

Project based Learning (PBL): Issues faced by Faculty for its effective implementation

SrinivasaPai P¹, Niranjan N.Chiplunkar², ShrinivasaRao B.R³

^{1,3}Department of Mechanical Engg.,NMAM Institute of Technology, Nitte – 574 110, Udupi District, Karnataka State.

²Principal, NMAM Institute of Technology, Nitte – 574 110, Udupi District, Karnataka State

¹srinivasapai@nitte.edu.in

²principal_nmamit@nitte.edu.in

³shrinivasaraobr@nitte.edu.in

Abstract: Project based learning (PBL) is increasingly being used in technical education as a learning methodology to enhance student learning and make them useful to the society and employable. There is a need to integrate it into the existing curriculum to make it current and relevant to the society. Projects have been an integral part of technical education, ever since it started. But these have not been managed properly to make students realize the use of this for their learning. The needs of the industries keep changing and the developments in science and technology is so fast that existing technologies become outdated in no time. In this changing scenario, there is a need to implement PBL in the teaching-learning process to effectively attain the 'outcomes' of a course, as there is a transformation to 'Outcome-based Education' (OBE), and the accreditation is also OBE based. Among the various aspects, the role of faculty in effective implementation of PBL is very important. In this context, this paper will analyze the various issues faced by the faculty and then take one of the departments of the authors' institution for obtaining feedback based on a survey instrument. The preliminary findings are presented along with the general guidelines to be followed to overcome difficulties and to facilitate effective implementation of PBL.

Keywords: Project based learning, faculty, implementation, questionnaire, feedback.

1. Introduction

A typical classroom would have a teacher and a group of students, where the teacher speaks and the students listen and try to understand the topics. Imagine a classroom where students make presentations on topics and teacher works only as a facilitator, helping them learn and understand things. PBL tries to achieve this, where students are made to work in groups to solve challenging problems that are authentic, based on the curriculum and most of the times interdisciplinary. Students learn how to approach a problem, what are the activities to be performed, what are the sources of information and how to use it to synthesize, analyze and derive knowledge from it. Project based learning (PBL) has come a long way since its use in the medical curriculum of McMasters' University in Canada. PBL can be defined as an instructional strategy in which students have to work on ill-structured problems and must make efforts to find meaningful solutions (Shinde, 2014). Today it has been accepted as an effective practice to impart knowledge to students. It can be applied to any type of education be it primary, secondary or higher education, medical, dental, engineering, arts, finance etc.

The need for adopting PBL, particularly in the

Srinivasa Pai P

Department of Mechanical Engg.,NMAM Institute of Technology,
Nitte – 574 110, Udupi District, Karnataka State.
srinivasapai@nitte.edu.in

Indian context is very important, because of large number of institutions, mostly in the private sector. Today industries need engineers who can be immediately put to work after they are recruited. Thus imparting proper knowledge and skills to the engineering graduates is very important. A recent survey done as part of a World Bank funded project indicated that 64 % of the graduate engineers were unemployable. They lack higher order thinking skills and ability to work in teams. The current curriculum offered in colleges is not current and does not meet the industry requirements. There is lack of innovation in the teaching-learning process, which has affected the quality of education imparted (Shinde, 2014).

In this context, there is a need to adopt this strategy to make our students employable and make our curriculum relevant. PBL has been researched and investigated throughout the world and there is lot of literature available. The implementation of any new pedagogy requires three main elements – students, faculty and the methodology. Faculty has a role of facilitator in adopting PBL. But there are issues during implementing this scheme and there is a need to understand these issues, so that measures can be taken to overcome this and help in its effective implementation. This paper attempts to look at this aspect and provide some general guidelines for the same.

2. Project based Learning (PBL) – Fundamentals

It is said that the first University to develop and implement a problem-based learning curriculum is the Mc Master University, Canada in 1968 for medical education. In 1972, Roskilde University in Denmark implemented it. Further Aalborg University in Denmark implemented it in 1974. Some of the other Universities, which implemented this technique, include University of Linkoping, Sweden and Maastricht University, Netherlands. These are some of the pioneering universities, which have been using this pedagogy for the last several years (Woods, 1994 cited in Shinde, 2014).

