Enhancing Engineering Curriculum through the use of Projects

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Abstract

The School of Engineering at Deakin University has embarked on a new path in engineering education with the announcement of the Centre for Advanced Design in Engineering Training (CADET) which embodies the principles of a new learning model, Project Oriented Design Based Learning (PODBL). Design based learning is the driving force for the new learning model which also incorporates the principles from project based learning to deliver the skills and knowledge students require to understand and solve design problems; a key requirement for employability of the modern day engineer. Along with this change a major shift is occurring at Deakin University in the way education is delivered with the announcement of Cloud and Located Learning. This shift in policy has affected every aspect of the student learning experience, including the way the content is delivered to the students, student assessments and their interaction with staff. This paper discusses the enhancements in the engineering curriculum to incorporate the changes to the content delivery and assessment strategies for cloud and located learning and keeping the principles of project based learning to deliver design based education in engineering.

Keywords: project based learning; Curriculum; ICT.

1. Introduction

The School of Engineering in Deakin University announced the plans for the Centre for Advanced Design in Engineering Training (CADET) which will embody the principles of a new learning model project oriented design based learning (PODBL). This new learning model encompasses design based learning as the key driving force along with the principle of project based learning. This change was followed with another change bought by Deakin University bringing about a change in the delivery of education across all disciplines affecting every aspect of the student learning experience described as Cloud and Located Learning. The School of Engineering was chosen in the sandpit as one of the early implementers of cloud and located learning in their courses and is involved in a course enhancement process to change the engineering curriculum. This process has provided the school a unique opportunity to achieve these enhancements through the use of projects.

1.1 Project oriented design based learning

Design is one of the fundamental processes in engineering and is involved in all the engineering activities. The study of engineering is not just learning the scientific knowledge and technological skills but it also the learning of established practices, beliefs and professional values of engineering culture. Engineering design has been identified as a systematic and intelligent process in which designers generate, evaluate, and specify concepts for devices, systems or processes which meet the requirements of the end user (Felder, 1988). Design problems which are a classified as open ended problems with multiple correct solutions allow students to use a systematic problem solving methodology with multiple iterations giving them a better understanding of the problem and the processes involved in solving a problem.

Learning an active process of investigation and creation based on the learner's interest experience and curiosity in most cases results in expanded knowledge and skills. Students when taught to solve a problem in general recollect 90% of what they do which is much higher than the recollection of the material they read, hear or see (Hung 2008).

Project based learning a student centred approach to learning uses project as task to direct the learning for the students. The projects are set by the facilitators and the students need to produce a solution to solve the project and are required to produce an outcome in the form of a report. The teachers act as facilitators and guide the students in this process and teaching is considered as an input directing the learning process.

Project based learning provides students with the opportunity to apply their knowledge to solve problems rather than problem solving activities which provide no evaluable real outcomes. Engineering pedagogy often uses a theory based science model which doesn't prepare the students for the practice of engineering and this is one of its biggest

criticisms, project based learning addresses this issue; as self-directed study is a big part of the student's responsibility in a project based learning module (deVere, I. 2009, Hung 2008).

Design based learning is also a self-directed approach; students here initiate learning by designing creative and innovative practical solutions fulfilling academic and industry expectations. The design problem solving process which is the centre of the design based learning approach has been adopted from a combination of problem and project based learning models (Wijnen 2000, Doppelt 2009, Doppelt 2008). Students with different learning styles are able to express their skills and talents working through design project which allows them to practice skills like problem solving, collaborative teamwork, and active learning while engaging in real world problems.

The school of engineering organized an industry forum and one of the key topics was the investigation of the industry and academic requirements for students and the feedback from industry representatives reflected that they are looking to recruit graduates who have acquired design skills and have acquired knowledge through projects. The industry views suggested for a sustainable design teaching and learning through a design based learning model using industry or community based design projects will enrich the student's problem solving skills, integrate design with manufacturing and give them a global perspective through real world projects (Littlefair 2012, Chandrasekaran 2012, Joordens 2012).

