Project Based Learning in Engineering Education

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Abstract— **Project based learning (PBL) is a student driven educational framework and offers the student an opportunity for in depth investigations of courses. This paper presents the need of PBL in engineering education for the student to graduate with a capacity to design and implement complex problems. The implementation strategy of PBL and its related challenges are presented. The case study that energizes the engineering curriculum with a relevance to the real-world of technology along with its benefits to the students is also included.**

Keywords—PBL,Engineering education,curriculum

I. INTRODUCTION

PBL is gaining knowledge by applying the theoretical concepts in a practical environment and solving real-world problems. Presently, majority of learning process in Engineering is paper-based and rote-memorization. The information gained through these approaches is found to have lesser retention period. PBL helps students to develop expertise and help them to think at a higher level. PBL can be incorporated in the curriculum by giving equal importance to projects as much as written examinations. This will motivate the students to work on projects and give a reason for mastering the concepts. PBL builds critical thinking, problem-solving and communication skills. Students engage in a rigorous process of asking questions, using resources and developing answers on their own.

II. LITERATURE SURVEY

PBL is a model that enables learning through projects. In many of the PBL handbooks, projects are defined as complex tasks based on challenging questions or problems, that involves solution design by students, problem solving and decision making (Jones, Rasmussen, & Moffitt, 1997; Thomas, Mergendoller, & Michaelson, 1999). According to the definition of project-based instruction, it consists of features related to the use of a driving question in a community which encourages inquiry-based learning (Krajcik, Blumenfeld, Marx, & Soloway, 1994; Marx, Blumenfeld, Krajcik, Blunk, Crawford, Kelly, & Meyer, 1994) [1]. In project-based science importance is placed on an intriguing question to lead an investigation (Blumenfeld et al., 1991; Marx, Blumenfeld, Krajcik, & Soloway, 1997) [2]. Torp and Sage (2002) described PBL as focused, experimental learning organized around the resolution of real-world problems [3]. When students work on projects that will impact others and involves a real life problem that needs solving, they are instantly motivated to work hard. Ed Gragert, director of iEARN, genuinely thinks that, by demonstrating that the students can make a difference to even a single life, they are motivated and tend to carry their experiences into a lifelong community and global service [4].

III. INTRODUCTION TO PBL

The idea of PBL dates back to centuries. Aristotle and Confucius advocated 'learning by doing' principle. PBL is a teaching methodology, wherein the students investigate and respond to complex problems, challenges or situations using a dynamic approach [5]. In traditional teacher-led class environment, the teacher is the controller of learning, whereas PBL gives opportunities for students to explore the concepts without restricting the learning process to the curriculum material alone. In turn, the students gain deeper knowledge of the subject and its real-world applications. Here the teacher acts as a facilitator, working with students to structure tasks, guiding knowledge development and social skills [6]. PBL creates a need to learn the essential skills and technologies in real-world. The 21st century skills: critical thinking, problem solving, collaboration, and various forms of communication, which are very much required to succeed in the current information age, are developed through PBL [7]. Overall, PBL is an educational approach that is learner focused where the students learn through experience.

IV. ESSENTIALITY OF PBL

Today's students often find classroom based teaching to be boring and meaningless because they lack the information about real-world applications of what they learn [8]. Engineering courses are too focused on technical aspects without sufficient integration of these topics. The curriculum prescribed programs do not provide the required design experience for a full-fledged engineering student. Learning

strategies in engineering programs are outdated and need to become more student-centered.

PBL creates a need to learn and create something new. On completion of a project, students tend to remember what they have learnt and retain it for a longer period of time than is often the case with traditional instructions. When students are presented with PBL experience, concepts are not taught in detail. As a result, they have the opportunity to encounter the central concepts and principles of a discipline and develop the ability to function in environments that require complex thinking. This thought process will help them in the work environments they'll encounter in the present knowledge-based high technology society.

V. Implementation of PBL

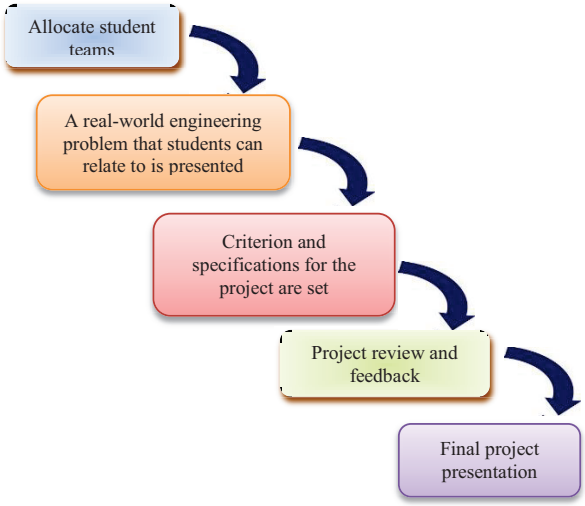

Fig. 1. PBL implementation strategy.