Erik de Graad & Anette Kolmos (2003) have summarized the main learning principles of PBL in three approaches namely learning, contents and social. The learning approach means that learning is organized around problems. A problem is the starting point for the learning process and places learning in context and base learning on the learner's experience.

The contents approach emphasizes interdisciplinary learning and the social approach is team based learning (Graad&Kolmos, 2003). Further in (2005), they identified the following three levels in PBL namely theoretical learning principles, specific educational models and different practices within the guidelines of traditional educational models According to Barrows (1986) cited in (Shinde, 2013), the six core characteristics of PBL adopted by McMaster University are:

- (i) Learning needs to be student centered.
- (ii) Learning has to occur in small student groups under the guidance of a teacher.
- (iii) The teacher acts as a facilitator or guide.
- (iv) The learning starts with a genuine problem.
- (v) The problem is used as a base to achieve the required knowledge and problem solving skills to solve the problem.
- (vi) Self-directed learning is used for acquisition of new information.

According to Thomas (2000), a project must include 5 criteria, which include –

1. PBL projects are central, not peripheral to the curriculum,
2. PBL projects are focused on questions or problems that "drive" students to encounter (and struggle with) the central concepts and principles of a discipline.
3. Projects involve students in a constructive investigation.
4. Projects are student-driven to some significant degree.
5. Projects are realistic, not school-like, to be considered an instance of PBL (Thomas, 2000).

3. Literature review

Before attempting to analyze the findings of the responses from the survey conducted by the authors among the faculty in a department at their institution, a few relevant literature is reviewed and the findings are presented below –

Karaman S., & Celik S. (2008), presented the perceptions of 29 prospective teachers about a course based on PBL approach. The course was 'Authoring Languages in PC environment '. In this course each prospective teacher carried out a project that required designing and developing courseware individually. The findings were in line with several similar studies carried out before, which include students can gain life-long learning skills, a lot of knowledge and skills, which cannot be obtained from conventional courses, it increased their self-confidence and they were more interested in the course. The teachers identified challenges which they encountered and included students had problem with time management skills, resource constraints and having prerequisite skills. The students found the project work tiresome and stressful. The students wanted more guidance from the teachers to manage time and anxiety. The study found that PBL is a convenient learning approach to allow prospective teachers to gain a lot of skills, which includes both interdisciplinary and multidisciplinary(Karman & Celik, 2008).

Shinde V. & Inamdar, S.S., (2013) through their literature survey found that PBL is an acceptable educational strategy. Teacher training and motivation of all stakeholders is essential for proper PBL implementation. There is a lack of research work on PBL implementation in India (Shinde & Inamdar, 2013). Hung W. et al., described the history of development and implementation of PBL in various educational settings and defined the major characteristics of PBL. They have reviewed the literature in terms of student learning outcomes and implementation issues, which include tutoring issues, curriculum design issues and use of technology(Hung, W, et al.). Kannan R. R. et al., (2016) described the use of PBL in teaching Data Structures and Algorithms, a core foundation course in computer science curriculum. They identified some issues faced by the teachers in PBL implementation, which was the need to implement an established PBL curriculum complete with project descriptions, directions for activities and instructional materials, which is qualitatively different from one in which a teacher decides to plan, develop and implement a PBL activity on his/her own(Kannan et al., 2016).

Bradley-Levine, J., et al., (2010) presented findings drawn from a mixed-methods research study that examined how a professional development workshop on PBL affected teacher's perception of its

