Work integrated learning for engineers – the effective use of blended learning environments

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Structured abstract

BACKGROUND
This paper reports on the integration of Engineers Australia's Stage 1 competencies in a mandatory, credit-bearing approach to work integrated learning (WIL). The use of blended learning environments (face-to-face and online) as a way of increasing flexibility, access and student engagement is also discussed.

PURPOSE
This investigation will inform work integrated learning teaching approaches and course development in engineering and will be of interest for those looking for more creative and flexible ways of exposing students to professional practice.

DESIGN/METHOD
The paper provides an overview of Engineers Australia's Stage 1 competencies; describes a credit-bearing approach to WIL; and discusses lessons learnt from the introduction of blended learning to support students in WIL preparation, placement and reflection.

RESULTS
It is anticipated that this investigation will assist in curriculum design and teaching approaches that improve student engagement in the development of EA's Stage 1 competencies – in many areas, such as Work Integrated Learning.

CONCLUSIONS
The approach described in this paper is only one aspect of the development of professional competencies across the undergraduate engineering curriculum. The development of these competencies must be clearly supported from first to final year. However, this approach requires continuous evaluation to ensure that students are motivated to remain engaged in a blended learning context; that staff regularly communicate and provide feedback on student progress; and that content is clearly presented.

KEYWORDS
Work integrated learning, Stage 1 competencies, blended learning, engagement

Introduction

This paper reports on a scaffolded, flexible approach to the development of professional competencies in an undergraduate engineering course at the Queensland University of Technology (QUT). To better support students in the development of these competencies and to emphasise their importance a credit-bearing unit was introduced in 2007. The unit is taught through blended learning. Blended learning is defined as a way of maximising the advantages of face-to-face learning and multiple technologies to deliver learning through combinations of face-to-face instruction and asynchronous and/or synchronous computer technologies (So & Brush, 2008).

The decision to introduce blended learning was based on evidence that many students were studying and working part time. Access to virtual classrooms could increase flexibility and access, as well as help students feel engaged and connected (Loch, Reushle, Rowe & Jayne, 2010). The blended learning approach has achieved most of the intended aims but it requires continuous evaluation to ensure that the development of professional competencies is clearly supported and that students are motivated to remain engaged.

Background

Stage 1 competencies

Engineers Australia (EA) identifies competencies that define professional standards required of graduates in order to commence practice as a professional engineer. To meet accreditation requirements Australian universities must demonstrate how these competencies (referred to as Stage 1 competencies) have been achieved by students (Engineers Australia, 2013).

The competencies fit into three general themes; knowledge and skill base; engineering application ability; and professional and personal attributes. Specifically, competencies cover theory based understanding of engineering study/work in a contextual environment, including engineering synthesis and management of engineering projects.

Other competency aspects cover ethical conduct, as well as professional communications and self/team management. To varying extents, the competencies are embedded in the undergraduate course with an expectation that the full range of competencies will be developed by graduation (at least to novice standard). The university's interpretation of EA requirement that students be exposed to professional practice is the completion prior to graduation, of a minimum of 60 days (or the equivalent) of relevant work experience and reflection on this experience through the credit-bearing unit.

Stage 2 competencies

Three to five years from graduation, Queensland engineering graduates are likely to be encouraged by their employer to seek Registration *(Professional Engineers Act, 2002)*. This registration process, like the National Professional Engineers Register (NPER), draws on demonstrating 16 Stage 2 competencies, through EA (or equivalent approved organisations) to acquire a Chartered Engineer status (CPEng) with subsequent recognition by the Board of Professional Engineers (Qld) to become a Registered Professional Engineer (Qld) – RPEQ. The Stage 2 competencies (post graduation skills), for this extended process, draw heavily on the basics covered in Stage 1 competencies. Specifically, applicants must provide 800 (maximum) word reflective work practice reports (16 individual subject areas in total) on such topics as ethics, sustainability, risk management, advanced engineering knowledge, legal / regulatory aspects, problem analysis, innovation, communications and evaluations (Engineers Australia, 2013).

