Design Based Learning – Students Views on Industry Requirements

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Abstract

The focus of this research paper is to illustrate students views on design based learning, and in particular to investigate and present how important design based learning is for a career in engineering. Students need to acquire various skills by learning and practicing engineering, which is necessary to explore themselves according to the industry requirements. However students and educators are not aware of existing industry requirements of graduates. In learning and teaching institutions, practicing design is one of the fundamental processes in engineering and all other engineering activities related to it. When students require the opportunity to apply their knowledge to solve design problems, design based learning is generally recorded as an innovative method for engineering education. This paper presents research findings from a quantitative analysis of student views on design based learning for future career readiness in engineering.

Keywords: Industry requirements; Design based learning; Curriculum development.

1. Introduction

In a tradtional, lecture-based environment, the fundamental knowledge is given to students by engineering staff members. Universities use different learning approaches to enhance the learning and teaching processes. An unanswered question in this space is whether the students are aware of their future career expectations while they study engineering. While students study engineering, normally a four year program in engineering, the curriculum structure does not changed however industry expectations of graduates changes every couple of years. From the Australian national engineering task force report, Australia needs an extra 70,000 experienced engineers by 2017. Australian Universities produce only 6000 domestic engineering graduates annually (Taskforce, 2010). It is clearly stated that skills shortages were identified for metal trade workers, manufacturing professionals, machinery operators, engineers, technicians, clerical and administrative staff, and managers in the Australian industry (K, 2006). To avoid the situation of skill shortage in the industry and to improve the level of collaboration between academics and industry, this paper focuses describes and illustrates students' views on design based learning for future career readiness.

Accreditation bodies such as the Accreditation Board for Engineering and Technology (ABET), Engineers Australia (EA), as well as the European Accreditation of Engineering Programs (EUR-ACE), all specify in some shape or form that the abilities to identify, formulate, and solve engineering problems are essential skills in an engineering program. However, integrating design and technology tools in engineering education will provide the students with dynamic learning opportunities to actively investigate and construct innovative design solutions.

This paper presents research findings from a quantitative analysis of student views on design based learning for future career readiness in engineering. The goal and motivation of this paper is to bridge the gap between the students and industry. It illustrates the views of over 100 undergraduate engineering students from first year (design based learning beginners) and third year (design based learning practicing students) in the Bachelor of Engineering (Electrical and Electronics). The research results show that over 75% of students are aware and believe that design based learning is an important skill and also a current industry requirement.

2. Design process and artefact

There is always a difference between the design process and the design end products created by designers in various domains. The design in architecture, interior design, product and industrial design, urban and landscape design, all requires the designer to produce beautiful and also practically useful and well-functioning end products. Design is one of the fundamental processes and activities in engineering and all other engineering activities relate to it. Studying engineering involves not only learning scientific knowledge and technological skills; it also involves learning the language, established practices, beliefs, and professional values of engineering culture that makes a student to be an engineer. RM Felder in (Richard M Fedler, 1988) identifies 'Engineering Design' as a systematic, intelligent process in

which designers generate, evaluate, and specify concepts for devices, systems, or processes whose form and function to achieve clients' objectives or users' needs while satisfying a specified set of constraints. Figure 2 illustrates the design process described above.