Industry views along with student perspectives on design based learning have been aligned together towards a new approach Project oriented design based learning. PODBL will have a positive effect on student content knowledge and help develop skills like collaboration, critical thinking, and problem solving skills and increase student motivation and engagement. Project-Oriented Design Based Learning (PODBL) is a teaching and learning approach (TLA) that is based on engineering design activities while driven by a project. Deakin Engineering has proposed the use of PODBL to encourage independent learning and a deep 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. Students learn through real engineering design activities while driven by a project that has a defined deliverable, which is presented to them by industry partners or academic staff.

2. Cloud and located learning

The school of engineering embarked on a journey towards PODBL and during the same period the Vice Chancellor of Deakin University launched the strategic plan called LIVE the future: Agenda 2020, which bought about a major shift in the delivery for education across all disciplines. This plan focusses on Cloud and Located learning which affects every aspect of the student learning experience including the way content is delivered, assessments and student interaction and engagement with staff. This policy is designed to help Deakin University move and drive in the digital frontier a change which is moving across the education sector (John Bourne et. Al 2005). Cloud and located learning is about two distinct learning environments the first being a seamless digital environment provided on the cloud and the second focusing on the located learning experience provided on campus and learning centers and in industry settings.

The cloud learning experience for the students takes place in a digital environment where students will be able to connect with teaching staff, mentors, and have the ability to create evidence of their achievements. The cloud learning experience looks to harness new technologies to provide highly visual, media rich, interactive learning experiences to Deakin university students at locations and times which suit them. To provide this experience requires the use of new delivery platforms with education resources which are media rich and engaging. This also requires an innovative strategy in assessment and assessment pieces which will be able to provide meaningful feedback to the students.

The located learning experience which is the second part of the cloud and located learning focusses on learning on campus, study center and in the industry or workplace. The aim is to provide the students a wholesome experience and allowing them the flexibility to conduct their learning in an online environment and access their portfolio of achievements, connect with their peers and staff and provide them with the real world experience through located learning.

The school of engineering was chosen as one of the early implementers of the new cloud and located learning policy and course enhancements were conducted to include the cloud and located learning principles in the courses and unit taught in engineering. The course enhancements aim to make the courses intellectually challenging, with an engaging cloud and located assessment and also provide resources and experiences thus making them engaging. It also aims to improve outcomes like graduate satisfaction and employability thus improving the course effectiveness.

2.1 Course Enhancement Process

The implementation of the new cloud and located learning policy is being effected through course enhancements. The aim of the course enhancements is to improve the engagement in the courses, the effectiveness of each course and also increase their efficiency. The course enhancement process started with the scoping stage which was conducted by a central team at Deakin University. The scoping process provided detailed information on the different courses on their current level of engagement which was gauged on the alignment of the learning outcomes, assessment strategies and the current resources. It also provided information on the effectiveness of the course based on the demand, retention, student feedback and graduate employability and also evaluated it to against the sustainability and affordability of the course.

The data from the scoping process and the course evidence portfolio is used to determine the areas of strength and areas for enhancement for each course. The next step in the course enhancement process is the Assessment and learning design process. The process is aimed at getting the courses aligned to the current Deakin graduate outcomes along with the accreditation standards and requirements. It also involves aligning the outcomes of each unit in a course to the assessment tasks and promotes the use of assessment and feedback, include peer and self-assessment and provide evidence for employability with a balance of individual and group assessment tasks. The assessment tasks are encouraged to resemble the tasks the graduate will be doing in their intended professional field and take place in industry setting where applicable and feasible. Formative feedback is recommended to be provided in time promoting learning and improvement in the next assessment and the use of assessment tasks as evidence for students to share with prospective employers as an e-portfolio.

