

Course Level PBL: an Excellent Teaching Method for Increasing Skill Levels and Learning Motivation in First Year of Engineering Students

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Abstract: The recent survey done by various agencies on employability of engineering students indicates that an Indian graduate engineers lacks crucial employability skills such as critical thinking, problem solving, team work and communication. Problem and Project based learning can be the best alternative to solve the employability issues of an Indian engineering graduate. In first year of engineering failure percentage, drop out and learning problems are generally high. Success of engineering profession largely depends on the knowledge gained and skills acquired by student during four years of engineering graduate programme. In this paper, to improve skills and learning motivation of students, an attempt is made to implement course level PBL model for one of the important technical course of first year as Basic Mechanical Engineering. The outcomes to be assessed were problem solving ability, team work and communication. Course Basic Mechanical Engineering was designed and developed to learn it in PBL environment. Course PBL assessment and evaluation strategies were communicated with students before starting the course. Implementation was carefully done for entire academic semester of the course and observations were noted. Implementation results were found very promising and satisfactory. Students were found extremely happy in learning PBL environment. They also stated that course level PBL was very much helpful for them to improve critical skills such as problem solving ability, team work, communication and self directed learning.

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1. Introduction

Engineers are technically skilled professionals. They are responsible for solving the problems faced by society and nation. Technological development of any nation is duty of engineers and technocrats. Thus, engineers are the backbone of nation building. To perform these duties effectively, engineers requires different sets of skills such as professional, soft and personal skills. To fulfil the requirements of society and nation, large demand of engineering graduates results into establishment of number of engineering institutes in our country. As per the numbers of survey performed by various agencies, the quality and competency of most of the engineering graduates coming from these institutes is questionable. To improve the quality of engineering graduates in India, government and engineering institutes have introduced number of skills enhancement programmes. I think, problem and project based learning could be one of best alternative to solve process skills and quality related problem of Indian engineering graduate student. If we able to implement problem and project based learning in scientific way, then we can improve the quality of engineering education.

2. Problem Statement:

In India, undergraduate engineering program is of four years. First year of engineering is very important for every engineering graduate. Because at first year failure percentage, drop out and learning problems such low learning motivation, change management are generally high. This is because the way by which students prepare for

10+2 pattern is not suitable to learn various engineering courses. In engineering it is expected that students should apply the knowledge of science to solve the problems. Basically, engineering is applied science wherein we have to apply knowledge of science to create something called product or to solve societal, industrial or engineering problems. Success of engineering profession largely depends on the knowledge gained and skills acquired by student during four years of engineering graduate programme. Therefore, to increase the levels of important process skills such as problem solving, critical thinking, communication, team work, self directed learning and to improve the learning motivation, to make students as active learners we have to think on non-traditional, innovative teaching-learning method. In this research paper problem and course level project based learning method is adopted for one of the engineering course of first year of engineering as Basic Mechanical Engineering to overcome above mentioned learning and motivation problems with students.

3. Objectives of the Research

In order to achieve desirable outcomes of the research, following objectives were formulated;

- To develop PBL curriculum for the course Basic Mechanical Engineering. PBL curriculum includes the details such as problem statement, activities of project with timeline, assessment and evaluation strategies for the desirable outcomes of the project work.
- To improve the important process skills such as problem solving, critical thinking, team work, communication and self directed learning of the students.
- To improve learning motivation in students to make them active learners.

This research work is motivated by requirements of critical process competencies in an Indian graduate engineer to make it employable in all over the world.

4. Methodology:

The research work mentioned in this paper is experimental. To achieve the desirable outcomes, following methodology is adopted.

- Development of course PBL curriculum and assessment-evaluation strategies for achieving desirable outcomes.
- Identification of activities of the work with their timelines.

- Actual implementation of the PBL course in entire academic semester.
- Taking students responses for PBL
- Review of students' responses and attainment of outcomes.

