Aligning Students and Staff Perspectives in an Engineering Design Curriculum

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***Abstract**: This paper focuses on the alignment of students and staff perspectives in an engineering design curriculum. Deakin University recognised the importance of student learning with engagement in design-centred education. Staff across the university are committed to ensure that students are engaged at a fairly deep learning level. Engaging students is an important aspect of learning and teaching process because it enhances the student to be self directed active learners. To measure the student engagement and staff experiences in learning and teaching process, Deakin engineering has used design based learning as one of its engineering learning principle. This study examines students perceptions of DBL in their curriculum through a paper based survey given to a cohort of senior year undergraduate engineering students. The research also illustrates the staff perceptions of DBL in engineering curriculum by conducting face-to-face interviews with them. From the analysed results, this research shows that the students and staff have an adequate experience of learning and teaching engineering through design based learning approach in an engineering design curriculum.*

Keywords: Project oriented design-based learning (PODBL), Design based learning, Design focused education.

Introduction

Educators believe education is one's self to become a skilful product of human society, while the others think it is to act on the needs of the stakeholder. Despite this, there are still many students who get overlooked during job openings for unknown reasons. To counter this problem, number of educators has developed many approaches and concepts such as Project Based Learning and Problem Based Learning, design based learning etc. These approaches have exposed noticeable changes within the performance and knowledge of students, especially when breaking out of traditional cultures and introducing creative ideas. To deal with problems and to find the solution for the problems is an essential quality for a professional. Therefore curriculum needs to educate and prepare the students to be a problem solver. Deakin University has practicing design-based learning (DBL) as one of its engineering learning principles for further development in learning and teaching process. The students' perspectives and staff perspectives are required to verify these methods and to identify the best practices in these methods to ensure the best possible learning experiences for the student.

This paper is part of a continuing process of a large research project, which analyses various teaching and learning approaches in engineering education. The paper firstly present research findings from a quantitative and qualitative research analysis of student perceptions about design based learning in

engineering. It presents the views of 30 on-campus and off-campus undergraduate engineering students from the senior year. In addition, a research study was also performed through face-to-face interviews with 25 engineering staff members who teach and research in engineering design in the School of Engineering at Deakin University. Finally this research paper presents an alignment of students and staff perceptions in engineering design curriculum.

Curriculum development

When students come from schools, they learned physics, chemistry, mathematics, science and computer systems that made their options to select in various engineering disciplines. But this broad knowledge of learning will not put them straight as an expert in any of the engineering fields, if they lack creativity, innovation and communication skills. It is basic quality for a professional to deal with problems and to find solution for the problems. Therefore curriculums need to educate and prepare the students to be a problem solver. There are different types of problems existing in engineering, design problems are most important that attracts young imaginative engineers.

Projects are considered to be finest way of student interaction with teacher. Godfrey (2009) states that this project work takes place in the 1st, 2nd, 3rd and final year at all university curriculum, because during this four year program there is always been a strong commitment to engineering design. This paper is a part of the research project that identifies the need to enhance important skills such as innovation and creativity through a whole learning process that incorporates design based learning features. From the in-depth analyses of all learning approaches and methods, design can be learned and taught through design based learning approach in a convalescent way.

Design focused education

Students are involved in solving a problem through a creative project. Students experienced meaningful ideas, which allows them to analyse the suitable solution for it. The important key is that students need to integrate the knowledge in any design process. The design process is similar to a problem solving method. Dopplet (2008) insists that to provide students with a better practise in design and technology, DBL involves several advantages such as good design that meets the social, economic and industrial needs. Design based learning is also an active learning process which makes students to practice and recognize different learning styles and team based activity which support learning and sharing through cooperative methods. Nelson (2004) reveals that design based learning (DBL) approach is used to enrich student involvement in learning science and to combine design experience with it.

Holistic thinking, understanding, imagination, creativity, visualizing problems and solutions are the fundamental skills of a designer. Davis (1998) revealed that to increase the importance of creative and innovative thinking, project and design-based learning are used in secondary school projects. Project and design based learning approaches are used to transform these skills into active learning and to evaluate student progress in classrooms. In secondary school education, teachers are prepared well to do interdisciplinary teaching and to understand the disciplinary content through practicing design education. Because of these design processes, students got their potential to mold themselves. Lehmann (2008) claims that the purpose of design education is to enhance the learning to teach students to become active participants to solve design problems around them.

