A comparative study of students' perceptions of Project Oriented Design Based Learning in Engineering education

Sivachandran Chandrasekaran[a]; Alex Stojcevski[b], Guy Littlefair[c], Matthew Joordens[d]
School of Engineering, Deakin University, Geelong
schandra@deakin.edu.au, a.stojcevski@deakin.edu.au, g.littlefair@deakin.edu.au, m.joordens@deakin.edu.au

Structured abstract

BACKGROUND
The focus of this paper is to present a comparative study of students' perceptions on project-oriented design based learning in engineering education. The paper is part of a continuing research process towards the development of a framework for the new Deakin engineering learning and teaching model, Project Oriented Design Based Learning (PODBL).

PURPOSE
The undergraduate engineering students perceptions from different levels of engineering discipline helps the School of Engineering, Deakin University to practice and enhance a design based learning approach across its curriculum. The students' expectations of learning and staff requirements of teaching can be balanced through these perceptions.

DESIGN/METHOD
A paper-based survey is designed and given to more than 100 students in different levels of undergraduate engineering students at Deakin. The qualitative and quantitative analysis of this survey gives a comparative study of senior year (2nd, 3rd and 4th year) students perceptions about Design Based Learning (DBL) approach in the year 2012 and 2013.

RESULTS
The survey results indicate that the School of Engineering should be undertaking some form of design based learning as one of its learning approaches. The comparative study shows that senior year students in 2012 and in 2013 have a detailed understanding of DBL. About 55% of senior students in the year 2013 and 39% in the year 2012 believed that the influence of DBL does help with their engineering curriculum. In addition, 27% in 2012 and 55% in 2013 perceived that DBL is important in their final year project.

CONCLUSIONS
This paper is a continuous work of a large research project, which is set to develop a framework for project-oriented design based learning approach in the School of Engineering at Deakin University. The comparative study survey results show a positive increase in the percentage of senior students perceptions in the year 2013 than in the year 2012.

KEYWORDS
Project oriented design based learning, students perceptions, course enhancement

Introduction

The industry expects engineering graduates to possess skills such as problem solving, critical design analysing, communication, teamwork and innovation. Education practitioners' are aware of these modern engineering skills required by the industry. Every university has the responsibility of educating students with glorifying knowledge in their engineering studies. The level of students learning outcomes is assessed at every stage of the curriculum, which makes teachers' to accelerate their curriculum content. By assessing students' perceptions on teaching content and approaches, it's always a good way of intimating one's own teaching approach in a classroom environment. It's always a self-assessment for lectures that help themselves to understand the students' perceptions about learning and teaching environment.

Design based learning (DBL) is one of the learning and teaching approach 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. There is a need to verify these methods and to identify the best practices in these methods to ensure the best possible learning experience for the student. This paper shows a comparative study of students' perceptions about the project-oriented design based learning in engineering education. A paper-based survey is designed and given to more than 100 students in different levels of undergraduate engineering at Deakin. From the qualitative and quantitative analysis of this survey gives a comparative study of senior year (2^{nd}, 3^{rd} and 4^{th} year) students perceptions about design based learning approach in the year 2012 and 2013. This paper is a part of the continuing research process of developing a framework for the new Deakin learning and teaching model, Project Oriented Design Based Learning (PODBL).

Project Oriented Design Based Learning approach

The Project Oriented Design Based Learning (PODBL) model is a learning and teaching approach (LTA) that is based on engineering design activities while driven by a project. It has been proposed to use PODBL in Deakin Engineering to encourage independent learning and a deeper approach to learning. It is also an approach that supports the development of information literacy and design thinking in the field of tertiary education - two of the key learning outcomes in engineering these days. There are many versions of project based learning as well as design based learning. Deakin's engineering approach is a unique combination of the two. PODBL indicates that students learn through real engineering design activities while driven by a project that has a defined deliverable, and is presented to the students with an industry partner or an academic staff.

Chandrasekaran, Stojcevski (2013c, 2013d) states that PODBL is able to motivate students and teach engineering science in classrooms in order to become more practical experience that meets the industry demands. Project oriented design based learning is set to have a positive effect on student content knowledge and the development of skills such as innovation and creativity which increases their motivation and engagement. It is an interesting research work to develop a framework and implement a PODBL approach in meaningful ways. The research aim is to find an approach, a method or a framework, which will balance the teaching and learning by incorporating design, innovation and creative skills in engineering education.

