

# Effectiveness of Project Based Learning models to achieve 6Ps in Vishwaniketan, India

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## Abstract:

Indian engineering education sector is looking for the suitable alternative for curricular and teaching learning practices to achieve its goal to align itself for outcome based education. Project Based Learning (PBL) approach has been considered as a suitable alternative to improve the learning outcomes and employability skills of the graduate engineers. ViMEET is an engineering institute established in the year 2012-13, with an vision to implement PBL. It has developed four different PBL models for improving quality of engineering graduates. In this paper, these models are discussed in detail. Also, focus of this paper is to investigate effectiveness of PBL models to achieve Performance, Placements, Products, Patents, Publication and Public Image. These parameters are shortly noted as 6Ps. To check effectiveness of PBL models, a quantitative data is collected from different departments with various methods and student's feedback is taken in the form of survey. Students mentioned that PBL model has been a key element for their personal achievements and largely accept that they learned better in PBL environment. Although thoughtfully designed, PBL models could not lead to expected number of patents and publications, more work would be required to refine these models to get better results. Overall, it is concluded that PBL approach has been accepted by the students and promises to be excellent practice to achieve 6Ps.

**Keywords:** PBL, Performance, Placements, Products, Patents, Publications and Public.

## 1. Introduction

India boasts on the roots of "Guru Shishya Paramapara" since its ancient history. Education in those days were focused on passing knowledge "Dnyan" to the "Shishya" by "Guru". It was well supported by the principals in Gurukul premises. In fact, India had first international university in the name of "Nalanda Vishwavidyalaya". During those days Indian education was largely based on art and culture. Accordingly society had various artists and groups of skilled people. Professional Technical education was started at the time of British ruled India where East India Company first started Gun carriage factory in Guindy. Since, then till date we are following education system inherited from British India (Shinde et al 2014).

Currently Indian education system is the third largest in the world with 399 state universities, 126 deemed to be universities, 48 central universities & 334 private universities (UGC, 2019). Gross enrolment in higher education is around 25.8% which is less than developed countries. Most of these universities are practicing traditional teaching learning practices and outcomes of these universities are not as per the global standard (thetstateman, 2019).

Various National reports on Indian engineering education claimed that graduate engineers lack critical employability skills. Blom & Saeki, 2011 reported that there is a gap between graduate engineers skills and the industry demands. This inconsistency or mis-match is attributed to curriculum design and existing teaching-learning practices (Rao, 2006, Pal, 2009, NKC, 2010, Blom & Saeki, 2009).

As per Yashpal, Rao Knowledge commission reports, most of the institution in India focus on rote learning; where focus is on "remember and reproduce". It's commented than curricular practices; Teaching, learning & assessment do not promote for skill development. Especially in higher education, it's needed that the education focus on essential skills such as design, problem solving, teamwork, and communication skill. Technology patents & employability is also questioned in recent times. It's our belief that our education must be tuned with current Industrial requirements and should be able to address problems of society. Government of India started a scheme like "Start up India" and "Make in India". Success of these schemes largely depends on outcomes from education systems. Unless and until, we create systematic change in the educational philosophy & practices, global ranking and success of Government schemes seems to be difficult goal

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to achieve. In this research paper, we treat PBL as a suitable alternative to achieve these objectives. However, there is a need to understand PBL philosophy and elements of PBL curriculum design in order to implement PBL effectively in the Indian context. This paper focus on discussing PBL principles and effective use of these principles to design different PBL models having different targeted outcomes. Also, effort has been made to evaluate designed models and this paper presents the report of evaluation.

## **2. Research Context and objectives**

Recently, Indian educational institutes are facing serious issue of attracting students towards engineering education. This may be because of outdated curriculum, traditional teaching learning practices which mostly promote rote learning or lack of sufficient engineering jobs to absorb outcome of huge number of engineering graduates. This situation demands systematic change so that students get attracted towards engineering and new types of engineering jobs creation. In addition, accreditation agencies which largely responsible for maintaining quality conformance in the country failed desolately to promote quality education culture in the country. Most of the institutes opting for accreditation are preparing documents for compliance without much attention on adapting quality practices. In view of all above mentioned issues and challenges, Problem and Project based learning (PBL) strategy has been considered as a suitable alternative (Shinde, 2011).