Davis (1998) says that by integrating design education with the curriculum, it has improved the teaching and learning process that prepares the teachers and students for a design based learning approach. To achieve the goal of developing education, design educators provided practical strategies that exhibited the pedagogy of design education and problem solving processes. From the Deakin University (2012) forum, it declares that the goal of the design approach was not changing the whole curriculum of art education but through design activities students develop the ability to enhance and transform ideas through visualization, manipulation and application of data to problem solving.

Project oriented design based learning (PODBL) at Deakin engineering

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. The problem solving is one of the important skills for students. Therefore the goal of all engineering programs is to teach problem solving skills to educate students as professionals. Industry is looking for professionals with design knowledge, which is integrated with creative and innovative interdisciplinary thinking. Therefore, Chandrasekaran (2012)et al. states that the new proposed project oriented design based learning (PODBL) approach will focus on skills such as innovation and creativity in the engineering discipline.

With different learning styles students are able to express their skills and talents through working on projects. By integrating design and technology tools into engineering education, the aim is to provide students with dynamic learning opportunities to actively investigate and construct innovative design solutions. Chandrasekaran (2012) et al. discloses that the project-oriented design based learning approach is focused on curriculum renewal to practice innovation and creativity for students learning to solve design problems through projects in engineering education.

This paper presents continuing work of a research project. As part of the PODBL learning model, this paper looks into the students and staff perceptions about design based learning approach in their curriculum. By aligning the student perspectives with the staff perspectives in engineering design education, it helps to develop a framework for the newly proposed 'Project oriented design based learning' approach. From the analysis shown in Chandrasekaran (2013) et al. illustrating Deakin's engineering programs educational objectives, student outcomes, assessment methods and evaluation of different undergraduate engineering programs, design can be learned and taught through project oriented design based learning approach in a convalescent way which is inspired by the accreditation requirements.

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.

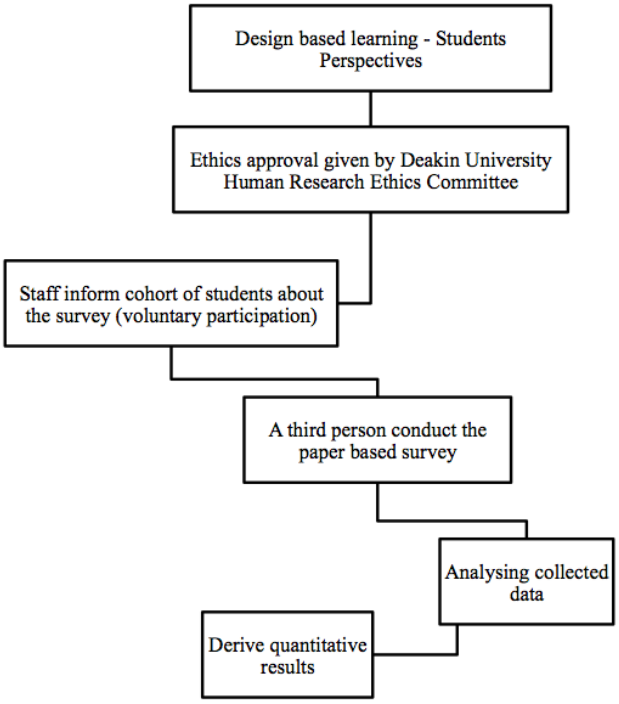

Figure 1: Student survey process

Figure 1 shows 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.

The paper based survey questions for students are listed below

- What does "Design Based Learning" mean to you? Please explain.
- How could the School of Engineering include "Design Based Learning" in your curriculum?
- List up to 3 advantages for team DBL.

The research also illustrates the staff perceptions of DBL in engineering curriculum by conducting face-to-face interviews with them. The face-to-face interviews are based on qualitative questions that are analysed and presented in quantitative form. The questions covered here are designed to determine the staff perspectives on design based learning through their level of experience from 1st year to final year.

