Full Paper

Introduction

In engineering education, learning and teaching is delivered and assessed based on student learning outcomes. Student learning outcomes are basically matched with graduate learning outcomes (GLOs) at Deakin University. Deakin Graduate learning outcomes describe the knowledge and capabilities that graduates should acquired and able to demonstrate in their future career. This study aims to analyse the views of the cohort of students about design based learning from fourth year undergraduate civil engineering. Design based learning is used as one of learning and teaching process at Deakin in the School of Engineering. The design based learning (DBL) process helps students to be self directed leaners which enhances the student learning outcomes towards attaining graduate career expected skills.

This research study examines students' perceptions of design-based learning in their curriculum through an online survey given to a cohort of fourth year undergraduate engineering students. With ethics approval given by Deakin Human Ethics Advisory Group, online survey is conducted through the link provided for students in Cloud Deakin website. By conducting online survey, the research illustrated the perceptions of students about DBL in fourth year civil engineering. From the analysed quantitative results, this research shows that students have adequate experience of project/design centric practice through design based learning approach in an engineering curriculum.

Different learning approaches

Problem solving is a component of the problem-based approach. Problem based learning (PBL) focuses on problem scenarios rather than discrete subjects and the selection of the problem is essential in PBL. There is strong evidence of PBL in these literatures (Duch, 1995; Graaff E. D, 2003; Julie E. Mills, 2003). The teacher acts to facilitate the learning process rather than to provide knowledge and solving the problem may be part of the process. Here, problem scenarios encourage students to engage in the learning process. The learning process is the central principle, which enhances students' motivation, and is a common element in problem and project-based learning. PBL is an approach to learning that is characterised by flexibility and diversity, which can be implemented in a variety of ways in different subjects and disciplines. Students work on their own learning requirements and teachers support this learning and it has strong evidence in this literatures (Gabb & Stojcevski, 2009; Savin Baden & Wilkie, 2004; Savin-Baden, 2000; Stojcevski, Bigger, Gabb,
& Dane, 2008).

Project Based Learning is perceived to be a student centred approach to learning. It is predominantly task oriented and facilitators often set the projects. In this scenario, students need to produce a solution to solve the project and are required to produce an outcome in the form of a report guided by the facilitators. Teaching is considered as input directing the learning process. The project is open ended and the focus is on the application and assimilation of previously acquired knowledge.

Solomon and Ian de vere intended that (Solomon, 2003; Vere, 2009) Engineering students require the opportunity to apply their knowledge to solve problems through project-based learning rather than problem solving activities as those do not provide a real outcome for evaluation. One of the greatest criticisms of traditional engineering pedagogy is that it is a theory based science model that does not prepare students for the 'practice of engineering'. Self-directed study is a large part of a student's responsibility in project based learning modules and there is strong evidence of this in these literatures (Frank, Lavy, & Elata, 2003; Hadim & Esche, 2002; Hung., 2008).

Students form their own investigation of a guiding question, allowing students to develop valuable research skills as students engage in design, problem solving, decision-making,

and investigative activities. Through Project-based learning, students learn from these experiences and take them into account and apply them to the world outside their classroom. PBL is a different teaching technique that promotes and practices new learning habits, emphasizing creative thinking skills by allowing students to find that there are many ways to solve a problem. Student role is to ask questions, build knowledge, and determine a real- world solution to the issue/question presented. Students must collaborate expanding their active listening skills and requiring them to engage in intelligent focused communication. Therefore, allowing them to think rationally on how to solve problems. PBL forces students to take ownership of their success.

Design based learning in engineering

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. The focus of this paper is to analyse students' perspectives on design based learning approach in engineering studies. The purpose of this study is to analyse the reflections of fourth year students on DBL approach. This study will also helps to enhance student learning outcomes through design based learning environment for current and future engineering students and to develop better teaching practices for academic staff at Deakin University

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

In project based learning, the learning process is around projects focusing on learning application rather than a product as an output. In design based learning, the learning process is around design activities focusing more on design product than application. Hence design based learning can be taught around projects but project based learning is not actually around design activities. This research study based on online survey that is performed on students enrolled in the Advanced Structural Design (SEV 454) in T1-2015. The assessment task for this particular unit is 100% project with design activities in it. The design activities involved in this unit are described below in unit details.

