

A Case Study on the Student Centric Course in Engineering Programme leveraging PBL

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Abstract: Quantification of the quality of Engineers is a significant parameter contributing to an Industry person in recruiting an Engineering student, a government organization in sponsoring/ funding an entrepreneurial aspect of the student and an esteemed University in granting scholarship for higher education of the student. There is a need to improve the students' technological, communication, entrepreneurial skills during the course of the Engineering education. One such pedagogical technique contributing to student's skills is the Project Based Learning (PBL). Through PBL, students learn the courses instead of merely studying it. The significance of PBL and the consequences of practicing PBL in Engineering education is portrayed in this paper. The approach of PBL practiced in Kalasalingam Academy of Research and Education is explained with a case study of one of the courses, that followed PBL pedagogy. The evaluation pattern, rubrics and the supremacy of PBL over traditional pedagogy methods is estimated.

Keywords: Project Based Learning, Assessment Methodologies, Engineering Education, Student Centric Course.

1. Introduction

As part of acquiring a dominant role in the professional environment, learners seek to master various skills embarked into them. The primary skill being the ability to design solutions to problems as a team. It is the fact that the expertise dominates the experience in today's competitive world. In addition to strong preliminary knowledge, the ability to apply the knowledge as design process, communication and support is expected by the employers (Filho et al., 2016). International Board of Standards for Training, Performance and Instruction (Grönroos et al., 2015) states that team work and effective communication at all-grounds including written, visual and oral, are an essential ability of a typical competent. The fact becomes evident when diverse group of people work on a common problem.

With an essential need to inculcate these skills in learners, various instructional strategies are used by the teachers including Think-Pair-Share activity, flipped classrooms, reading comprehension activities, open-ended problems as assignments, literature survey, among others (Hutchings et al., 2015). One of the state-of-the-art instructional strategy that provide students with various skills is the project-based learning or problem-based learning abbreviated as PBL (Harris et al., 2017). PBL is termed as the application of knowledge to solve a complex problem, in collaboration and cooperation with the team. Outcome of PBL is deemed to be an artifact, typically a prototype, technology, research paper, among other similar kinds, developed by the student [Ryszard et al., 2020]. Kokotsaki et al., (2016) surrounded PBL with

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five different criteria, which need to be satisfied by a project, to categorize itself as an implication of project-based learning. The project should be (a) Curriculum centric, (b) enable students/ learners to encounter complex problems and varied choice of solutions in multiple disciplines, (c) proper investigation directing to the solution, knowledge enhancement, discoveries, (d) student autonomy in terms of working hours, ways of solving the problem and (e) Generate or develop implementable solutions focusing authentic changes Hussein et al., 2015, Jacobs et al. 2014).

The main challenges possibly be faced by the instructors by having PBL into action is the way to structure the course to be offered in PBL mode. PBL, being a student-centric approach, the efficacies of the students are to be evaluated through the student-preferred metrics. The ultimate aim being the process of inculcating students' interest over the course. Various studies (Noguera et al., 2018, Miller et al., 2015) suggest that the students need to acquire self-learning, collaborative, error finding skills, with appropriate amount of scaffolding provided by the instructor. Scaffolding is a strategy where instructor provide assistance required by the students in contents, which the students are not able to grasp by self. Once the students' gain enough knowledge, the instructor slowly fades his/her assistance over the student. Scaffolding deems to be an efficient pedagogy to inculcate self-learning skills. In addition, PBL also act as a source for the students to develop potential among the learners to identify the strength and weakness of thyselves and the fellow teammates. It also makes the learners as able candidates to survey in diverse working conditions.

In this paper, we provide a standard methodology to apply student-centric models in Engineering courses. The key contributions of the paper include:

- Design of a standard template to mobilize student-centric PBL courses in Engineering curriculum.
- Enumeration of possible assessment methods to evaluate a typical learner of PBL course.
- A case study on the run of a PBL course in Kalasalingam Academy of Research and Education.
- We provide a detailed comparison of traditional instructional strategies with PBL.