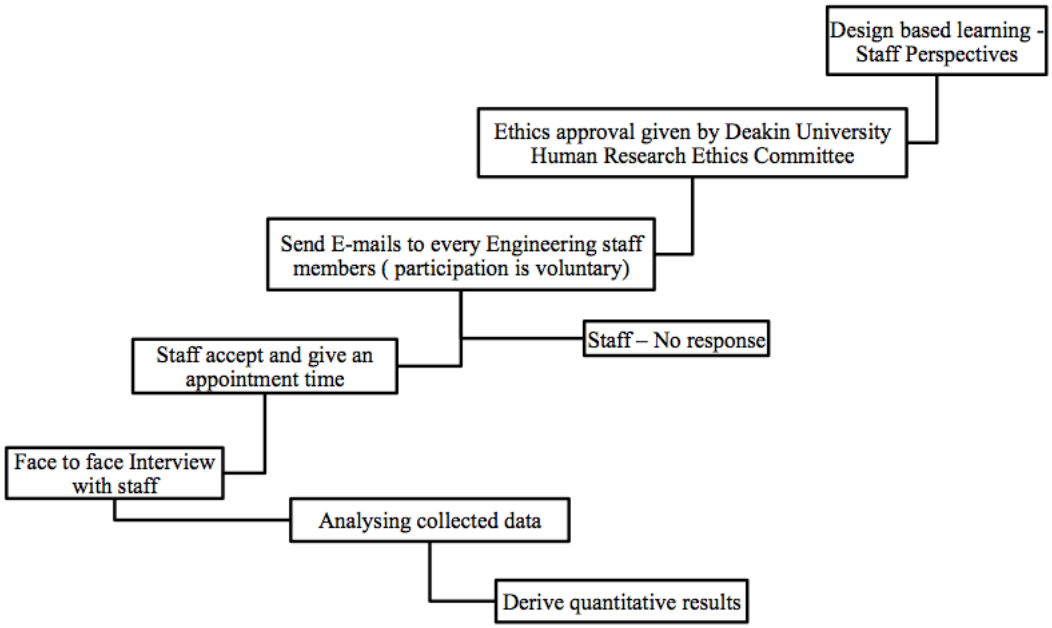

Figure 2: Staff interview process

The above flowchart shows the process of staff interviews conducted by the research assistant involved in this research. In line with the ethics approval process and procedures, research assistant send individual E-mails to every staff member in the School of Engineering. When a staff given an appointment time, the research assistant will conduct the face-to-face interview. An interview question set was asked to each staff that teaches and performs research in engineering design. The data collected are anonymous and non-identifiable. The collected data are analysed to derive a quantitative outcome that shows the staff perceptions on design-based learning.

Staff Interview questions are listed below

- Define Design based learning (DBL)?
- Are aspects of Engineering Design taught in your unit? If yes, How?
- What do you think of some of possible ways to teach design?
- Could you please list some of the skills attained by students through DBL in your unit?

Results

Students perspectives on design based learning

Design Based Learning (DBL) is one of the most important fields of engineering learning that the school of engineering at Deakin believes would enhance the learning experience for students. The School of Engineering is currently using these methods at different levels in various units. Chandrasekaran (2012) reveals that there is a need to verify these methods and to identify the best practices in these methods to ensure the best possible learning experiences for the student.

When students learn to solve design problems, they need to use design process as a methodology to approach a problem and they have to understand the user requirements for an end product. It is a vital role of an engineer to satisfy the need of user in every domain of designing an end product. Figure 3 shows the student perception of design based learning means, about 44% of students says that DBL is learning in a particular way, learning in doing and hands on projects, 22% of students defined it as project based learning (real world projects), learning through projects. The below results show that students have a good understanding of DBL from their prior learning experiences.

