

## A Project/Design approach to Electrical Engineering

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### INTRODUCTION

Learning when conducted as an active process of investigation and creation based on the learner's interest, experience and curiosity result in expanded knowledge and skill sets. The process of problem solving when taught to students results in a general recollect of 90% when compared to processes involving reading, hearing or seeing the material [1].

Design is a key feature in engineering and manifests in every engineering process. Studying engineering is not just about acquiring scientific knowledge and technological skills but it also about understanding the practices, belief and professional values of engineering culture. In the process of engineering design, designers are involved in generating and evaluating ideas which specify concepts to create devices, systems or processes pertaining to the requirements of the end user [2]. Design problems are open ended problems with multiple correct solutions, students in solving these problems use a systematic problem solving methodology and go through multiple iterations which gives them a better understanding of the problem and the processes involved in solving a problem.

## **1 IMPLEMENTATION OF THE PROJECT/DESIGN APPROACH**

### **1.1 Project/Design Approach**

Project based learning is a student centred approach to learning in which students work towards solving a problem and produce a report supervised by the teacher as an outcome of this process; the teacher and teaching become inputs in the learning process [3]. Design based learning is a self-directed approach in which students employ creative learning through hands on solutions developed for problems which meets the expectations of academia and industry[4]. Design based learning provides students with an opportunity to apply original and innovative ideas to problems and when applied with project based activities it allows students to explore cooperative learning methods along with the self-directed approach.

Design based learning a self-directed learning approach opens up the learning activity so design skills are not only learnt but are also applied [5]. Students must locate the resources required, and analyse any needs in order to create a design [6]. DBL gives students the freedom to apply their design skills as they think best. DBL not only looks at the end product but also at the underlying process in creating that product [7]. DBL is a type of problem-based learning where problems are solved in teams. It is important to have a pedagogy style or approach, such as design based learning, which is similar to project based or problem based learning.

The School of Engineering at Deakin University has explored new directions in teaching and learning to improve the delivery of its units for a better student experience and also to make its graduate ready for the job; and one of the methods It has explored and practiced is Design Based Learning (DBL) [8,9,10]. Students are encouraged to study subjects where 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 integrating experience.

### **1.2 Project/Design Process**

The project/design approach based on the project oriented design centred learning was implemented in the first semester of third year engineering. The project/design approach used a design project to teach students the fundamentals of electronic signals and systems. The design project is a team based activity and the students worked in teams of five to six members and each team was given the design problem which encompassed the learning outcomes for the unit. The staff member played the role of a facilitator, facilitating the student centred learning process. The same group of students met regularly throughout the trimester to work on a series of design activities. The design activities in the project drive the learning process which follows the design thinking process. Figure 1 shows the seven step process of the project/design approach.

The process can be grouped in three stages: definition, ideation and prototype & testing. The key idea behind the behind the learning process is to drive student centred learning with a rich interpersonal interaction with peers and staff. In the definition stage the students come together to identify and define the design problem. The project presented to the students by the staff member is an open ended project which has open ended solutions. The students brainstorm on the project and start to identify the significant issues and try to understand the problem outlined in the project brief. Students locate resources that are directly relevant to the learning issues and

the other members of their team are advised by posting a message in the appropriate discussion forum.

