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The Process of Design Based Learning: a Students' Perspective

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BACKGROUND
Deakin engineering has used Design Based Learning (DBL) as one of its engineering learning principles for further development in teaching and learning. Whilst the students are surveyed after every unit, this data only provides a generic overview of the process and does not help the academic staff determine if DBL is a preferable learning and teaching approach. What is required to improve the process is a holistic approach from the students' perspective over the entire degree program.

PURPOSE
Do students see any value in DBL and should it be is further developed for teaching and learning? This study examines students' perceptions of DBL in their curriculum, DBL in final year project, DBL in engineering career.

DESIGN/METHOD
A survey dedicated to DBL from the students' point of view has been designed and given to 30 fulltime students in 3rd year in engineering at Deakin. A qualitative and quantitative analysis of this survey will give students' perspective of DBL as they progress through their degree studies.

RESULTS
The full time students' surveyed indicated that they believed that DBL was a useful tool and was of value to their career. Also that it would be helpful as part of their final project and that it helps teamwork although they would like to see it used for both team and individual work.

CONCLUSIONS
The full time students' surveyed displayed a basic understanding of DBL and an eagerness to use it. Students' perceived that DBL approach got an important value in their learning curriculum and it is a positive sign for the Deakin engineering to use it as one of its engineering learning principle.

KEYWORDS
Design Based Learning, Students' Perspective, Quality Assurance

Introduction

The School of Engineering at Deakin University has always tried to improve its unit delivery method to enrich the student experience and to produce a capable, job ready engineering graduate. To this end it has looked for new teaching methods that aid in this process. One such method is Design Based Learning (DBL). Unlike Problem Based Learning (PBL), DBL opens up the learning activity so that design skills must be learnt and applied.(Perrenet, Aerts, & Woude, 2003) DBL is a self-directed learning approach. The students must locate the resources required, analyse any needs in order to create some design.(Iwane, Ueda, & Yoshida, 2011) The method gives the students' the freedom to apply their design skills as they think best. DBL looks not only at the end product but at the underlying process in creating that product.(Wijnen, 1999) Whilst this is seems to be a valid unit delivery method, one key piece of information is missing; what does the student think about DBL? The students' perspective is required to help validate, improve or reject this method as a useful teaching tool.

Purpose

Design projects have been used to motivate and teach elementary, middle, and high school students. For over a decade, students have been taught different methodologies in the hope to pursue science and engineering careers. With different learning styles students are able to express their skills and talents through working in team based projects or simple design experiments in authentic learning environments. Engineering schools must develop best practice in engineering education to promote student learning and deliver intended graduate outcomes (Rosalie Goldsmith, 2010).

Project Based Learning is perceived to be a student centred approach to learning. Students need to produce a solution to solve the problem and they are required to produce an outcome as a report supervised by the teachers. Teaching is considered as an input directing the learning process (Kolmos, 1996). Problem based learning focused around problem scenarios rather than discrete subjects and the selection of the problem is essential here. Teacher is to facilitate the learning process rather than to provide knowledge. Solving the problem may be part of the process (Xiangyun Du & Kolmos, 2009).

Accrediting 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 that Design is an essential element of graduate outcomes for an engineering program. When students' require the opportunity to apply their knowledge to solve the design problems, Design based learning is approached as an innovative method for engineering education(ABET, 2012-2013; EA, 2012; EUR-ACE, 2008).

Design based learning is a self-directed approach in which students initiate themselves to learn creatively by hands on solutions to meet the academic and industrial expectations of society. It is an effective process centred on problem solving structures which flow from problem-oriented project based education. By engaging students in design, DBL provides an opportunity to apply original and inventive ideas, which aid in the students development and growth. The intention of engineering science education is to produce a curriculum, which improves the learning for all students. This can be achieved by using design based learning through the preparation and training of project based activities that support learning of cooperative methods.

Students are encouraged to study subjects that they learn by building, creating and implementing products and prototypes. The objective is for students to integrate their knowledge in processes where problem solving is essential. Therefore design based learning is used to enrich student involvement by combining experience. DBL is a type of Problem based learning where problems are solved in teams.

To increase the importance of creative and innovative thinking, design based learning styles are used in projects. Holistic thinking, understanding, imagination, creativity, visualising problems and solutions are the fundamental skills of a designer. The DBL approach is used to transform these skills into active learning and to evaluate student progress in the classroom. Teachers are prepared well to do interdisciplinary teaching and to understand the disciplinary content through practising design education and because of these design concepts and processes, students got their potential to mould themselves. Design education in secondary school aims to enhance the learning of students to acquire skills and become active participants in solving every day engineering problems (Nelson, 2004).