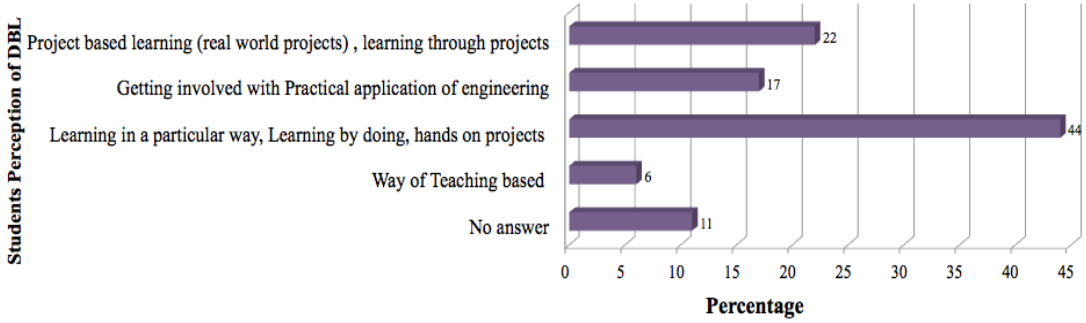

Figure 3: Students perception of DBL

Figure 4 illustrates students' perception of design based learning in their curriculum. The majority (34%) students in the senior year says that DBL is practical learning, demos in classes, 17% mentioned DBL is industry related projects for future needs, 16% define DBL is more project based learning, assessments and less exams and 11% of students mentioned that DBL units show significance gain in scientific reasoning skill. Yaron dopplet in Doppelt (2009) states that DBL is used to produce a curriculum which improves the learning for all students in science education.

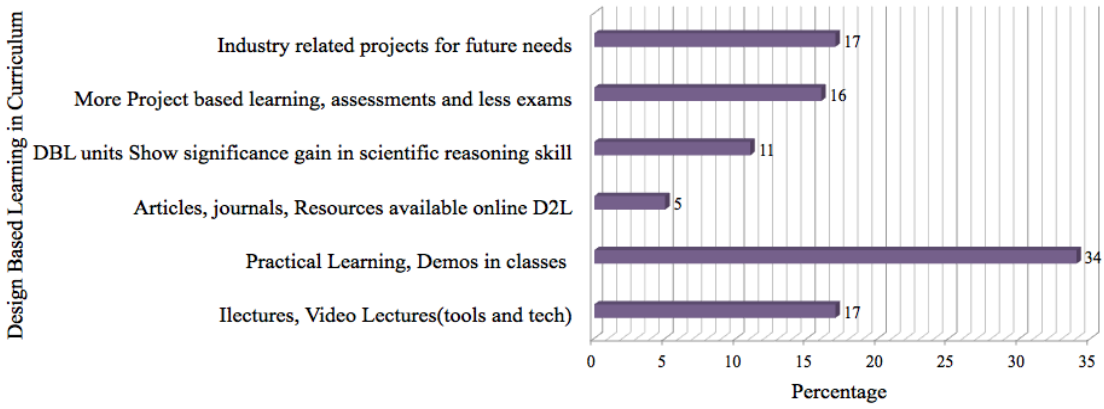

Figure 4: Students perception of DBL in curriculum

The students are also asked about the advantages of design-based learning. Figure 5 show that more than 80% of students realized that DBL is advantageous to their curriculum, final year projects and future career. The senior students mentioned DBL gives real world experiences (industry projects), develops collaborative, management and social skills, teamwork and interactive knowledge. To provide students with a better practise in design and technology, DBL involves several advantages such as good design that meets the social, economic and industrial needs.

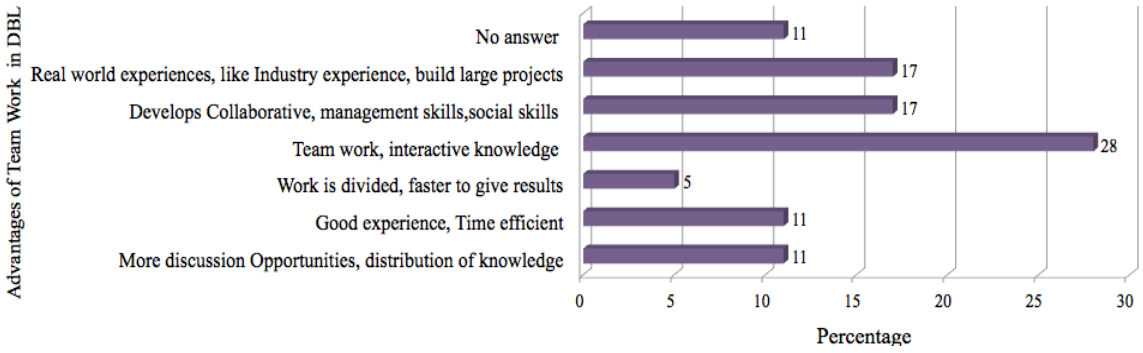

Figure 5: Advantages of teamwork in DBL

Staff perspectives on design based learning

The questions covered here are designed to determine the staff level of experience from teaching engineering using design based learning approach as one of the teaching model of Deakin University. Figure 6 shows the staff perceptions about design based learning means, it is good to see most of the staff members mentioned DBL approach as learning design through projects, learning through design activities, focus on aspects of design and active learning process. As part of the process towards identifying what design based learning means to staff, it was important to find out are aspects of engineering design taught by the staff in their engineering programs.