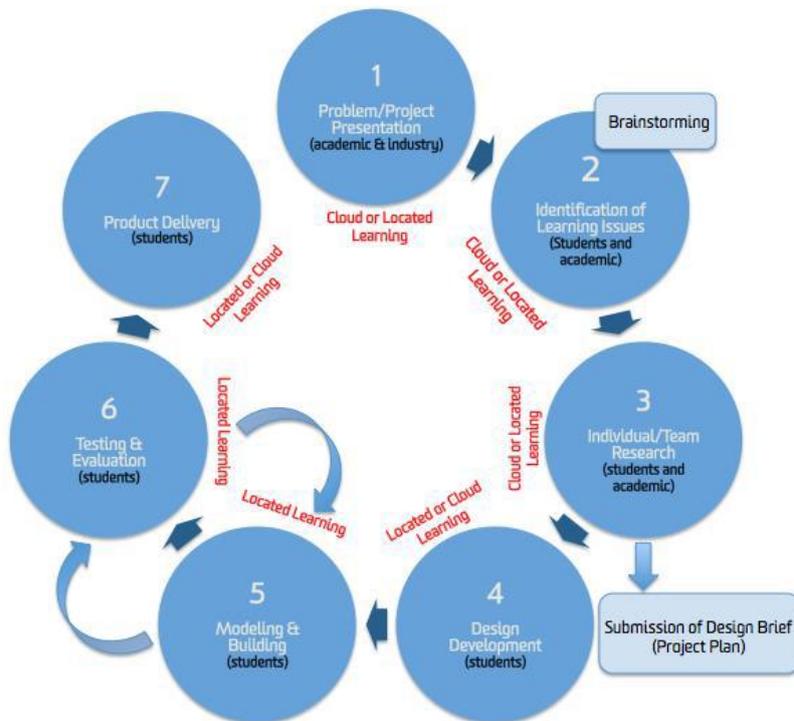


Fig. 1. Seven step process for the project/design approach.

In the ideate stage the teams develop the design brief which is the key project planning document. The teams specify the objectives the project will achieve and detail the means and timeframe for it. The development of this document is correlated to ideas and finding from the concept research. The final stage is of prototype and testing; teams start by modelling and building their design and testing and evaluating the design against the requirements and specifications. Once the design has been verified and validated against the specifications the final product is delivered.

### 1.3 Project

The project is the key to the implementation of the new learning and teaching approach as it drives the activities in the project/design learning process. The project needs to help students achieve the learning outcomes of the unit and also the content in the unit needs to be aligned with the project. The project chosen for this unit was a Spectrum Analyser, the project allowed students to explore signals and their behaviour and also study various systems and its behaviour. Students were given a brief which described the design problem, they were encouraged to interpret the problem and come up with a design solution. The project is the same for all teams and the staff member who is the facilitator also acts as the client and also gave them direction about resources and content pertaining to the key concepts of the project were provided, which included video lectures, reading material and links to publications.

## 1.4 Weekly Activities

The seven step process described in figure 1 applied across the 11 week semester followed in the Deakin University is shown in table 1.

*Table 1.* Weekly Activities for Project/Design learning approach

<b>Week No.</b>	<b>PODBL process</b>	<b>Deliverable</b>
Week 1	Project Presentation	
Week 2	Problem Identification	
Week 3	Problem Identification / Concept Research	
Week 4	Concept Research / Design Brief Development	Design Brief
Week 5	Concept Selection / Design Development	
Week 6	Design Development / Modelling and building / Testing and evaluation	
Week 7	Design Development / Modelling and building / Testing and evaluation	
Week 8	Design Development / Modelling and building / Testing and evaluation	
Week 9	Design Development / Modelling and building / Testing and evaluation	Design Presentation
Week 10	Design Development / Modelling and building / Testing and evaluation	
Week 11	Product Delivery	ePortfolio

Table 1 presents the student activity from week 1 to week 11 and the details of the weekly activities are listed below:

Week 1: The project is presented to students. Students start to form teams and teams are identified.

Week 2: Teams meet individually with the facilitator and brainstorm the project. Team members decide on individual concepts for research.

Week 3: Teams meet and discuss the concepts. Information is shared on Cloud Deakin. Teams update the facilitator on the concept research. Teams take the first step towards the development of the design brief.

Week 4: The information from the concept research is assimilated and the teams work together to produce the design brief document. The facilitator provides feedback on the design brief.

Week 5: The design brief is developed and teams move towards the selection of ideas and take the first step towards the design development of the final product.

Week 6: Teams follow a cycle of design, model and evaluation for each individual component of the product. The facilitator's role is to provide feedback and help the teams stay on track with the project.

Week 7: The cycle of design, model and evaluation continues.

Week 8: The teams continue the cycle and also begin to look at issues relating to the integration of individual components. Students also begin to prepare the presentation of the design.

Week 9: The teams present the design and the intermediate results. Each team member presents one component of the product, and the students start working on the final report and ePortfolios.

Week 10: Teams move towards integrating of all the individual components. Testing and evaluation of the final design is also completed. Students continue work on the final report and ePortfolios.

Week 11: Final changes are made to the design. The final product and ePortfolios are delivered.