We assume that without changing towards Problem Based Learning approach this cannot be achieved to the greater penetration. PBL is considered as suitable alternative for achieving this and Vishwaniketan is a place where various experiments on PBL are carried out since its inception in 2012-13. Vishwaniketan is an educational non-profit trust established in 2012-13. Currently, it runs Engineering, Architecture & Design professional courses. Vishwaniketan's Engineering courses are affiliated to University of Mumbai & approved by competent statutory bodies. We aim to create competent design professionals who can create novel products and solve social and National issues keeping global context in mind. Institute has its educational philosophy developed on Project Based Learning philosophy & practice. It has created PBL Centre of Excellence which works for PBL Training and consultancy. So far, through PBL-COE; six institutes have been trained to implement PBL & more than 63 workshops have been arranged & headed by PBL-COE Team. This way PBL-COE has created pathway towards transforming traditional institutes into PBL Institutes.

This research is carried out in ViMEET which is an engineering institute in Vishwaniketan campus, located in Khalapur, India. ViMEET has designed and practiced four different PBL models. This paper discusses these PBL models practiced in Vishwaniketan and its outcomes. To assess PBL models, we developed 6P framework which include parameters like Performance, Placements, Products, Patents, Publications and Public; combined together considered as 6Ps in this paper. Thus, objective of this

paper is to investigate effectiveness of PBL in achieving 6P. The rest of the paper is organized in following manner; Section 3, describes methodology adapted for assessment for PBL models, Section 4 is dedicated to a PBL: Philosophy and Practice at ViMEET, an Section 5 elaborates outcomes of assessment of PBL models.

## **3. Methodology**

The aim of this paper is to investigate effectiveness of PBL practice. A case study approach is used. The outcome assessment is carried out based on theoretical insights in PBL practice and the past reports of the institute. Student's Performance is judged based on academics, competitions inside and outside institute. Placements are judged based on actual placements data and employability of students based on industry feedback. Products are counted based on the number of the projects which are completed as prototypes and number of start-ups. Analysis and simulation projects are excluded from the list. Patents are counted based on actual patents filed, and potential patents. Publication data is collected for the last three years which include both staff and students' publications. Public is a factor which represents parents, partner industries, local people and academicians. Their opinion about PBL models are collected and analysed. The data collected from all the sources are combined together, analysed and discussed.

## **4. Problem and Project based Learning**

PBL practice which is originated in McMaster University in 1968 for medical education has now been practiced in many professional fields. Many institutes have developed PBL models and practices suitable for their educational culture. However, it's been observed that most of the PBL models uses similar principles for learning (Kolmos et al 2009). Cognitive principle states that problem is a driver for the learning process and students learn while solving the posed problem. Content principle depicts exemplary practice adapted to achieve learning objectives and puts problem in the contextualised setting. Social principle puts an emphasis on learning in team setting where cooperative and collaborative learning principles are used for promote learning. These principles are effectively used to develop four models listed below.

### **4.1 Problem Based Learning Cycle**

Fig.01 shows Project Based Learning (PBL) cycle which (PBL) focuses on curriculum development based on current contextualised problems. These problems may be adapted from industry or societal needs or it can be global issue or future technology demands. Thus, PBL curriculum has a problem at the centre and syllabus content is developed based on this problem. Appropriate assessment methodologies are used to assess and evaluate student's performance in PBL curriculum.

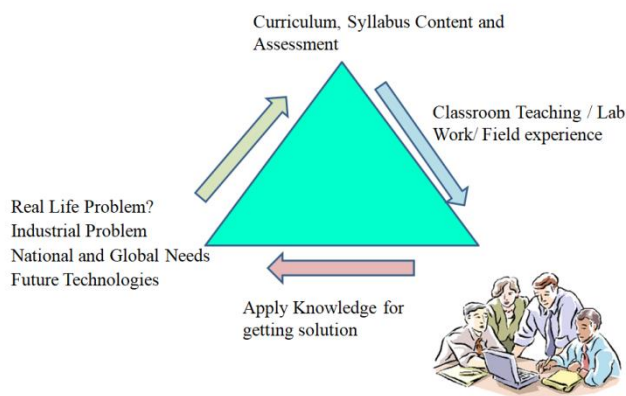


Fig. 1 Typical PBL cycle

Once the curriculum is developed basic fundamentals and prerequisite knowledge required to solve the problem is provided by using various instructional and teaching-learning strategies. Thus, in PBL students receive basic prerequisite knowledge required for solving the problem. Since, most of the time the problem under investigation is complex and require interdisciplinary knowledge, students' teams with various disciplines work together. This way, students in PBL environment learn to practice problem solving, team work and design skills during the process itself. Thus it promotes problem solving and novel product development which is a need for strengthening quality of engineering education in India.

