

Integrating Mini Project Based Learning Approach in Teaching-Learning Process

Dr. M. C. Padma

Department of Computer Science and Engineering
PES College of Engineering
Mandya, India
padmapes@gmail.com

Dr. V. Sridhar

Department of Electronics and Communication Engineering
PES College of Engineering
Mandya, India

Abstract — As the technical community is growing rapidly, our students must be prepared to be global engineers to successfully function as professional engineers in the international corporate world of the 21st century. In this competitive world, teamwork, learning ability and soft skills along with academic excellence are very much needed for the career growth of a student. In addition, our engineering students must acquire lifelong learning to be able to apply their knowledge in accordance with the new problems faced in their daily life. In that context, a project-based learning (PBL) is considered to be the best platform for the students to gain greater depth of understanding of concepts, broader knowledge base, improved communication and interpersonal/social skills, enhanced leadership skills, increased creativity, and improved writing skills. In this paper, the experience of using the technique of mini project-based learning (MPBL) as a key pedagogical method for teaching a course Advanced Data Base Management System within the context of a Master's programme is reported. The positive feedback from the students proves that the implementation of MPBL is a successful pedagogical method to prepare our students ready for the 21st century requirements.

Keywords—*Teaching-Learning Process; Project Based Learning; Mini Project; Team work; Critical Thinking.*

I. INTRODUCTION

Technical institutions are considered to be the main sources of producing best technical professionals through quality technical education. Hence, quality technical education is considered to be the most significant factor for the progress of any Nation as it further leads the Nation grow technologically and socio economically. Because of this reason, there is a greater demand for engineering education.

In today's ever increasing world of information technology, it is not possible to meet the demand of the industry through our traditional teaching methods like black board and power point presentations. In addition, the modern engineering profession requires skills and technical competencies. But, the main pedagogy for engineering education still remains "chalk and talk" following the traditional teaching method. In addition, the attitudes of most our students is still exam oriented and hence fail to gain in-depth knowledge, skill and competencies which in turn fails to produce effective

graduates. Because of this reason, engineering education scenario today is failing to meet the industrial requirements. Complete involvement of students in the class room teaching-learning process may help changing their attitude as well as enabling them to understand the importance and application of what they are learning. Hence transformation from a traditional teaching method to latest teaching methods like outcome based education is a must.

As the technical community is growing rapidly, our students must be prepared to be global engineers to successfully function as professional engineers in the international corporate world of the 21st century. Accordingly, our undergraduate educational curricula must be revised to make our students technically versatile (multi-disciplinary), able to solve problems from a systems-level perspective, effective communicators, function in diverse ethnic teams and demonstrate social responsibility. In addition, our engineering students must acquire lifelong learning to be able to apply their knowledge in accordance with the new problems faced in their daily life. Hence, the Accreditation Board for Engineering and Technology has modified their accreditation criteria to place an emphasis on project-based learning (problem solving) and self-directed learning which supports life-long learning [2]. In that context, a project-based learning (PBL) is considered to be an approach to capture all the needs of graduates for the workplace.

This paper is organized as follows. In Section II, literature work related to project based learning is presented. A brief about teaching and learning process is presented in Section III. In Section IV, Project Based Learning along with a case study is explained in brief. Results and discussions are presented in Section V. Conclusions are given in Section VI.

II. LITERATURE REVIEW

From the literature it is observed that, PBL approach has been used in multidiscipline. PBL as an instructional and curricular learner centered approach that empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem [1]. In [3], the experience of using the technique of miniproject-based learning (MPBL) as a key pedagogical method for teaching advanced computer networks within the context of a Master's programme is reported. The design of the

MPBL thread exploited the practical experience of the course lecturers and allowed the students to carry out small-scale research in the key areas of network protocols and technologies. The students indicated that they had found that the mini projects enhanced their critical thinking and had helped them to develop a deeper understanding of network protocols and technologies [3]. PBL mainly highlights its concepts to the students by means of challenges in the form of problems relevant to their future practice [3].