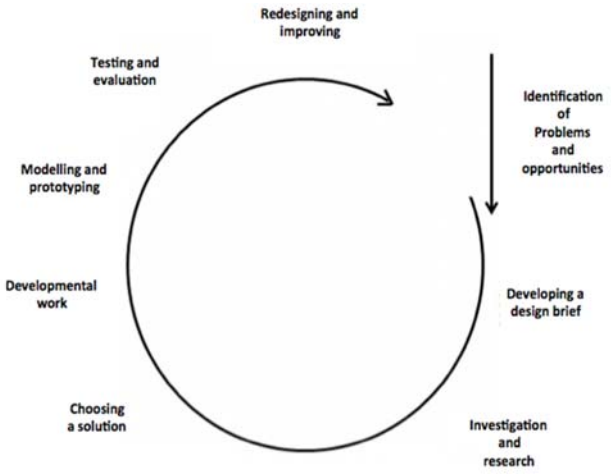

Figure 1: Design process

Design problems are classified as open-ended problems that generally have multiple correct solutions. A formal systematic problem-solving methodology is useful for these types of problems. Design is a continuous process of problem solving which could involve multiple iterations. The design process starts with identifying the problem. This allows students to search for possible opportunities to assist them in understanding the problem and therefore develop a design brief. Through research students can then gather information on different methods, approaches and ideas to allow them to seek new solutions. When a new solution is implemented, a model or a prototype is developed. The prototype is then tested and evaluated against the specifications developed in the design brief for functionality.

Students are future consumers, manufacturers, engineers or designers and thus they need to have a critical attitude towards designing products and be aware of the way in which the products/systems affect individuals, society and the environment. They must become considered users rather than passive consumers of technology (McLaren, 1997). Figure 2 illustrates four different segments of a design artefact.

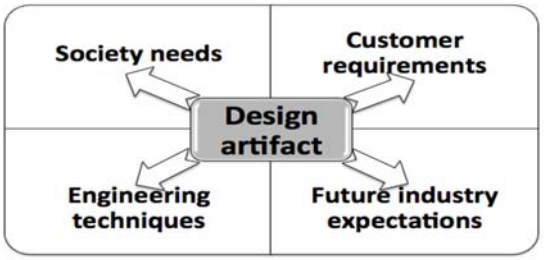

Figure 2: Design artefact

The design artefact is the end product of a consumer's need that should satisfy the customer requirements as well as the societal needs, which should encounter future industry expectations with the current engineering techniques. Design education represents both serious challenges and outstanding opportunities; the intelligent and thoughtful design of the engineering curriculum should be the community's first commitment (Clive L Dym, 2005).

3. Project oriented design based learning

Learning is an active process of investigation and creation based on learner's interest, experience and curiosity and it should result in expanded knowledge and skills. At Deakin University, engineering curriculum practiced various learning and teaching approaches to enhance student learning outcomes. Design based learning is one of the most important fields of engineering learning that the school of engineering at Deakin believed that it enhances the

learning experience for students (Chandrasekaran, 2012b). The school of engineering is currently using these methods at different levels in various units.

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 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 characterize DBL as an educational concept in higher engineering education (Wijnen, 1999) (Doppelt, 2009; Dopplet, 2008).

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. Figure 3 illustrates a design based learning process.

Figure 3: Design based learning process

Projects are considered to be the finest way of student interaction with teachers. Learning through projects has a positive effect on student content knowledge and the development of skills such as collaboration, critical thinking, and problem solving which increases their motivation and engagement (Chandrasekaran, 2012a). John Webster in (Webster, 2000) recommends that, engineering courses must be outcome-oriented and equip graduates for lifelong learning. In addition, he also suggests that in an engineering first year, most of the time should spent on the mathematical and scientific basics that underpin all engineering disciplines. If the curriculum is based around projects, the actual projects should be defined and structured by teachers in the first year for students to obtain the fundamental knowledge. In the second and third year, students work in industry and/or community projects, and industry practice takes place in the final year (Webster, 2000).

The newly proposed approach, project oriented design based learning (PODBL) is applicable to motivate the students and also to teach engineering design classrooms to get more practical experience that fulfil the academics and university needs. Design can be learned and taught through a PODBL approach in an improving way which is inspired by the accreditation requirements (Chandrasekaran, 2013). PODBL investigating the student views about learning design that will transform the present situation in the academic teaching and learning environment and to fulfil industry needs (Chandrasekaran, 2012c). It encourages the staff and student in the school of engineering to practice a unique teaching and learning framework that will achieve the students learning outcomes.