3. Curriculum change

Implementation of this change requires the School of Engineering to concentrate on the areas of media rich content, enhanced communication between staff and students, new assessment strategies. The change in the curriculum has provided the school with the unique opportunity to achieve these course enhancements through the use of projects.

3.1 The PODBL cycle

Project-Oriented Design Based Learning (PODBL) is a teaching and learning approach (TLA) that is based on engineering design activities while driven by a project. The PODBL approach at Deakin Engineering encourages independent learning and a deep approach to learning. 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, which is presented to them by industry partners or academic staff.

The model is applied across all four years of engineering and across the four disciplines of civil, mechanical, electrical and mechatronics taught in the school of engineering. Students are introduced to projects from the first year of engineering; the projects in the first year are university projects and as the students' progress in year two through to year four projects from the industry are introduced.

In the PODBL model participants work in teams four to six members with a facilitator which is similar to the project based learning approach. The same group meets regularly throughout the trimester to work on a series of design activities. The PODBL cycle involves nine main steps. The steps are illustrated in figure 1 below. Steps 1-3 take place in the cloud, step 4-6 are a combination of both cloud and located learning, and steps 7-9 are performed through located learning.

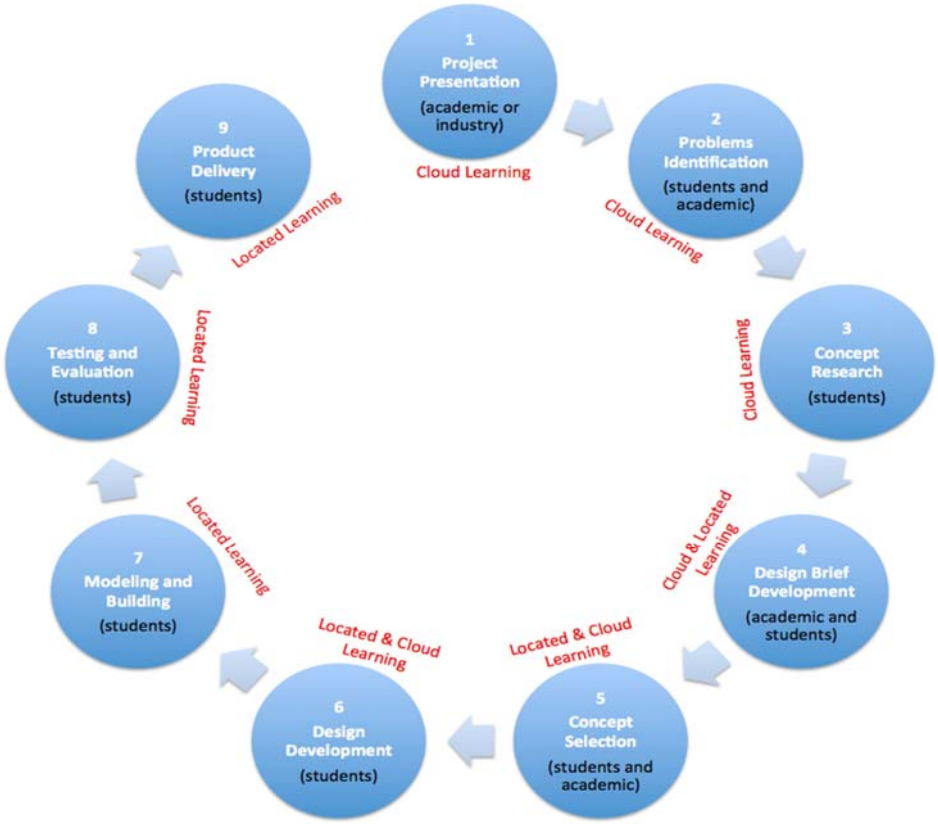

Figure 1: The PODBL learning process

3.2 Media content

Steps 1 to 3 of the PODBL cycle the project is presented to the students by the academic or industry based facilitator and the students are given the opportunity to brainstorm on the project to identify the problems and engage in concept research to understand the essential learning issues and the overlapping issues. These activities are conducted in the seamless digital environment for cloud based learning. The students are provided with 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.

