

Using a Project-Based Learning Approach to Mechanical Engineering Students at Shaqra University

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Abstract : Concept of project-based learning was applied to Mechanical Engineering Students at College of Engineering, Shaqra University, Saudi Arabia. For electrical power and water desalination, Saudi Arabia mostly depends on burning of fossil fuel. This not only depletes valuable fossil fuel but also creates pollution. Use of green energy like solar energy can be reducing problems. Saudi Arabia has one of the highest solar energy resources in the world. Purpose here was to create awareness and confidence among students about use of plenty available solar energy. Two student groups, each containing three members were formed. After constructing projects, student tested project for operation. Projects assigned were solar Dyer and solar still. Students used locally available material for construction of projects. These projects were showcased in an exhibition organized in the college.

IndexTerms - Project-based learning, educational techniques, solar energy.

I. INTRODUCTION

Present scenario in job market for engineering students demands graduate with a wider skills base and ability to learn with huge information available in digital and non-digital format. To survive in global competition Industries needs creativity and added values to product. Thus Industries need transformative employees with the skills to analyse, critique and communicate innovative solutions within a team-based work environment. Due to increased globalization, basic engineering skills are commodities that can readily be sourced in low-cost economies. United States Accreditation Board for Engineering and Technology (ABET) requires student to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics under various constrains. [1]

This paper discussed the development of a project-based learning in Mechanical Engineering developed at College of Engineering, Shaqra University, Saudi Arabia. The paper first reviews the application of problem-based learning (PBL) in education and engineering education. While the literature contains few illustrations telling benefits of problem-based learning. Paper describes implementation and outcome of project based education at the college.

II. LITERATURE SURVEY

John Dewey gave idea of "learning by doing". According to John Dewey, "The teacher is not in the school to impose certain ideas or to form certain habits in the child, but is there as a member of the community to select the influences which shall affect the child and to assist him in properly responding to these." Thus student becomes active learning by doing.

Characteristics of project-based learning:

- a) Organized around an open-ended driving question or challenge.
- b) It creates a need to know essential content and skills.
- c)It requires inquiry to learn and/or create something new.
- d)It requires critical thinking, problem solving, collaboration, and various forms of communication, often known as 21st century skills.
- e)It is based on realistic problem
- f)It results in a publicly presented product or performance. [2]

Project-based learning (PBL) is student centric approach. According to the definitions found in PBL handbooks for teachers, projects are complex tasks, based on challenging questions or problems. Main characteristic of project-based learning are a) PBL projects are central, not peripheral to the curriculum b) PBL projects are focused on questions or problems that "drive" students to get solution. c) Projects involve students in a constructive investigation d) Projects are realistic. [3]

It was thought that the gap between theory and practice could be minimized by implementing CDIO (Conceive, design, implement, operate) philosophy. Way to implement CDIO philosophy was project based learning. Project based learning system at Southern Federal University, Russia for engineering students was established. The University implemented combination of conventional teaching- learning process and project based learning. To actively monitor project based system, dedicated project management software was implemented. PBL was implemented from first year of engineering studies to make students experience connection between theoretical knowledge and practical skill. The University website displays current project themes and details about project tasks aiming at developing working product. Project team consisted 4 to 8 members. Project is

performed under guidance of mentor. Students are expected to results during implementation project management system. Project participant roles and responsibilities are clearly assigned. [4]

Study was conducted in to know understanding of teachers of Kazakhstan about project based learning its benefits and challenges. Study was focused on 4 teachers teaching Chemistry, Computer Science, English language, and Physics in a Kazakh-Turkish Lyceum in the northern part of Kazakhstan. Data was conducted through semi-structured interviews. Teachers perceived that project based learning as a beneficial teaching approach that has the potential to increase student engagement and help them understand more deeply the subject content through self-learning and learning by doing. Teachers also stressed that project-based learning improved teacher-student and student-student relationships, skill development and real-world practice. The study also identified the challenges faced by teachers were shortage of time, less knowledge, and team work issues.[5]

A Project-Based Learning Approach was used in teaching Mechanical Design to First-Year Engineering Students at Rowan University, USA. Earlier, students were not exposed to challenging, hands-on design problems until much later in the curriculum, usually the third year. Because of this, most of their first two years were spent in a “context-free” manner, learning mathematics, basic sciences and engineering sciences without seeing any practical application. New course was introduced in updated syllabus at first year, “Introduction to Machine design”. Students were required to choose either the compressor Project or the Walker Project. Student group contained 3 to 4 members. It was required to present working project fulfilling constraints set by mentor. Project-based learning was successful to create interest in student about Mechanical Engineering.[6]

Project-based learning activity was given to twenty secondary school students from Anambra State, Nigeria. As Nigerian people mostly uses wood and coal for cooking results in smoke. Frequent exposure to smoke leads to loss of vision among ageing women and chronic obstructive pulmonary disease of women. Social issue of pollution was addressed by providing alternate green solar energy. Project was aimed at designing a solar concentrator using locally available materials. The students used the designed solar concentrator to generate high temperatures at the absorber located at focus point. Solar radiation falling was measured with pyranometer and temperature of collector with thermometer. It was found that temperature of absorber was enough to carry cooking or other activities to replace fissile fuel.[7]

Project-based learning used to teach design skills to civil engineering students at University College Dublin, Ireland. PBL module case studies in civil engineering which is taken by the students in the first semester of the 2 year Master of Engineering (ME) course in Civil Engineering. Core Civil Engineering Design courses are taken which build on the theoretical principles of Structural Engineering and Soil Mechanics developed during the BSc. programme and apply these to real design problem. It involved weekly presentations by students to experts. The project based learning module helped to develop skills like problem-solving, innovation, teamwork and presentation skills desired by graduate employers. It was clear that the students enjoyed the peer to peer teaching and increased interaction with staff and external experts.[1]