However, PBL is not rooted in Indian Education system. Surprisingly none of the universities is practising PBL to its fullest potential. This may be because; PBL philosophy has an origin in the western world, where the educational culture and values are different than those in India. May be Indian educators are not sufficiently trained to practice scientific PBL. Thus, need for one representative PBL institute would be required where PBL has been successfully experimented. ViMEET has been created to serve as model institute and has been continuously experimenting with PBL practice. It has adapted PBL by customising exiting academic culture and infrastructure; called as PBL ecosystem. Following section provides insight into ViMEET PBL models.

## 4.2 Types of PBL models practiced at ViMEET

### 4.2.1 Value Addition PBL

ViMEET is an affiliated institute to Mumbai University (MU) and it practices curriculum designed and developed by it. Through MU curriculum analysis, we understood that University curriculum do not have enough focus on future technologies such as Machine learning and Artificial intelligence etc. So, institute decided to integrate future technologies with PBL practice. Accordingly institute identify key technologies and industry partner for training. These industries provide list of problems which is discussed with the students in detail. Once the students approve particular technology, institute signs a Memorandum of Understanding with the industry partner.

According to the technology each department organise VA-PBL training for students in each semester. Fig-02 shows this pre-processing cycle.

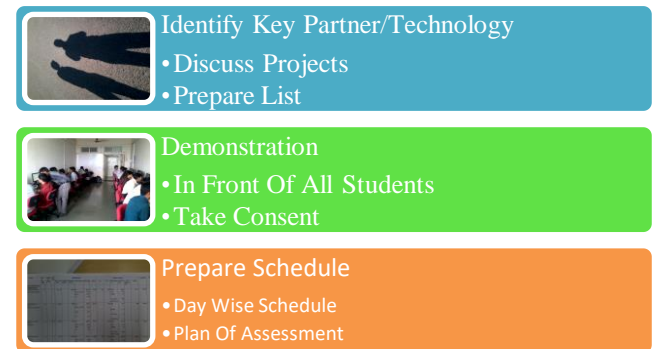


Fig. 2 VA-PBL Pre-processing

As shown in the fig. 03, at the beginning of every semester, industry expert gives training to the students on future technology. Usually this training is conducted for 60-70 hours. After training, students are divided into groups and topic for a project is given to the students which they are expected to work on throughout the semester. Students are allowed to apply knowledge to solve problems given by industry trainer during the entire semester. At the end of the semester, the projects are evaluated by the external members, faculty and the trainer. Students are graded based on the rubrics developed for the projects. To conduct training, lab infrastructure is provided along with one faculty coordinator who ensures smooth conduction of the VA-PBL for whole semester. This practice is followed till sixth semester.

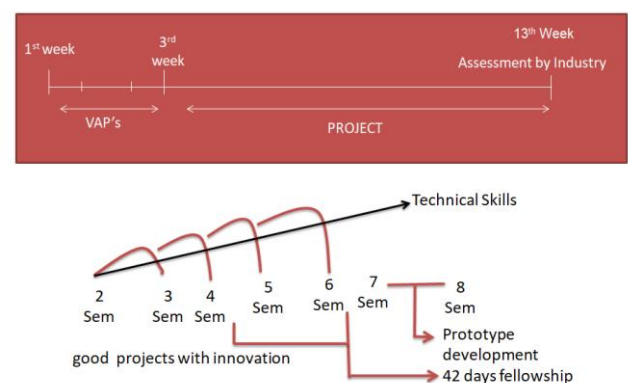


Fig. 3 VA-PBL cycle

### 4.2.2 Course level PBL model

This model is designed to improve content learning of the students. Every semester, PBL is implemented and practiced in the one course or multiple courses (Fig.04) of the second and the third year of each programme of the institute. Faculty allocate projects to the students. The project topics were selected in such a way that course content also learned with real life problems solutions. It is assumed that such practice will help students to learn relevance of classroom learning in the real life contest.



Fig. 4 CL-PBL cycle

#### 4.2.3 Industrial PBL

Depending upon the student's interest and their achievement in above two models, some of the students are allowed to work on the real industrial problems. This model provides industrial problem solving experience to the students. Fig 5 shows industrial PBL cycle.