Developing Stage 1 competencies through work integrated learning

Work integrated learning (WIL) is the intersection and engagement of theoretical and practice learning ie the process of bringing together formal learning and productive work, or theory

and practice (Patrick, Peach & Pocknee, 2009; Cooper, Orrell & Bowden, 2010, p.xiii). Prior to graduation EA expects that students will undertake:

professional engineering practice integrated throughout their program to enable them to develop an engineering approach and ethos, and to gain an appreciation of professional engineering ethics. The purpose of this is to facilitate their entry into the profession and to better prepare them to be able to develop the generic graduate attributes (Engineers Australia, 2007).

At QUT, exposure to engineering professional practice includes the completion of a minimum of 60 days of work experience, as well satisfactory completion of a credit-bearing unit. Figure 1 maps the four year degree against three phases of WIL i.e. preparation, placement and reflection across (Billett, 2010).

PHASE	YEAR	SEMESTER	STUDENT ACTIONS
PREPARATION	1	1&2	Prepare CV – career preparation
	PART TIME WORK		
	2	1&2	**Attend Preparing for WIL Seminar** Update CV – Apply for WIL placement 1
PLACEMENT	First placement – minimum 6 weeks full time or part-time		
	3	1&2	Update CV - Apply for WIL placement 2
	Second placement – minimum 6 weeks full time with an option to complete unit in summer semester		
REFLECTION	4	1&2	Update CV - Apply for graduate positions **Complete Unit – with face-to-face lecture and webinars**

Figure 1: Three phases of WIL

The *preparation phase* helps students focus on the preparation of their CVs, job applications, and interview techniques. Support during this phase includes a Blackboard WIL Community site available to all students (from 1st to final year); access to unit Blackboard site; preparing for WIL seminars (in collaboration with Careers and Employment Services); online registration of work placement details and submission of evidence of time worked; and staff available for consultation. The *placement phase* can commence once students have completed the equivalent of the first two years of the degree. Students find their own work placement (with some careers guidance advice available). Work experience commonly occurs during end-of-year vacation, mid-semester vacation or on a part-time basis. Placements may be paid, or unpaid. Overseas work placements must be approved. Students must keep a record of their experiences using work logs and reflective field notes. The *reflection phase* includes completion of the mandatory, 12 credit point unit (12/384) total credit points for degree.

The introduction of the unit in 2007 was seen as a valuable mechanism to highlight the value of work experience and reflective practice and to engage students in the further development and consolidation of the Stage 1 competencies. Students are required to reflect on their knowledge and skills as an emerging professional and identify areas of strength and those areas requiring further development; focus on activities and experiences of the workplace and aspects of career development learning; consider a strategy to improve ongoing professional development; keep work logs and reflective field notes; and to consider what it

means to be a professional within an engineering workplace. That is, students are required to:

- Prepare appropriately structured and researched reports based on professional engineering report styles;
- Record structured work logs and reflective field notes, then subsequently expand and research all aspects with the culmination in professional reports; and
- Develop strong reflective skills based on EA's Stage 1 competencies. These competencies include both technical and non-technical aspects from students' work experience and include aspects such as critical practice reviews, professional ethics appraisals, and time management observations

Students are assessed on the submission of two 3000 word reports. These reports document the mandatory minimum 60 days of work including their learning experiences and are derived from students' experiences. That is,

- Report 1 – drawn from at least 30 days work placement (prior to their initial 30 days work experiences). It is preferable for the placement to be in the engineering work force. However, approved placements outside engineering fields (with comparable management structures) may be approved. This report must include specific considerations of insurance issues (personal & projects), quality assurance, intellectual property, Workplace Health and Safety, and Codes of Practice.
- Report 2 – drawn from the last 30 days of work placements (preferably at five (5) days/week) where the work must be in the student's discipline of engineering. This report must include detailed reflections on a minimum of 5 workplace events/experiences with a focus on technical and generic skills and competencies.
- Employer signed certificates authenticating the completion of work experience

Consistent with the philosophies of EA's competencies for Stage 1 *(primary engineering degree)* and their likely future Stage 2 *(Graduate Chartered Engineer requirements),* the reports require daily work logs and reflective field notes to be kept and submitted as appendices. These work logs and reflective field notes help reinforce accreditation competencies and valuable engineering work practices. The reports are assessed using criteria focussed on content, presentation, professional writing, and research skills. Students must clearly demonstrate both technical and non-technical lessons learnt in the workplace.