Project-based learning allows in-depth investigation of a topic worth learning more about and learners typically have more autonomy over what they learn, able to maintain interest and are motivated to take more responsibility for their learning [4]. In engineering programs, PBL approach has been reported by several authors, although the practice is still far from widespread. It is observed that various universities have introduced several student-centered teaching strategies out of which problem based learning is one of its components to make their students world class [5]. In this PBL process, students learn how to analyze sustainability, work with decision makers, and put classroom knowledge into practice. This relates to a more general educational concern that the classroom often focuses on what information students should be told, rather than on how students can effectively learn and apply their knowledge [6]. Also the implementation of PBL into engineering program allows the groups of students to be able to identify their learning needs and find their learning resources [5].

Survey on introducing mini project based learning as a pedagogical method in teaching learning process shows that students can enhance their critical thinking and develop more competency in that subject. This motivated to introduce the concept of mini project based learning for a course Advanced Data Base Management System for Master's program. Hence, in this paper, the experience of using the technique of mini project-based learning (MPBL) as a key pedagogical method for teaching a course Advanced Data Base Management System within the context of a Master's programme is reported.

III. TEACHING – LEARNING PROCESS

Teaching and learning is the most important process for teachers and students in any educational institutions. The students need to perform well in their academic to gain knowledge, skill and competency for their better carrier. Teachers play an important role in preparing the students learn the fundamental and advanced concepts, and make them to acquire various domain knowledge and skills and competency.

In this competitive world, teamwork, learning ability and soft skills along with academic excellence are very much needed for the career growth of a student. In the global work culture, engineering graduates have to work in groups. As the technology is changing drastically, conventional means of teaching and learning should be kept aside and new innovative ways should come up and faculty should get transformed from teacher to facilitator. Hence, it is the responsibility of the institute to think about the introduction and redesigning of latest teaching and learning techniques which best suit to this

advanced technology. Concepts like learning by doing, project based learning, etc. can be used to penetrate the concept deep and improve the involvement of students.

Culture of learning by doing by incorporating mini project concept in small group of student results to develop problem solving and presentation skills, excellent team spirit, increase research skills, self-confidence, attitudinal change and sense of achievement in the students. This is possible only if teaching-learning process is upgraded by introducing project-based learning.

In engineering studies, the undergraduates usually have project work as major subject in the final year of their degree program. However the incorporation of Project Based Learning (PBL) and integrated projects in each year can improve the learning of undergraduates. Two groups of graduate students of different batches have been considered for analysis. The results show that the students who were taught adopting mini project based learning gave better performance than the students who were taught with traditional teaching method. This shows that introducing “Mini Project-Based Learning” is considered to be a good strategy for Teaching and Learning process.

A. *Transforming traditional teaching pedagogy to Outcome Based Education for engineering education*

Feedback taken from industry experts about the quality of engineering graduates states that today's engineering graduates lack in in-depth knowledge, strong communication and team work skills. They do not have a broader perspective of the issues that concern their profession such as social, environmental and economic issues. Also, they are not capable of applying their knowledge to solve realistic problems. Even though our students are graduating with good knowledge of fundamental engineering science and computer literacy, they are lacking in applying their knowledge to solve realistic problems as they do not know how to apply that in practice. This is a major drawback of our graduates that is observed in the current industry field. Hence, today's engineering graduates need to have strong communication and teamwork skills with a broader perspective of social, environmental and economic issues. These reasons gave a major influence on the revision of the criteria for engineering programs by National Board of Accreditation (NBA). To get “International Recognition of Educational Qualifications” as per Washington Accord, NBA put more emphasis and focuses on Outcome Based Education (OBE).

Though India became a provisional member of the Washington Accord (WA) in the year 2007, it became signatory membership of Washington Accord in June 2014. The Washington Accord is an international agreement among bodies responsible for accrediting engineering degree programmes. In this context, National Board of Accreditation (NBA) should now seriously look for the transformation of engineering education to the global standard by adopting Outcome Based Education (OBE). Importance and significance of NBA is to get international recognition of awarded degree; to provide quality education to the students lead to job opportunity and international mobility; to make institute/department aware about strength and weakness and to

facilitate institute for updating themselves in curriculum, teaching and learning process.

The new accreditation approach shifts emphasis away from “what is being taught” to “what is being learned” [1]. To achieve this, traditional education was transformed to “Outcome Based Education”. Outcome-based education, as defined by Spady [1] is “a way of designing, developing, delivering and documenting instruction in terms of its intended goals and outcomes”. “Exit outcomes are a critical factor, in designing the curriculum”, Spady suggests. “You develop the curriculum from the outcomes you want students to demonstrate, rather than writing objectives for the curriculum you already have” [1].