2. Project Based Learning

Project Based Learning (PBL) is typically referred as an interactive instructional strategy, tempting the learners to acquire knowledge necessary to solve complex problems/ projects. Scaffolding, collaborative learning, focus towards learning outcomes, development of perceptible artifacts are core trademarks of PBL (Brundiers et al., 2013). Creation of artifacts for solving complex real word problems through the state-of-the-art technology knowledge acquisition is the key feature that distinguishes PBL from other instructional strategies. The teachers pave the way for the students in the acquisition of knowledge, through effective scaffolding. Establishment of PBL requires inculcating couple of qualities into students including self-learning, design thinking, collaborative learning, communication and leadership skills. These skills are typically set as the outcome of the courses in first and second semesters, in PBL based curriculum structure. Thus, students will have a motivation to acquire the scaffolding methodology for complex authentic problem solving and project development. These methodologies enacted for main stream courses offered possibly after second year of the Engineering study, will raise entrepreneurial skills in the students. The learners get motivated to develop products or solve societal problems using engineering solutions.

Bringing on student centric learning will increase the advantage of PBL (Krajcik et al., 2014). For instance: student learning the core python course in PBL mode will acquire the knowledge and applications of Python Programming. With their interest towards any one of the main stream technologies including Internet of Things, Image Processing, Machine Learning, Data Analytics, Cyber Security, among others, student can pursue project/ problem solving in those streams with Python. The course teacher will provide sufficient scaffolding in project development.

Several analyses (Ralph et al., 2015, Reis et al., 2017) on PBL reveal that framing the outcomes of the courses in PBL oriented curriculum is difficult. The main focus is usually on the gap between what students learn in the University and in the Work. This gap can be minimized only when students are provided with the view of wide variety of main streams and inculcating a motivation towards the students to have driving questions and project ideas.

The paper is structured in the following manner: Section 3 depicts the typical design of a PBL course (P standing for either Project or Problem). Section 4 describes on the assessment methodologies for a PBL course. A detailed case study of a PBL course run is explained in section 5. Section 6 compared the traditional pedagogy methods with PBL, followed by conclusion.

3. KARE-SCL Model for implementing PBL

The meaning of the PBL grows from first year engineers to final year engineers as problem-based to project based. It is not mandatory that final year students are not doing with problem-based learning. They can manipulate problems at a higher level of difficulty with a skill to implement the solution of the problem as a project. PBL cannot inculcate all its skills into the students in the initial stage. In each semester/ trimester, students acquire knowledge on various technologies and concepts. Thus, the level of PBL moves from narrow to broad side as the students complete each semester/ trimester. KARE-SCL is a model defined and followed in Kalasalingam Academy of Research and Education (KARE) in various engineering courses. SCL corresponds to Student Centric Learning. In the subsequent year, the skill sets mandated for the students are self-learning, communication and team work. The preliminary requirement for students to take part in PBL is the self-learning capability. Students approaching a complex problem can formulate it, identify the underlying challenges and strategies to solve the same through design thinking ability.

Once the learners start to solve or implement the design, they require new technologies and identification of various techniques. Techniques and algorithms can be improved through sophisticated brainstorming sessions in teams. A proper technical communication and collaborative work is required for successful brainstorming sessions. Online courses from esteemed web sites are rich in state-of-the-art technologies. Many content-out-of-syllabus topics can be learnt by students through online courses. Mandating online course certification imposes self-learning in students. Online forums, group participation in competitions, conferences and symposiums develops communication and team work skills in students.

Having mastered in the above skills in the early two years of the engineering program, prepares students to

solve complex problems and develop projects. Assignments, open-book tests, model designs can include questions focusing complex problems. Students with design, apply and analysis skills will be the strong stakeholder of a typical team project. KARE curriculum includes four credits for Community Service Project (CSP) in the third year. The project is carried out in two sessions. Session 1 comprises field visits to identify the societal problem and necessary survey of state-of-the-art techniques to solve the problem. Session 1 of CSP is carried out in the 5th semester. In Semester 6, session 2 of CSP is followed. In this period, the project design is implemented and deliverable is completed. Students are given support and facilities to copyright, publish, commercialize and extend the work. With the varied skills and having done the CSP project, the students will have complete knowledge in undertaking an industrial project through internship or a real time project in college during final semester.

