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Project Based Learning: An Effective Technique of Learning Programmable Logic Controller

Prof. Shrutika S Sawant, Prof. Subodh S Ingaleshwar
Asst. Prof., Dept. Of ETC, RIT, Islampur, Maharashtra
shrutika.sawant@ritindia.edu, subodh.ingleshwar@ritindia.edu

Abstract:

In today's world of transforming a traditional teacher centric learning to student centric learning, use of collaborative activities are essential. Project Based Learning is one of the efficient pedagogical tools. Project based learning is widespread and proven pedagogical tool to achieve a variety of learning outcomes. This tool has been used in course Programmable Logic Controller to understand core concepts of it and identify its applicability in real time scenarios which requires in-depth visualization. Programmable Logic Controller is program elective course taught in last semester of Electronics & Telecommunication engineering department. In this paper, the implementation of PBL to course is analysed with direct & indirect attainment of course outcomes. The paper intends to promote PBL as successful and active learning tool for student's engagement.

Keywords:

Project based learning (PBL), Programmable Logic Controller (PLC), Direct & indirect attainment, course outcomes (COs).

1. Introduction:

To engage students in continued, collaborative real-world investigations Project-based learning is an effective teaching approach. Due to developments in learning theory over past 25 years the method of project-based learning has been emerged. Because learning is a social activity, teaching methods can scaffold on students' prior experiences and include a focus on community and culture. Furthermore, because we live in an increasingly more technological and global society, teachers realize that they must prepare students not only to think about new information, but they also must engage them in tasks that prepare them for this global citizenship. Based on the developments in cognitive research and the changing modern educational environment in the latter part of the 20th Century, project-based learning has gained popularity.
The objective of this paper is to present effectiveness of project-based learning over traditional learning method for course programmable logic controller which has been taught to final year students of ETC dept. as a program elective. The implementation of PBL to PLC course is analysed with direct & indirect attainment of course outcomes. The results are compared with previous years result which shows that, it has improved significantly with efficient use of PBL.

2. Literature Review:

John Thomas (2000) explains that PBL requires "complex tasks, based on challenging questions or problems, that involve students in design, problem-solving, decision making, or investigative activities; give students the opportunity to work relatively autonomously over extended periods of time; and culminate in realistic products or presentations."[1]. According to Ronald Marx et. al. (1994), project-based instruction often has a "'driving question' encompassing worthwhile content that is anchored in a real-world problem; investigations and artifacts that allow students to learn concepts, apply information, and represent knowledge in a variety of ways; collaboration among students, teachers, and others in the community so that participants can learn from one another; and use

of cognitive tools that help learners represent ideas by using technology…"[2]

3. Project Based Learning:

PBL is a model that organizes learning around projects. According to the definitions found in PBL handbooks for teachers, projects are complex tasks, based on challenging questions or problems, that involve students in design, problem-solving, decision making, or investigative activities; give students the opportunity to work relatively autonomously over extended periods of time; and culminate in realistic products or presentations [3][4]. 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. Why are so many educators across the world interested in this teaching method? The answer is a combination of timeless reasons and recent developments.

- PBL makes more engaging for students: Today's students, more than ever, often find school to be boring and meaningless. In PBL, students are active, not passive; a project engages their hearts and minds, and provides real-world relevance for learning.
- PBL improves learning: After completing a project, students understand content more deeply, remember what they learn and retain it longer 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.
- PBL builds success skills for college, career, and life: In the 21st century workplace and in college, success requires more than basic knowledge and skills. In a project, students learn how to take initiative and responsibility, build their confidence, solve problems, work in teams, communicate ideas, and manage themselves more effectively.
- PBL provides opportunities for students to use technology: Students are familiar with and enjoy using a variety of tech tools that are a perfect fit with PBL. With technology, teachers and students can not only find resources and information and create products, but also collaborate more effectively, and connect with experts, partners, and audiences around the world.
- PBL makes teaching more enjoyable and rewarding: Projects allow 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.

The graphical representation of phases PBL cycle is shown in fig.1.1

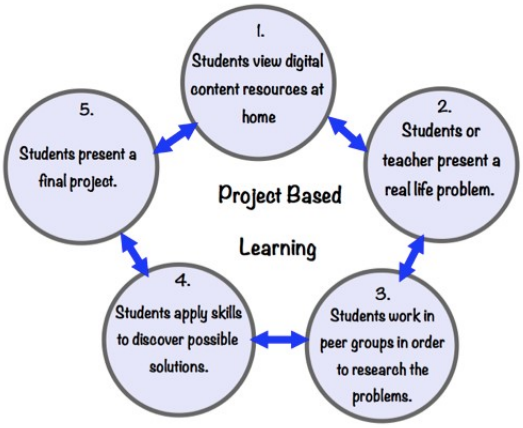

Fig. 1.1 PBL cycle

4. Implementation of PBL:

Programmable Logic Controller (PLC) is program elective course taught in last semester of Electronics & Telecommunication engineering department. A programmable logic controller, PLC, or programmable controller is a digital computer widely used for automation of industrial electromechanical processes, such as control of automated factory assembly lines, robotics, or batch process controls. They were developed in the automobile industry to meet a need for flexible, ruggedized and easily

programmable automation controllers to replace hard-wired relays and timers, but have been widely adopted in industry as highly-reliable industrial automation controllers. A PLC is an example of a "hard" real-time system since output results must be produced in response to input conditions within a limited time, otherwise unintended operation will result.

