similarly to the workplace, the most effective people are those that are engaged in what they are doing. Through exposing engineering students to 'real world' projects coupled with passionate and successful engineering professionals showcasing such projects, goes a long way to cement student learning engagement and a sense of purpose.

### PURPOSE

This study sought to ascertain students' satisfaction with a 2nd year civil engineering course that included a number of embedded case study presentations by experienced engineering professionals serving as guest lecturers. The survey also sought to identify whether students felt they were getting sufficient exposure to authentic professional practice experiences through project-based learning, case studies, guest lecturers, site visits, etc. in the early part of their engineering program. The primary goal of the study was to identify the extent of deficiency in exposure to professional practice in the early years of the engineering program and the resulting diminished benefits that such exposure could have derived in terms of learning engagement, discipline contextualisation and career purpose.

### DESIGN/METHOD

Data for this study was collected through a questionnaire survey of 83 second year undergraduate students completing the 'Construction Engineering' course in the Bachelor of Civil Engineering Program offered by Griffith University. The questionnaire was comprised of three main sections: Part A collected basic demographic information; Part B was designed to elicit the undergraduate engineering students' perceptions on the extent to which the case studies presented by the guest lecturers helped to improve their learning and engagement with the course and degree program; Part C requested students to provide their opinion on the extent of professional practice exposure in the early years of their program (i.e. year 1 and 2). Descriptive statistics and paired sample *t*-test statistical techniques were applied to achieve project aims.

### RESULTS

The findings are consistent with anecdotal evidence that engineering students felt that early exposure to engineering practice assisted them to contextualise and engage with their engineering discipline better. Further, the results confirmed that there is room for improving the current level of professional practice exposure in the early years of the civil engineering degree program.

### CONCLUSIONS

Industry exposure through guest lectures, site visits and current case studies needs to be intertwined into modern engineering programs to improve student engagement, purpose and retention.

### KEYWORDS

Professional practice; guest lecturers; graduate attributes; student engagement; graduate readiness.

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# Introduction

## Student attrition in engineering education

Attrition of students has been highlighted as a major concern within Australian engineering education context (Godfrey et al., 2010). In a typical four-year engineering degree, students entering the programs are often required to undertake core first year courses that cover mostly fundamental science and mathematics, generic skills and engineering principles. Many students entering second and sometimes even third year of their engineering program still lack an exposure to the projects, roles and responsibilities of engineers within their discipline. Moreover, there is often a lack of 'big picture' context provided at the start of an engineering program, as to why the students need to learn a range of theoretical concepts and generic skills, leaving them disconnected from their chosen engineering discipline. Many students leave their program due to a lack of motivation stemming from a lost sense of purpose and career conceptualisation.

In Australia and the USA, student attrition rates from engineering degrees are reportedly higher than those from other professional disciplines, particularly medicine (Crosthwaite and Kavanagh, 2012). Godfrey et al. (2010) cited the average completion rate of engineering graduates of approximately 54%, as reported by the Australian Council of Engineering Deans. This indicates the attrition rate of approximately 46%, which represents a significant loss of both qualified workforce, adding a strain on the existing shortage of skilled engineers (Godfrey et al., 2010). It should be further noted that this attrition rate is much higher than the mean attrition rate of all universities across Australia (12.82%) as recently reported by *The Australian* (University student attrition rates across Australia, 2014). Attrition also has financial and reputational implications for the universities given the need for them to stay competitive in the current globalised higher education market; it forms part of the key performance indicators used in the allocation of the Commonwealth Government's Learning and Teaching Performance Fund for Australian universities (Crosling et al., 2009). As a result, attrition rate is a prime indicator that every Australian university closely monitors.

## Enhancing engagement through authentic learning

In coping with student attrition, much attention has been paid to enhancing student engagement to improve student retention during the early period of the degree program, especially among first-year students, to provide strong foundation for their successful study in later years (Crosling et al., 2009; Crosthwaite and Kavanagh, 2012). Within the higher education literature, one important key to students' achievement in learning is the need for the educators to focus on fostering the use of deep approach to learning by the students. According to Biggs and Tang (2007), the deep approach is developed from "a felt need to engage the task appropriately and meaningfully, so the student tries to use the most appropriate cognitive activities for handling it" (p.24). Such feeling of the "need to know" enables the students to automatically focus on the underlying fundamental of concepts, while making sure they understand the "big picture", allowing them to feel a sense of importance and purpose about what they are learning (Biggs and Tang, 2007). To achieve deep learning, students need to have an intrinsic motivation to learn; this essentially requires continuing successful engagement with authentic and worthwhile academic activities (Biggs and Tang, 2007). One means by which authentic learning experience can be achieved is through providing an appropriate real-world context to increase engagement (Maier, 2009).