4. Industry needs on engineering design

One of the challenging tasks of an engineering curriculum is to get science and technology to serve better the needs of society. Learning and teaching institutions such as universities are considered to be the place of identification for new knowledge and industries are expected to be the environment where knowledge is transferred into practice. Industry and university collaboration seems to be actively increasing in the engineering education development in several engineering disciplines (Katikorhonen-Yrjanheikki, 2007). A research study performed by the Australian Industry Group (AIG) shows that most employers reported on their difficulty in recruiting people with practical trade skills as well as generic skills. Inadequate skills in existing employees were also reported (K, 2006). Australian industries are facing an increasingly tougher environment. Graduates need world-class skills to survive and grow to compete with

the current global manufacturing market. Universities need to deliver higher quality in teaching and learning engineering and technology. A sustainable design model from industry and academia is illustrated in figure 4 (Guy Littlefair and Alex Stojcevski, 2012).

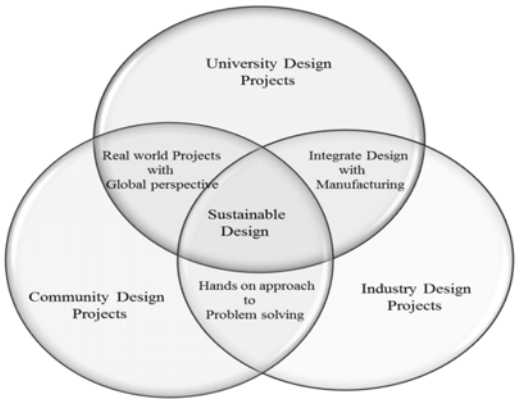

Figure 4: Sustainable Design model from industry and academic feedback

For a sustainable design, learning and teaching through design-based learning is better practiced when using a design project, community design project, or an industry design project. This enhances practical approaches to problem solving, integrating design with manufacturing and real world projects with a global perspective.

The close co-operation between universities and industry is one of the fundamental strengths of engineering education. This cooperation in education helps academics to provide more practical training for engineering students. Finland universities are using visiting lecturers from industry, and in some course project topics, which are real development needs from industry (Katikorhonen-Yrjanheikki, 2007). A research study performed by Deakin design forum, shows that the following key skills are essential elements required for a successful project oriented design based learning curriculum (Deakin University, 2012).

a) Creative and Innovative skills
b) Successful industry engagement
c) Awareness of design
d) Communication and project management
e) Industrial safety assessments

Industrial participation in learning and teaching provides further opportunities for students to gain knowledge of specialist engineering topics, awareness of industrial and commercial realities, and develop vital transferable skills. When identifying graduate attributes particularly for undergraduate engineering programs in Australia, the program accrediting body (EA) initiates a set of attribute elements mentioned in 'Stage1 competencies and elements of competency'. It states that one of the important engineering application ability is application of systematic engineering synthesis and design processes. The industry and academic collaboration are highly regarded by the professional accreditation bodies such as Engineers Australia (EA), Accreditation board of engineering and technology (ABET) and European accreditation of engineering programs (EUR-ACE) (ABET, 2012-2013; EA, 2012; ENAEE, 2008).

5. Methodology

This paper is a part of a continuing process of a research project, which analyses teaching and learning approaches in engineering education. The aim of this research paper is to examine students' perceptions of DBL in their curriculum through a paper based survey given to a cohort of senior year undergraduate engineering students. Figure 5 show the flowchart of the process of paper-based survey conducted with the cohort of students in senior year of undergraduate engineering. The survey questions are based on quantitative and qualitative analysis. From the quantitative and qualitative analysis performed, the results presented students' perspectives on design based learning within the curriculum. In line with the ethics approval process and procedures, a third party carried out the paper based research survey. The data collected is anonymous and unidentified. The collected data are analysed to derive a quantitative outcome, which shows the students' perception on design-based learning (DBL). The paper based survey questions for students is listed below

Q1: How important is DBL to your career?