Methodology

The purpose of a survey to explore students' perspectives about a design based learning approach is to discover their teaching expectations and learning outcomes. The DBL survey was conducted using a qualitative and quantitative analysis method.
Hammel (Hammel J, 1999) proposed that qualitative methods are useful for evaluating, developing program goals and for involving participants in the evaluation process to gain their insight and perspective. In this method, results from the survey are manually

analysed by the researcher. The questions in this online survey were developed to obtain the students' views on design based learning in engineering education. The survey results provided various views and expectations from students that could assist a school to implement and practice a design centred education. In addition, the questionnaires were prepared to identify the difficulties in teaching and learning and to discover student perspectives for practicing design based learning.
The survey is online based which was conducted by a third person who is not involved in the research project. The survey was given to more than 50 students' in 4th year engineering and 12 students answered the 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, assessment method, team grouping. The survey questions used in the research are shown below in

1. Which semester are you enrolled in?
2. How comfortable do you feel practicing design based learning (DBL) approach in your unit?
3. Which design based learning mode do you prefer?
4. What is the level of satisfaction you have in DBL delivery in selected DBL mode?
5. How do you want to divide the contact hours between formal lectures and design class?
6. For partial DBL mode which one of these options do you prefer for assessment?
7. For full DBL mode which one of these options do you prefer for assessment?

Questions one to seven are quantitative questions focus on design-based learning and in particular focus around project oriented design-based learning. These questions are designed to analyse students' preference and level of satisfaction on design based learning approach, students' preference on contact hours, assessment on partial DBL (30% project/ 70% exam) and Full DBL (100% project).

Unit details

This survey is performed on students enrolled in the Advanced Structural Design (SEV 454) in T1-2015, who had completed the pre requisite unit of Reinforced Concrete Structures (SEV 353), in T2-2014. The assessment tasks for SEV 353 are one design project (30%), one laboratory report (15%), and final examination (55%), hence considered as partial DBL unit. However, the assessment tasks for SEV 454 are two design projects (50% each), and hence considered as full DBL unit. The variable level of involvement of the design based learning approach in the teachings of the two units will help the authors to assess the students' satisfaction based on the adopted level of DBL approach.

The unit SEV 353 introduces the material properties and fundamental concepts for design procedures of concrete structures and their behaviour during service life and according to the valid design codes. This includes introduction to the basic material properties and design parameters, flexural design of simply supported and continuous beams using Australian Design Code AS-3600, design of beams for shear and torsion, serviceability requirements, steel bond & development length, design of one-way slabs, design of two way slabs. However, the unit SEV 454 addresses the advanced topics in structural design of concret structures including the design of reinforced concrete columns and walls, design of footings and retaining walls. Fundamental concepts for design procedures will be introduced through design seminar and projects.

Design Activities

In this unit (SEV454), students were given a full set of architectural drawings for a six-storey building and were requested to carry out a complete structural design following the professional procedures and Australian design codes. The architectural drawings given to students include the external building perspectives and views, lay out for each floor, construction details, materials, and dimension. The design work commenced as group task for 20% of the total mark and then continues as individual task for 80% of the mark. Each group has to submit a conceptual design report including the assumed loading, selection of the structural system and the construction materials. Also, to carry out a full structural analysis for the selected design members. The individual task per student includes the full structural design of the major five structural elements in any concrete structure, which includes typical concrete beam, floor panel, column, shear wall and footing. The design work shall be submitted in two individual reports by each student throughout the trimester. Noting that the theoretical background for the design of each of those members were discussed during the contact hours.

Results

The purpose of analysing students' views in learning and teaching is one of the ways for staff to evaluate and develop their academic performance. This academic performance and professional development will help to ensure the course learning outcomes and standards, which are aligned with Deakin Graduate Learning Outcomes, professional accreditation requirements and relevant Australian Qualifications Framework specifications. These survey
questions are based on quantitative analysis. The students' views on design based learning in this research come from 4th year undergraduate engineering unit. The survey was given to
50 students and 12 of them responded the online survey. These results are from the students own experiences and the results presented gives various views, which include students knowledge and expectations on practising DBL, contact hours and assessment.

Student perceptions on design based learning

The student views on practising DBL is 100% project in this particular unit. The ultimate goal is to determine the students' perspectives of practising DBL and the perspectives changes over the years studying the engineering. Figure 1 shows around 83.34% (66.67% + 16.67%) of students mentioned that practicing DBL approach is helpful and it is necessary in their learning and 16% says DBL is not necessary. This cohort of students already experienced practising partial DBL in last semester and the same cohort will practise full DBL in their next semester.

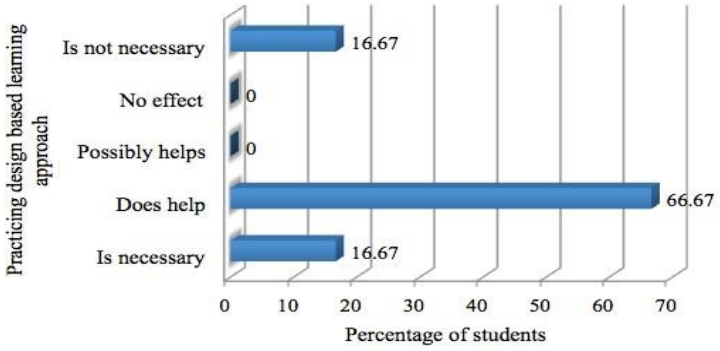

Figure 1: Students perceptions on practising DBL

As it can be seen from Table 1, 83.33% of students preferred full DBL and 16.67% preferred partial DBL mode. This difference in students experience gives encouraging and positive sign for curriculum design to be implemented around 100% DBL. Through students' perceptions, it is clearly shown that the students' want to learn through projects around design activities.