5. Experimentation:

5.1 Introduction to PBL:

PBL can be defined as educational strategies in which the learning of knowledge skills and competence is organized around contextual, well-structured and authentic problems. In such a learning environment, students take responsibility for their own learning and work collaboratively with each other to achieve meaningful solutions of posed problems. In this way, PBL encourages students to learn about aspects of collaboration, problem solving, co-operation and teamwork. This is called as learner centric and participant directed approach in which students own their projects and make decisions to get desired outcome. PBL way of learning is based upon is based on three principles of learning such as cognitive learning, content and social learning. In a typical PBL way of learning, the learning is problem centered and problem acts as motivation of learning. PBL starts with identification of authentic problem for study. Once, problem statement is declared then the students are advised to prepare the teams. Generally team size is 4 to 5 members in each team. Team members undergo brainstorming and discussions to find the number of solutions for the problem.

Out of all alternative solutions, team selects one solution as initial feasible solution. During the process of development of solution, the problem solving and critical thinking abilities of the students gets nurtured. Collaborative and cooperative learning motivates the students for self learning and learning in team. Preparation of project reports and presentation helps the students to improve verbal and non-verbal communication skills.

Benefits and features of PBL way of learning are:

- i.** It helps to nurture critical thinking and problem solving abilities in students.
- ii.** It helps to improve learning motivation in students.
- iii.** It improves self learning and team working abilities in students.
- iv.** It encourages students for entrepreneurship and product development.

5.2 Details of course selected for PBL:

In this research paper, course level PBL model developed by Dr. Vikas Shinde of Vishwaniketan, Khalapur India is adopted for one of the engineering course of first of Bachelor of Technology as Basic Mechanical Engineering at Kolhapur Institute of Technology's, College of Engineering (Autonomous), Kolhapur, India. This course is common for students of all programs at F Y B Tech. The course Basic Mechanical Engineering deals with understanding of construction, working and applications of various work producing devices, work absorbing devices, energy conversion devices, power plants, energy sources, mechanical power transmission devices and manufacturing processes. In credit system, this course has three credits for theory and one credit for laboratory. The course consists of three one hour lectures and one two hours of practical per week

Table 1: Course credit details

CLPBL Course	Credits	
	Theory	Laboratory
Basic Mechanical Engineering	3	1

5.2 Development of course curriculum in PBL:

Before implementation of CLPBL, the course curriculum was developed in PBL. The details of course level PBL are as follows.

Problem Statement:

Create working model/prototype of your innovative product or idea which can be very much useful to mankind and society by applying knowledge and skills of mechanical engineering.

Problem description:

Most commonly observed mechanical systems in our day to day life and industries are; work producing devices, work absorbing devices, energy sources and power plant, energy conversion devices, actuators, power transmission devices, mechanisms, manufacturing processes and machine tools, robots and automatic systems. By applying knowledge of mechanical engineering, is it possible to create innovative product or develop solution for problems faced by mankind and society in agriculture, industrial, power generation, automotive, renewable energy sources, fuels, kitchen and household appliances or any suitable sector.

Project activities with timeline:

Following schedule shown in table 2 was adopted for carrying out various activities of the CLPBL.

Assessment of project was completed in three steps;

- i. Project Synopsis presentation
- ii. Project Progress Presentation with Model/prototype

iii. Final evaluation of the PBL Project and Projects competition

All these assessments were supported by rubrics to make assessment more fair and unbiased. Sketch of the proposed model/prototype, project plan, number of references used, individual contribution and presentations were the rubric parameters used to evaluation of synopsis presentation. For project progress presentation percentage completion of work according to project plan, individual contribution and presentation were considered as rubrics parameters.

For assessing final presentation of project, use of eco-friendly materials, project cost, operational accuracy, individual contribution and presentation were considered as evaluation rubric parameters.

Table 2: Project activities with timeline

Sr. No.	Activity	Timelin
1	PBL awareness in class	1 st week
2	Discussion of problem for PBL and its evaluation rubrics	2 nd week
3	Team formation	3 rd week
4	Project Synopsis presentation	5 th week
5	Completion of corrections/improvements in	6 th week
6	Project Progress Presentation with	10 th
7	Completion of correction/improvements in previous evaluation	11 th week
8	Final evaluation of the PBL	13 th



Students Presentation



PBL projects competition

5. Experimentation Results and Discussions

Out of total 319 students involved in PBL activities of the course, 279 students submitted their responses to various questions as shown in Table 3 below.