implementation in their classrooms. About 250 teachers participated in this workshop. They were trained regarding implementation of PBL. The authors further tracked the teachers after the workshop to determine their effectiveness in implementing a PBL plan and support structures that facilitated the process. Some interesting observations included PBL is complicated and difficult for teachers and administrators, it represents a significant change in the way schools work, teachers went back to their traditional methods, when faced with challenges and they struggled to write and develop necessary documents(Bradley-Levine et al., 2010). Roberto L.C. et al., (2005) presented the findings of the student feedback regarding implementation of problem-based learning in a post-graduate curriculum of a public university in Brazil. The authors felt that though the student evaluations are in agreement with the literature and the overall results establish its viability to be used as an instructional method, there is a need to investigate some issues related to institution and staff(Roberto et al., 2005). Yusof K.M. et al., (2004) discussed about PBL, its benefits and potential in engineering education. They also identified challenges faced by teachers, which included need to go for a paradigm shift from being in control of the class to be a facilitator, apprehensions that it will take more time and hence there will be less time to complete the syllabus. They suggested some remedies for the same like taking a part of the syllabus for its implementation, lack of experience in handling groups and hence they suggested use of cooperative learning rather than jumping straight to PBL. Administrators needed to provide necessary support for its implementation in terms of awareness, training, support system and incentives(Yusof et al., 2004). Hung, W.,(2011) discussed the implementation issues of PBL and reported the differences in the results of PBL implementation actually and the theoretical assumptions. He suggested that the issues related to research methods could be alleviated through collective efforts from PBL researchers, but the issues related to PBL implementation have far-reaching implications and include administrative, which is beyond instructional interventions (Hung, 2011).

Mergendoller J.R. & Thomas J.W described class room management techniques used by teachers, who are experts in use of PBL instructional strategies. 12 teachers were interviewed, their descriptions of class room practice was subjected to qualitative analysis. Accordingly 53 class room management principles

emerged, which were grouped under 7 themes and 18 sub-themes. The themes included –time management, getting started, establishing a culture that stresses student self-management, managing student groups, working with others outside the classroom, getting the most out of technological resources and assessing students and evaluating projects (Mergendoller & Thomas).

Gavin K., (2011) described the use of PBL to teach design skills to civil engineering students of University College Dublin. The learning and assessment methods designed were implemented to meet some of the key learning outcomes. A student survey suggested that the course was already achieving many of its stated objectives. Students were satisfied by the PBL process and they found that the key skills required by industry namely group work, time management and the development of technical competence were enhanced. The instructors felt that the adoption of PBL allowed the use of open questions, which were useful in testing students' understanding of material. Another major benefit observed was that PBL process significantly improved staff-student interactions and improved their relationship. The major drawback identified in the application of PBL was the time required by both students and staff (Gavin, 2011).

This review has identified some of the major issues regarding implementation of PBL, with emphasis on issues related to faculty. Though the review is not comprehensive, yet it provides a basis for the work reported in the next section.

4. Research Methodology

There are efforts being made to implement PBL in the authors' Institution. Accordingly a questionnaire survey has been carried out to understand the basic awareness about PBL and the issues they are likely going to face, if they want to implement PBL. This survey was carried out among faculty of Mechanical Engineering department of the Institution. The questionnaire had 14 questions. A Google form was prepared and the questionnaire was emailed to 45 faculty members of the department. After a remainder email was sent to the faculty, finally 15 responses were received, which is 33.33 %. The questionnaire included name of the faculty and the responses for 13 questions.

5. Results and Discussion

The results are presented based on the responses given by the faculty to various questions:

a) Are you aware about PBL?

Fourteen out of fifteen faculty were aware about PBL. Among the responses received, four faculty were senior faculty (Professors and Associate Professors) and the remaining were Assistant Professors. This is a positive scenario, as it will be easier to implement PBL in the department, as and when it is decided to implement.

b) What is a project according to you?

The responses are as given in Table 1:

The overall understanding and belief about the concept of project is similar, which is developing a model or a system applying theoretical concepts.

Table 1: Definition of a Project

1.	A project typically has a distinct mission that it is designed to achieve and a clear termination point is the achievement of the mission.
2.	Project means (i) Preparing a model based on the theory studied or (ii) Solving additional problems from the text exercise or (iii) Applying the principles studied in the theory, collecting additional information on the subject on internet and presenting a paper.
3.	Applying the concepts what is studied in the curriculum into real life application
4.	Self-Learning
5.	A project represents collection of activities where a student/ group of students review the literature/ existing solution/ situation and apply their abilities and knowledge to solve the problem/ better represent the situation and make suggestion in this regard.
6.	It is an attempt to do something prototype temporary model for the welfare/benefit of the society
7.	Anything which gives hands on experience to the students and also allows them to learn team work
8.	Project means a group of students / individuals working towards execution of an idea or accomplishment of a particular task with in a given time period. A project should have a plan and a goal.
9.	Project may be a research or design and fabrication or developing a model to achieve a particular aim
10.	Application of study of Engineering to Practical use
11.	Anything which enables a student to understand the theory concepts well.
12.	Putting theory into practice
13.	preparation of working model using proper mechanism
14.	A set of well planned, inter connected individual or collaborative tasks involving research, design or experimentation leading to analysis of a problem by factual arguments.
15.	Implementing the theoretical knowledge and students experience in develop a prototype or model for betterment.

c) Do you think the major project work carried out by the students in the final year is useful? If yes, how? If no, what do you recommend?