In addition to providing students with a better practice in design and engineering, project oriented design based learning will involve several advantages such as good design that meets the social, economic and industrial needs. Chandrasekaran, Stojcevski (2013) intended that this is an active learning process, which prepares the students to practice and recognise different learning styles that support learning and sharing through cooperative methods. Chandrasekaran, Stojcevski (2012, 2012a) states that the Projects are considered to be the best way of student interaction with instructors. Chandrasekaran, Stojcevski

(2013a) declares that Project Oriented Design Based Learning is set to have a positive effect on student content knowledge and the development of skills such as collaboration, critical thinking, creativity, innovation, and problem solving which increases their motivation and engagement. Chandrasekaran, Stojcevski (2013b) found that it is a challenging task for academic staff to implement a PODBL approach and integrate technology into projects in meaningful ways.

Course enhancement

Course enhancement is a systematic approach taken with all courses undergoing in creating course learning outcomes and standards. The course learning outcomes describes the graduates knowledge and capabilities that they should acquire and able to apply; demonstrate at the completion of their course. The course learning outcomes and standards are derived and instructed by the relevant professional bodies. For example, Australian Qualifications Framework (AQF) is the national policy for all regulated qualifications in Australian education and training. It provides the standards for Australian qualifications. In the higher education sector, the Tertiary Education Quality Standards Agency (TEQSA) provides the national consistency in the regulation of higher education.

At Deakin University, students undertake common subjects in their first year and then choose a discipline to specialise in. This includes civil, electrical and electronics, mechanical or Mechatronics engineering. This format allowed students to make a more informed decision and to gain a broad base of knowledge in engineering. These undergraduate engineering courses are designed to meet the requirements of engineers Australia.

In project oriented design based learning environment, participants work in teams of four to six members with a facilitator. The same group meets regularly throughout the trimester to work on a series of design activities. The learning and teaching delivery is a combination of cloud and located learning activities. The cloud learning enables students to evidence their achievement. The units contain integrated short, accessible, highly visual, media-rich, interactive learning experiences rebuilt for the mobile screen, and integrating learning resources created by Deakin and other worldly universities and premium providers. Cloud learning requires students to be generators of content, collaborators in solving real world problems, and evidence their achievements in professional and personal digital portfolios. With located learning experiences in place, students who come to campus will have the opportunity to engage with teaching staff and peers in opportunities for rich interpersonal interaction through large and small team activities.

Why students' perceptions?

The external quality standards of a course are developed through the perception of quality assessed professional bodies and the internal quality standards are developed through the perceptions of the education providers. The student quality standards are developed only through the perceptions of the students. Hammel, (1999) says that the student perceptions of their learning environment help the academics to determine how teaching factors influence a particular approach to their learning outcomes. Qualitative methods are useful for evaluating, developing program goals and for involving participants in the evaluation process to gain their insight and perspective.

For a quality teaching, excellent learning of student engagement is a positive experience. Ferguson (2010) found that the researchers over many decades have suggested that students will engage more deeply and learn more thoroughly when their teachers care about them to educate, learn, and communicate and to be innovative in the classroom. Academics need students' perceptions to analyse their experience in practicing, learning a particular approach. The paper based survey and online survey methods are used for this research. It also facilitates the teachers to understand the level of expectation of students in their area of expertise.

Design Methodology

This paper is 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 shows the flowchart of the process of a paper based survey conducted with the students in undergraduate engineering.