## Industry involvement and authenticity of learning experience

In the report entitled "Engineers for the Future" prepared by the Australian Council of Engineering Deans (King, 2008), it was recommended that educators and practitioners must collaborate and engage more intensively to bring about authentic students' learning

experience through such measures as increasing work-integrated learning in the curriculum and the number of joint industry-academic appointments as well as opportunities for more academics to expose themselves to contemporary industry experience. What was further recommended in the report to increase authenticity of students' education experience through industry relevance was to use more effectively industry-led case studies, programmed site visits and high-quality guest lecturers (King, 2008).

According to Maier (2009), students who are exposed to actual engineering projects, and the knowledge required to complete such projects, via real-life industry case studies are likely to be more motivated to learn the concepts associated with the case studies. Moreover, direct involvement from the industry, such as the use of guest lecturers, can play a pivotal role in fostering the students in developing deep learning and understanding through a "vicarious experience of relevance" (Hodgson, 1997). In this way, students can perceive the relevance of the concepts taught in the course by learning the actual applications of the concepts indirectly from what was experienced first-hand by the guest lecturers.

### **Aim of the study**

The aim of this study is to ascertain students' satisfaction with a 2<sup>nd</sup> year civil engineering course that included a number of embedded industry case studies presented by experienced engineering professionals serving as guest lecturers. A total of four guest lecturers presented their experiences and lessons learnt on large civil and building projects currently being constructed in South-east Queensland, Australia. Both senior and early career engineers spoke about their experiences.

The study also sought to examine the students' perception on whether they were provided with sufficient exposure to authentic professional practice experiences through a range of activities (e.g. project-based learning, case studies, guest lecturers, site visits) in the early stage of their engineering program. The primary goal of the study was to identify the extent of deficiency in exposure to professional practice in the early years of the engineering program and to highlight the resulting diminished benefits that such exposure could have derived in terms of learning engagement, discipline contextualisation and career purpose.

## **Methodology**

### **Study participants**

Data for this study was collected through a questionnaire survey of 2nd year undergraduate students completing the *2104ENG Construction Engineering* course in the Bachelor of Civil Engineering Program offered by Griffith University. A total of 83 respondents or (48.8% of the total students enrolled in the course) completed the questionnaire.

As can be seen in Table 1, 88% of the cohort was in their third semester of study (the start of the second year of the four year engineering degree). Unsurprisingly 78% of the group were male and the majority of students were recent secondary school graduates (72%). Having a majority of school leavers only in their second year of study, it was expected that 57% had no prior industry experience with 18% having only 1-6 months of industry experience.

### **Questionnaire instrument and approach**

The questionnaire was comprised of three main sections: Part A collected the basic demographic information; Part B (5 items) was designed to elicit the undergraduate engineering students' perceptions on the extent to which the case studies presented by the guest lecturers helped to improve their learning and engagement with the course; and Part C (4 items) requested students to provide their opinion on the extent of professional practice exposure in the early years of their Civil Engineering Program (i.e. year 1 and 2).

A five point Likert scale was used for the 9 questionnaire items of Parts B and C, with a scale from '1: Not at all' to '5: To a very great extent'. The mean score was determined along with the Standard Deviation using SPSS version 22.

**Table 1: Descriptive statistics for survey participants**

Age (Years)	Percent	Industry experience (including work experience)	Percent	Semester of engineering study	Percent
18-21	72.3	None	56.6	<80CP	7.2
22-25	10.8	1-6 months	18.1	80-160CP	88.0
26-30	10.8	7-12 months	13.3	170-240CP	3.6
31-40	6.1	1-3 years	2.4	>240CP	1.2
		4-6 years	3.6		
		7-10 years	2.4		
		10+ years	3.6		

## Results

Questions B1 to B5 asked students as to their satisfaction of the level of industry exposure in the *2104ENG Construction Engineering* course. Questions C1 to C4 asked students to rate their overall level of satisfaction with the level of industry exposure within the first two years of the engineering program as a whole.

