

# A Blended Approach for Teaching Laboratory Course: Internet Technology

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**Abstract:** Teaching laboratory courses is a challenging task as compared to teaching theory courses. From a teacher's perspective, it is a challenging task because he must be able to engage student actively for two hours. From a student perspective, it is challenging because students need to work themselves on machines or other equipment's to find out the solution which actually works for a particular problem. Four laboratory courses, students must be able to apply their past theory knowledge and skills for figuring out desired solution. So the lab course is beyond theory course.

But as a hand on experience is necessary for understanding of the associated theory concepts, it is inevitable. Also in conventional mode of teaching laboratory course where experiment list is predefined by the instructor, the student is passively involved in experimental work. This paper reveals how two pedagogic paradigms, namely Project Based Learning and Collaborative Learning are applied to the Internet Technology Laboratory course and shows how a student attains greater course outcomes than conventional methods used for teaching laboratory course. Project based learning gives better understanding of the concept because student learns by self-exploring and actually doing. On the other hand, in collaborative learning students work

collectively in groups to deduce an answer to common problems.

The Internet, Technology Laboratory course is basically designed for understanding the terminologies related to internet protocols at application, routing and transport layers. It is challenging task to motivate students to design and develop all such applications. Hence, collaborative approach has been applied for enhancing the knowledge of the students related to this course by developing application layer protocols in a group. Also the commercial project design technique is used to solve real time problems of customers by designing websites. The student showed keen interest in understanding the customer needs and design the website for them. The analysis shows that there is an average increase of 15% to 20 % in course outcome attainment when this blended approach is applied.

**Keywords:** Internet Technology Laboratory; Project Based Learning; Collaborative Learning.

## I. Introduction

Laboratory courses are equally important as student gets machine experience of the concept which is taught to him in the class. This leads to deeper understanding of concepts and building robust technical skills. In conventional mode of teaching an instructor finds difficult to motivate student and engage them actively for the entire session. Hence, to create interest among the students about the Internet Technology Laboratory course (ITL), collaborative

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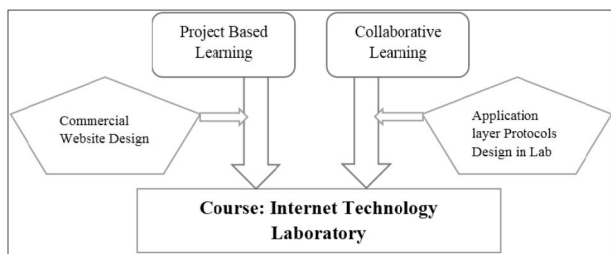
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learning during lab hours has been applied that helped a lot in terms of student engagement and hands on experimentation. Also, with Project Based Learning approach enhanced the student's ability to deal with real clients in understanding the requirements to build commercial web sites. Figure no. 1 shows two methods applied while teaching the Internet Technology course:

1. Project based Learning (PBL): To develop a commercial website
2. Collaborative Learning (CL): To perform various application layer protocol designs in a group during lab hours.

The ITL course mainly focuses on the design and development of the application layer protocols like FTP, DNS, etc. The collaborative learning approach will help in this regard as there is a need of demonstrating this activity in client-server architecture design.



**Fig. 1: Teaching Learning Methods for ITL**

Traditional approach had applied to teach this course in previous academic years, and it is observed that the course outcome attainment was very poor. So, there is need of any innovative teaching, learning methodology that may result in better understanding of the course and that in turn increases overall course attainment.

### Overview of the ITL Course:

This course is a part of the Computer networking domain, hence the basics of computer networking, reference models: OSI and TCP/IP is required as a prerequisite for this course. The following topics are included in the entire course design:

1. Socket programming is used for client server architecture design and lab experiments associated with this has been performed using CL approach.

2. Application layer protocol: HTTP design is associated with PBL approach in which students have to design and host website for commercial purpose.
3. Design of application oriented servers like FTP, DNS, etc. need to be demonstrated in client server modelling.
4. Design and testing of Audio video streaming protocols in a group of 2/3 students.
5. Routing Protocol analysis using NS-2 simulators in a group.