Engineering programs are now required to demonstrate that their graduates are achieving a set of specified learning outcomes. Hence, the Accreditation Board for Engineering and Technology has modified their accreditation criteria to place an emphasis on project-based learning (problem solving) which supports life-long learning [2]. In that context, a project-based learning (PBL) is considered to be an approach to capture all the needs of graduates for the workplace.

IV. PROJECT BASED LEARNING

Recent education system has posed a big challenge to all educators in nurturing intellectual development which primarily focuses on the resources available to students and lecturers using a more student centered learning approach. To improve teaching and learning of a program, an attempt has been made to a new paradigm with utmost commitment towards learner-centric.

Project-based learning (PBL) provides a best platform for the students to gain greater depth of understanding of concepts, broader knowledge base, improved communication and interpersonal/social skills, enhanced leadership skills, increased creativity, and improved writing skills. John Dewey initially promoted the idea of “learning by doing” [7]. Educational research has advanced this idea of teaching and learning into a methodology known as “Project Based Learning” [7]. Project-based learning emphasizes learning activities that are long-term, interdisciplinary and student-centered. Unlike traditional teacher-led classroom activities, students often must organize their own work and manage their own time in a project-based class.

Project-based learning also gives students the opportunity to explore problems and challenges that have real-world applications, increasing the possibility of long-term retention of skills and concepts. In project based learning students learn by designing and constructing actual solutions to the real life problems. Hence, for the today’s ever growing world of information technology, it is very much necessary to adopt into Project Based Learning. The experience of thousands of teachers across all grade levels and subject areas, backed by research, confirms that PBL is an effective and enjoyable way to learn and develop deeper learning competencies required for success in college, career and civic life [8]. Because of these reasons so many educators across the United States and around the world are interested in this teaching method.

In PBL, students become more active engaging in their projects and build competencies such as critical thinking, communication in a variety of media, and collaboration valuable for today’s 21st century. After completing a project, students remember what they learn and retain it for longer time than is often the case with traditional instruction. Because of this, students who gain content knowledge with PBL are better able to apply what they know and can do to new situations. In PBL, students not only understand content more deeply but also learn how to take the responsibility and build confidence, solve problems, work collaboratively, communicate ideas, and become creative innovators. For the current generation students who are more fascinated to this modern technology, this PBL seems to be a perfect fit. Project-based learning activities generally integrate language and cognitive skills, connect to real-life problems, generate high learner interest and involve some cooperative or group learning skills.

PBL allows teachers to work more closely with active, engaged students doing high-quality, meaningful work, and in many cases to rediscover the joy of learning alongside their students. Current models of PBL are not like some past examples of “doing projects” in which student learning outcomes were not clear. Project Based Learning is a teaching method in which students’ gains knowledge and skills by working for an extended period of time to investigate and respond to a complex question, problem, or challenge. Project-based learning is a dynamic classroom approach in which students actively explore real-world problems and challenges and acquire a deeper knowledge. Students from different branches can also group together to develop inter disciplinary projects.

With the traditional teaching method, students are limited to acquire the knowledge theoretically which in turn limits them to lower order thinking. According to Bloom’s Taxonomy, students should acquire higher order thinking skills i.e., apply, analyse, evaluate and design. This can be achieved by incorporating project based learning in the design of curriculum. Through project based learning, students can develop real-world, 21st century skills which are expected by today’s employers. The elements described as 21st century student outcomes are the skills, knowledge and expertise students should master themselves to succeed in work and life in the 21st century.

Researchers say that PBL improves learning when learners apply classroom-gathered knowledge to real-world problems. For example, the Intel® Teach Program is a worldwide initiative to provide teachers with the skills to effectively integrate technology into existing curriculum to improve student learning. Since 1999, the Intel Teach Program has helped over 5 million educators in more than 40 countries. The goal of the Intel® Teach Essentials Course is to help classroom teachers develop student-centered learning through technology integration and project-based approaches.

The implementation of OBE towards learning system in the faculty has created new dimensions in monitoring the students’ development through the Program Outcome achievement. One of the difficulties found in its implementation is the

measurement of the Program Outcome related to student's lifelong learning (affective domain).