When students work under projects, they share their ideas with other team members and they are encouraged by formal and informal classroom activities. On the other hand, today's industry desires professionals to have design knowledge, which is integrated in to interdisciplinary ways of thinking outside the box. In a classroom of 120 students, lecturing could be possible through teaching but what do students really absorb. At the end of teaching, students do not recognize the attained knowledge. Passing a subject is a basic need rather being an expert in that area is somewhat different to look at it. It is important to have a pedagogy style or approach such as design based learning, which is similar to a project based, or problem based learning. Through design based learning approach, design is driven by qualitative thinking, speculation, ideation, prototyping and specification. The educators realized that most of graduates are lacking in communication skill such as verbal as well as writing skills. So they proposed an idea to incorporate these skills through design engineering projects. DBL seems to be an innovative approach to initiate this plan. When design centred education is practiced, students in their first and second year are trained with design skills as well as communication and project skills. Then the team work skills are practiced or experienced by the students in the third year large engineering projects (Jacob Perrenet, 2003).

This paper focused on students' perspective about design based learning approach to explore the teaching expectations and learning outcomes experienced by them. Qualitative methods are useful for evaluating, developing program goals and for involving participants in the evaluation process to gain their insight and perspective (Hammel J, 1999). It is about the students' perceived value of DBL and not about the value of DBL itself. The implication is that if the students value the teaching method then this, of itself, given more value to that teaching method. (When looking at only one unit it may be that the students' perception may be coloured more by the lecturer's teaching ability, but future surveys across various units and lecturers will mitigate this factor.)

Design / Method

This paper is a part of a continuing process of a research project, which analyses teaching and learning approaches in engineering education. These survey questions are based on qualitative and quantitative analysis. The questions covered here are designed to determine the students' level of experience from 1st year to final year. Some other questions involved in the survey are designed to cover the student background, level of experience or understanding in their education. The same set of questions will be given to all years in the future surveys. The students' views on DBL in this research come from 3rd year undergraduate engineering unit. From the quantitative and qualitative analysis performed, the results are analysed and presented from a student's perspective about design based learning within the curriculum. 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 30 students' in 3rd year engineering and 18 students answered the survey. The data collected are anonymous and unidentified. These results are from the students' own experiences and the results presented give various views, which include students' knowledge and expectations from which in turn can informs the school to implement a design centred education. In line

with the ethics approval process and procedures, a third party carried out the research survey. The questions were prepared to identify the challenges in teaching and learning and in particular to investigate the student's perspective on the practice of design based learning. The survey questions used in the research are shown below in Table 1.

Questions one to four are quantitative questions and are based around the background of the students in terms of their study and work balance. Questions five and six look at the students' understanding of engineering. The reminder of the questions (question seven to question twelve) focus on design based learning and in particular focus around project oriented design-based learning.

Table 1: Questionnaire

Number	Quantitative Questions
1	Are you enrolled full time or part time?
2	What is your mode of study?
3	Do you work while you are studying?
4	Is your work engineering related?
	Qualitative Questions
5	Could you please define "Engineering"?
6	Why did you choose to study Engineering at Deakin?
7	What does "Design Based Learning" mean to you? Please explain.
8	How could the School of Engineering include "Design Based Learning" in your curriculum?
9	How important is DBL to your career?
10	How important is DBL to your final year project?
11	Should DBL take place in teams of students or with individual students?
12	List up to 3 advantages and disadvantages for team DBL and individual DBL

Results

The students' views on DBL in this research come from 3rd year undergraduate engineering students who are currently studying in studying DBL based unit. They were chosen for this initial survey as they have some experience with DBL. This limits the current survey to look at one cohort of students selected to be a starting point for our research. The ultimate goal is to determine the students' perspective of DBL and how the perspective changes over the years studying the engineering. Therefore in the early years, the students may not able to answer some questions in formed way. The way engineering students tackle their university degrees is somewhat very different to the way engineering students carried out their studies few years ago. As it can be seen from Table 2, 78% of the students surveyed work and study at the same time. Of the 78% working, 72% work part time, and 6% work full time. Only 22% of the students in this research study choose not to work while studying. All the students who took part in this study are enrolled in full time study at Deakin University. This is illustrated in Table 3.