The school of engineering has already started in this direction with the use of technology to enable learning practice and under this initiative encouraged staff to record the lectures and tutorials. The staff could record their lecture on video or use screen capture software to record the lecture slides along with audio and the recording are provided to the students via the cloud. These lecture resources provide the students with an opportunity to revisit lectures and go through the concepts discussed during the session. The lecture videos allow the students to catch up on missed lectures with an experience similar to attending a lecture. Students have indicated in a survey they use the lecture as a catch up exercise and it allows them greater interaction. The school is moving towards the recording of short topic based clips no longer than ten minutes which will allow the students to access material which are media rich and visually engaging (Joordens, 2012).

3.3 Online Tutorials

Steps 4 to 6 in the PODBL cycle the teams are involved in developing the design brief to produce the key planning document with the specifications for the project and project plan, select the concept for the solution based on the ideas generated during the concept research step and move on to the design and development step to develop the final design. These activities are a combination of cloud and located learning activities. The students will interact with the staff during the design brief and concept selection stage; this interaction can be over the cloud or on campus for students who are able to come on campus.

The school of engineering has taken a step in this through the use of online tutorials. Tutorials conducted in the classroom provide the students to interact with the staff member and also revisit concepts covered in the lectures and collaborate with staff. This initiative of collaboration and interaction between the students and staff has been taken online through the use of Elluminate Live! eLive a technology resource which facilitates communication and collaboration between staff and students. It allows the staff and students to talk over the internet and also via an online chat room and to have online meetings and facilitates learning and training. It presents off campus students to interact and collaborate with the staff and their peers in a safe and secure environment. Staff members can share audio and visual materials with the participants and can also invite guest speakers like experts from the industry. The flexibility of the online environment allows for the meeting to set up without the boundaries of time and space. The initiative from the school has been well received by the off campus students and also by the on campus students who use this as an extra opportunity to collaborate with the staff and their peers.

Project oriented design based learning approach focusses on this interactivity between the staff and students and among themselves and this resource provides them opportunity to interact in various setting in which members from the industry can also be invited to share their ideas and views. This resource also allows the school to provide the enhanced interaction between student and staff as mentioned in the cloud learning policy

3.4 Online Assessments

The PODBL model allows for a variety of assessment techniques to be used during each step of the cycle. The teams are working in a group which makes it ideal to implement self and peer assessment strategies. The cloud and located learning interaction allows for the students to receive feedback at every step in the cycle. The feedback provided by the academic or industry facilitators allows for formative assessments techniques to be applied along with summative assessments. The project which drives the design activities in PODBL has a defined deliverable based on real world problems giving the students the opportunity to work on the tasks they will face when they graduate as engineers. The cycle also allows for the student to collaborate on real world projects and evidence their achievements in professional and personal digital portfolios.

The project in the PODBL model allows for the learning and teaching delivery to take place as a combination of cloud and located learning activities. Cloud learning enables students to evidence their achievement and requires students to be generators of content, collaborators in solving real world problems, and evidence their achievements in professional and personal digital portfolios. With premium cloud 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 and also provided through the use of lecture videos, online tutorial for students who are able to make it on campus.

4. Conclusion

The school of engineering is moving towards the implementation of a new learning and teaching approach which combines the approaches of design based learning with the project based learning model. Project oriented design based learning model is a student centred and project driven way of teaching engineering which motivates the students. The project driven approach allows the school of engineering to achieve the enhancements suggested for the course to be engaging, effective and efficient. Media rich content provided by lecture videos and short clips allow the student to engage in the topics which drive the design activities in the project, the online tutorials, the interactions between academics and students during each step allows for a favourable environment for staff and students to collaborate. The project which is based on real world problems allows the students to work on real engineering design activities similar to the tasks performed when they graduate which can be evidenced as a professional or personal digital portfolio.

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