In this paper, we have taken up this challenge of the measurement of the Program Outcome related to student's lifelong learning through one of the post graduate courses of Computer Science and Engineering program i.e., Advanced Data Base Management System for 1st semester students. It is demonstrated in this paper that by transforming the learning to Project Based learning by incorporating a Mini project, students can capture their lifelong learning skills.

A. Case Study to introduce mini project based learning

Mini projects can be introduced for some courses to provide an opportunity to integrate knowledge and skills acquired in a set of courses belonging to the curriculum thread to solve complex engineering problems. Introduction of mini projects also helps to directly assess student learning outcomes in each of the curriculum thread. As these projects are carried out in teams, students are able to develop and demonstrate several professional competencies that are critical for engineering practice.

As a case study, in this paper we have considered the course "Advanced Data Base Management System (ADBMS)" from the Computer Science and Engineering post graduate program. Out of 13 program outcomes formulated as per ABET rules, four program outcomes such as PO - 3, PO - 9, PO - 10 and PO -11 as listed below can be achieved by adopting MPBL:

PO-3 : An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs, within realistic constraints such as economic, environmental, societal, political, health and safety, manufacturability, and sustainability (creative skills).

PO - 9: An ability to function effectively individually and on teams, including diverse and multidisciplinary, to accomplish a common goal (teamwork).

PO – 10: An ability to communicate effectively, both in writing and orally with a range of audiences (speaking / writing skills) and

PO - 11: Recognition of the need for, and an ability to engage in continuing professional development and life-long learning (continuing education awareness).

ADBMS is a course which can provide knowledge about the development of DBMS package for any real life applications. Some of these most commonly used DBMS software packages are in banking system, library management system, Hotel management system, Railway reservation system, airline reservation system and so on. These types of problems can be identified and assigned as a mini project for a group of students. Thus by introducing MPBL, students can gain theoretical and practical knowledge by development a mini project for a given scenario. According to the OBE paradigm, a set of course outcomes are derived following the concept of Bloom's taxonomy. Students are assessed to verify whether they have achieved all the course outcomes of a course. For example, one of the outcomes of this subject is to

apply and design a DBMS package for solving a real life problem. This outcome can be best measured by incorporating MPBL, where students are given the opportunity to understand the subject, apply their knowledge, design and develop a software for a realistic problem. By evaluating the performance of the mini project, students can be assessed how best they have achieved the course outcome. Thus, achieving some of the course outcome will in turn lead to achieve the Program Outcomes, which is the requirement of Outcome Based Education.

In this paper, an example of developing a mini project namely a Banking System by a group of students is considered. The method of achieving the three Program Outcomes: PO -3, PO-9 and PO-11 and the method of assessment of the students through this mini project is explained below:

PO-(3): An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs, within realistic constraints such as economic, environmental, societal, political, health and safety, manufacturability, and sustainability (creative skills):

Generally, a group consisting of 2 to 4 students is assigned to develop a DBMS package as mini project for a Banking System. As a first step to develop a mini project, students should understand the working principle of the Banking system which helps them to identify the entities, relevant attributes and the type of relationship among the entities. Then, they should represent the complete model of the system by writing the Entity-Relationship (ER) diagram. Later, ER to relational mapping is done considering all the necessary constraints. In this stage, they can construct the relational schemas by identifying the different type of constraints. Once the schemas are ready, tables can be constructed using Structured Query Language (SQL). Then, data base is constructed for the given system by entering the values into all the tables following the given constraints. Finally, queries are written using Structured Query Language (SQL) to extract the required information. This is how the students can better understand the subject by designing the backend of the DBMS software.

For making the software user friendly, they should design the front end which helps the customers to use that software. For this, students have to understand the needs of the customers and the type of the customers so that they design it as per the requirement of the customers. Thus, by developing a DBMS software for a particular application, students can acquire the ability to design, implement, and evaluate a computer-based system to meet desired needs of the customers, within realistic constraints such as economic, societal and sustainability using their creative skills. By evaluating the mini project developed by a group of students, students can be assessed to measure how best they have achieved the PO-3.

As the students are working in a team to design and develop a product for solving real life problem, students can definitely acquire the ability to function effectively on teams to accomplish a common goal. This shows that the PO-9 can be achieved.

Students have to give seminar and demonstrate the progress work of their mini project in each stage to their mentor or

project guide. This opportunity of presenting their work increases their confidence level of communication. This shows that students have achieved the PO -10.