Table 2: Students who work and study

	Work Mode	%
1	No work	22
2	Part time	72
3	Full time	6

Table 3: Students studying full time and part time

	Enrolled at Deakin Engineering	%
1	Part time	0
2	Full time	100

Table 4: Work related to Engineering

	Engineering jobs	%
1	No	84
2	Yes	16

Table 5: Student's mode of study

	Study Mode	%
1	On campus	83
2	Off campus	11
3	Blended learning	6

It is interesting to see in Table 4 that only 16% of the students work in an engineering related environment. Deakin University has about a third of its students studying off-campus. From the engineering students involved in this study as illustrated in Table 5, it can be seen that 83% of the students are studying on campus whereas 17% of the students are in mixed mode (blended learning and off-campus learning).

As part of the process towards identifying what DBL means to students, it was important to find out how students define engineering and why they decided to study engineering at Deakin. Figure 1 shows that a large number of students' responses (33%) define engineering as the use of science and technology that benefits the society and integrates practical applications of science, 22% define engineering as solving problem and critical thinking, 22% defines that applying knowledge in the process of creating new things, 12% of students defines it as a profession of acquiring and applying scientific, science skills and 11% defines engineering as creating complex structures or machines.

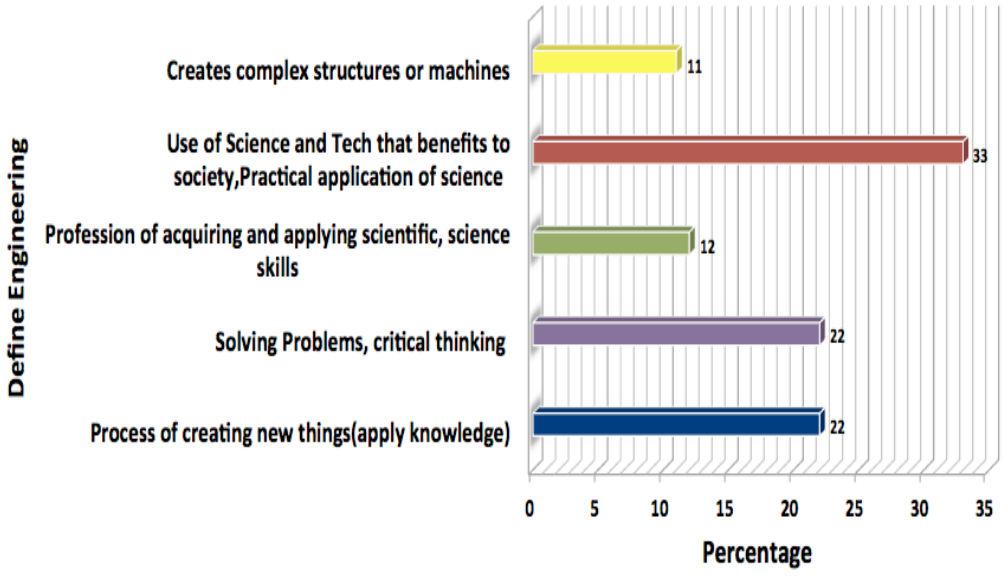

Figure 1: Students' definition of Engineering

Figure 2 shows that a large number of students select to study engineering at Deakin due to the analytical process of the program, meaning an integration of theoretical learning with practical practice. Also a large number have selected Deakin engineering due to the off-campus offer of the engineering program, and the balance of good learning and living environment. One of the major students' perceptions of DBL as illustrated in Figure 3 is the practical 'learning by doing' approach. The practical theme continues throughout the students' responses, particularly when asked about what design based learning means. Figure 4 clearly illustrates that majority of the students position DBL as a practical approach to learning as well as the integration of industry project in the curriculum.