Project Based Learning has been used in course PLC of batch 2015-16 to understand core concepts of it and identify its applicability in real time scenarios which requires in-depth visualization. The assessment of PBL activity has been considered as part of In-semester evaluation. The total numbers of students who have opted the PLC course were 25. These numbers were divided into 8 groups each of 4/5 students. To each group separate problem statement has been given. The some examples of problem statement given to students are as follows:

1. A bottling process for 12 bottles operates as follows:
   Bottles are counted until all 12 are in position for filling. When in position in the carton, the 12 bottles are filled simultaneously for 6.3 seconds. After filling, there is a pause of 3.8 seconds for foam to subside. The 12 caps are then put on & counted as they are installed. A solenoid then pushes the completed carton of 12 on to a conveyer. The system is reset for a new group (to be restarted manually) of 12 bottles by a limit switch that indicates that the carton is out of the fill position & on the conveyer. Design PLC ladder diagram program for the above process.
2. Design PLC ladder diagram for washing machine which will accomplish the following task.
   When a push button is pressed & released the motor starts running in forward direction for 10 sec & then automatically stops for 5 sec. Again same motor starts running in reversed direction for 10 sec & remain stops for 5 sec. this logic continues for 1 minute & then machine is totally stops automatically. If the process is to be stopped in between 1 minute of operation, then stop button is to be pressed & released.

Students were instructed to complete the task by the end of semester so that it was possible for students to use the knowledge of PLC to solve given problem statement. Also the flexibility was given to students to choose simulation software. Students have used 2 to 3 different software's like RSLogix (Allen Bradly PLC), Sematic Manager (Siemens PLC), Ladsim Demo (free simulator for ladder programming), Ladder Builder for KV (Keyence PLC), etc. it has been observed that students were introduced with different simulation tools which has given students the opportunity to engage in higher-level earning.

Course Outcomes of PLC:

At the end of the course the student should be able to:

1. Identify basic components and symbols of ladder diagram.
2. Explain major components of PLC and their interfacing with sensors and motors in industrial application.
3. Predict response of given system based on its ladder logic diagram.
4. Design ladder logic diagram for given problem statement.
5. Apply advanced programming techniques for specialized applications.

5. Assessment of the activity:

The implementation of PBL to PLC course is analysed with direct & indirect attainment of course outcomes. The CO attainment is very important as it determines student achievement in particular course. This attainment can be further used to evaluate the attainment of Programme Outcomes (PO). The outcome of analysis will be used to improve the teaching and learning experience in the particular course.

While calculating direct attainment of CO, In Semester Evaluation (ISE), Mid Semester Evaluation (MSE) & End Semester Evaluation

(ESE) marks are considered. Course exit survey report is considered for indirect attainment of CO. Marks allocated to ISE is 20, MSE is 30 and ESE is 50. For overall attainment 80% direct attainment and 20% indirect attainment is considered.

The results are compared with previous years result which shows that, it has improved significantly with efficient use of PBL.

The actual evaluation of PBL is carried out for 20 marks as ISE. The assessment criteria for evaluating the performance of the students are shown in below table 1.

Table 1: Assessment Criteria

Sr. No.	Assessment Criteria	Weightage	Bloom Level
1	Effective & professional design of project (software)	25%	Synthesis (Level 5)
2	Use of appropriate tools and techniques for project design	25%	Application (Level 3)
3	Implementation of the project (100% work completion is expected)	20%	Synthesis (Level 5)
4	Quality of results	15%	Analysis (Level 4)
5	Quality of answers given to the questions	15%	Evaluation (Level 6)

Student's feedback about PBL activity is taken during the course exit survey.

6. Result and discussion:

Though PBL activity has been carried out as part of ISE, but it has shown good impact on result of MSE and ESE. Some design based questions were asked in MSE and ESE question paper which has been correctly solved by students.

The following figures shows graph of weighted average ISE, MSE marks of class for year 2015-16 & year 2014-15.