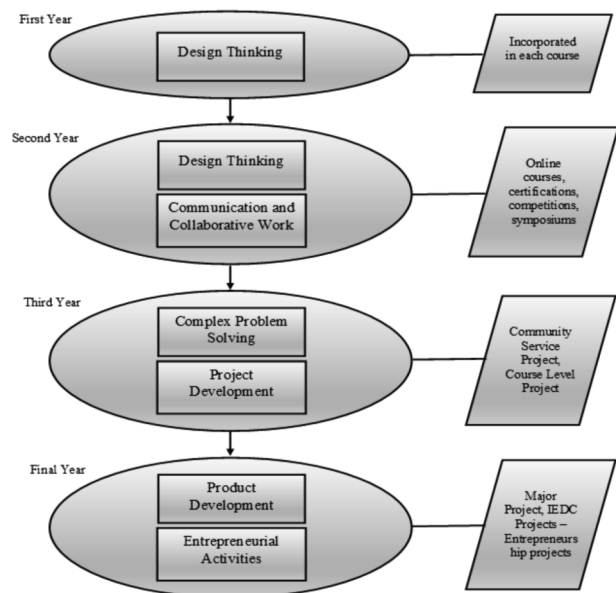


Fig.1 : KARE-SCL Model for imparting Project Based Learning in Engineering

4. Assessment Methodologies for a PBL course

Assessing students' performance periodically is required to ensure their knowledge growth and performances. Typical education institutes consist of various course categories including Theory, Practical, Integrated Course (Theory with Practical) and Project. Each such category consists of a maximum of four evaluations comprising written examinations, assignments, practical examinations, Quizzes. To embark PBL in courses, the KARE-SCL model

stabilizes the assessment methodologies to be carried out in the courses.

The faculty member is expected to choose a minimum of 5 or more evaluation methods for their course. The weightages for the evaluation methods is left to the discretion of the faculty members in consultation with the mentor, but will be finalized and communicated to the students as well as the Office of Controller of Examinations (CoE) before the start of semester. The set of assessment methodologies is enumerated in Table 1.

Table 1: Different Assessment Methodologies for a typical Engineering course

S.No.	Assessment Methodologies	
	Methodology	Type
1.	Assignments	Practical/ Problem Solving
2.	Quizzes (incl online quiz)	Options, Match findings, GATE level questions, debugging questions (programmatic courses)
3.	Mini projects	Practical
4.	Practical Examination	Practical
5.	Model development/ Simulation/ Animation of idea	Practical
6.	Field visit with brainstorming session	Experiential learning/ Problem solving
7.	Research articles-based evaluation	Exploratory learning
8.	Seminars	Self-learning
9.	Open book test	Problem solving
11.	Interview by Externals (Industry/ academic)	Question/ Answer session
12.	Written examination	Theory
13.	Group Discussion/ Brainstorming sessions	Team work/ Problem solving

5. Case Study: Application of PBL on a Course

KARE started offering PBL based teaching methodologies, since the academic year 2018-19. Currently, about 100 courses across various disciplines (CSE, ECE, EEE, Mechanical, Civil, Aeronautical, Bio-medical Engineering) are offered with PBL approach. The following is a case study of the first PBL course in KARE, Introduction to Python Programming (CSE18R309). The course is offered in even semester for second year students. The assessment methodology chosen by the faculty on discussion with the mentor is depicted in Table 2.

Python is an essential prerequisite for programming jobs in many Industries today. Besides learning the technologies demanded by the industry, after completing the Engineering degree, the students should learn during period of study and the Institution should guarantee the same. This is one of the reasons of having industry-oriented curriculum in academic institutions. KARE offers Python programming as a core course for CSE and as an open-elective too for aspirants from other streams.