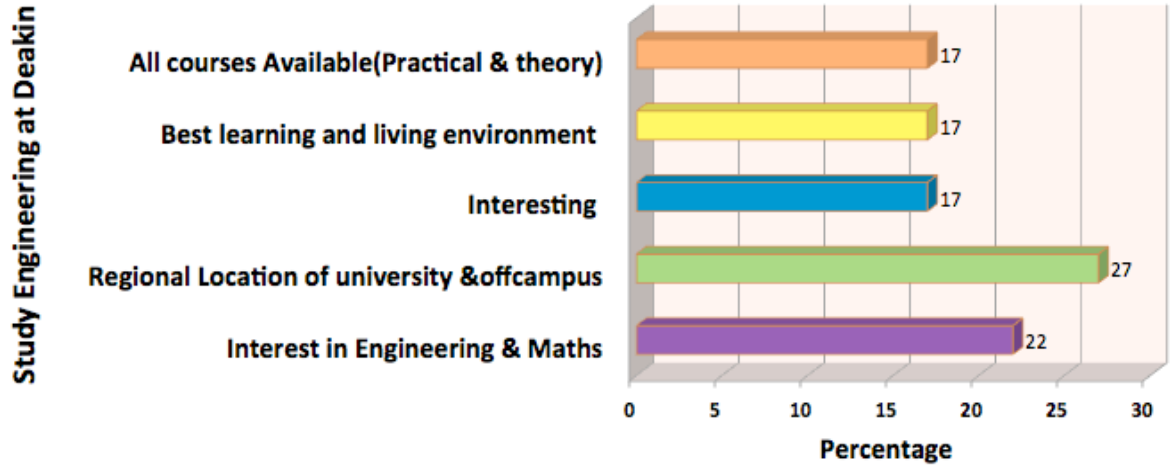

Figure 2: Why Deakin Engineering

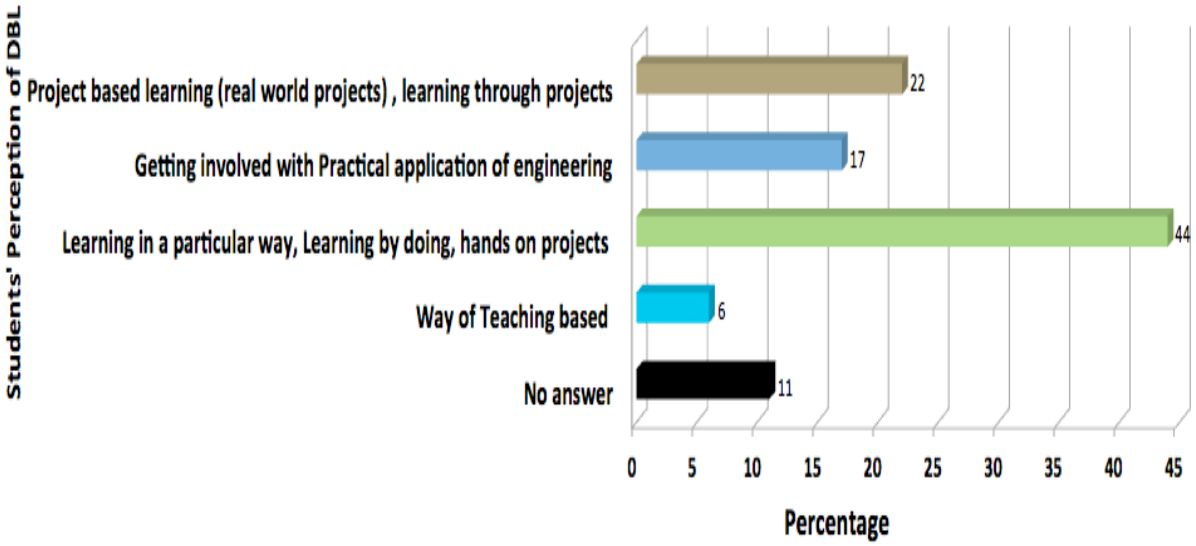

Figure 3: Students' Perception of DBL

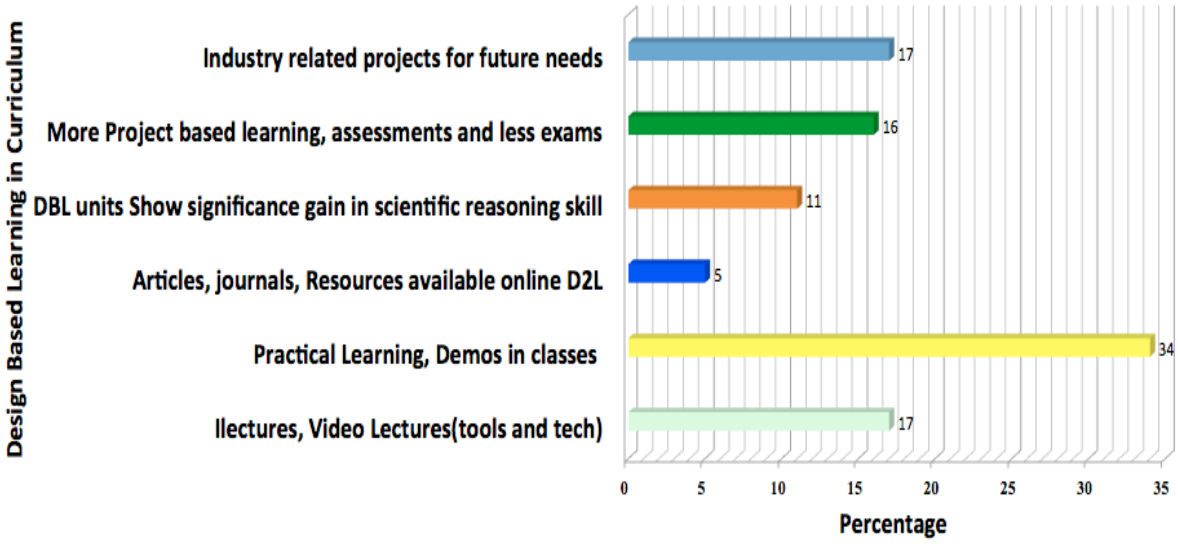

Figure 4: Students' Perception of DBL in the curriculum

The students were also asked about the influence of design based learning in their career as well as design based learning in the final year project of their engineering degree. From Table 6 and Table 7 it can be seen that majority of the student believe that DBL is necessary and it will assist them in their professional careers as well as their final year project.