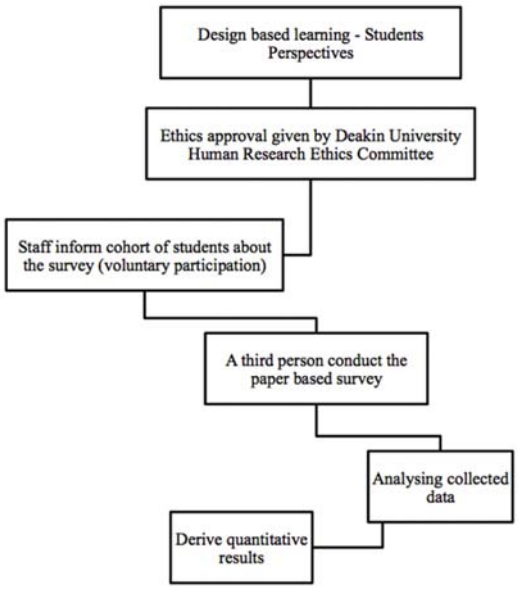

Figure 5: Student survey process

6. Results

This paper is a part of a continuing process of a research project, which analyses learning and teaching approaches in engineering education. From the quantitative analysis performed, the results are analysed and presented from a student's views on design based learning for future career readiness. The survey is paper based which was conducted by a third person who is not involved in the research project. The survey was given to more than 100 students in undergraduate engineering.

6.1 Students views on career readiness

The students views on career readiness come from 1st year and senior year undergraduate engineering students. The goal of the survey is to determine the students' perspective of design based learning for career readiness and how it helps to meet today's industry requirements for future careers. Figure 5 shows that 58% of students in 1st year says that DBL possibly helps for their future career, about 28% says it does help to understand the job market to meet the industry requirements and 14% believes that DBL is necessary in their curriculum. The intention of the design education in engineering is to produce a curriculum, which prepare the student to involve and experience more industry related projects in any particular discipline.

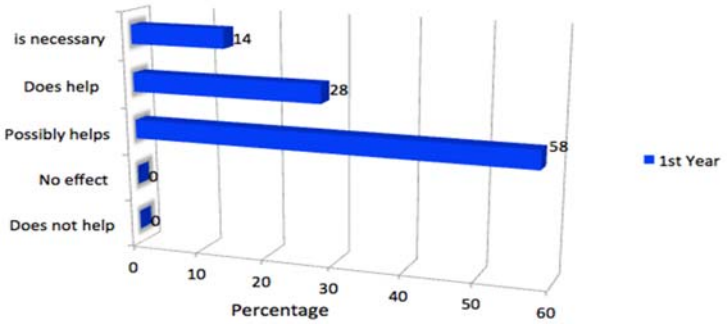

Figure 5: 1st year students' views of DBL on career readiness

Whereas figure 6 shows that 39% of senior students says DBL does help with their curriculum which prepare the students for future career opportunities and about 39% revealed that DBL is necessary while 17% of students in senior year felt that it would possibly help their future career. It is interesting to see that about 5% of students say that DBL got no effect on their curriculum learning experience.

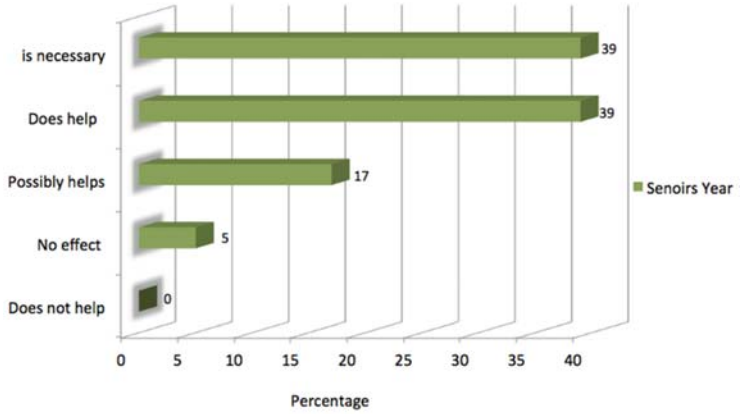

Figure 6: Senior year students' views of DBL on career readiness

The integration of discipline based theory and practical work has become an increasing priority for the Higher Education sector. The partnerships between industry and educational institutions have become highly significant which act as a vehicle for work integrated learning (Smith, 2010). Engineering schools must develop best practice in engineering education which promotes student learning and delivers intended graduate outcomes (Rosalie Goldsmith, 2010). These student perceptions reveal a positive sign to the School of Engineering at Deakin University to continue practicing a design-centred approach that enhances student learning.