Table 3: Students responses towards achievements of process skills and learning outcomes (Shinde 2014)

Question No.	Question	Students Response (%)		
		Agree	Neutral/no opinion	Disagree
1	My course PBL project helped me to take responsibility for my own learning and motivated me for self learning	85.30	11.11	3.59
2	I learned to become a more independent and self-directed learner	84.58	10.03	5.37
3	My learning through projects was better than classroom learning	94.95	4.65	0.4
4	I feel, project work motivated me to become self learner.	84.94	10.75	4.30
5	I feel project work improved my interest in learning and learning motivation	86.37	12.54	1.07
6	I learned to think deeply	81.36	14.33	3.58
7	I feel, my problem solving ability is improved	80.64	15.05	4.30
8	I feel, my presentation skills are improved due to project work	86.37	13.63	-
9	Working on a projects was a good experience	95.34	4.65	-
10	The project engaged my learning and thinking skills throughout the semester	95.69	4.30	-
11	I feel, due to projects I learned project management principles	96.05	3.94	-
12	Working in a team was a nice experience	91.39	4.30	4.30
13	The team member's roles was crucial for project outcome	90.68	9.32	-
14	PBL helped me to improve my ability to work in a team	91.75	6.45	1.79
15	My teammates helped me to complete my part of project and also helped in understanding the technical concepts involved in project.	92.83	6.09	1.07
16	I feel, working models competition helped me to learn number of new technical things.	94.98	5.02	-

The effectiveness of project in motivating students for self learning was evaluated on the basis of students' responses to question numbers 1, 2, 4 and 5 as shown in Table 3. From these responses it seems that 85.30 % students felt that due to project work their self learning ability and learning motivation get improved which is very closely related to National Board of Accreditation (NBA) programme outcomes PO12: Lifelong learning. This improved learning motivation results into development of interest and enthusiasm of students in learning process.

The effectiveness of project in nurturing problem solving ability of students was evaluated on the basis of students' responses to questions 6 and 7 of Table 3. From these responses, it seems that 81.36 % students agreed that CLPBL work helped students to nurture their problem solving abilities which is very closely related to attainment of NBA programme outcomes PO2 and PO3.

The effectiveness of project work in improving communication and soft skills of students was evaluated on the basis of students' responses to question 8 of Table 3. From these responses it seems that 86.37 % of students realized that due to PBL approach their communication and soft skills improved much which is very closely related to NBA programme outcome PO10 (communication). As per assessment plan of CLPBL activities, each project group has to give three presentations of their project work in entire semester. These presentations helped students to improve their communication and soft skills.

The effectiveness of PBL approach in improving team work of students was evaluated on the basis of students' responses questions 12 to 15 of Table 3. From these responses it seems that 91.66 % students felt that due to PBL approach their team work is improved which is very closely related to NBA programme outcome PO9 (team work). Students learn to work in collaboration and co-operation while working in teams. Students also learn and understand various technical concepts involved in project through their teammates

6. Conclusions

In this research paper, an attempt is made to implement course level PBL model for one of the technical course of first year of engineering. Results of implementation are very much promising. From students' responses to PBL approach as shown in Table 3, it can be concluded that PBL approach helped students to nurture the important process skills such as; problem solving, critical thinking, learning motivation, team work and communication. It was found that students actively participated in all activities of the project work. Students interest in learning and enthusiasm were improved which was very useful to convert them into active learners. Total 319 students participated in PBL projects competition in 71 projects. Evaluators of this competition remarked that out of 71 projects, six projects were ready as a product to launch in market. Course teachers were very much actively

participated in all activities of the PBL project. Students and teachers also recommended that PBL approach should also be used for teaching other courses of first year of engineering.

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