Being a course of Industrial importance, it is offered in PBL mode. The lectures of the course included not only chalk and talk, power-point presentations, but many experiential learnings. Each nuance in the course topic is explained practically to provide depth knowledge to the learners. The course covers Python 3 version. Many projects were demonstrated step-by-step to showcase the power of python packages and to motivate the students to develop similar projects. The course included quizzes for evaluating remember and understand levels of the bloom's taxonomy. Assignments, Experiment-based evaluations are used to test the apply, analyze and create levels of bloom's taxonomy. Sessional examination is usually a written examination, where the students are provided with the set of problem scenarios, to be answered with in a period of 90 minutes. The question requires understand, design, apply knowledge for answering. Finally, a mini-project is to be done by the students. A project team of not more than four members, can choose a problem and work on the same. The end product will be software or hardware deliverable done using python. In order to depict the attainment and expected outcomes, the programme outcomes of B.Tech. Computer Science and Engineering, KARE, the Course (CSE18R309) Outcomes and the CO-PO mapping is depicted in Table 3, Table 4 and Table 5 respectively.

It is obvious that the outcomes of the course focus major expectations of industry from Python Programming, viz., the major packages including RegExp, Tkinter, NumPy, Pandas, Matplotlib, among others. All assessments are evaluated using rubrics in 4-point scale. The rubrics of the metrics chosen for evaluation as stated in Table 2 are framed in line with the course outcomes. Rubrics of Quiz, Programming Assignment, Sessional Examination, Experiment Based Evaluation and Mini project are depicted in Table 6, Table 7, Table 8, Table 9 and Table 10 respectively.

The weightage for each evaluation and the rubrics is decided by the course faculty. The faculty with expertise in the course is given autonomy for handling such courses. The learners of the course are mandated to complete an online certification in python either through NPTEL or Coursera. This is used to ensure self-learning skills and to cover contents out-of-syllabus. The online course will be helpful in implementing the mini-projects. Mini Project Evaluation is chosen as the sample evaluation for the case study explanation and the results are described in detail. With respect to mini-project: level of understanding, design, implementation, efficiency, ethics, communication are the measures under which the students are evaluated. The same will be reflected in the rubrics of evaluation: R1 – depicting the level of understanding of the problem and its domain, R2 – figuring out the ability of the learner in providing an appropriate algorithm for solving the problem, R3 – specifying the capability of implementing the algorithm, R4 – stating the ethical principles and managerial deadlines followed by the learner as a team and R5 – depicting the communication and justification skills.

The evaluation of the mini-project is done based on the rubrics stated in Table 10. The course is enrolled by 61 students. In 4-point scale, the student is said to attain the course outcome contributed by the corresponding assessment, if he scores more than 2.5 in 4-point scale. The rubrics-based mark report for Mini Project Evaluation is stated in Table 11. Fig. 2 depicts the distribution of student scores with respect to the rubrics. It is evident that all the students score more than 1 in the first three rubrics corresponding to understand, design and implementation ability.

Table 2: Evaluation method for the course Introduction to Python Programming (CSE18R309)

S. No	Evaluation method	Weightage (%)	Units covered
Internal Continuous Assessment (50 marks)			
1	Quiz (2 Nos) [Each carry 25 questions]	7	III, IV
2	Assignment (3 Nos)	8	All units
3	Sessional Examination	10	I, II
4	Experiment based Evaluation	10	All units
5	Mini-Project	15	All units
External Assessment (50 marks)			
6	End Semester	50	All units

All most 50% of students score 3 points in all rubrics which is categorized as Very good. The ethical principles and managerial deadlines (R4) are the areas requiring concentration in next run of the course. It is also inferred that students performing well in understand (R1) and design (R2) skills, lack implementation (R4) skills. Hence, substantial action plan is required to improve the same in next run of the course/ similar courses.