Following are the course outcomes (COs) of this course:

1. To design and implement socket programming by using C/Java OR Python language
2. To develop and host website for commercial purpose
3. To build application oriented servers like FTP, DNS etc.
4. To demonstrate audio/video streaming
5. To analyse routing protocols using the NS-2 Network Simulator.

Hence, to assess this laboratory course traditional approach will not work there is need of some innovative methodologies that can evaluate students in groups. To achieve above mentioned course outcomes different innovative teaching, learning methodologies has been applied, like for CO2 project based approach, CO1 and CO3: Collaborative Learning and CO4 and CO5: Demonstration. Here in this paper, two approaches (PBL and CL) are discussed in the next two sections. Comparative analysis, of course outcomes attainment of this course did in the last section.

## 2. Literature Review

Project based learning is a student centric learning approach in which a student learns by actually solving real world problems by himself. It not only enhances technical qualities of the student, but also improves decision making and thought process. This approach

deals with total reformation of a student and not just syllabus which is a global need of today. PBL is the methodology by which students can learn the things by doing. In general, the PBL approach can increase the involvement of the students towards the project or product design as the goal is to come up with an end product / project. Project based learning approach is been used by many researchers [1, 2, 3] for better understanding of the course. In this journey from project title selection to final project/product creation, students have faced many challenges and overcome that by discussion, knowledge sharing and trial methods among the group. The entire process teach many technical as well as social things to the students like leadership quality, knowledge sharing etc. that in turn enhance the overall personality of the student.

Collaborative learning (CL) [4] is the instructional employment of small groups in which student autonomy is emphasized. Due to the autonomous nature of the approach, the teacher sets the goal, but does not specify the procedure for the groups to meet the goal. Students choose roles and decide among themselves how things should be done. CL approach basically teaches students about how to work in groups and also enhance the ability to solve the problems by contributing their skills and knowledge. Srinivas, H. [5] and Dillenbourg, P. [6] had discussed about the basic idea behind the Collaborative Learning that may help the beginner practitioner to understand main terminology. Roselli, N.D [7] had also highlighted on the theoretical and application aspects of Collaborative Learning. Panitz, T [8] had focused on the basic differences between other interactive learning tools and collaborative learning approach. Dillenbourg, P.etl[9] had given the details of evolution procedure of collaborative learning approach along with comparative analysis of learning steps in humans and machines.

### 3. Project Based Learning

As ITL course is more practical oriented, project design approach is best suitable for understanding of the course. PBL approach prepares students to solve real world challenges/problems by providing technology based solutions. Hence in the process of teaching-learning of the ITL course, students were met real time stakeholders, list out the requirements and specifications, discuss on the consultancy amount and finally host the website as per client requirements.

A] Objectives:

1. To motivate students to deal with real clients
2. To design and develop websites

B] Outcomes:

1. To understand the Web, designing concept by developing a project.
2. To design website for commercial use.

C] Activity Plan:

The teacher tells students to form groups of 3 to 4 students by their choice.

1. Each group visit to nearby shops like medical store, parlour, gas suppliers, bakery stores, jewellers etc. and collect their requirements for designing websites.
2. Convince client to pay money if possible.
3. Collect all information and submit to faculty with signed document on the client.
4. Design the website
5. Demonstrate project in front of the client and make modifications if any, and submit reports to the faculty. (Once or twice in a month)
6. Submit a report of customer satisfaction to the faculty.
7. Demonstrate project in front of faculty.

List of projects designed by the students is mentioned in Table 2. This work was evaluated on the basis of rubrics defined in Table 1.

Table1 list out the parameters under which website design project has been evaluated. Dimensions are also categorized as per the task completed, specified marks were allocated. Table 3 list out the details of the groups and respective website design project description. Few group members have also generated consultancy amount through their project design. All groups have an outsourced code of their projects on GitHub. Each group submitted Feedback from duly signed by the respective owner / client. It has been observed that many real world stakeholders like restaurant owners, government sectors, private sectors NGOs etc. has been addressed by many PBL groups.