Majority (73 %) of the faculty feel that major project work is useful as it helps students to think independently, work in groups, help in putting theoretical concepts into practice and help in developing interpersonal skills. But they also feel that there is a need for proper monitoring by the faculty. Three teachers partly agree with the need for having major project work in the final year and they feel there are several factors that influence its success. One faculty member felt that it is not useful, as it depends on the facilities available to the student and also the geographical location of the college.

d) Can projects be used as a means to teach the course you offer effectively? If yes, how? If no why?

All the faculty who took part in the survey agrees that the use of projects definitely helps in teaching a course. Some reasons given include – better understanding of the theoretical concepts, through mini projects, through fabrication, through case studies, through software, problems etc. Some expressed apprehension regarding whether it would be possible to adopt it in the current semester based system and how seriously students take it up or whether they would misuse the opportunity.

e) Are you willing to adopt PBL for teaching your course (yes/no)?

All teachers (100%) are willing to adopt PBL for teaching their course.

f) If yes, which course are you planning to consider?

All the faculty wants to consider the course they are teaching either in the odd and even semester for adoption of PBL.

g) Do you think PBL can help in meeting some important outcomes of the course?

Twelve teachers agree that PBL will help in meeting some important outcomes of the course. One faculty felt that it is possible, if enough time is available to both students and faculty. One faculty felt that it has helped in validating the results using software.

How are you going to integrate PBL into your teaching scheme?

The observations are interesting and given in Table 2. It throws a spectrum of thoughts about PBL by the

Table 2: Integration of PBL into teaching scheme

1.	One extra hour of lecture should be given at the end of each topic to inform about the projects they can do on the topics.
2.	Asking students to make some prototype models based on the theory that they study
3.	Forming pneumatic circuit using proper element to perform particular task
4.	Mini-project with one credit...or compulsory project to take up final sem exams
5.	Yet to see
6.	By having certain topics related to PBL.
7.	By giving Case studies. Mini project.
8.	Project based on the class room study
9.	Need to follow institutional academic curriculum
10.	Assigning task marks to Projects
11.	No Idea
12.	Student awareness to be created on what is PBL and how it is important. As many students consider creating database is an attendee's job
13.	In asking students to solve exercise problems.
14.	I have rough idea we have to sit and discuss.
15.	I can introduce PBL in one of the units of my course and consider it as a assignment and allot some marks for that.

faculty. Three faculty members are not sure about bringing in PBL into their teaching pedagogy. Others have suggested different methods to adopt the same, considering the constraints they face, students face and from the system.

h) What do you think are the problems, you will face, while implementing PBL?

This is the most important question in the questionnaire as the main focus of this paper is to understand the issues the faculty will face, when they want to implement PBL. The responses are given in Table 3

Table 3: Problems faced while implementing PBL

1.	When i give some problem to the student it should be well defined and i should know the possible outcomes. It should be time bound. Evaluation will be more time consuming because in a class of 60 students if all will be given different projects (to avoid copying) the method adopted by each one of them will be certainly different. It is going to be a extra load for the faculty if done seriously.
2.	already mentioned workload will increase but it will be a welcome change
3.	Lack of time for students. Students may not be interested due to low weight age in terms of marks.
4.	Time Constraint
5.	Building the material
6.	Time, making students meet the deadlines given by authorities and issues related to discipline.
7.	Not say anything, because problems starts only when we adopt this PBL
8.	literature survey / review in right area
9.	Coming up with new project. Evaluation criteria and duration.
10.	Time and resource constraints.
11.	Students involvement
12.	availability of resources
13.	cost (to purchase material)
14.	Equal enthusiasm and involvement of all students considering time constraint is a challenge. It should fit well within their academic schedule
15.	time constraints to complete syllabus n students active participation may not be there.