Table 3: Programme Outcomes – B. Tech. Computer Science and Engineering

Programme Outcomes (POs)	
PO1:	Ability to apply knowledge of mathematics, science and computer engineering to solve computational problems.
PO2:	Ability to identify, formulate, Analyze and derives conclusions in complex computing problems.
PO3:	Capability to design and develop computing systems to meet the requirement of industry and society with due consideration for public health, safety and environment.
PO4:	Ability to apply the knowledge of design of experiment and data analysis to derive solutions in complex computing problems.
PO5:	Ability to develop and apply modeling, simulation and prediction tools and techniques to engineering problems.
PO6:	Ability to assess and understand the professional, legal, security and societal responsibilities relevant to computer engineering practice.
PO7:	Ability to understand the impact of computing solutions in economic, environmental and societal context for sustainable development.
PO8:	Applying ethical principles and commitment to ethics of IT and software profession.
PO9:	Ability to work effectively as an individual as well as in teams.
PO10:	Ability to communicate effectively with technical community and with society.
PO11:	Demonstrating and applying the knowledge of computer engineering and management principles in software project development and in multidisciplinary areas.
PO12:	Understanding the need for technological changes and engage in life-long learning.

Table 4: Course Outcomes (COs) for the course CSE18R309 – Introduction to Python Programming

CO1:	Develop basic programs using control flow structure and collection data types.
CO2:	Implement user defined python functions and build an efficient program leveraging modules and exception handling mechanisms.
CO3:	Create python programs to handle file I/O and validate contents using regular expressions.
CO4:	Create graphical user interfaces using Python Tkinter and CGI scripts.
CO5:	Understand OS Modules, Network programming, Data processing, plotting concepts in python and create python analytic plots using matplotlib, numpy packages.

Table 5: CO-PO Mapping for the course CSE18R309 – Introduction to Python Programming

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	S	M					L		L	M
CO2	S	S	S	S			L		M		M	M
CO3	S	S	S	S	M		L		M		S	M
CO4	S	S	S	S	S		M	L	M	M	S	S
CO5	S	S	S	S	S	M	M	M	M	S	S	S

S – Strong Correlation, M – Medium Correlation, L – Low Correlation

Table 6: Rubrics for Evaluation of Quiz

<i>Parameters</i>	Excellent (2)	Very good (1.5)	Good (1)	Fair (0.5)
<i>(R1) Ability to debug a code snippet</i>	100% correct answer following the syntax of the language	Write the answer with formatting errors alone	Write the answer with 50% syntax errors	Write the answer with 70% syntax errors
<i>(R2) Ability to identify the output of the given code snippet</i>	Exact output is written without any formatting errors	Exact output is written with formatting errors	Logic is understood and written 50% correct output	50% of logic is understood and written the output

Table 7: Rubrics for Evaluation of Programming Assignment

<i>Parameters</i>	Excellent (4)	Very good (3)	Good (2)	Fair (1)
<i>(R1) Understand the problem and identify the suitable design strategy for solving the problem</i>	Developed the design considering all the constraints	Developed the design considering 80% of the constraints	Developed the design considering 60% of the constraints	Developed the design considering 40% of the constraints
<i>(R2) Apply the design and frame an appropriate algorithm for the problem in question</i>	Able to design a perfect algorithm for the underlying problem corresponding to the design	Ability to design an algorithm for solving the problem with 80% perfectness	Ability to design an algorithm with partial knowledge on the design strategies	Ability to design an algorithm partially satisfying the stated requirements.

<i>(R3) Implement the algorithm using python</i>	Ability to implement the algorithm using python with necessary and efficient using predefined packages.	Ability to implement the algorithm using python using predefined packages, even for simple processes.	Ability to implement the algorithm, using python, with typical errors	Ability to implement the algorithm with commendable errors.
<i>(R4) Management of deadlines and ethical principles</i>	Deadlines are strictly followed with 0% plagiarism in the project code and report	Deadlines are strictly followed with 0% plagiarism in the project code and 5% plagiarism in report	Project modules are completed with slight deadline misses (max 3 days after the deadline date), and have a plagiarism of max 5% and 10% in code and report respectively	Deadlines are not followed (More than 3 days after the deadline date) and have more than 5% and 10% plagiarism in code and report respectively