Table1 list out the parameters under which website

**Table 1: Rubrics to evaluate PBL**

Criteria	Dimensions				Total
	Poor (Marks: 0 to1)	Fair (Marks: 2 to5)	Good (Marks: 6 to7)	Excellent (Marks: 8 to 10)	
Code validity, code readability, cleanliness of folder structure.	The submission's coding (and code presented in the style guide) is not human readable, nor valid HTML5 and CSS3 with up to 4 major errors (things we have taught you directly) and up to 8 minor errors. There are some major concerns with the cleanliness of the file and folder structure.	The submission's coding (and code presented in the style guide) is human readable valid HTML5 and CSS3 with 1 major error (things we have taught you directly) and up to 4 minor errors. There are some minor concerns with the cleanliness of the file and folder structure.	The submission's coding (and code presented in the style guide) is human readable, semantic and valid HTML5 and CSS3 with up to 4 minor errors (things we have not taught you). File and folder structure is clean.	The submission's coding (and code presented in the style guide) is human readable, semantic and valid HTML5 and CSS3 with absolutely no errors. CSS uses a meaningful naming convention, and file/folder structure is clean.	
Design: Consistency, interface and interaction elements.	The style guide presents an inconsistent aesthetic with unclear interface and interaction cues that respond poorly to user interactions. Little to no connections are built in the final sketches/wireframes, hindering our understanding of navigability significantly.	The style guide presents fairly consistent aesthetic with some unclear interface and interaction cues that respond somewhat effectively to user interactions. The final sketches/wireframes show how navigation will occur, though the structure of the site and navigation is unclear at times.	The style guide presents a consistent aesthetic with clear interface and interaction elements that effectively respond to user interactions. The final sketches/wireframes demonstrate an understandable model of the site's structure.	Effectively leverages principles of 'atomic design' to construct combinations of elements (i.e. navigation, product/service listing) that effectively respond to different devices. The final sketches/wireframes help demonstrate how the site will effectively direct the user to move deeper into the site.	
Deliverables, weekly checks, quantity and quality of exploration.	Numerous weekly deliverables are missing.	Some of the required weekly deliverables are missing.	Deliverables meet the expected amount of process exploration outlined in the brief.	Deliverables demonstrate more exploration both in quantity and quality than outlined in the brief.	
Website Feedback survey by the end user	End user Dissatisfied	End user neutral	End user satisfied	End user very satisfied	
					Total
					---/40

**Table 2: PBL evaluation based on Rubrics sheet**

Criteria	Dimensions				Total
	Poor (0 to 1)	Fair (2 to 5)	Good (6 to 7)	Excellent (8 to 10)	
Code validity, code readability, cleanliness of folder structure .			✓		7
Design: Consistency, interface and interaction elements.			✓		7
Deliverables, weekly checks, quantity and quality of exploration.		✓			5
Website Feedback survey by the end user			✓		7
<b>Total</b>					26/40

**Table3: Commercial Website Project details**

Group No.	Roll No.	Name of Client	Name of company/Organiz ation	Website Specifications
1	1403060, 1503002, 1503014, 1503055	Sanjay Bhosale	Hotel Maharaja	Creative Design, All the Menu card details, Photos of hotels, dishes, chefs, Customer feedback form
2	1501056, 1503009, 1503013	R.R.Jadhav	Gandhi Vidhyalaya	Creative Design, Profile with Photo, Photos and information is in good manner. Customer feedback form
3	1503008, 1504014, 1503017, 1503018	Sanket unune	Shreemant hotel	Creative Design, Menu card details, Photos of hotels, chefs, Customer table form
4	1504040, 1504048, 1504063, 1505053	Aniruddha Manolikar	Sarthi	Creative interface for both mobile and web, Booking for E-rickshaw, Uber facility in rural and urban areas
5	1653003, 1653008, 1553010, 1403038	Manish Bhat	Shree Institute	Creative design and Effective User Interface. Portal to post event information and posters. Gallery includes pictures of already happened events. Facilities: Online registration, login and application.
6	1504027, 1504029, 1504031, 1653005	Sai Patil	Sai Rentals	Effective User Interface. Gallery with car photos and price. Online registration. Login Page
7	1653012, 1653011, 1503042, 1504045	Mr. Vishal Jadhav	Angnipankh	Effective User Interface. Gallery with children photos and Donate Page Online registration. Login Page
8	1503027, 1503028, 1503022, 1503015	Mrs. Rekha Bhosale	balkrishna sangle vidyamandir ichalkamji	User Interface, Online registration, Login Page, student data adding and deleting
9	1503031, 1503053, 1503056, 1503059	Mrs. Dinesh Jadhav	Bhagyashree Cards	Effective user interface, Order page, gallery with wedding card photos, Menu bar with different religion cards
10	1503051, 1403057, 1504049, 1503043	Shri. Krishanji Jadhav	Jadhav Enterprises	Register, User to system, Login/logout features, Filter out cars according to user, requirement, Show details of each car