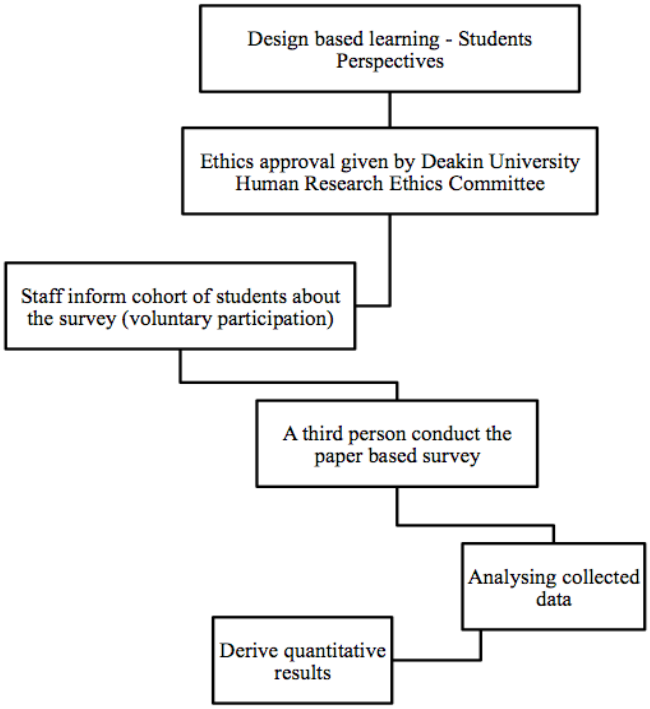

Figure 1: Student survey process

The paper based survey questions given to students are listed below

- What is your mode of study?
- Do you work?
- Is your job engineering related?
- Could you please define "Engineering"?
- What does "Design Based Learning" mean to you? Please explain.
- How could the School of Engineering include "Design Based Learning" in your curriculum?
- How important is DBL to your career?
- How important is DBL to your final year project?
- Should DBL take place in teams of students or with individual students?
- List up to 3 advantages and disadvantages for team DBL.

Results

Students' perspectives on design based learning

The students' views on DBL in this research come from 2012 and 2013 senior year undergraduate engineering students'. The study goal is to determine the students' perspective of DBL and how the perspective changes over the years studying engineering. The way engineering students tackle their university degrees are somewhat very different to the way engineering students went through their studies few years ago. The tables below show a comparison of 2012 and 2013 senior year students' perspectives.

Table 1: Students who work and study

Work Mode	2012 (%)	2013 (%)
No work	22	18
Part time	72	78
Full time	6	4

Table 2: Students studying full time and part time

Enrolled at Deakin Engineering	2012 (%)	2013 (%)
Part time	0	0
Full time	100	100

Table 1 illustrates that in year 2012, 6% of students working full time, 72% of students working part time and only 22% of the students have chosen not to work while studying. The 2013 senior year students, about 4% working full time, 78% working part time and 18% are not working. Overall 18% to 22% of the students in senior year choose not to work while studying. This shows that senior year students' want to engage more in studies that adds more value to their future career. It is interesting to see Table 3 that only 16% (2012) and 7% (2013) of senior year students work in engineering related jobs that helps them to get more practical experience and knowledge while studying. As it can be seen from Table 4, 83% of students studying on campus, 11% studying off campus and 6% of blended learning in year 2012. In year 2013, 100% senior students studying on campus.

Table 3: Work related to Engineering

Engineering jobs	2012 (%)	2013 (%)
No	84	75
Yes	16	7

Table 4: Student's mode of study

Study Mode	2012 (%)	2013 (%)
On campus	83	100
Off campus	11	0
Blended learning	6	0

Table 5 shows senior year students views on defining "Engineering". It is also interesting to see more than 80% of senior students' definition of Engineering looks familiar. In year 2012, students (22%) define Engineering is a process of creating new things, solving problems and critical thinking and 2013 students (26%) states that it is a practical application of science and technology to improve or create new things and 30% of students defined it as problem solving, creating solutions, designing to solve problems. The overall students' perception says that Engineering is use of science and technology that benefits society, practical application of science. Design based learning has been implemented more than ten years ago; nevertheless it is a concept that still needs further development. Therefore Wijnen (1999) and Dopplet (2009, 2008) intended that it is very important to characterise DBL as an educational concept in engineering education.

Table 5: Student's definition of Engineering

2012 Seniors Perceptions	%	2013 Seniors perceptions	%
The process of creating new things (apply knowledge)	22	No answer	14
Solving Problems, critical thinking	22	Practical application of science and technology to improve or create new things	26
Profession of acquiring and applying scientific, science skills	12	Problem solving, creating solutions, designing to solve problems	30
Use of Science and Tech that benefits to society, Practical	33	Creative application of scientific principle to design or develop	12

application of science		structure	
Creates complex structures or machines	11	Use of Science and Tech that benefits to society, Practical application of science	18

Table 6 shows students perception of design based learning approach, which is used as current curriculum methodology at Deakin engineering. Approximately 18% to 44% of students in both years revealed that DBL is learning in a particular manner, learning by doing, hands on project. About 18% to 22% of students says that DBL is a project based learning (real world projects), learning through projects (design projects). The senior year students' perception on DBL gives an encouraging sign for the engineering curriculum educators in the School of Engineering at Deakin University.