## 1.5 Student Staff Interaction

Communication and continuous interaction is an important aspect in the project/design approach, as detailed in the previous sections once the design problem has been presented to the students, they need to brainstorm and develop individual concepts of research. Students need to share their individual concepts of research with their peers and staff and start to build the design brief for the solution, to facilitate this interaction students are given access to a group page where they can collaborate and share information. Figure 2 shows the group page where the student teams can post discussions internal to the team and also share information collected in the concept stage.

Topic	Threads	Posts	Last Post
<b>Student Discussion</b> ▾ This Student Forum allows you to get to know fellow students and to discuss unit content and support each other in your learning. <i>Please note: This is an educational forum and as such proper etiquette should be followed.</i>	2	15	Jaideep Chandran Mar 27 at 3:32 PM
<b>Team Alpha Topic</b> ▾ Group/section restrictions.	9	104	NICK KENNEDY May 30 at 4:27 PM
<b>Team Bravo Topic</b> ▾ Group/section restrictions.	12	43	JAMES DOOLAN May 14 at 5:28 PM
<b>Team Charlie Topic</b> ▾ Group/section restrictions.	0	0	
<b>Team Delta Topic</b> ▾ Group/section restrictions.	3	3	JEFFREY SMITH May 1 at 2:20 PM

Fig. 2. Discussion forums for student teams.

In all the stages of the learning process there is continuous interaction between the peers. This interaction is also facilitated through the use of a technology resource called ELive. ELive allows the students to set up meetings in the online environment. The meeting link is set up with access allowed only to the members of the team and the facilitator. Team members discuss the progress of the project and the progress of the individuals' tasks in the project. The facilitator's role in these meetings is very limited and many times the student carry on without the facilitator.

## 2 STUDENT EXPERIENCES

### 2.1 Workload

The new learning and teaching model is a student centered approach where students drive the learning activities and the staff act as facilitators and this is evident from the workload for the staff and students across semester it was implemented in. Figure 3 shows the workload of staff and students engaged in the project/design process from week 1 to week 11.

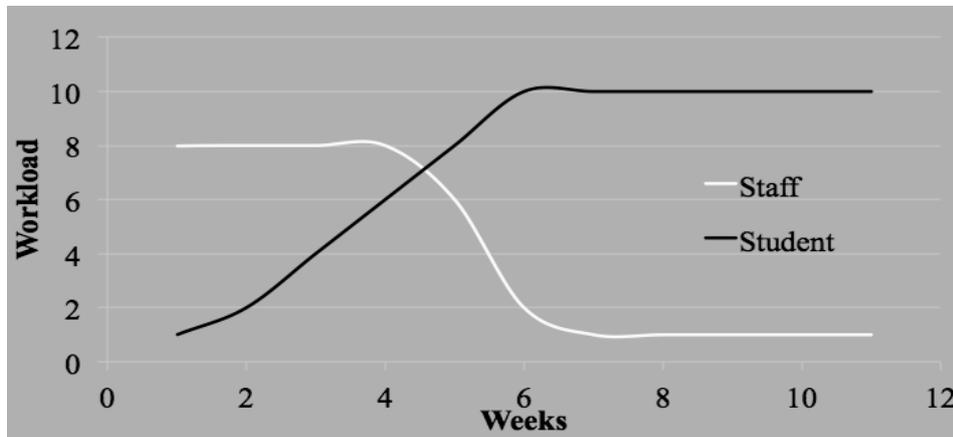


Fig. 3. Student and staff workload across the trimester

In the initial stages from week 1 to week 4 the workload for the staff member is higher as this is the period in which the design problem is presented to the students and the teams are formed. Also in this period staff coordinates the availability of content and resources and encourages the student enquiry through questions and suggestions in the weekly meetings, in the stages after week 4 the students are well on their way with the design process and the staff workload starts to reduce as the students are driving the process themselves. The student workload steadily increases from week 1 and once the design brief is submitted in week 4 or 5 their workload reaches maximum as they have ownership of the project and the direction of the solution.

### 2.2 Student Experiences

Students at Deakin University are given the opportunity to provide feedback on the units they are studying and the teaching staff through the use of a course experience survey. The course experience survey collected anonymously from student's gathers student evaluations of the quality of the unit, its material and the way it was taught. The course experience survey is collected every semester and this presented us with an opportunity to compare the student experience of the third year engineering unit when it was offered in the traditional lecture based approach to the new project and design centred curriculum.