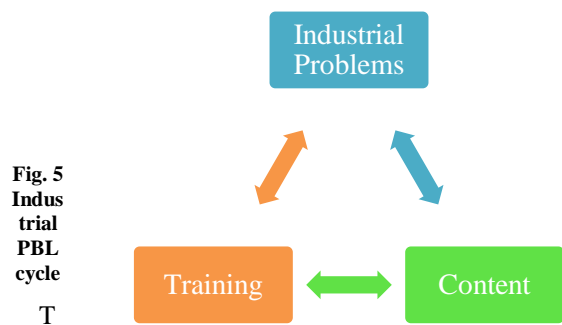


Fig. 5 Industrial PBL cycle

To support this model industry has sponsored labs to the institute with tailor-made practice and mentoring sessions. Institute supports it through finance, space and logistics. Following fig. 6 shows, one semester plan of Industrial PBL cycle. Before actual start of the project, team of the interested students is selected and trained on the project requirement. Usually, this training is offered by the sponsoring industry. After training, students apply their knowledge to solve the given problem. During the process faculty and industry mentors are provided to keep the track of the project work. During and after project work continuous assessment and evaluation is done. Since, this is industrial PBL cycle; non-disclosure agreement is signed with the industry, institute and the students.

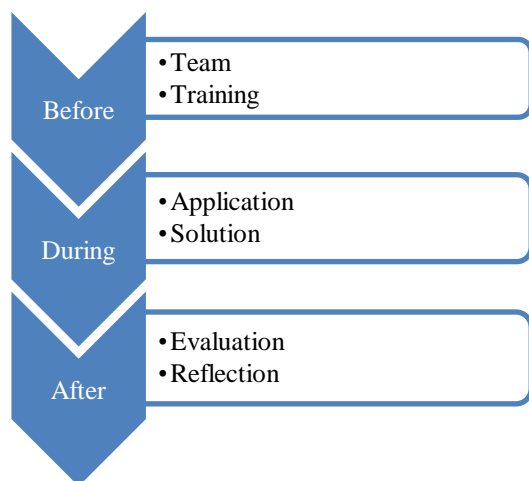


Fig. 6 Typical PBL cycle

#### 4.2.4 Undergraduate fellowship

This programme is also known as international project based summer internship. Depending upon the student's

achievements and interest to pursue international career, some of the students are allowed to work on the international projects. Every year the students from India are sent to the foreign universities which have signed collaboration agreement with ViMEET. Due to this model, the students get an opportunity to explore the foreign university courses and also learn innovative things. The aim of this model is to help students to get an exposure in international universities. Since, its start this programme has benefitted 800+ students and faculty from India.

Fig 7 shows this model in which students are sent to the international university for 42 days during summer. During 42 days of stay, students work on the projects provided by the professor from that particular university. These projects are either research projects or sponsored projects. This way student's gets an international project based learning experience.

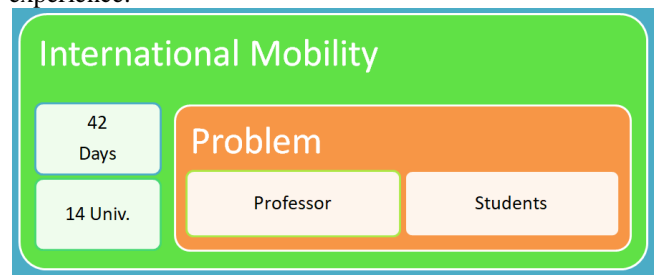


Fig. 7 International Project based summer Internship

In summary, it can be understood that ViMEET has developed different PBL models for benefit of their students and faculty. However, auditing of these PBL models have not been done so far. Thus it was needed to conduct research to investigate an effectiveness of these PBL models.

To start the performance audit, a case study approach is used. One department is chosen to collect the data. Various tables and formats are prepared to collect the data. The outcome assessment is carried out based on theoretical insights in PBL practice and the past reports of the department. Student's Performance is judged based on academic performance. Employability of students is judged based on industry Placements data. Products are counted based on the number of the projects which are completed as prototypes and number of start-ups. Analysis and simulation projects are excluded from the list. Patents are counted based on actual patents filed, and potential patents. Publication data is collected for the last three years which include both staff and students' publications. Public is a factor which represents parents, partner industries, local people and academicians. Their opinions about PBL models are collected through informal discussions and platforms. The data collected from all the sources are combined together, analysed and discussed.