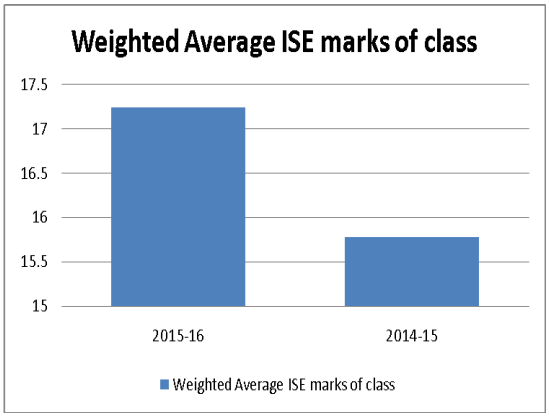

Fig.1.2 Weighted Average of ISE marks

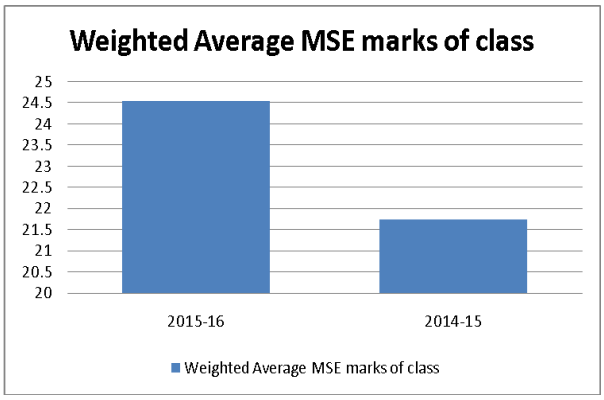

Fig.1.3 Weighted Average of MSE marks

Direct CO attainment:

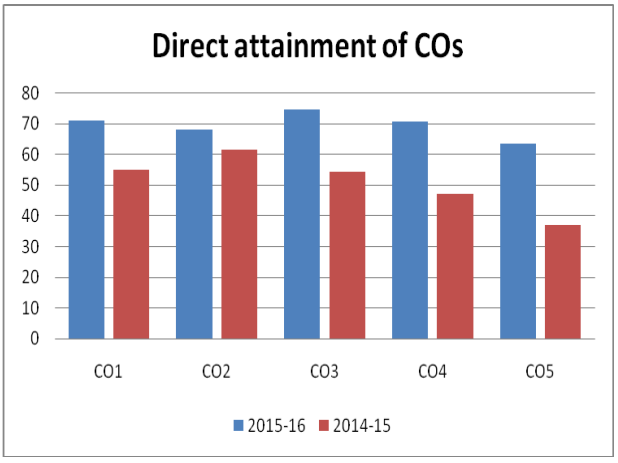

Fig. 1.4 Direct attainment of COs

Direct attainment of CO is calculated from ISE, MSE & ESE marks. It has been observed that result has improved.

Indirect CO attainment:

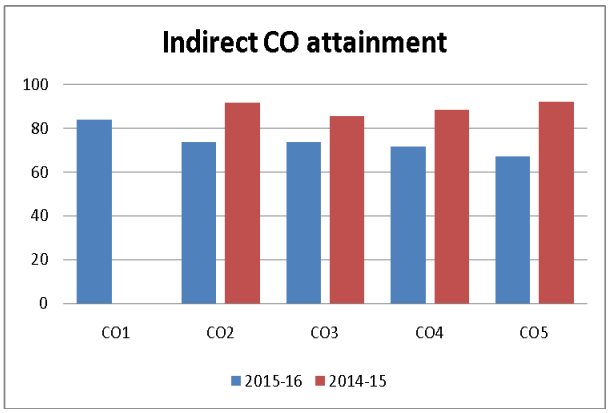

Fig. 1.5 Indirect attainment of COs

Fig.1.5 shows Indirect attainment of COs which has been calculated through course exit survey. There is no improvement in achievement of COs except CO1. In previous year CO1 was not attained but in year 2015-16 about 80% of CO1 has achieved.

Overall attainment:

The overall attainment of CO is calculated by considering 80% weightage for direct attainment and 20% weightage for indirect attainment. From figure 1.6 it has been observed that except CO2, attainment of the entire COs is remarkable because these COs are application oriented and CO2 is related with theory.

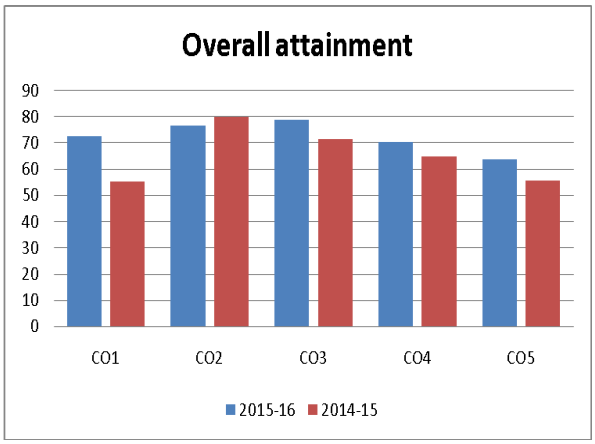

Fig. 1.6 Overall attainment of COs

7. Conclusion:

This paper presents effectiveness of project based learning to PLC course. It has been observed that results of students have improved which impact directly on to attainment of course outcomes. The overall outcome as seen from the result analysis clearly indicates that the approach adopted was significantly encouraging to the student's development.

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[1] Thomas, J. (2000). *A Review of the Research on Project-Based Learning*. The Autodesk Foundation.

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[4] Thomas, J. W., Mergendoller, J. R., and Michaelson, A. (1999). Project-based learning: A handbook for middle and high school teachers. Novato, CA: The Buck Institute for Education.

[5] http://www.bie.org/about/why_pbl

[6] D.R.Woods, "PBL: An evaluation of the effectiveness of Authentic".