11	1504036, 1503048, 1503052, 1504026, 1504035	Grampanchayat Rethare	Grampanchayat Rethare	Informative webpages about Rethare, Should inform regarding new Notices . Should help to know about Panchayat Schemes
12	1403008 , 1403012, 1503026, 1503049	Shri.Amrut Patil	Javant Automobiles	Effective user interface, Login/Register features, Car booking options, Creative design
13	1503016 1503021 1503029 1503030	Harshad Varkhat	Hotsip cafe and bistro	Effective user interface , Login/Register features, View and add menu card details, photo gallery
14	1503023, 1503033, 1503040, 1503047	Nikhil Gijare	Imprinteo	Creative Design, About consist good Images, Photos and, information is in good manner.
15	1403033 1403040 1503019	Mr. Abhinay Patil	Cafe blue	about, menu list, gallery, contact

design project has been evaluated. Dimensions are also categorized as per the task completed, specified marks were allocated. Table 3 list out the details of the groups and respective website design project description. Few group members have also generated consultancy amount through their project design. All groups have an outsourced code of their projects on GitHub. Each group submitted Feedback from duly signed by the respective owner / client. It has been observed that many real world stakeholders like restaurant owners, government sectors, private sectors NGOs etc. has been addressed by many PBL groups.

D] PBL Evaluation: To assess groups mentioned in Table2, rubrics defined in Table1 are considered. As per the criteria's mentioned in Table1 marks are given. Sample evaluation sheet as shown in Table2 has been designed and used for the assessment of PBL activity. Total four criteria's were defined, namely related to code validity, code design, weekly checks and end user feedback. Total four dimensions have been considered: poor, fair, good and excellent.

As per the ranges mentioned per dimension, marks were given to the students out of 40. In the evaluation procedure of ITL course total 100 marks are allocated as per mentioned below:

1. In Semester Evaluation1 (ISE1) = 10 marks
2. In Semester Evaluation2 (ISE2) = 10 marks
3. Continuous Assessment Sheet (CAS) = 30 marks
4. End Semester Evaluation = 50 marks

Also, the weekly checks concept has been applied in PBL, which contains following points:

- a. Task completed till date
- b. Modifications/suggestions in completing tasks by the client

- c. New task assigned by the client along with a deadline
- d. Duly signed a paper with signature of the client

PBL evaluation is associated with ISE2 examination. Hence marks obtained out of 40 as per PBL evaluation rubrics were finally converted into 10. This evaluation strategy is applied to assess all the groups.

### 3. Collaborative Learning

In ITL course, hands on sessions are carried out to learn the terminologies like socket programming, client and server etc. Hence, the task is divided among the group of 2/3 students and the group need to demonstrate the client server model for giving application.

A] Objectives:

1. To understand the working of client server architecture with hands on.
2. To design and develop application oriented servers

B] Outcomes:

1. To implement the client server architecture in a group of students
2. To understand application oriented servers by hands on Coding in a group.

C] Activity Plan:

1. Tell students to work in a group of three and one must act as a server and remaining 2 as a client's (as per their choice)
2. Discuss the server and client code in a group
3. Execute client server architecture for giving problem statement

D] CL Evaluation: It is easy to evaluate individual student based on task completion, but in group task assignment, it is difficult to keep track of the individual group member contribution, some protocols need to be defined in the evaluation. Hence, to evaluate this group activity, rubrics were designed as shown in Table 4 and sample assessment sheet of CL evaluation is as shown in Table 5.

Following four criteria's were considered for the group evaluation:

1. Ability to demonstrate the program in groups: students must be able to demonstrate the code.
2. Ability to run /debug on different platforms: Able to run on Linux as well as Windows Operating System.
3. Ability to perform input validation: Code must be worked on all types of inputs
4. Ability to produce readable programs: Program must be readable and easy to understand.