7. Student career development

The Australian survey of student engagement (AUSSE) 2010 survey results reported that Deakin first year students who are engaged in their learning obtained sound learning outcomes in a supportive learning environment. The report also shows that Deakin's later year students were are well prepared to enter the workforce (career readiness) through work integrated learning (AUSSE, 2010). At Deakin University, work integrated learning contributes to provide opportunities for students to effectively combine study, work and other interests by integrating opportunities for experiential learning into appropriate courses. Deakin University has used its strong linkages with business, industry and community organizations in enhancing work integrated learning placements for the students (TEQSA, 2012). Figure 7 illustrates a work-integrated learning model.

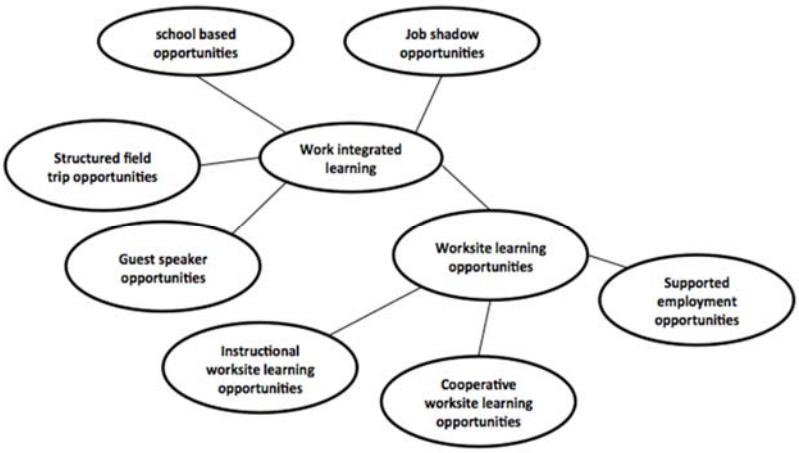

Figure 7: Work integrated learning

Work integrated learning gives students the opportunity to learn a variety of skills by expanding the walls of classroom learning to include the community (David Malicky, 2006-1771). By narrowing the gap between theory and practice, work integrated learning creates meaning for students. It provides opportunities for students to learn a variety of skills

through in-depth academic preparation with hands-on project focused experiences. Under the guidance of facilitators, students learn to work in teams, solve problems, and meet employers' expectations. Through work integrated learning experiences students see how classroom instruction connects to the world of work and future career opportunities. Experiences include, but not limited to, apprenticeships, career fairs, field studies, guest speakers, job shadows, and student internships (David Malicky, 2006-1771). The engineering graduates should acquire technical knowledge (the science of engineering) and technical skills (the practice of engineering), which are the fundamental building blocks for their success in industry. Interpersonal skills, communication, teamwork and management are an essential graduate attribute that is built on the technical skills as foundation (Rosanna martin, 2005; Alex Tymon, 2011). In general Australian universities need to work more closely with the industry so that graduates are better equipped for employment (Nair, 2009).

8. Conclusion

The research results show that over 75% of students are aware and believe that design based learning is an important skill and also a current industry requirement. From the survey results, it is clear that the first year engineering students have an interest in learning engineering through a design based learning approach. The senior year students who are practicing design-based learning are fully engaged in their studies. The academic focus on getting real world industry sponsored design projects helps students to exchange knowledge and experiences with the industry. Consequently, design based learning at Deakin University School of Engineering is seen as a model, which enhances students involvement with industry and therefore fulfills a rich learning experience.

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