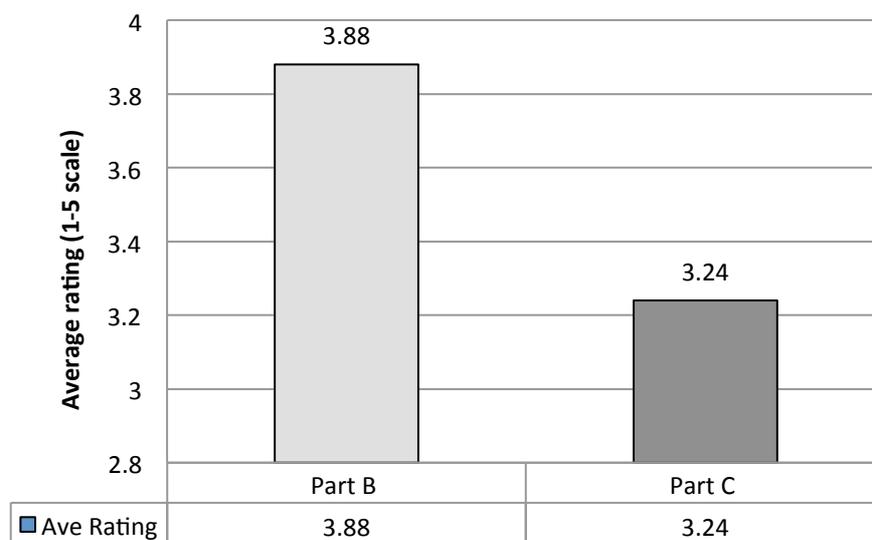
The first item of note in Table 2, is that the average ranking of section B questions (mean=3.88 where a "4" is assigned "To a great extent") was higher than the average for the section C questions (mean=3.24 where a 3 is assigned "To some extent"), meaning that on the whole, the authors' subject was perceived to offer a better level of exposure to real-life engineering experiences (Figure 1). The difference between the Part B and C mean rating was 0.63. Based on a paired sample *t*-test, the difference between the overall mean values for Part B and C was significant at the  $p < 0.001$  level ( $t= 7.26$ ). This is encouraging to the authors, as there was a focus on the design of the course so as to increase the level of industry exposure, which has been accordingly reflected in the mean score assigned by the students.

Overall, it was good to see that the students felt that the level of industry exposure was satisfactory overall in the current Civil Engineering Program with an average Part C rating of 3.24. However, an overall score closer to 4 is more desirable indicating that there is significantly more work to do to ensure that the first two years of the program embeds a much higher degree of industry exposure.

A final question was asked in the survey on the extent that the engineering program to date excited and motivated students to pursue a career in the civil engineering industry. An average rating of 3.64 was provided for this question indicating that students overall were motivated to stick with it and could see themselves in this industry. The authors feel that early industry exposure through applied case studies and guest lecturers allows students to visualise themselves working in the industry and this provides them with the necessary motivation to work through the more fundamental courses offered at the beginning of an engineering program. Ultimately, such instilled motivation will enhance student grades and retention. All through merely coordinating and embedding a series of "real-world" guest lecturers, applied case studies and authentic experiences into the engineering program.

**Table 2: Participant ratings for Part B and C items – Experience with industry exposure**

Item	Item Description	Mean	Std. Dev.
B_1	To what extent would you say that the three guest lecturers have helped you to better understand the construction industry generally and civil engineers role in it?	3.92	.67
B_2	To what extent have the guest lecturers helped you to contextualise the more theoretically based course content taught by the lecturing team?	3.59	.81
B_3	To what extent would you say that guest lecturers' discussions on current construction projects in the region and their industry experiences have helped you to stay motivated in this course and the civil engineering program?	4.07	.81
B_4	To what extent would you say that having local and visible (South-east Queensland region) examples of project site case studies has helped you to better relate to the case study content of guest lecturers?	3.90	.78
B_5	To what extent would you say you that the site case studies presented by guest lecturers have helped you to better understand construction techniques and management than at the commencement of the course?	3.90	.73
<b>B_Ave</b>	<b>Your experience with industry practice exposure in 2104ENG Construction Engineering</b>	<b>3.88</b>	<b>.56</b>
C_1	Considering all the courses you have undertaken to date, to what extent have these courses helped you contextualise the engineering industry and your role in it?	3.27	.84
C_2	To what extent would you say that the engineering program to date has helped you to understand the roles and career paths of civil engineers?	3.34	.98
C_3	To what extent is the engineering program to date giving you exposure to the engineering sector and its practices?	3.10	.85
C_4	To what extent is the engineering program providing authentic experiences of engineering practice through practical exercises, projects, guest lecturers, case studies, or other 'real world' type exposures?	3.28	.86
<b>C_Ave</b>	<b>Your experience with engineering practice exposure in the first two years of your engineering program</b>	<b>3.24</b>	<b>.70</b>



**Figure 1: Part B and C 'industry exposure' average rating and comparison**

## Conclusion

The authors' have attempted to improve the "real-world" experience of the course 2104ENG by integrating a series of purposeful guest lecturers providing engineering case studies.

This paper has presented a study to assess the students perceptions of the industry practice exposure they received in this course and the also the first two years of the engineering degree. Encouragingly, the students have implicitly acknowledged through the questionnaire survey that "real-world" engineering case studies (i.e. current projects) presented by junior and senior practitioners from industry not only enhance and contextualise their learning but also fosters a desire to remain in the program and the engineering profession upon graduation.

The author's are currently investigating other methods to complement the guest lectures and site visits currently offered in the course to further improve the level of industry exposure. Moreover, they are seeking to implement a strategically linked set of industry exposure activities in the early years of the civil engineering curriculum of Griffith University.

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