Through MPBL, students can learn by designing and constructing actual solutions to solve the given problem. Hence, mini project-based learning provides students the opportunity to explore problems and challenges that have real-world applications, increasing the possibility of long-term retention of skills and concepts. This shows that the PO-11 can be achieved.

B. Benefits of Adopting MPBL

- Provides a platform in multiple ways for students to participate and apply different kinds of intelligences to demonstrate their knowledge and skill.
- Serves as a medium for those students who do not usually participate in team work and encourage them to participate in group activities.
- Stimulates students to work together and supports self-directed learning.
- Provides a learning experience by combining the thinking and shared efforts of several individuals.
- Supports students to develop a variety of social skills relating to a group work and collaboration by providing a supportive environment.
- Promotes the internalization of concepts, values, and modes of thought, especially those related to cooperation and conflict resolution.
- Provides an experienced learning by transferring the responsibility of learning from teachers to students.
- Provides an opportunity to each student to explain or defend their position to others in their project groups, so that learning is more appropriate to be personalized and valued.

V. RESULTS AND DISCUSSION

An analysis has been conducted to get students' feedback on the implementation of MPBL for the course ADBMS for post graduate students. Feedback form was formulated comprising of only three questions like 1 (Excellent), 2 (Good) and 3 (Poor). Students have to rate their learning by emphasizing the benefit of implementing PBL strategy. Feedback from 24 students who actively took part in the MPBL was collected. The students were given an opportunity to comment on the implementation of MPBL in the feedback form.

From the feedback form received, it is observed that 75% of the students have graded excellent, 17% have graded good and remaining 8% have given poor remark. This shows that implementation of Mini Problem Based Learning helps 92% of students to apply, design and develop a solution for the real life application using their learning skills. 8% percentage of the students is unable to see the benefits of MPBL. However, these 8% of the students can definitely join the team consisting of

good students and can certainly improve their learning ability. The faculty has taken all these comments and look for the continuous quality improvement of the course by designing more effective MPBL for students.

The feedback proves that the students have attained not only four Program Outcomes but also other Program Outcomes. Whereas, in traditional education, the outcomes are not defined and hence students cannot be assessed whether they have attained any outcome. Hence, it is best to adopt the type of education which follows the slogan of the Outcome Based Education - "Begin with the End in Mind". From this paper, it is observed that adopting mini project based learning is considered to be the best pedagogical method to implement Outcome Based Education, which is the need for the current 21st century.

A. Difficulties in implementing MPBL

Though the implementation of MPBL has many benefits, the implementation remains a challenging task for both faculty and students. Hopefully, some of the experiences shared in this paper will support and encourage others to facilitate the integration of these activities in their undergraduate engineering curriculum. Normally, strength of undergraduate students is quite large ranging from 60 to 120, compared to strength of post graduate students which ranges from 18 to 24. Because of this huge strength, it is quite difficult to implement this concept of project-based learning for undergraduate students. However, if some necessary arrangements are made to supervise the teams of students, then definitely, it is worth of taking additional responsible task, as the quality of graduates meets the requirements of the industry. One way to overcome from this difficulty is to make use of PG students who are selected as Teaching Assistants in TEQIP funded colleges.

VI. CONCLUSION

The modern engineering profession requires skills and technical competencies. Also, our engineering students must acquire lifelong learning to be able to apply their knowledge in accordance with the new problems faced in their daily life. Hence, it is anticipated to introduce Mini Project-based learning (MPBL) which provides a best platform for the students to gain greater depth of understanding of concepts, broader knowledge base, improved communication and interpersonal/social skills, enhanced leadership skills, increased creativity, and improved writing skills.

In this paper, the experience of using the technique of mini project-based learning (MPBL) as a key pedagogical method for teaching a course Advanced Data Base Management System within the context of a Master's programme is reported. The positive feedback from the students proves that the implementation of MPBL is a successful pedagogical method to prepare our students ready for the 21st century requirements. Hence, Project-based learning can be considered an extremely effective method that empowers students to learn both the fundamental concepts and principles and, to develop an understanding of how they are utilized in applied engineering to solve design problems. It also provides them an opportunity to understand designs from a systems perspective

for technical challenges in the context of global societal, economic and environmental requirements. Hence, the authors claim that the integration of mini project based learning has to be included in teaching learning process for at least one subject in second and third year of undergraduate program and at least one subject in every semester of post graduate program.

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