Table 1: Students preference of design based learning mode

DBL mode	Students (%)
Full DBL (100%)	83.33
Partial DBL (30% project/70% exam)	16.67

Students experienced formal lectures in the traditional way of teaching for a long time. The curriculum enhancement towards project based and design focused environment is giving a different experience to students. It was interesting to see students' preference, when they are asked about dividing the contact hours between formal lectures and design class. Figure 2 clearly shows that majority of students prefers 70% lecture/ 30% design class, which deliberately explains that students need the unit content to be discussed before they start working on project/design. It is also interesting to see that 16.67% of students preferred 30% lectures/ 70% design class. The way of teaching engineering education is changing towards project-based learning and design based learning (Joordens, Chandrasekaran, Stojcevski, & Littlefair, 2012). The students also mentioned about their level of satisfaction in DBL delivery in their selected DBL mode. Table 2 shows about 66.67% of students revealed that they are fully satisfied and 33.33% of students' reveals fully unsatisfied in DBL delivery.

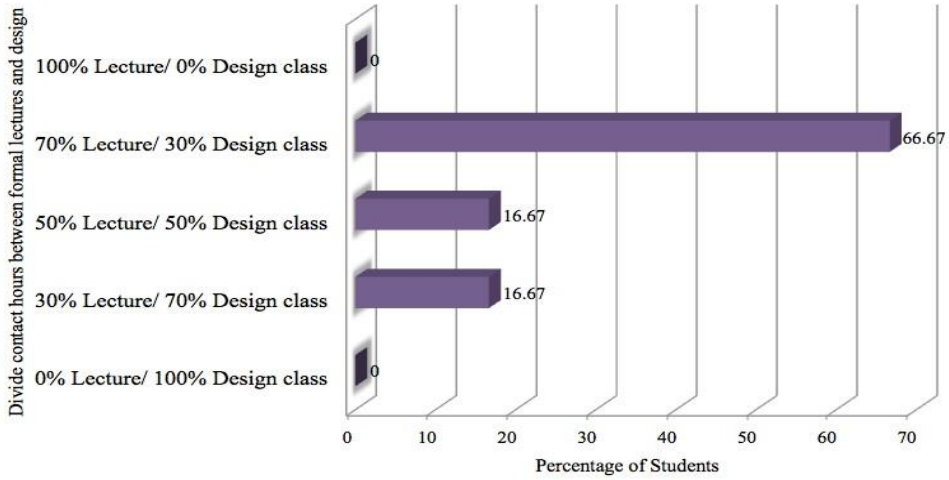

Figure 2: Students perceptions on contact hours

Table 2: Students level of satisfaction in DBL delivery

Selected DBL mode (in Table1)	Students (%)
Fully satisfied	66.67
Satisfied	0
Unsatisfied	0
Neutral	0
Unsatisfied	0
Fully unsatisfied	33.33

Ian de vere stated that (Vere, 2009) engineering students require the opportunity to apply their knowledge to solve problems through project-based learning rather than problem solving activities that do not provide a real outcome for evaluation. Hung intended that (Hung., 2008) one of the greatest criticisms of traditional engineering pedagogy is that it is a theory based science model that does not prepare students for the 'practice of engineering'. Self-directed study is a big part of a student's responsibility in a project based learning module. Table 3 and Table 4 shows remarkable views of students preference on assessment for partial DBL and full DBL.

Table 3: Students preference on assessment for partial DBL mode

Assessment preference for partial DBL mode	**Students (%)**
0% Project / 100% Exam	0
10% Project / 90% Exam	0
30% Project / 70% Exam	0
50% Project / 50% Exam	33.33
70% Project / 30% Exam	0
90% Project / 10% Exam	0
100% Project / 0% Exam	66.67

Table 3 illustrates that around 66.67% of students preferred 100% project / 0% exam and 33.33% preferred 50%project/ 50% exam. It is fascinating view of students to prefer 100% project in partial DBL, which is exciting for enhancing student learning outcomes through projects. Chandrasekaran and Stojcevski stated that (Chandrasekaran, Stojcevski, Littlefair,
& Joordens, 2012) the projects are better way of teaching students in an engineering curriculum. Table 4 clearly explains students' preference on assessment for full DBL mode. Most of the students (around 66.66%) preferred 25-30% Proposal, 25-30% E-portfolio and 40-50% Project, which shows that students have an adequate knowledge of assessment criteria towards learning outcomes.