Table 6: Students' perception of Design based learning (DBL)

2012 Seniors Perceptions	**%**	**2013 Seniors perceptions**	**%**
No answer	11	No answer	22
DBL is a way of design based teaching	6	Learning in a particular way, Learning by doing, hands on projects	22
Learning in a particular way, Learning by doing, hands on projects	44	Learning through Practical application of engineering (design problem)	38
Getting involved with the practical application of engineering	17	Project based learning (real world projects), learning through projects (design projects)	18
Project based learning (real world projects), learning through projects	22		

A design based learning environment helps a curriculum to practice career-focused skills for students such as practical learning, problem solving, collaborative teamwork, innovative creative designs, active learning, and engagement with real-world assignments. Dopplet (2008) states that DBL is also an active learning process, which makes students to practice and recognize different learning styles. Also team based activity, which support learning and sharing through cooperative methods. Table 7 indicates senior year students' perceptions of DBL in their curriculum, almost 50% of students from the year 2012 and 2013 experienced DBL as practical learning, demos in their classroom. More than 50% of all students in both years believed DBL through industry related projects; learning through projects, design techniques.

Table 7: Students' perception of DBL in the curriculum

2012 Seniors Perceptions	**%**	**2013 Seniors perceptions**	**%**
iLectures, Video lectures (tools and tech)	17	No answer	37
Practical Learning, Demos in classes	34	Practical Learning, Demos in classes, more practical less theory	26
Articles, journals, Resources available online D2L	5	Learning through projects, design techniques	7
DBL units Show significant gain in scientific reasoning skill	11	Integrate with teaching (Individual DBL units)	15

More Project based learning, assessments and less exams	16	Labs, practicals, lectures, tutorials, more assessments based on practicals	15
Industry related projects for future needs	17		

When students are asked about the influence of DBL in their future career and importance of DBL in their final project. Table 8 shows about 55% of senior students in year 2013 and 39% in year 2012 believed that the influence of DBL does helps in their engineering curriculum. In addition, Table 9 shows that (27%) students in 2012 and (55%) students in 2013 perceived that DBL is important in their final year project. It is clearly shown in Table 8, senior year students in 2012 (39%) and 2013 (25%) recommended DBL is necessary for their future engineering career. Almost 27% of 2012 seniors and 22% in 2013 seniors strongly maintains that DBL is very important in their final year. Project and design based learning approaches are used to transform these skills into active learning and to evaluate student progress in classrooms. Lehmann (2008) also declares that the purpose of design education is to enhance the learning to teach students to become active participants to solve design problems around them.

Table 8: Influence of DBL in future career

DBL to your career	2012 (%)	2013 (%)
Does not help	0	0
No effect	5	0
Possibly helps	17	15
Does help	39	55
Is necessary	39	25

Table 9:Importance of DBL in final year project

DBL in Final year project	2012 (%)	2013 (%)
Does not help	0	0
No effect	11	4
Possibly helps	27	55
Does help	33	19
Is necessary	27	22

Table 10: Modes of DBL preferred

DBL mode	2012 (%)	2013 (%)
All individuals	17	4
Mostly individuals	22	15
Half teams and half individuals	61	62
Mostly teams	0	15
All teams	0	4

From the design workshop held at Melbourne by Deakin University (2012), it was found that the goal of the design approach was not changing the whole curriculum of engineering education. Through design activities students develop their ability to enhance and transform ideas through visualization, manipulation and application of data to problem solving**.** Table 11 illustrates students perceptions on advantages of teamwork in design-based learning, which includes real world experience, teamwork and interaction. Only 18% of senior year students' in 2012 and 2013 mentioned that they don't have an idea about the teamwork DBL experience. This indicates that the present curriculum needs a change in teaching by implementing the DBL units from 1st year engineering programs. Students' in the year 2012 (28%) and year 2013 (34%) says through teamwork DBL, they acquired interactive

knowledge, 17% of 2012 and 15% of 2013 senior year students mentioned that it develops collaborative skill, management skill and social science. It's interesting to see 17% (2012) and 11% (2013) senior year says that they get the opportunity of managing large projects through real world problems with industrial experiences. Overall students views resembles that most of the essential graduate abilities are attained through teamwork DBL mode.

Table 11: Advantages of Teamwork in DBL

2012 Seniors Perceptions	%	2013 Seniors perceptions	%
More discussion Opportunities, distribution of knowledge	11	More discussion Opportunities, distribution of knowledge	15
Good experience, Time efficient	11	Good experience, Time efficient	11
The work is divided, faster to give results	5	The work is divided, faster to give results	7
Team work, interactive knowledge	28	Team work, interactive knowledge	34
Develops Collaborative, management skills, social skills	17	Develops Collaborative, management skills, social skills	15
Real world experience, like industry experience, build large projects	17	Real world experience, like industry experience, build large projects	11
No answer	11	No answer	7

Table 12 illustrates students perceptions on disadvantages of teamwork on design based learning. Most of the students mentioned the problems exist in team work such as lack of consistence, communication, decision making, co-opeartaion and time management.