## 5. Results and Discussion

In this section, efforts have been made to analyse the data provided by the mechanical engineering department for primary analysis. It may be noted that this department is the largest department in the institute with annual intake



capacity of 120 students per year. Thus, this department is chosen to represent the institute. This data collection is still in progress and data for beneficiary for each model is still in progress. Other, departments may have better data than this department. Mean while, to meet the deadline for submitting the paper, preliminary data is used for this paper. This data collection is still in progress and subjected to change. Since more data is expected but not received on time, detailed analysis will be made available for the next version of this paper.

### 5.1 Performance

In this part, student's performance in the final year examinations is discussed. In general, it has been found that the results are better in all years except few students failing to pass the examination. However, these results cannot be attributed to PBL alone and neither it reflect quality of the result.

**Table 1 Students performance in the final year examination for Mechanical Engineering department**

Academic Year	Number of students appeared in the examination	Number of students passed the examination	Passing %
2018-19	134	130	97
2017-18	141	134	95
2016-17	138	136	99

### 5.2 Placements

In this part, student's performance in placement activity is tabulated for the final year students. Students' employability is reflected in actual placements and quality is reflected in the number of eligible students for placements. From the data, it is understood that placement is on positive side or within acceptable range but the number of eligible students are less. Thus, focus must be made to improve academic performance of the students. Placement performance can be attributed to various PBL activities. As per the feedback from placement department, industry is happy with technical skills of the students but advised to focus on communication skills of the students.

**Table 2 Placement data for Mechanical Engineering department**

Placement Year	Number of eligible students	Number of students placed	% placement
2018-19	68	56	82.35
2017-18	77	47	61.03
2016-17	53	37	69.81

### 5.3 Products

Products are the outcomes of the complete PBL process and choice of the problem statements made by faculty and the

students. Data provided suggests that almost 55% project are inclined towards product development cycle, which can be considered as a good performance.

**Table 3 Project data for Mechanical Engineering department**

Academic Year	Total Number of projects	Total Number of prototypes	% Prototypes
2018-19	32	18	56
2017-18	29	17	58
2016-17	28	15	53

### 5.4 Patents

Patents are the technology right for the producer of the good projects. In general, it indicates innovative contribution made by the students. Although, in the table 3, suggests that almost 55% project are inclined towards product development cycle, number of prototypes having potential patent possibility are very less, which shows that lack of innovations in project making.

**Table 4 Patent data for Mechanical Engineering department**

Academic Year	Total Number of expected patents	Total Number of patents filed	Number of potential patent prototypes
2018-19	5	1	4
2017-18	5	0	3
2016-17	5	0	3

### 5.5 Publications

Publication data suggests the students' capacity to do research and write in good quality technical language. The data suggest students are inclined towards conference publications and less towards journal publications. Also, journals in which papers are published are national journals. In this category, department can think of adding some activities to enhance publication quality.

**Table 5 Publication data for Mechanical Engineering department**

Academic Year	Conference Papers	Journal Papers
2018-19	13	19
2017-18	9	7
2016-17	13	3

### 5.6 Public

Institutes public image can be judged through its interaction with various stakeholders through formal and informal interactions. Institute has in total number 48 MoUs with industries out which mechanical department has 7, which is considered to be good number for the department. ViMEET has 16 international collaborations which is an exceptional number considering the age of the institute is only 6 years.

Mechanical department has conducted six Parents meet through which parents informed their satisfaction about department activities. Through two Alumni meet it is understood that PBL environment helped students in their professional life. Through students exit survey it's understood that most of the students are inclined more towards project based learning approach.

## **6. Conclusions**

ViMEET has developed different PBL models for benefit of their students and faculty, however, effectiveness of these PBL models to achieve its desired goal were not conducted. Through this paper, an effort has been to create framework for PBL model audit to investigate its effectiveness. Six performance parameters are considered and analysed using Mechanical Department case study. Through case study data, its understood that although PBL is been practiced in the department, there is a scope for improvement in the performance. May be some changes in administration of PBL activities is needed.

Students experienced that PBL model has been a key element for their personal achievements and largely accept that they learned better in PBL environment. Although thoughtfully designed, PBL models could not lead to expected number of patents and publications, more work would be required to refine these models to get better results. Overall, it is concluded that PBL approach has been accepted by the stakeholders and promises to be excellent practice to achieve 6Ps. Further research would be required to give concrete conclusions on effectiveness of PBL models. In future, similar data can be collected from all departments and also institute level survey can be conducted to improve PBL practice.

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