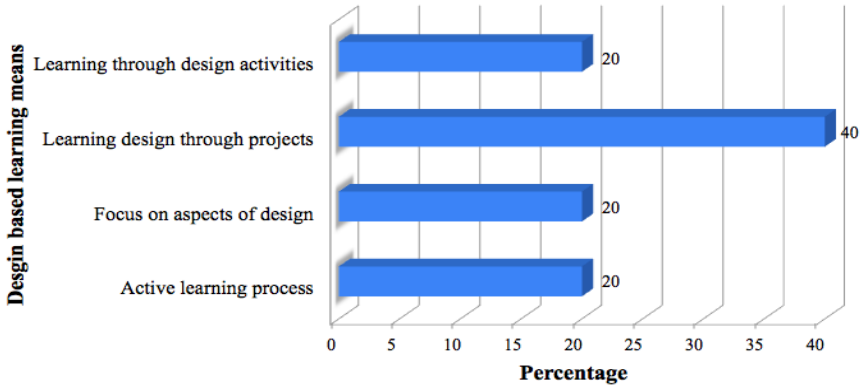

Figure 6: Staff perspectives on Design based learning

Figure 7 illustrates the staff way of teaching aspects of engineering design, 35% of staff teaching application of design through projects, 30% of staff teaching through design process with theory, 20% of staff teaching concept development to design process and 15% teaching design methodologies (design for x). Overall staff perceptions are to teach design-centered education in engineering curriculum that leads to design based learning approach, which enhances student-learning outcomes.

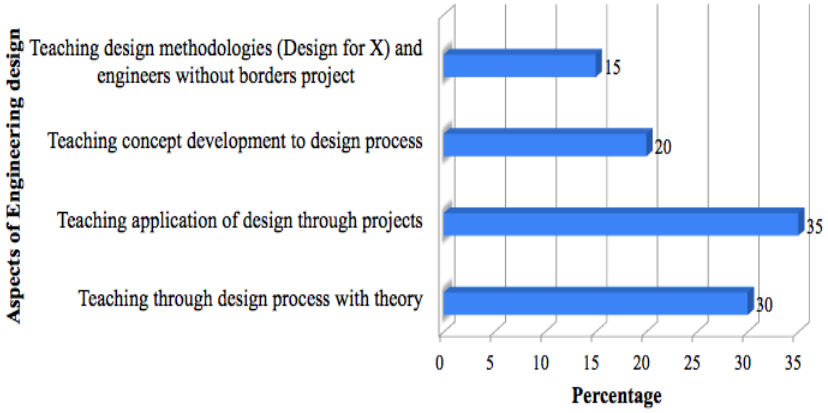

Figure 7: Aspects of engineering design taught by staff

The staffs are also asked about the possible ways to teach design. Table 1 illustrates that 35% recommends through activity based learning, 30% initiates self-directed learning, 20% wants analytical thinking and 15% expects team based learning. Dopplet (2008) states that to provide students with a better practise in design and technology, DBL involves several advantages such as good design that meets the social, economic and industrial needs. It is also an active learning process that makes students to practice and recognize different learning styles and team based activity, which support learning and sharing through cooperative methods.

In addition Table 2 illustrates the staff perspectives on skills attained by students. Through design based learning, staff reveals that students attaining all essential skills needed for their future career. The important skills revealed by the staff from the students is teamwork, communication, learning by doing, problem solving and self directed learning skills. 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.