Table 8: Rubrics for Evaluation of Sessional Examination (12 marks Question)

<i>Parameters</i>	<i>Excellent (4)</i>	<i>Very good (3)</i>	<i>Good (2)</i>	<i>Fair (1)</i>
<i>(R1) Understand the problem and identify the necessary tools required to implement the program</i>	Enumerate all the necessary tools and data structures required for the implementation of the given problem statement	Enumerate 80% of the necessary tools and data structures required for the implementation of the given problem statement	Enumerate 60% of the necessary tools and data structures required for the implementation of the given problem statement	Enumerate 40% of the necessary tools and data structures required for the implementation of the given problem statement
<i>(R2) Ability to describe the tools used for the implementation of the program and explain the base syntax of the same</i>	100% describe the relevance of the data structure or package used to implement the program with the corresponding syntaxes and use cases	80% describe the relevance of the data structure or package used to implement the program with the corresponding syntaxes and use cases	60% describe the relevance of the data structure or package used to implement the program with the corresponding syntaxes and use cases	40% describe the relevance of the data structure or package used to implement the program with the corresponding syntaxes and use cases
<i>(R3) Ability to write the complete program for the given problem</i>	Write the complete program using an efficient logic without any errors and appropriate comment lines	Write the complete program with any logic and less than 20% error	Write the complete program with any logic and less than 40% error	Write the partial program <u>at least</u> 50% relevant to the problem statement in question

Table 9: Rubrics for Evaluation of Experiment Based Evaluation

Parameters	Excellent (4)	Very good (3)	Good (2)	Fair (1)
<i>(R1) Understand the problem and identify the suitable design strategy for solving the problem</i>	Developed the design considering all the constraints	Developed the design considering 80% of the constraints	Developed the design considering 60% of the constraints	Developed the design considering 40% of the constraints
<i>(R2) Apply the design and frame an appropriate algorithm for the problem in question</i>	Able to design a perfect algorithm for the underlying problem corresponding to the design	Ability to design an algorithm for solving the problem with 80% perfectness	Ability to design an algorithm with partial knowledge on the design strategies	Ability to design an algorithm partially satisfying the stated requirements.
<i>(R3) Implement the algorithm using python</i>	Ability to implement the algorithm using python with necessary and efficient using predefined packages.	Ability to implement the algorithm using python using predefined packages, even for simple processes.	Ability to implement the algorithm, using python, with typical errors	Ability to implement the algorithm with commendable errors.
<i>(R4) Applying ethical principles and ensure commitment</i>	Implement the program with the own logic without any plagiarism	Implement the program with the own logic and usage of less than 20% built-in packages	Implement the program with the own logic and usage of more than 20% built-in packages	Implement the program with more than 50% plagiarism

Table 10: Rubrics for Evaluation of Mini Project

Parameters	Excellent (4)	Very good (3)	Good (2)	Fair (1)
<i>(R1) Identification of a suitable problem for mini-project and choose appropriate design strategy to implement the problem</i>	A deliverable real time problem statement is identified, with all the required designs to implement the same	A real time problem statement is identified with 80% designs required to implement the same	A problem statement pertaining to programming is identified and able to enumerate at least 60% of necessary design tools to implement the same	A practical and partial problem statement identified without specifying the constraints and appropriate use cases
<i>(R2) Apply the design and frame an appropriate algorithm for the problem in question</i>	Able to design a perfect algorithm for the underlying problem corresponding to the design with proper literature survey	Ability to design an algorithm for solving the problem with 80% perfectness in survey	Ability to design an algorithm with partial knowledge on the design strategies used in state-of-the-art works	Ability to design an algorithm partially satisfying the stated requirements.

