Integration of Technical Equipment in a Project Driven Learning Environment

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ABSTRACT

Purpose:
This paper describes the integration of technical equipment in a project driven learning environment in the School of Engineering in the Faculty of Science, Engineering and Built Environment at Deakin University, Geelong, Australia. Technical or laboratory equipment is a critical factor when designing learning environments and more so in a project driven learning environment.

Important Findings:
Deakin University has strong partnerships with industry and the community and with its cloud and located based learning policy has extremely flexible learning environments tailored to the needs of the students, with all the programs being offered in on-campus mode as well as off-campus mode. The off-campus study mode has made it even more important to have flexibility in the usage and access of the technical equipment in the laboratories.

Conclusion:
The School of Engineering at Deakin University Australia has developed a project-oriented design based learning environment which allows students to learn through design activities while being driven by the deliverables and outputs of a project. The technical equipment is required to be able to be used for traditional laboratory experiments in order to achieve fundamental knowledge requirements as well as project oriented knowledge and practice.

Keywords: *Laboratory, Project Oriented Design Based Learning, Electrical Engineering, Renewable Energy Engineering, Technical Equipment.*

INTRODUCTION

Project-based learning (PBL) is generally regarded as an innovative method for engineering education (Kolmos, 2003). The success of this method is very much dependent on the learning principles which the method possesses. When compared to traditional lecture-based engineering curriculum, the PBL models appear to inspire a higher degree of involvement in study activity. This could be due to the fact that the project work is the initialisation of the learning process (A.Stojcevski, 2008). The School of Engineering at Deakin University in Australia has introduced a new learning and teaching model in Project Oriented Design Based Learning. The focus of the model is on learning through engineering design activities while being driven by a project, which has defined deliverables and outcomes. For this reason, the selection of the appropriate technical equipment becomes one of the critical factors in the operations of the program.

There are many factors that need to be considered when choosing technical and laboratory equipment for a program in electrical engineering. After considering many manufacturers of educational technical equipment Lab-Volt was selected as the supplier of the electrical and renewable energy engineering for Deakin University. Lab-Volt is a company based in Quebec, Canada and has been a developer of educational training equipment and systems for over 50 years. Lab-Volt provides complete solutions to the learning requirements for all years of a Bachelor of Electrical Engineering program with virtualization, computer system integration and complete documentation for all systems. This flexibility allows for a well defined and student driven approach to the electrical and renewable energy engineering programs at Deakin University. One example of the type and versatility of the technical equipment is the Lab-Volt Solar and Wind power generation trainer. This trainer can be used both in a traditional laboratory environment in order to achieve fundamental knowledge, as well as be taken outside and used in a real world environment. The flexibility of the trainer allows students to work on projects such as renewable power generation, monitoring, efficiency, storage and grid connection, to name a few.

THE LEARNING MODEL

The Project oriented design based learning (PODBL) model is a teaching and learning approach (TLA) that is based on engineering design activities while driven by a project. It has been proposed to use PODBL at 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 by an industry partner or an academic staff.

PODBL is able to motivate students and teach engineering science in classrooms in order to get more practical experience that fulfill the industry needs. 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 (Chandrasekaran, 2012a, 2012b; S Chandrasekaran and A Stojcevski, 2013).

In this learning environment, participants work in PODBL 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. Cloud learning enables students to evidence their achievement. 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 require 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.

The PODBL cycle involves nine main steps. The steps are illustrated in figure 1 below and described below. Steps 1-3 take place in the cloud, steps 4-6 are a combination of both cloud and located learning, and steps 7-9 are performed through located learning (on-campus or in industry).

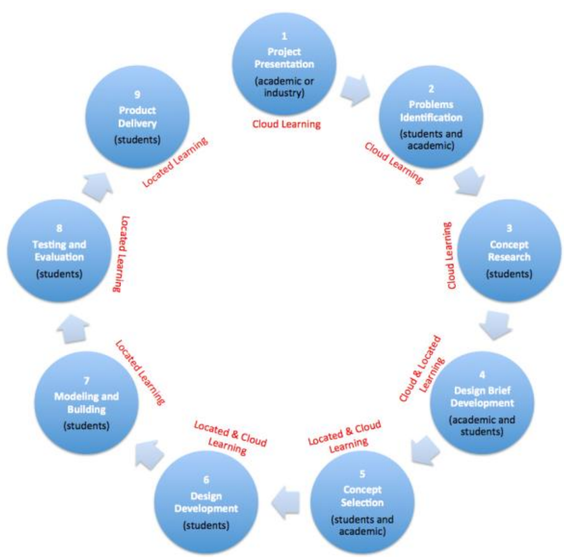

Figure 1: The PODBL learning process

In step 1 the project is presented to the team of students by the industry client (if project is industry based) or by the academic facilitator of the team if the project is university based. The project outline, which is usually open-ended, is about half in length. It is recommended that one member of the student’s team reads the project outline aloud to the group without comment at this stage. The second step is problem identification and is the brainstorming stage where the problem is outlined from the brief and the students ask questions about the significant issues and the priorities are established. The third step is about concept research in which students undertake research to understand the learning issues, the resources available and the overlapping issues. The students locate resources and share it with their team members and discuss the resources. All of the above mentioned steps can take place in the cloud and allows the students flexibility and allows them to communicate with their team members and their peers.