Table 8 illustrates that student prefer for design based learning to take place in both modes, at individual level as well as team based. In addition Figure 5 shows over 50% of the students' view some aspect of the advantage of teamwork in design-based learning, which includes real world experience and interaction, develops collaborative, management and social skills.

Table 6: Influence of DBL in engineering career

	DBL to your career	%
1	Does not help	0
2	No effect	5
3	Possibly helps	17
4	Does help	39
5	Is necessary	39

Table 7: Importance of DBL in final year Project

	DBL in Final year project	%
1	Does not help	0
2	No effect	11
3	Possibly helps	27
4	Does help	33
5	Is necessary	27

Table 8: Modes of DBL preferred

	DBL mode	%
1	All individuals	17
2	Mostly individuals	22
3	Half teams and half individuals	61
4	Mostly teams	0
5	All teams	0

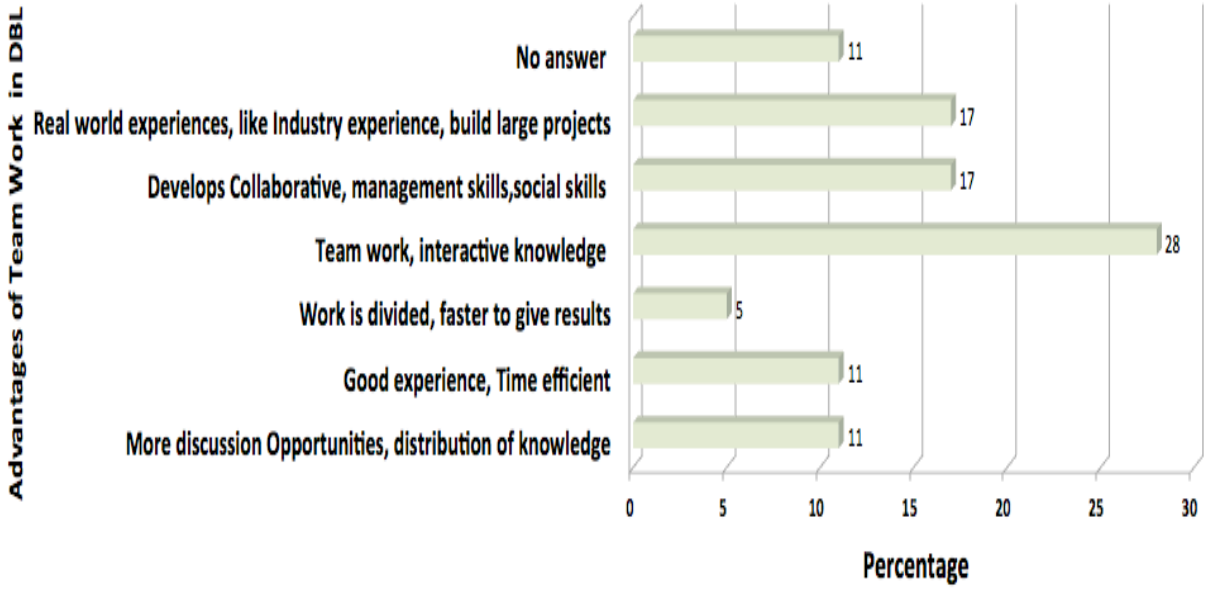

Figure 5: Advantages of teamwork in DBL

Conclusion

The current students seem to have a basic understanding of DBL (as hoped since they were selected from a DBL based unit) as illustrated in Figure 7 and an eagerness to engage in it during their studies as shown in Figure 2, Table 6 and Table 7. This is encouraging to the School of Engineering who will try to foster a better understanding in the students. This paper shows students' perceptions on DBL has an important value in their learning curriculum and encourages Deakin engineering to use it as one of its engineering learning principles. This work is ongoing and further survey, focus groups and interviews will attempt to determine the relevance or importance of DBL at Deakin and identify any improvements in student understanding and engagement.

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