CDIO Open day learning activity to inspire the next generation of engineering applicants

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SUMMARY

The new engineering provision at Canterbury Christ Church University has adopted the Conceive, Design, Implement and Operate (CDIO) pedagogy approach. In particular the degree MEng and BEng and BEng with Foundation Year are grounded in the fundamentals of Physics and Engineering Science. To inspire the potential students on the open day we have developed taster sessions to develop their understanding of the important factors in fundamental Physics and Engineering. The taster sessions are a selection of Physical activities in the form of practical sessions that are related to the Engineering programmes on offer at Canterbury Christ Church University and offer the potential applicants on applicant day a flavour of the course activities and projects to our potential students for the Mechanical Engineering based programmes. The open day CDIO sessions aim to achieve the following learning outcomes:

- Students complete the preliminary design exercise of an engineering project by working in a small group.
- Students communicate their ideas.
- Students demonstrate an understanding of the project

This practice paper will provide an opportunity to discuss and review the results of the implementation of this approach to engineering recruitment practice.

INTRODUCTION

The new engineering provision at Canterbury Christ Church University (CCCU) has adopted the Conceive, Design, Implement and Operate (CDIO) pedagogy approach. The rationale for adopting CDIO education approach is that it has been shown to close the engineering skills gap, and produces professional practicing engineers fit for purpose, (Crawley, et al, 2014). To support the student recruitment cycle the University and the School of Engineering, Technology and Design run a number of open days and applicant days throughout the academic year. These open and applicants days are to support and inspire student applicants to apply and accept an offer on their programme of choice of study in engineering at CCCU.

To create this inspirational and positive learning experience the School of Engineering, Technology and Design offer a number of CDIO activities. These activities have been designed to showcase the CDIO pedagogy approach adopted on engineering programmes at CCCU, but also to provide flavour to the different engineering programmes offered at CCCU. These CDIO open day activities at CCCU have been inspired initially by the Mechanical Design module (MECH113 & MECH114) in the active learning lab (ALL), at the University of Liverpool (UoL) where Ghazal Sheikholeslami was co-teaching these modules beforehand. The course in UoL was an "industry-shaping" module that provided students with the fundamentals set in the context of CDIO whilst designing and building a modelled race car as a team.

LITERATURE REVIEW

CDIO approach provides students with the opportunity to actively learn engineering through 'doing engineering', as Massey (2012) reported this is more exciting and motivating than sitting in a lecture. The CDIO activity for CCCU applicant day/open day has been designed and based upon the vison of the "CDIO-based education", (Sadchenko, 2016; Malmqvist et al, 2017; Yong et al, 2018) to enhance the fundamentals and integrate learning of professional skills such as teamwork and communication. Correspondingly, provide student applicants with an active empirical learning experience in a short period of time, an hour.

OPEN DAY ACTIVITY CHALLENGE

The CDIO open day activity is to inspire University applicants to apply and accept a place on an engineering programming at CCCU. In this paper we are reporting on one of the CDIO activities that have been developed for the open day at CCCU was based on a programmable LEGO® MINDSTORMS® robots to make STEM concepts more tangible teaching experience by using the hands-on approach of LEGO® Education, (LEGO, 2019). This was a project-based learning for engineering, introducing students to the engineering mindset such as critical-thinking and problem-solving as well as collaboration skills. As said by LEGO Education.

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DESCRIPTION OF INTERVENTION / PRACTICE

The CDIO activity discussed in this paper used EV3 core set, the software, iPads and stop watches.

The rationale for using Lego EV3 Brick is as LEGO (2019) highlighted;

> *"The system includes the Intelligent EV3 Brick, a compact and powerful programmable computer that makes it possible to control motors and collect sensor feedback using the intuitive icon-based programming "(LEGO, 2019).*

Also, LEGO (2019) explained,

> *"The software is an easy-to-learn, easy-to-use software and the programming app are optimised for group use. Programming is done by dragging and dropping icons into a line to form commands allowing students to build simple programs, and then easily and intuitively build on their skills until they are developing complex algorithms" (LEGO, 2019).*

The students were encouraged to work in pairs, or groups of three. Each pair/group was provided with introduction worksheet and related components, to start the session. The robots were already built in different shapes due to time limitation. The groups were responsible for planning a 30 minutes experimental work with the aim of optimising the robot's program to follow the pre-designed path with different obstacles whilst reaching the finish line and then race among themselves.

The winner group who would reached the finish line in the shortest time whist successfully overcome the obstacles with a calibrated robot would be given a prize unique to School of Engineering, Technology and Design.

This CDIO exercise was designed in context to the engineering science and processes of calibration, programming and design of the speed in correlation with the pre-designed path, obstacles and several rotations. The exercise is undertaken using problem-based learning in groups of typically 2 or 3, and is operated predominantly within the active learning environment. The exercise provides learning experience of;

software engineering through programming the system

mechanical engineering in context to;

electro-mechanical engineering challenges of twin servos mechanically subtle different, resulting in on-linear system

mechanical operations of the LEGO robot servos and wheels, etc.

control and instrumentation engineering; calibration of the instrumentation and servo systems

systems engineering through wider engineering implications of different engineering field impacting on the solution and cumulative effect of mechanical, electrical/electronic errors

The personal develop learning for each student in the group enable them to perform and participate in a team of engineers to optimise the "design" of the most precise route tracker and the fastest robot. Developing their organization and time management skills. This part of exercises is 40 minutes session and takes the form of a group discussion among the members, with group members taking on roles of optimising the program, timing, calibrating and choosing the best strategy to overcome the obstacles.

EVALUATION OF INTERVENTION / PRACTICE

Each open day it was observed that the groups managed to show good understanding of the robots' designs, programming, calibration and aerodynamics by answering the popped question at the end of this activity.

The key aspect of the activity the student applicants engaged with the activity and the learning opportunity , made use of the interactive environment to finish the task. Also, it indicated the applicants were engaged in the activity and the students demonstrated an Engineering habits and mind-set (EHoM) of thinking like an engineer, as defined by Royal Academy of Engineer, 2014). The experience was so inspiring and engaging that our greatest challenge was getting our students to leave the room!

The observed results of the first open day operation of this CDIO activity:

- The students successfully completed the preliminary design exercise of an engineering project by working in a small group.
- All the groups successfully reached the final line and managed to follow all the route.
- The students were able to communicate their ideas.
- The students came up with different strategies to finish the race. It showed in the feedback we received after the race that students were satisfied their creativity was allowed and appreciated. Hence, they recognised their contribution to the project.
- The students were able to demonstrate an understanding of the project by answering the questions asked by lecturers at the end of the session.

We repeated the same exercise at the outreach event of "Skinner Academy day" at CCCU with the students of year 12. Learning from the previous exercise, we dedicated a longer time slot of 45 minutes experimental work which provided students with additional time to explore more diverse ideas. Because the first time was a success, the second time we provided them more basic program so students would communicate more of their ideas. Once more students successfully completed the exercise. The feedback we received after the

activity were very positive. They found the exercise very engaging, interesting and not happy to leave the room.

CONCLUSIONS & RECOMMENDATIONS

CDIO open day active learning session can be developed and operated in short amount time of an open day and provide a taster to the pedagogy approach and provide learning opportunity in the principles and fundamentals of engineering science relevant to programmes of study offered by an institution.

For the next time, we are developing a questionnaire to assess the students learning from the exercise, and to reinforce the key concepts of learning that students need to take away from the session. Also a feedback questionnaire is to be developed to provide formal feedback on the session to identify areas we can improve.

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