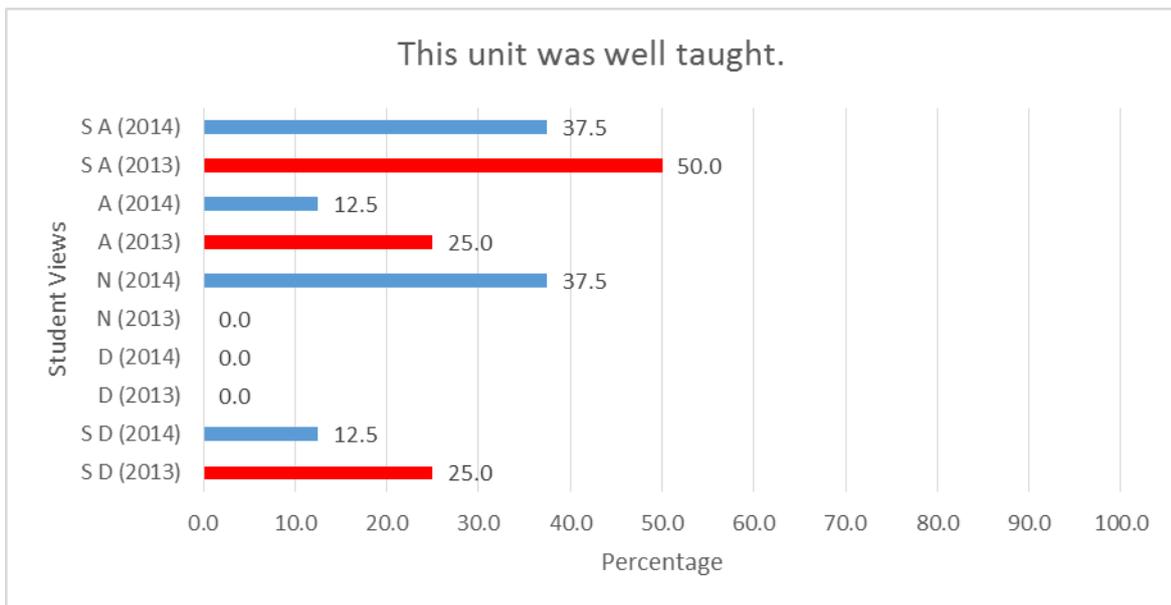


Fig. 4. Student views on how the unit was taught

In a comparison of the student views on well the unit was taught, figure 4 shows the traditional lecture fared better with 25% more student agreeing the unit was well taught in 2013 as compared to 2014 when the new learning approach was introduced; this was expected as the students were experiencing a new learning process but it is good to see the number of students who disagreed that the unit was well taught has been halved from the previous year. There is a significant number of students who have shared a neutral view on the new learning process but other questions on the unit have shed more light on their views. When asked if the students would recommend the unit to other students there is a 25% increase from 2013 and again a drop in half for the number disagreeing shown in figure 5.