The responses can be clearly put under three categories namely availability of time, availability of resources and evaluation process. In addition some faculty felt that need for increased student involvement and increase in their work load is some other issues. Thus effective implementation of PBL requires tackling these issues effectively to motivate the faculty to implement the same.

i) Do you think students will be interested in taking part in this technique while teaching the course? If yes why? If not why?

Two faculty felt students may not be interested to take part in this technique and gave reasons like it depends on what project is given to them and it will require extra cost and time. Remaining faculty feel students would be interested for various reasons like – it may help them to score good marks, by proper motivation, they may show interest, practical exposure, happy to apply the theoretical knowledge, when they are ready to spend huge money for external training, with some encouragement, they will participate in PBL in the institution, easy to understand concepts and are more interested in practical rather than theory.

j) What kind of evaluation criteria, you are going to adopt for evaluating the work completed by a student in a PBL project?

This question again has led to interesting observations, most of them useful and in line with the requirements of OBE namely – effectiveness of the project, understanding the concepts by the students, project completion and difficulty level, ability to complete the project within the deadline, interest in the project and innovativeness, based on continuous monitoring, preparing customized rubrics, utility of the model developed on large scale to the society, comparative evaluation among all the projects done and project report preparation. It is clear that each faculty has a distinct view about evaluation.

l) What skills do you think are necessary for successful implementation of PBL?

Some of the skills identified by the faculty include dedication, design skill, software knowledge, experience, communication, inquisitiveness, motivation, discipline, practical exposure, visualization, problem solving, sound in fundamentals, creativity, active participation, attitude and hardworking. These skills and attributes identified are clearly from the point of view of the student. A few teachers have identified that their knowledge and understanding of PBL is equally important for its successful implementation.

m) Do you think implementation of PBL will improve the teaching-learning process and help students learn better? If yes give reasons? If no give reasons?

Except for one faculty, all felt that implementation of PBL will improve the teaching-learning process. The faculty who did not agree felt that in the current semester system, this is going to be an additional burden to the students. All of them who agreed felt that it would improve student's understanding of theoretical concepts, give them practical exposure, improve their problem solving skills, improve their ability to work in groups and it facilitates experiential learning.

A. Discussion

This is a preliminary study by the authors to understand the awareness of the faculty about PBL, issues concerned with its implementation, what are its

advantages and limitations. The findings may not be comprehensive. The survey can be extended to faculty of other departments and may include students to obtain their perspective. The faculty appreciated the use of PBL as a teaching-learning pedagogy, but has their individual apprehensions. There are confusions regarding how to implement the same in their curriculum and derive the benefits out of the same. Each course has its own strengths and limitations and all courses may not be amenable for PBL implementation. There are issues of evaluation, student management and discipline and most important being time management.

Some Guidelines that can be followed for adopting PBL are as follows:

- 1) PBL can be adopted in autonomous colleges easily, but in affiliated colleges it may be implemented partially. There is a need to decide whether the adoption of PBL is as part of the curriculum or it will be a supporting element or as a regular methodology by either giving it credits or marks.
- 2) There is a need to create awareness among the faculty regarding the implementation of PBL for the courses they teach. It may not be possible to implement it effectively for all the courses. Hence attempt must be made in only those courses where it can be implemented.
- 3) The students may accept or resist the adoption of PBL. There is a need to orient them and make them understand the advantages of adopting it as a part of the curriculum.
- 4) Regular feedback need to be taken to know the comfort level of students and also to know whether the implementation is on the right path.
- 5) The identification of problems to be offered under PBL needs to be done carefully, so that it is neither too easy nor too tough, but challenging.
- 6) The necessary resources must be made available to the students. Preferably give problems, for which solutions can be obtained based on the available resources.
- 7) PBL should not become an excuse for the teacher to avoid teaching difficult concepts and giving it as problems to the students. Teachers must be

available to the students, whenever they need them.