Along with this total five dimensions were considered, namely very poor, poor, Fair, good and excellent. Marks a range for each dimension is predefined.

As per the individual experiment requirements along with mentioned rubrics few associated rules were defined.

Example: Experiment no. 1 evaluation as per rubrics:

Expt1: Design client server architecture to check the entered number is strong number or not.

Following assessment rules has been considered along with defined rubrics:

- a. Successful connection between client and server machine
- b. Client sends an integer number to the server
- c. Server machine processes the code written at the server end to check received integer number is strong or not.
- d. Server sends results back to the client i.e. "number is strong" or "number is not strong".

Expt.6: FTP server creation

Following assessment rules has been considered along with defined rubrics for this experiment:

**Table 4: Rubrics to evaluate CL**

Criteria	Dimensions					Total
	Very Poor (Marks: 0 to1)	Poor (Marks: 1 to2)	Fair (Marks: 3)	Good (Marks: 4)	Excellent (Marks: 5)	
Ability to demonstrate program in groups	Unable to Explain program design	Able to explain a Little program design	Able to explain Some program design	Able to explain Entire program Design correctly as it is	Able to explain Program design Correctly and Provide alternative solutions	
Ability to run /debug on different platforms	Unable to run program	Able to run program but have logic error	Able to run Program Correctly Without any logic error	Able to run Program correctly without any logic error and Display inappropriate output	Able to run program Correctly without any logic error and display appropriate output	
Ability to perform input validation	The program produces incorrect results	The program Produces correct Results but does Not display Correctly Does not check for Errors and Out-of-Range data	The program produces correct Results but does Not display Correctly. Does little check for errors and out of range data	The program works and Meets all Specifications. Does some Checking For errors and Out of range data	The program works and meets all Specifications. Does exception checking for errors.	
Ability to produce readable programs	No Documentation	Documentation is simple, comment in code.	Documentation is Simple comment Embedded in code with header separating the codes	Documentation is simple Comments and header that useful in understanding the code	Documentation Is well written and clearly Explains what The code is accomplishing	
					<b>Total</b>	---/20

**Table5: CL evaluation based on Rubrics sheet**

Criteria	Dimensions					Total
	Very Poor (Marks: 1)	Poor (Marks:2)	Fair (Marks:3)	Good (Marks:4)	Excellent (Marks:5)	
Ability to demonstrate program in groups				✓		4
Ability to run /debug on different platforms					✓	5
Ability to perform input validation				✓		4
Ability to produce readable programs				✓		4
<b>Total</b>						17/20

**Table 6: CO to Experiments Mapping**

Co/Expt.	1 Website Design	2 Socket programming using TCP	3 Socket programming using UDP	4 Domain Name Server	5 Telnet	6 FTP	7 SMTP and POP	8 Proxy Server	9 Streaming video with RTSP and RTP	10 NSG and NS-2 Simulator
	Teaching Learning Method									
	PBL	CL	CL	CL	CL	CL	CL	CL	CL	CL
CO1		✓	✓							
CO2	✓									
CO3				✓	✓	✓	✓	✓		
CO4									✓	
CO5										✓

- a. FTP server successfully created by the group
- b. Client can able to upload data on FTP server
- c. Client can able to download data on FTP server

Accordingly the assessment procedure is carried out for the entire batch of 20 students. The whole class of 80 students is divided into total four batches.

#### 4. Experimental Analysis

Total 10 experiments were included in the Internet Technology Lab course, the mapping of each experiment with the respective course outcome (as mentioned in introduction part) is as shown in Table 6. It also shows the teaching, learning methodologies that were applied per experiment. The PBL and CL methodologies had been applied for third year students in academic year 2017-18.

##### A] CO Attainment Measurement:

To calculate the attainment of each course outcome (mentioned in introduction section) both direct and indirect approaches [10] are applied. The weight allocation for direct method is equal to 80% and for

indirect method 20% weight is given.

##### I) Direct Method:

The ITL course evaluation procedure is explained here by considering sample 10 students marks in various examinations conducted during the semester.