The next step involved is the design brief development and the students develop the key project planning document that specifies what the project has to achieve, by what means, and within what timeframe. During this step, the teams of students use the concept research ideas and findings to develop the ‘design brief’. In the fifth step they move on to concept selection which is achieved by evaluating the research findings performed in step 3, during this step the team decides and selects the most appropriate concept to be used in order to develop their final design. Design development takes place as step 6 and during this step the student team uses the selected concept to finalise and develop their final design. This could include new ideas and additional features on top of the selected design. The aspects of step 4-6 can be conducted both on the seamless digital environment and also be included as a part of the located learning experience. As part of the located learning the students as part of their teams can visit on campus or industry to explore the concept to aid them in their design brief and concept selection.

Modeling and building takes place in step 7 and the students move towards building their models and/or their designs. Depending on the engineering discipline this could be done using hardware equipment, modeling software, and laboratory equipment. Once the design has been modeled and/or built, the team tests it and evaluates it against the set requirements and specifications as a part of step 8. Laboratory equipment or industry tools could be used to do this. In the final step of product delivery the student team presents their final product to the academic and/or industry member(s). The final product can be in the form of a hardware, software, presentation, report, and other deliverables as set and agreed on by the team and the facilitator at the start of the project. The final product is assessed based on an agreed rubric.

LAB-VOLT EDUCATIONAL TRAINING SYSTEMS

There are many factors that determine the selection of equipment for engineering laboratories. These factors range from industry partners’ requirements, the pedagogical model that is being used in the learning environment and the student’s needs and expectations. A project driven learning environment is a student oriented and environment that allows for project work, team work, accessibility, and versatility. Lab-Volt educational training systems have provided technical equipment that meets all the requirements for this environment (Lab Volt). The Lab-volt systems allow for design and project work as well as giving the flexibility of computer integration and remote learning via the range of virtualization/simulation software. Over the course of its 50 plus years, Lab-Volt has gained prominence as a developer of computer-based learning systems, simulation training software, and modular multimedia educational programs with supporting classroom management systems, as well as web-based training programs. Lab-Volt's Tech-Design program has led the way in meeting the highest educational standards available in modular technology education today, using the most effective pedagogical techniques to provide a multilevel, competency-based, and interactive multimedia curriculum.

Laboratory Equipment

Laboratory equipment needs to fit the curriculum of the program and unit that is being delivered. However, when a project driven learning model is used as the delivery method it requires a more careful selection of technical equipment for laboratories. The technical equipment needs to be flexible enough to allow for traditional laboratory session to run workshops for teaching course fundamentals as well as allow for students to work on design and project work in further years of study. To this end, the School of Engineering at Deakin University has worked closely with Lab-Volt to select a range of technical equipment to allow for multiple scenarios including but not limited to traditional laboratory work, team work for a project driven learning environment, and distance learning in keeping with Deakin university's policy on cloud and located learning. Table 1 below is an extract of some of the major pieces of technical equipment purchased by Deakin University to accomplish its goals in electrical and renewable energy engineering.

As is shown in Table 1 all the technical equipment in the electrical engineering laboratories are very flexible in the type of delivery they can be used for. This flexibility has given the School of Engineering at Deakin University the benefits of running traditional laboratory workshops for teaching fundamentals as well as projects in the same space with the same technical equipment with the extra benefit for students in having a good understanding of the equipment before their project work begins.

Table 1: Technical equipment list

Items	Traditional	PBL	PODBL
Solar / Wind stations	✔	✔	✔
Solar Thermal stations	✔	✔	✔
Renewable Energy stations	✔	✔	✔
Electrical Machines Stations	✔	✔	✔
Fuel Cell Station	✔	✔	✔
Lab Volt Virtual Lab	✔	✔	✔
Nacelle Trainer	✔	✖	✖
Facet trainer with mind sight server	✔	✖	✖

The Lab-Volt Solar/Wind Energy Training System

To give a better understanding of one of the trainer modules the Solar/Wind Energy Training System is presented in this section. As it can be seen in figure 2 below, the training system is a portable modular system that allow student to cover a large range of topics in relation to energy creation, distribution and storage. A large number of project topics can be created using this system while still allowing for the teaching of energy fundamental, solar power generation, wind power generation and energy storage systems. For safety purposes the blades of the wind energy trainer are removed during experimental procedures, as shown in figure 3.

Figure 2: Solar/Wind Energy Training System

Figure 3: Motor Generator Wind Simulator

CONCLUSION

Technical or laboratory equipment plays a critical component when designing learning environments and more so in a project driven learning environment. There are many factors that need to be considered when choosing technical and laboratory equipment for a program in electrical engineering. The School of Engineering at Deakin University Australia has developed a project oriented design based learning environment which allows students to learn through design activities while being driven by the deliverables and outputs of a project. For this reason the integration of the appropriate technical equipment requires careful consideration. The technical equipment is required to be able to be used for traditional laboratory experiments in order to achieve fundamental knowledge requirements as well as project oriented knowledge and practice.

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