- 8) The students selected must be representative of different categories. Probably a group of five students would be ideal. Each student should perform a role in the execution of the project and his/her role should be clearly defined.
- 9) Regular monitoring of the progress of the project execution is necessary.
- 10) The students should work as a cohesive team and perform their roles to the best of their ability.
- 11) The evaluation of the project should be a continuous process with weightage given for different evaluations. The project needs to be evaluated not only on the basis of individual contribution, but also the group. The evaluation can be based on rubrics, developed for the same.
- 12) The project report preparation should follow a common format and the contents necessary need to be defined in the beginning. Every member in the group should make a part of the presentation to know his or her involvement in the project.
- 13) The implementation of PBL in a course should be for an entire semester providing sufficient time for the students to involve themselves in the project. It should be a pleasant experience both to the teacher and students.

6. Conclusions

Project based Learning (PBL) has been effectively used in medical curriculum, since last several years with very good results. Its adoption in the engineering curriculum has started recently. Several success case studies of its adoption are available in the engineering education research literature. Several leading universities in the world like Aalborg University, Denmark, McMaster University, Canada have been pioneers in implementing PBL in their curriculum. In India there have been very few efforts in implementing PBL except in may be a few IITs and NITs. VIT University, Vellore has been adopting PBL, since last few years. In this context, this paper aims to understand the issues regarding its implementation from the point of view of the faculty. There has been handful of research papers on PBL in the Indian

context. This paper presents the observations of a questionnaire survey among the faculty in the first author's department. The observations are encouraging with the entire faculty who participated in the survey being interested to adopt PBL, but have their own apprehensions and few of them have limited understanding of PBL. The authors feel a concerted and systematic effort at the Institutional level will alone sort these issues and providing the faculty with necessary guidance will help to implement it effectively.

Acknowledgement

The authors thank all the teachers who have participated in this survey and have given their valuable feedback.

References

- [1] Shinde, V., 2014. Design of Course Level Project Based Learning Models for an Indian Engineering Institute: An assessment of students' learning experiences and learning outcomes .Institut for Planlægning, Aalborg Universitet, 2014.
- [2] De Graaf, E., and Kolmos, A. (2003). Characteristics of problem-based learning. International Journal of Engineering Education, 19(5), 657-662.
- [3] Thomas, J. W. (2000). A review of research on project-based learning, <http://www.theshg.com/education/a-review-of-research-on-project-based-learning-john-w-thomas-ph-d-march-2000>.
- [4] Karaman, S., and Celik, S. (2008). An exploratory study on the perspectives of prospective computer teachers following project-based learning. International Journal of Technology and Design Education, 18(2), 203-215.
- [5] Shinde, V. V., and Inamdar, S. S. (2013). Problem based learning (PBL) for engineering education in India: Need and recommendations. Wireless personal communications, 69(3), 1097-1105.
- [6] Hung, W., et al, Problem-Based Learning, faculty.ksu.edu.sa/Alhassan/.../ER5849x_C038_fm.pdf

- [7] Kannan R.R., Mahajan S. and Rajkumar R. (2016). An approach on Effective & Efficient Project based learning”, *International Journal of Applied Engineering Research*, 11(8), 5920-5926.
- [8] Bradley-Levine, J., Berghoff, B., Seybold, J., Sever, R., Blackwell, S., and Smiley, A. (2010, April). What teachers and administrators “need to know” about project-based learning implementation. In *Annual Meeting of the American Educational Research Association*. Denver, CO.
- [9] Luis Roberto, C. Ribeiro & Maria Da Graca N. Mizukami. (2005) “Problem-based learning: a student evaluation of an implementation in postgraduate engineering education”, *European Journal of Engineering Education*, 30(1), 137-149.
- [10] Yusof, K. M., Aziz, A. A., Hamid, M. K. A., Hassan, M. A. A., Hassim, M. H., Hassan, S. A. H. S., and NMA, A. (2004, December). Problem based learning in engineering education: a viable alternative for shaping graduates for the 21st century. In *Conference on Engineering Education*, Kuala Lumpur.
- [11] Hung, Woei. (2011). Theory to reality: A few issues in implementing problem-based learning.” *Educational Technology Research and Development* 59.4, 529-552.
- [12] Mergendoller, J. R., and Thomas, J. W. (2001). *Managing project based learning: Principles from the field*. Buck Institute for Education. Available: <http://www.bie.org>.
- [13] Gavin, K. (2011). Case study of a project-based learning course in civil engineering design, *European Journal of Engineering Education*, 36(6), 547-558.