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Problem Based Learning: A Case Study from Mechanical Engineering

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PROBLEM BASED LEARNING: A CASE STUDY FROM MECHANICAL ENGINEERING

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INTRODUCTION

Engineering graduates today must be capable of much more than solving technical problems taught in engineering school. Despite learning to quantify the performance of certain engineering objects, undergraduate students find it challenging to integrate these elements into basic design concepts through a coherent and systematic design process. To help students develop real-world engineering skills as part of their engineering education, the Mechanical Engineering Discipline in Technological University Dublin (TU Dublin) introduced Problem Based Learning (PBL) for Third Year Mechanical Engineering students in 2005 [1].

A recent review of this teaching approach highlighted deficiencies not envisaged when the initial PBL module was conceived. Examples include a significant lack of awareness among students of how parts designed can actually be made and assembled to form completed, functioning systems fulfilling a product design specification in addition to an over-confidence in the ability of their designs to solve the assigned problems.

Inspired by the Japanese concept of Monozukuri, the art of making, significant changes were implemented in 2017. This paper considers the experience to date and shows that students are overwhelmingly positive of the changes implemented and feel they are better prepared for their future despite the increased workload involved.

MATERIALS AND METHODS

Small groups of Mechanical Engineering students now design, build, and test real machines within the constraints of a strict specification, budget and time limit. The 2017-18 project was a machine to dispense ten rectangular blocks vertically in a straight line with variable pitch, an example of which is shown in **Error! Reference source not found.**. The 2018-19 machine is an autonomous warehouse picker. Students meet project facilitators for an average of 2.5 hours per week.

Each group's design must include parts made using the manufacturing processes of additive manufacturing, laser cutting, sheet metal forming, milling and turning. Electromechanical components and controllers must be sourced, programmed and optimised as needed. Groups work to the same standard specification for the project but end up with unique solutions to the challenge.

Students must submit a device completed to specification, present at milestone reviews, and submit a poster and report showing the work completed including an overall project costing and technical drawings.

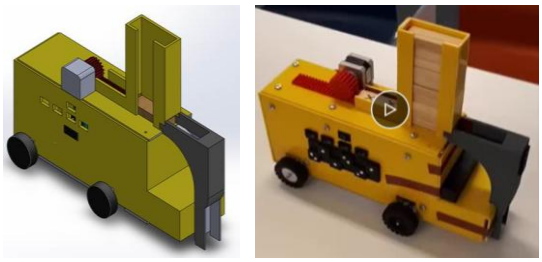

Figure 1 Block dispensing robot from 2017-18 projects

DISCUSSION

Previous research has shown that students can find it difficult to plan and integrate their design activities as part of a group. Some students appear reluctant to make decisions; they appear afraid of being “incorrect” and believe there is a right or a wrong answer for everything. The design problems posed have many solutions and students are encouraged to refine their concept and justify the chosen solution. Students must learn to justify their decisions since it is an important skill for engineers. During the initial project sessions advice is given to students on implementing appropriate project management techniques and how to document and record the decisions made by the team.

The revised module increases students’ confidence resulting in more resourceful, motivated students with experience of designing, manufacturing and optimizing machines as they enter their final year of study and embark on their future careers. Monozukuri-style projects are more time consuming for students, lecturers and support staff since open ended self-directed design projects require many variations to be accommodated.

Based on surveys conducted, the students' response is overwhelmingly positive. In a concluding comment, one student remarked that "Needless to say, this project was my highlight of 3rd year."

REFERENCES

[1] Delaney, K.D. and Kelleher, J.B., International Symposium for Engineering Education, ISEE-08, Dublin 2008.