Table 4: Students preference on assessment for full DBL mode

Assessment preference for full DBL mode	**Students (%)**
10% Proposal, 30% E-portfolio and 60% Project	16.67
15% Proposal, 25% E-portfolio and 60% Project	16.67
25% Proposal, 25% E-portfolio and 50% Project	33.33
30% Proposal, 30% E-portfolio and 40% Project	33.33
40% Proposal, 30% E-portfolio and 30% Project	0
10% Proposal, 30% E-portfolio and 60% Project	16.67
15% Proposal, 25% E-portfolio and 60% Project	16.67

The purpose of all engineering degrees is to provide a strong grounding with the principles of engineering science and technology. By learning the engineering methods and approaches in an academic environment, graduates are enable to enter the world

of work and tackle real world problems with innovation and creativity.

From these analyses of students' views on design based learning delivery, mode, contact hours and assessment, it gives a clear idea for the curriculum educators to understand the cohort of students' preferences. It will definitely create a vast difference in implementation of project/design based learning approach, which will not be a challenging task for an academic to support student learning in undergraduate engineering.

Conclusion

The focus of this paper is to analyse cohort of students' perspectives on design based learning approach. From analysed survey results, it shows students in fourth year civil engineering (undergraduate) have a adequate experience on DBL which gives a more than 50% of course content focus on design and project oriented learning. Most of the students experienced DBL as a necessary and helpful approach, preferred 100% full DBL mode in curriculum, are fully satisfied in DBL delivery. The cohort of students' preference on assessment of partial DBL mode reveals 100% product assessment and student preference on full DBL mode reveals 50% process and 50% product assessment. The full DBL mode assessment is also reveals students preference on mark (proposal, e-portfolio and project) distribution. Overall paper shows students perceptions on design based learning has an important value in their learning curriculum and encourages Deakin engineering to change curriculum structure towards 100% design based learning.

References

Chandrasekaran, S., Stojcevski, A., Littlefair, G., & Joordens, M. (2012). *Learning through Projects in Engineering Education.* Paper presented at the Eurpean Journal of Engineering Education Conferences (SEFI 2012), Thessaloniki, Greece.

Duch, B. J. (1995). What is Problem-Based Learning? A Newsletter for the Centre for Teaching Effectiveness.

Frank, M., Lavy, I., & Elata, D. (2003). Implementing the Project-Based Learning Approach in an Academic Engineering Course. *International Journal of Technology and Design Education, 13*(3), 273-288. doi: 10.1023/a:1026192113732

Gabb, R., & Stojcevski, A. (2009). *Designing problem-based learning for student success*.

Graaff E. D, K. A. (2003). Characteristics of Problem-Based Learning. *Journal of Engineering Education*.

Hadim, H. A., & Esche, S. K. (2002, 2002). *Enhancing the engineering curriculum through project-based learning.* Paper presented at the Frontiers in Education, 2002. FIE 2002. 32nd Annual.

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

Hung., J. D., Liu.R. (2008). Problem Based Learning.

Iwane, N., Ueda, H., & Yoshida, M. (2011, 3-5 Aug. 2011). *Design based learning by knowledge reuse: Towards its application to e-learning.* Paper presented at the Information Reuse and Integration (IRI), 2011 IEEE International Conference on.

Joordens, M., Chandrasekaran, S., Stojcevski, A., & Littlefair, G. (2012). *The process of design based learning: A students' perspective.* Paper presented at the Profession of Engineering Education: Advancing Teaching, Research and Careers: 23rd Annual Conference of the Australasian Association for Engineering Education 2012, The.

Julie E. Mills, D. F. T. (2003). Engineering Education – Is Problem Based Or Project

Based Learning The Answer?
Perrenet, J., Aerts, A., & Woude, J. V. d. (2003). *Design Based Learning in the Curriculum of Computing Science - a Skillful Struggle*. Paper presented at the ICEE 2003.
Savin Baden, M., & Wilkie, K. (2004). *Challenging research in problem-based learning*: McGraw-Hill International.
Savin-Baden, M. X. (2000). *Problem-based learning in higher education: Untold stories*: McGraw-Hill International.
Solomon, G. (2003). Project-Based Learning: a Primer. *23*(6). Retrieved from Technology and Learning website
Stojcevski, A., Bigger, S. W., Gabb, R., & Dane, J. (2008). 5.3Engineering Problem-Based Learning Spaces at Victoria University. *Learning Spaces in Higher Education: Positive Outcomes by Design*, 53.
Vere, I. D. (2009). *Developing creative engineers: a design approach to engineering education*. Paper presented at the The 11th International Conference on Engineering and Product Design Education, Brighton, United Kingdom.
Wijnen, W. (1999). Towards design-based learning. *Educational Service Centre*.

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