To measure CO attainment mapping of examination with respective CO is need to be input along with the marks of the students.

Steps to evaluate CO1 attainment for the example given in Table7 & Table8:

Step1: Calculate total marks for each exam type  
 $i = \text{TotMi}$

Step2: Calculate the average marks for each exam type  
 $\text{AvgMi}$

Where  $i = 1 \text{ to } N$  (Number of Examination)

Step3: Identify exam types associated with particular CO. for example ISE1, CAS and ESE exam types are associated with CO1.

Step4: Calculate the sum of Avg marks for ISE1, CAS and ESE exam types (6.3+25.7+35 = 67)

Step5: Calculate the sum of marks for ISE1, CAS and ESE exam types (10+30+50 = 90)

Step6:

CO<sub>k</sub>Attainment =

$$[\sum \text{AvgMarks} \div \sum \text{sum of Marks}] \times 100$$

Associated with particular CO<sub>k</sub> .....eq1

where k=1 to number of COs

**Table7: Sample Marks of 10 students**

Roll No	Examination Type			
	Programming Test(ISE1)	PBL (ISE2)	CAS	ESE
Marks->	10	10	30	50
R1	8	8	22	39
R2	5	7	18	25
R3	6	7	22	32
R4	4	6	21	28
R5	10	7	28	43
R6	9	8	29	45
R7	8	9	27	41
R8	6	9	21	40
R9	3	6	19	31
R10	4	7	20	26
<b>Total Marks</b>	63	74	257	350
<b>Average Marks</b>	6.3	7.4	25.7	35

**Table8: CO Mapping with examination Type**

Course Outcome	Examination Type			
	Programming Test(ISE1)	PBL (ISE2)	CAS	ESE
CO1	✓		✓	✓
CO2		✓	✓	
CO3			✓	✓
CO4			✓	✓
CO5			✓	✓

Here in this example (67/90)\*100=74.44 is the attainment of CO1.

II) Indirect Method:

In this type of the CO attainment calculation method instead of marks secured by students in particular questions associated with any CO, students' feedback is considered. For example consider the below mentioned question associated with CO1:

Q.1) Can you able to design client server programs?

Options: a. Yes b. No

The above question is associated with CO1. If out of 80 students 60 students have chosen Yes and 20 students choose No, then the indirect attainment of

$$\text{CO1} = (\sum \text{No of students' type option a} \times 100) \div \text{Total number of students} \dots\dots\dots\text{eq2}$$

Here, Total number of students=80

Number of students' type option a =60

Hence CO1 indirect attainment=75%

i.e. (60 \*100/ 80)

III) Direct + Indirect Method:

Total 100% distribution is as follows:

A 80 % weight for the direct approach and 20% weight for indirect approach. Hence, here in this sample case Direct CO1 attainment= 74.44% and indirect CO1 attainment=75%. Total CO1 attainment =74%

Similarly, course outcome attainment is measured for all Cos. The attainment of each course outcome is measured and analysed with the traditional approach in which the course was taught by conventional manner and the PBL + CL approach as shown in Table 9 and Figure2. It has been observed that as in previous academic years, the course had taught by traditional way, i.e. individual lab assignments were given and students were found it very difficult to complete. In academic year 2017-18, two innovative tools, i.e. PBL and CL were applied and that shows the tremendous increase in the course outcomes attainment.

To measure the attainment of course [11] direct attainment is considered. For experiments that were mapped with CO1, CO3, CO4 and CO5 CL approach had applied. Every CO attainment shows around 15%



to 20% increase as compared to conventional approaches.

Traditional approach of teaching ITL course has been applied to the students of Third year computer engineering at Dr. Babasaheb Ambedkar Technological University, Lonere Raigad in which individual lab experiment allotment and assessment have used. While the same ITL course had been taught by using a PBL+CL approach at Rajarambapu Institute of Technology, Sakharale. The above analysed experimental work was applied to total 160 students, i.e. 80 students from Dr. Babasaheb Ambedkar Technological University, Lonere Raigad and 80 students from Rajarambapu Institute of Technology, Sakharale.