Table 12: Disadvantages of Teamwork in DBL

2012 Seniors Perceptions	%	2013 Seniors perceptions	%
Less individual learning	16	Team members are not contributing	27
Time management	22	Independent learning not applicable, Relaying on other tasks	27
Culture, communication barrier	11	No individual effort, loss of time	15
Team members are not cooperated	40	Hard to make decisions and organize	16
Leadership qualities	11	Lack of consistence, slack students	15

Conclusion

In this paper, the overall students views resembles that most of the essential graduate abilities are attained through design based learning approach in the School of Engineering at Deakin University. It is clear that senior students in every year who are practicing design-based learning are fully engaged in their studies. The comparative study survey results show a positive increase of about 25% of senior students' perceptions on the project oriented design based learning in year 2013 than in the year 2012. This paper is a continuous work of a large research project, which is set to develop a framework for project-oriented design based learning approach in Engineering education.

References

Chandrasekaran, S., and Stojcevski, A. (2012). *Learning through Projects in Engineering Education.* Paper presented at the 40th SEFI Annual Conference European Society for Engineering Education, Thessaloniki, Greece.

Chandrasekaran, S., and Stojcevski, A. (2012a). *The Process of Design Based Learning: A Students' Perspective.* Paper presented at the Australasian Association for Engineering Education (AAEE) Annual Conference, Melbourne.

Chandrasekaran, S., and Stojcevski, A. (2013). *Project Oriented Design Based Learning: Aligning Students' Views with Industry Needs*. International Journal of Engineering Education, 29(5), 1-10.

Chandrasekaran, S., Stojcevski, A. (2013a). *Accreditation Inspired Project Oriented Design Based Learning curriculum for Engineering Education*. Paper accepted at the 2nd International Engineering and Technology Education Conference (IETEC), Ho Chi Minh City, Vietnam.

Chandrasekaran, S., Stojcevski, A. (2013b). *Project Oriented Design Based Learning - Staff Perspectives.* Paper presented at the The 4th International Research Symposium on Problem-Based Learning (IRSPBL) 2013, Malaysia.

Chandrasekaran, S., and Stojcevski, A. (2013c). *Design Based Learning - Students Views on Industry Requirements*. Paper presented at the International Symposium on Project Approaches in Engineering Education (PAEE), Eindhoven University of Technology, the Netherlands.

Chandrasekaran, S., and Stojcevski, A. (2013d). *Aligning Students and Staff Perspectives in Design Curriculum.* Paper presented at the Proceedings of the Research in Engineering Education Symposium, Kuala Lumpur.

Deakin University. (2012). *Deakin Design Forum : Industry and Academia Needs*, Deakin University,Australia. http://www.deakin.edu.au/__data/assets/pdf_file/0004/23674/2012-Annual-Report.pdf

Doppelt, Y. (2009). *Assessing creative thinking in design-based learning.* International Journal of Technology and Design Education, 19(1), 55-65.

Dopplet, Y., Christian, M.M.M., Schunn, D., Silk, E., and Krysinski, D.,. (2008). *Engagement and Achievements: A case study of Design-based learning in a science context.* Journal of Technology Education, 19(2), 23-39.

Ferguson, Ronald F. (2010). *Student Perceptions of Teaching Effectiveness: Discussion Brife*. National Centre for Teacher Effectiveness and the Achievement Gap Initiative, from http://www.gse.harvard.edu/ncte/news/Using_Student_Perceptions_Ferguson.pdf

Hammel J, Royeen C B, Bagatell N, Chandler B, Jensen G, Loveland J, Stone G. (1999). *Student Perspective on Problem-Based Learning in an Occupational Therapy Curriculum: A Multiyear Qualitative Evaluation.* American Journal of Occupational Therapy, 53(2), 199-206.

Lehmann, M., Christensen, P., Du, X., Thrane, M.,. (2008). *Problem-oriented and project-based learning (POPBL) as an innovative learning strategy for sustainable development in engineering education*. European Journal of Engineering Education, 33(3), 283-295.

Wijnen, Prof. Dr. W.H.F.W. (1999). *Towards Design-Based Learning,* Educational Service Centre: Technische Universiteit Eindhoven. http://w3.tue.nl/fileadmin/stu/stu_oo/doc/OGO_brochure_1_EN.pdf

Acknowledgement

We wish to thank cohort of students in the School of Engineering, Deakin University for participating in this study.

Copyright statement