PBL is an innovative educational framework for producing the next generation of engineers. Introduction and implementation of PBL methodology in a traditional classroom setting is an elaborate challenge. It will involve a change in the professor's teaching methods and the student's learning approaches. This is possible only when teachers provide guidance and support to the students. Fig.1 illustrates the stages of implementation of PBL in engineering education. In the first stage, students are assigned to small teams and are expected to work collaboratively. In the next stage, each team selects and refines a central question in the course related domain for which an engineering solution will be crafted. In the succeeding stage, beginning with the end in mind, a plan for the project is laid out. Ideas are communicated and debated; predictions are made which contributes in getting a clear picture of the project. The parameters for the completion of project are set. The team conducts research, collects and analyzes data, conclusions are drawn. This triggers new questions and helps them in designing the solution. In the following stage, the project is reviewed at each phase and the teacher evaluates and gives feedback. The project teams improvise their project based on the feedback. Finally, the working model is submitted to a panel of evaluators for assessment. This assessment focuses on the student's understanding and application of the concepts involved.

VI. Case Study

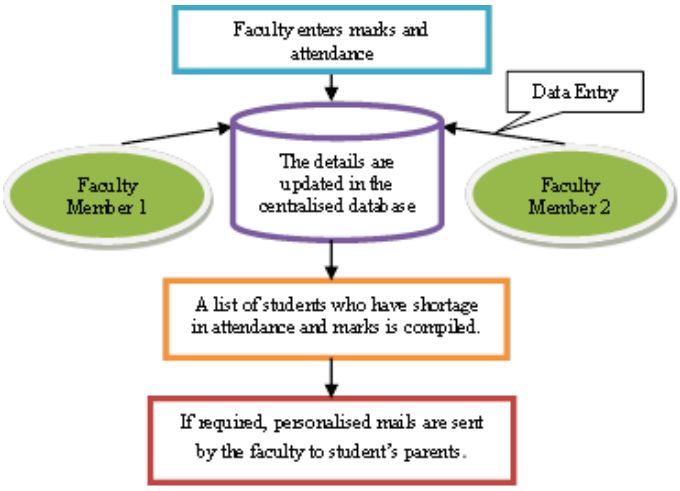

Fig. 2. Overview of the project.

As an experiment and personal experience for implementing PBL, we did mini projects to test the effectiveness of PBL over traditional methods. Here, we present the case study of the project done by us.

We had two courses, Java and DBMS in our 5th semester, department of ISE. These courses had a predefined set of practical programs to be performed in our laboratory classes. We were assessed on the same set of programs during our lab examinations. This confined our knowledge to the program manual.

For a hands-on experience in the course the faculty of ISE department decided to do a project using Java in the front-end and MySQL for the database as back-end. The project was to develop an application to make attendance and marks managing system an easy task for the faculty of our department. The application was designed to store the marks and attendance of each student in the database and updating it as and when the faculty does so. It also had an additional feature of sending mails to the parents about their ward's marks and attendance status in case of shortage.

Fig. 2 illustrates the flow of data and operations in the project. Initially the students will be marked present for all the classes, so each day the faculty has to just mark the absentees. The project is programmed to automatically update the attendance percentage. This reduces the manual work. The details are updated in a centralized database as and when the faculty enters the marks and attendance. The database is designed according to the credits and displays the laboratory marks, quizzes and internal marks respectively. At the end of

the semester, list of students having attendance and marks shortage is generated. The faculty has the option of mailing these student's parents intimating them about their ward's academic status.

We came up with the concept of reverse engineering to calculate attendance where in the student initially has 100% attendance and as he/she misses classes, the attendance is decreased and updated. We also realized this approach is useful only when the number of classes was fixed and known before in hand.

This project effectively helped the faculty to maintain all the records of the student on the application rather than in marks and attendance registers. For us, it was a new experience away from the usual lab programs. We realized how we can put our theoretical knowledge into application for real life problems.

VII. Benefits Of PBL

The benefits of PBL are plenty. When students work on a project in teams, they hold each other responsible for learning and completion of tasks. It develops the ability to work with the teammates and builds teamwork and group skills. Students become "self-managers" in this approach when they work independently. PBL provides an opportunity for students to demonstrate their skills; this in turn helps them find their area of expertise. When project-based learning approach is adopted, it invigorates the learning environment. It energizes the engineering curriculum with a relevance to the real-world of technology. This sparks the student's desire to investigate research and understand the engineering world. Another important benefit which PBL offers is motivation to students. Projects provide a way to utilize student's voice and choice, and personalize their learning experience. Since projects are open-ended, students need to consider and evaluate multiple solutions and in turn, defend the choices they have made. It trains them to think 'out-of-the box' which acts as a major criteria to differentiate an exceptional student from a normal one.

VIII. Conclusion

Project-Based Learning is an effective method that emphasizes on the involvement of students in academic learning, and skill building. PBL helps the students to improve communication skill and enhance critical thinking. This also provides students with opportunities for meaningful self-expression through project presentation. This paper has shown that PBL sparks the student's desire to research and understand Engineering world. This paper emphasizes on the need of upgrading the engineering curriculum to meet the solutions to the real world problems.

Acknowledgment

The authors would like to thank Technological Education Quality Improvement Programme (TEQIP-II), BMSCE and ISE department faculty for supporting the work.

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