



Case Study

A learning factory: Enhancing societal needs awareness and innovation through manufacturing class

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Abstract

The manufacturing course is a common course in most Mechanical and Industrial Engineering programs around the world. In this course, various aspects of product design and manufacturing process selection are discussed. Students are occasionally given the opportunity to utilize and fabricate some parts by using the discussed manufacturing technologies. To bring further appreciation to the course, the Manufacturing Course in Qatar University has added innovation and entrepreneurship with active learning. Instead of teaching the course material in one daunting block, the faculty (mentor) used a “*Just in Time Teaching*” strategy by integrating engineering theory and product design within a business plan. The students were divided into groups, and each group had to address a societal need within Qatar. The students were given sessions about idea generation tools and creativity techniques. Once the problem had been identified and formulated, these groups were advised and coached to prepare a comprehensive business plan that included selection of materials, manufacturing processes, organizational structure, marketing of the product, market segmentation and penetration, break-even analysis and economic analysis, as well as environmental issues. From the course assessment and student course outcomes surveys, it was found that the interest and learning curve for students increased drastically for this manufacturing course compared to previous approaches. Besides

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improving the interest and learning curve, the approach had indirectly exposed the student to project management skills, economic analysis, lifelong learning, communication and teamwork. On the whole, the approach was an interesting and led to further enhancing the student's learning process by using different learning styles through varied and innovative teaching techniques.

Introduction

Engineering activities, in particular manufacturing activities, can be dated back to the first man on Earth. Humans use manufacturing skills to transform natural resources into goods and products that will improve the quality of life. As the number of humans increased, engineering became the backbone for the growth of civilization (Jolgaf et al., 2003). Engineering is a professional activity servicing the societal needs and hence engineering education is a vital pivot for the growth of a nation. As such, the engineering education for future engineers cannot be taken lightly. Unfortunately, engineering education globally has major deficiencies (Felder et al., 2000). Literature has shown that traditional teaching, particularly rote learning, is no longer sufficient for engineering education (Esquivel, 1995; Prince and Felder, 2006), and this is particularly true in the local context of the Middle East and North Africa (MENA) region, especially in the Gulf countries (Loveluc, 2012; Mrabet, 2010; Khair et al., 2013).

With the rapid development of new technologies and the development of new economic models such as innovation ecosystems, it is imperative that traditional engineering curriculum undergoes a major overhaul (Tarlochan and Hamouda, 2015). One enhancement in engineering education pedagogy is the use of active learning, especially Project Based Learning (PBL) (Musharavati and Hamouda, 2010). Many studies have shown that PBL is an effective pedagogy tool for solving problems. Another new pedagogy that is being used is *Just in Time Teaching* – JiTT (Garvin, 2006).

JiTT came from the manufacturing management approach of Just in Time (JIT). JIT originated from Japan in 1950's and was adopted by Toyota and other manufacturing companies with excellent results. JIT is an approach where a "waste free" environment is generated by purchasing raw materials just sufficient to meet production demands, which leads to minimum inventories. With this, resources are better utilized to maximize profits. Similar in nature, JiTT approach is to maximize classroom efficacy by utilizing the internet. All instructions actually happen in the classroom and the internet is just a pedagogy resource or tool. The internet here serves as a feedback loop between homework and the subsequent classroom activities. The work that students do at home is used to leverage the time they spend in class. Hence, the instructor will have a better idea on the class progression and will help the instructor to better plan the following lectures.

Generation Z is a branding given to those who were born around the new millennium. This generation spends more time in front of TV's, computers, video games and tends to remain indoors, connecting with others digitally through social media (Gibson, 2013). Due to this, societal awareness is lacking amongst Generation Z students. Besides this, these students are adventurers and prefer to do things out of the norms. Notably, they prefer to be entrepreneurs (Shawbel, 2014).

Hence, the objective of this paper is to share a hybrid pedagogy approach between PBL and Just in Time Teaching (JiTT) with the emphasis of societal awareness and innovation to promote

young entrepreneurs. The course chosen to implement this pedagogy is the traditional Manufacturing Processes course.

Course organization

The course was organized as normal PBL and JiTT courses. In terms of the PBL, students had to start working on the project from day 1 itself. The PBL activities used are summarized in [Figure 1](#). The class hours were dedicated to teach the contents of the course syllabus. Portion of each class was allocated to discuss the PBL activities, and students work on their projects in teams, in tandem to what was discussed in class. The allocated time to discuss PBL activities was possible due to JiTT. Through JiTT activities, student had “Warm up Exercises”. These exercises are online which is due before class and were designed in *Blackboard*. Students have to do a pre-read, answer these questions online and come prepared for class. Part of the “Warm up Exercises” involves students’ discussion online, which is visible to the course instructor. The instructor will now have the privilege to see what students had understood from the assignments and pre-reads, and is in a better position to prepare for the coming lecture. In this way, time resource is optimized and students are engaged in active learning. To make the class “interesting”, selected students answers were discussed in class as starting blocks for the information to be shared. This totally made the class “alive”.

The project involves students identifying societal needs in Qatar which require an innovative solution and that the outcome can be marketed. Some students identified the need to reinvent lunch boxes for laborers. The students found that the existing lunch boxes were heavy and did



Figure 1: Semester long PBL activities

not fulfill the needs of laborers. Other students found that there are many accidents related to fire and it is important to educate children on this. Hence this particular group of students proposed to work on an education tool for children. Once the students have identified the societal needs that need to be addressed, the PBL activities as stated in [Figure 1](#) were deployed.

The findings from the implementation of this pilot study were encouraging. The students were more attentive in class, attendance and formative assessment results—in comparison to previous semesters—were much better, but the most overwhelming finding is that students enjoyed the Manufacturing course, which was not the case in previous semesters.

Conclusions

Teaching courses such as Manufacturing Process can be a daunting process, mainly because the course material is not appealing to Generation Z students. But using PBL and JiTT together made the class interesting with almost no extra hours needed to be put in. The advantages of JiTT exceeded expectations. It is a good pedagogy tool to be used in almost most courses. Adding flavors of societal awareness and innovation leading towards entrepreneurship made the students more enthusiastic in their projects. On the whole, the approach was an interesting and led to further enhancing the student's learning process by using different learning styles through varied and innovative teaching techniques.

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