Engaging students through blended learning approaches

In 2011, the unit was redesigned to incorporate blended learning approaches. The blended approach adopted combines an intensive, five hour, on-campus seminar at the start of semester with three online webinars. The webinars are delivered via Blackboard Collaborate and apart from a headset do not require additional software. Webinars are scheduled in the evening and run for 1.5 hours. Two facilitators are assigned to each group and material is shared via powerpoint and document sharing. This approach was seen as offering several advantages including: addressing timetabling constraints; increasing flexibility and accessibility for large, diverse cohorts e.g. students in a range of work locations (e.g. rural, remote, and international) and students studying and working part time. Success depended on staff developing skills and confidence in the use of the technology; clearly presented and appropriate content; opportunities for student interaction (either through chat or microphone); and access to webinar recordings and other resources for students who may miss a class.

Students interviewed in 2011 used a range of terms (Table 1) to describe the benefits of the unit and the blended learning approach.

• flexible	• well balanced
• responsive lecturers	• interesting/ stimulating
• informative	• great for reflection
• information provided upfront	• assessment was informative and enjoyable
• interdisciplinary mixing	• used real life examples
• fewer lectures	• appropriate workload
• allows for working around existing course load (especially with summer semester option)	• tied to past experience and information in first session
• improved accessibility	• able to identify areas for personal improvement
• well organised sessions	• reinforced professionalism
• easy to use	
• saved travel time	
• opportunity to add to skills (in use of technology)	

Table 1: Terms used by students to describe benefits of blended learning approach

Staff feedback, provided as a part of a formalised continuous improvement process, indicates that the introduction of blended learning has helped reduce student isolation in large classes and encouraged peer learning and peer networks. Moreover it is considered to have improved the communication processes and reduced workload (for both students and staff). Staff also noted that it has fostered a more student-centred approach to the development of professional competencies (Peach, Gomez & Ruinard, 2013). However, aspects requiring further development include: managing staff-student ratios; class size; industry and past student involvement; and increased technical support. Some of these issues have been addressed in subsequent semesters. However, further development is also needed in relation to pre and post webinar activities, content, teaching styles, student engagement, and partly due to staff turnover - further training for staff in the use of technology (Peach, Gomez, Ruinard, 2013).

The capacity for students to engage meaningfully in the work place experience and the unit is also impacted by other factors e.g. the type and quality of workplace experiences available; whether the placement is paid or unpaid (and the impact unpaid placement has on student financial stress); and the time lag between undertaking the work placement component and enrolment in the unit.

Conclusion

This paper identifies some of the issues related to designing an engaging curriculum that exposes students to professional practice and the development of professional competencies. Exposing engineering students to professional practice and the development of EA Stage 1 Competencies continues to present a significant challenge for universities. At QUT increasing engineering enrolments exerts pressure on the requirement for 60 days work experience. The requirement that students complete a credit-bearing unit also brings challenges especially with large, diverse cohorts; and often limited work experience opportunities (Sher & Sherratt 2010, Brown 2010; Engineers Australia, 2012). More flexible ways of exposing students to engineering practice must be found. Student engagement is a pervasive challenge for educators (Zepke & Leach 2010). It requires flexible, thoughtful and effective design to ensure ongoing student engagement and relevance from first to final year. This paper provides some insight into ways that work experience combined with a WIL unit delivered through a blended learning approach provides a range of benefits for students and staff. However, this approach requires continuous evaluation to ensure that students understand the relevance and are motivated to develop high level professional competencies.

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