Table 1: Staff perspectives about possible ways to teach design

S.no	Possible ways to teach design	%
1	Team based learning	15
2	Activity based learning	35
3	Analytical thinking	20
4	Self directed learning	30

Table 2: Staff perspectives on skills attained by students

S.no	Skills attained by students through DBL	%
1	Team work & Communication	30
2	Learning by doing	45
3	Problem solving	45
4	Self directed learning	40
5	Creativity	70

PODBL – Bridging the gap

A decade ago, many university staff used traditional methods and practices in learning and teaching. With the rapid technological advances, academic staff are starting to practice new learning approaches to meet the educational requirements. On the other hand, students are unable to link their skills with the professional learning curriculum. A gap exists between the students learning expectations and staff teaching approach. Graduates are expected to be skillful and be ready to work on projects early in their industry careers. From the initial stage of academic curriculum, teaching staff and the academic

management are responsible for the curriculum development. To bridge the gap between students and staff, this study examines both students and staff perceptions about design based learning approaches in their curriculum. By integrating design and technology tools into engineering education, the aim is to provide students with dynamic learning opportunities to actively investigate and construct innovative engineering design solutions. This project-oriented design based learning approach is focused on innovation and creativity where students learn through design based activities but are driven or oriented by a project.

Table 3: Aligning students and staff views

Design based learning *Overarching Principle*	**Learning principles of the model PODBL**	**School of Engineering, Deakin University**	
		Students views	**Staff perspectives**
	Self directed learning	Learn to learn	Act as a facilitator
	Activity based learning	Practical learning	Learning by doing
	Interdisciplinary learning	Learning without borders	Common goal
	Analytical learning	Thinking different	Unique solution
	Team based learning	Collaborative learning	Social approach

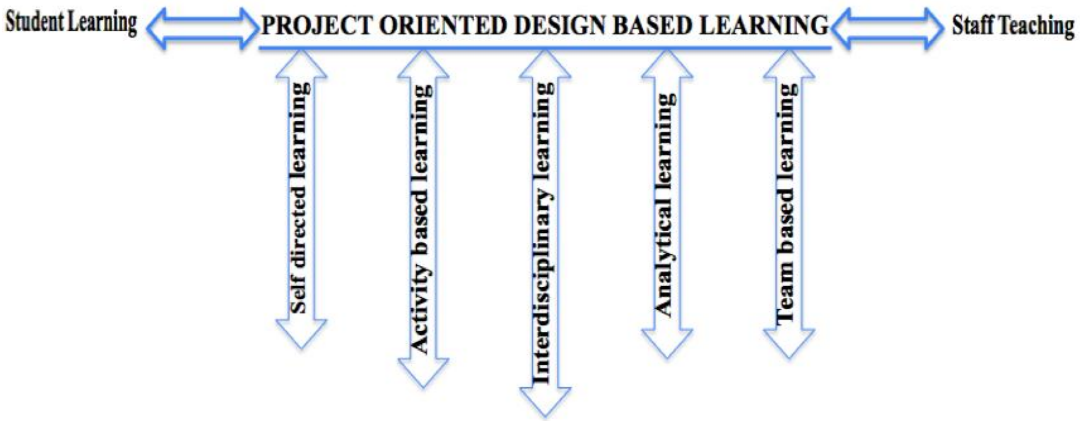

Figure 8: PODBL – bridging the gap

Table 3 show a common alignment of students and staff views on the learning principles of the PODBL model. These learning principles were developed to provide a structure for the teaching and learning process. They provide strong basement for an effective pedagogy. DBL is an overarching principle that incorporates all above learning principles. Figure 8 shows that PODBL focus is to bridge the gap between the students and staff learning and teaching process in engineering design education. With the students' views and staff perspectives, this research mapped the results (Table 3) with the learning principles of the project oriented design based learning model. The results shown above are a preliminary report, which is part of a continuing process of a research.

Conclusion

This paper presented the perspectives of senior year students' in a Bachelor of Engineering on design-based learning. Results indicate that students have a good understanding of DBL and are fully engaged in their learning process. The paper also presented staff views on design-based learning. The engineering teaching staff perspectives showed that they have an adequate experience of teaching through design based learning approaches. This research is part of a continuing process of a research project that helps to foster Deakin University engineering curriculum for enhancing student learning outcomes through PODBL. The project oriented design based learning is set to have a positive effect on bridging the gap between student content knowledge and staff teaching expectations in engineering design curriculum.

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