Project- based learning was introduced Mechanical Engineering at Technology University of Dublin, Ireland. Under PBL, Mechanical Engineering students designed, built, and tested 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. Students met project mentor for an average of 2.5 hours per week. It was expected to include parts made using the manufacturing processes like 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. During the design process students got various alternatives, they selected appropriate solution and further refined solution. Students were required to justify their decisions as an important skill for engineers. Project management techniques were taught at start of project. It increased confidence of students. Student got experience of designing, manufacturing and optimizing machines. But student felt it as time consuming. [8]

III. PBL IN MECHANICAL ENGINEERING

3.1 Background

Saudi Arabia has one of the highest solar energy resources in the world. Presently Saudi majorly use petroleum products for electrical power generation and desalination. Majority of water demand is fulfilled through desalination using petroleum products. Thus both activity consume very huge amount of fossil fuel and create pollution. Demand for electrical power and water is increasing drastically day by day. Demand for electrical energy expected to rise from 40 GW up to 120 GW between years of 2010 and 2028. This will put further pressure fossil fuel and create pollution. One of ways to reduce pollution is to use green energy like solar radiation.[9]

It was felt need to create awareness and confidence about use of solar energy through projects. Project-based learning module was given to 6 students of mechanical engineering. They were told to construct and test **one of two** a)solar Dyer b) solar still from locally available materials. They searched related material and made project. They exhibited their work by making poster and showing their project to students and faculty members from the University.

3.2 About projects

Students were allotted two projects, one project per group. After allotting project, students searched related papers. Student made plan for manufacturing and discussed among them. Students searched local longitude and latitude to decide slope of glass. As time allotted was 1 hr per week, hence very fine tuning of project was not possible. Two projects allotted were a)solar Dyer b) solar still

Background of two projects is as follows,

a) Solar Dyer:- Objective of solar dryer is to supply the product with more heat than available under ambient condition, thereby increasing sufficiently vapour pressure of moisture held and decreasing relative humidity of drying air and increasing moisture carrying capacity. Solar dryer can dry food items which perish if not dried.

b) Solar still: - Saudi Arabia majorly contains area with low rain fall. Fossil fuel is burned to obtain water from sea water by process of desalination. Using solar energy for desalination can save fuel and reduce pollution. To fulfill need of people of Saudi Arabia Solar still can be used. Solar still uses solar energy to convert sea water to distilled water. Thus people can locally get distill water. The sun's energy heats water to the point of evaporation. As the water evaporates, water vapor rises, condensing on the glass surface for collection. This process removes impurities such as salts and heavy metals as well as eliminates microbiological organisms. The end result is water cleaner than the purest rainwater.

IV. OUTCOME

Following outcome were achieved from Project-based learning

- i) A greater depth of understanding of concepts,
- ii) Broader knowledge base,
- iii) Improved communication and interpersonal/social skills
- iv) Enhanced leadership skills,
- v) Increased creativity,
- vi) Improved writing skills
- vii) inspired other students of college about use of solar energy

Photographs of solar dryer (Fig. 1) and solar still (Fig. 2) are shown. These projects were exhibited in college and were open to all. Students also made posters shown in Fig. 3 and Fig. 4. Response to exhibition was very good. Students felt proud to build project and test. But student found it time consuming. It build ability work in team, enhance communication skill and thinking ability of students.



Fig. 1 Photograph of solar dryer made by students

V. CONCLUSIONS

The project-based learning was success at College of Engineering, Shaqra University. Following conclusions can be drawn,

- i) This active learning method gives greater depth of understanding of concepts,
- ii) It improves communication and team work skills
- iii) It enhanced leadership skills among students,
- v) It enhanced creativity of students,
- vi) It improved writing skills
- vii) It inspired other students of college about use of solar energy

In overall students were very satisfied by learning by doing. But students were not happy about more time spent in it.

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REFERENCES

- [1] K. Gavin, 2011. Case Study Of A Project-Based Learning Course In Civil Engineering Design. European Journal of Engineering Education.vol 3, pp. 547-558
- [2] Project-based learning (2021, May 10), https://en.wikipedia.org/wiki/Project-based_learning
- [3] John W. Thomas, 2000. A Review of Research On Project-Based Learning. Project report supported by the Autodesk Foundation.
- [4] G E Veselov, A. P. Pljonkin and A Y Fedotova, 2019. Project-based learning as an effective method in education. Proceedings of the 2019 International Conference on Modern Educational Technology. pp. 54-57.
- [5] Aidyn Intykbekov, 2017. Teacher Perceptions Of Project-Based Learning. Master of Science thesis, Nazarbayev University Graduate School of Education.
- [6] Eric Constans and Jennifer Kadowec, 2011. Using a Project-Based Learning Approach to Teach Mechanical Design to First-Year Engineering Students. American Society for Engineering Education. AC 2011-511:
- [7] O. M. Felicia and E. C. Innocent, 2017. Project-Based Learning And Solar Energy Utilization Using Locally Designed Solar Concentrator: Encouraging Sustainable Development Practices Among Nigerian Science Student. PUPIL: International Journal of Teaching, Education and Learning. pp. 28-50.
- [8] Kevin D. Delaney and Gerard Nagle, 2019. Problem Based Learning: A Case Study From Mechanical Engineering. INSPIRE Conference, TUDublin
- [9] A. Baras, W. Bamhair, Y. AlKhoshi, M. Alodan and J. Engel-Cox, 2012. Opportunities and Challenges of Solar Energy in Saudi Arabia. Conference on World Renewable Energy Forum