**Table9: Comparative analysis of Course Outcome**

Course Outcome (CO)	Course Outcomes Attainment (In %)	
	Traditional Approach	PBL + CL Approach
CO1	60.13	77.23
CO2	67.05	80.43
CO3	58.3	78.15
CO4	56.5	79
CO5	40.5	67.06

Also, the feedback related to PBL and CL teaching, learning methodologies had taken on the scale of 0 to 10 i.e. individual students need to give mark to the activities PBL and CL in the range 0 to 10. It is observed that the 84% students has given 9 to 10 marks to CL activity and 56% students given 10 marks to PBL activity. 10% students have given below 5 marks to PBL activity and 12% students has assign below 5 marks to CL activity. From the above statistics, we can say that the CL activity is appreciated by most of the students as compared to PBL.

Hence there is need to do some modifications in PBL activities like to provide options in PBL activity. Here in this course total two below mentioned options can be provided:

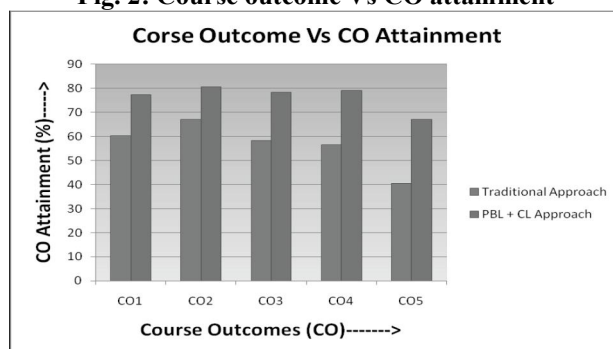
### 1. Commercial Website Design

### 2. Multimedia Application Design

So, the group of students who will not able to get the clients for commercial website design can create any multimedia application for different stakeholders like to create multimedia applications for primary school students for a better understanding of mathematical operations etc. or design multimedia application for any critical topic that may help in better understanding the concept.

It has been observed that there are many hurdles in this entire process like students can't able to find the stakeholder; students were not able to complete the assigned task within the deadline or consultancy amount not paid by the client even with successful completion of the project. So, there is a need to come to some solution to tackle such type of run time situations. In successful execution of the entire process many things are important like student's sincerity, the teacher's role, stakeholder's role, run time environment, etc. Also there are many hurdles in the implementation of CL activity such as few students were reluctant to participate hence here teachers' role is very much important. The teacher need to motivate students so that all students should participate actively along with this strict monitoring and question answer inferring also help in the entire process.

**Fig. 2: Course outcome Vs CO attainment**



In short, we can summarize the things as below:

1. For successful completion of any innovative teaching, learning activity, proper planning is needed.
2. The teacher should act as an instructor instead of leading the class.
3. The teacher should ensure 100% involvement of the students in the activity

4. Activity assessment as per defined rubrics may reduce the conflict in marking scheme.
5. The collaborative learning approach will result in better understanding of the course
6. Project based learning approach enhances the skill of dealing with real time stakeholders
7. Feedback regarding every activity is needed to be collected for further improvement plan.
8. Analysis of the result will tell about the impact of the applied methodologies.
9. Innovative methods may or may not work, the experience is important to plan the course accordingly.

### Conclusion

Traditional teaching, learning technique is not suitable for many laboratory courses, especially the courses that need to design some client server architecture. In today's era of internet, all types of information are easily available on the internet so as a teacher one needs to plan laboratory courses in such a way that the student learning can take place by working in groups. Hence, the CL approach had applied that result in a tremendous increase in the understanding of the students. This approach also enhances the other qualities among the students like group discussion, leadership, etc. The PBL approach helped students to apply the things taught in the course to solve real time problems, i.e. students need to visit nearby stakeholders and convince the clients for giving project that enhances the skill of dealing with real time clients. Also, it increases the confidence among the students about working with real project. Hence the experiences of handling real world projects can get through the entire process. Students also need to encourage the stakeholders about the consultancy amount of the project. So, students can understand about calculating the amount of project done and can able to convince the client for the same.

To teach The Internet, Technology Laboratory course two methodologies are applied, namely Project based Learning (PBL) and Collaborative Learning (CL). It has been observed by result analysis that there is an increase in the percentage of every course outcome of around 15% to 20%. Hence, the applied methodologies were succeeded in enhancing the student learning capacity.

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