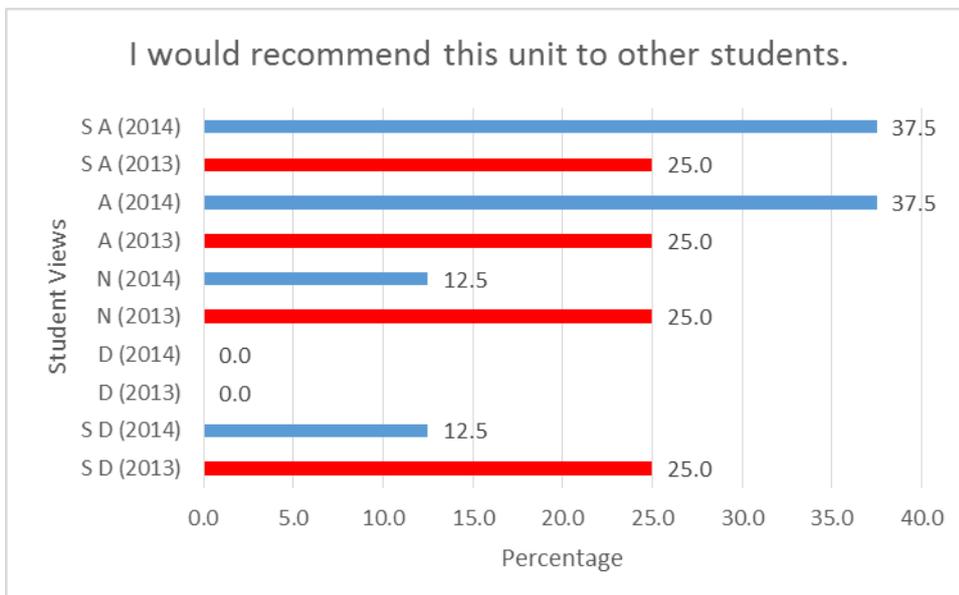


Fig. 5. Student views on recommending the unit to other students

In other views expressed by students when asked if the unit challenged them to learn an overwhelming 75% of the students agreed the unit challenged them as shown in figure 6 and they also expressed thoughts like "The project based learning approach was great. The task set was challenging and interesting." and "I really enjoyed the

fact that the unit was design based. It was challenging and at times very confusing but in the end when the final solution comes together it is worth it. We got to focus on what we found challenging at our own pace.”

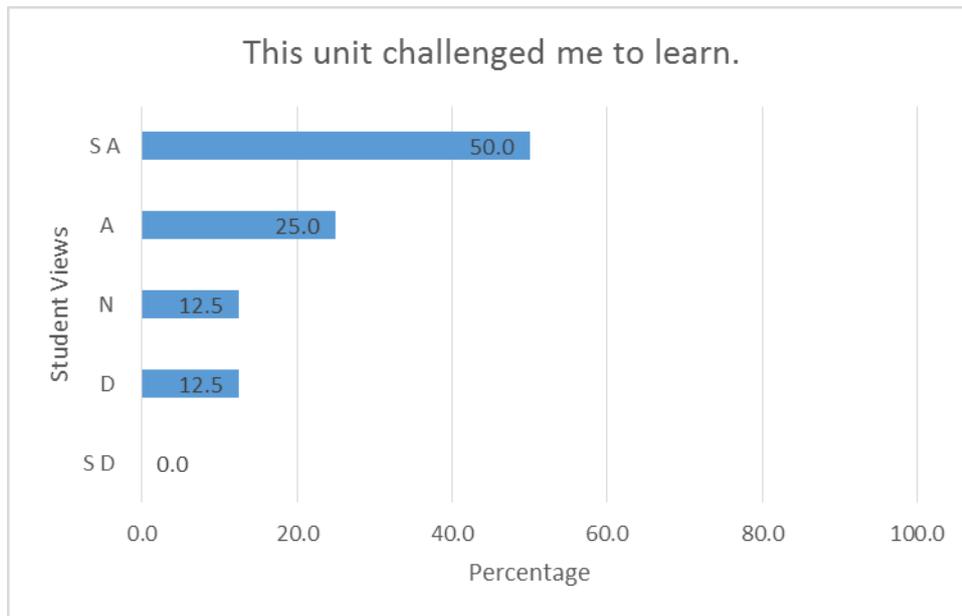


Fig. 6. Students views if the unit challenged them.

In comparison in the comments for the unit in 2013 the students quoted the unit was enjoyable and they liked it but it also mentioned “The lecturer engaged with the class frequently and gave useful feedback and solutions” putting the onus on the staff member to engage the class and drive the learning in the unit. In the new approach the learning was driven by the students and from the comments it is evident the student were driving it and also they enjoyed the challenges it presented.

### 3 CONCLUSION

The School of Engineering at Deakin University adopted a new project/design approach in which students learn through design activities driven by a project with a defined deliverable to deliver the skills and knowledge students require to understand and solve design problems a key requirement for employability of the modern day engineer. The new approach following the principles of project/design based learning used a design project to teach students the fundamentals of electronic signals and systems. The design project the key element needs to address the learning outcomes and also align with the content. Students need to be provided with avenues for interaction and communication, this can be achieved using technology and face to face meetings, as the continuous interaction promotes learning. Students have welcomed the new learning approach and the challenges presented by it and are happy to recommend the unit to others.

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