(R3) Implement the algorithm using python	Ability to implement the algorithm using python with necessary and efficient using predefined packages.	Ability to implement the algorithm using python using predefined packages, even for simple processes.	Ability to implement the algorithm, using python, with typical errors	Ability to implement the algorithm with commendable errors.
(R4) Applying ethical principles and ensure commitment	Implement the program with the own logic without any plagiarism	Implement the program with the own logic and usage of less than 20% built-in packages	Implement the program with the own logic and usage of more than 20% built-in packages	Implement the program with more than 50% plagiarism
(R5) Ability to communicate and justify the usefulness and efficiency of the project	Able to communicate with fluency and 100% technical knowledge and answer all the questions raised	Able to communicate with fluency and 80% technical knowledge and answer at least 80% of the questions raised	Able to communicate technically and answer 60% of the questions raised	Able to communicate with less than 40% technical knowledge on the project and answer at least 40% of the questions raised

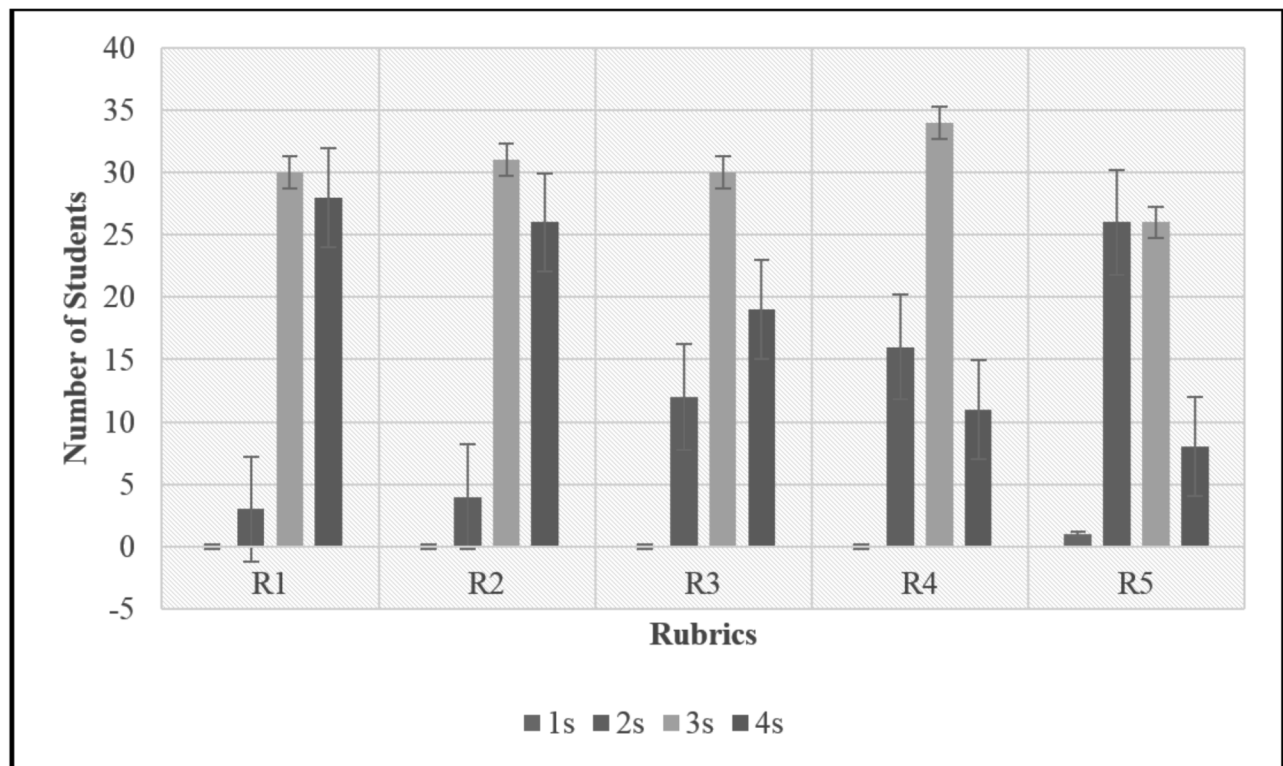


Fig. 2 : Students distribution based on Rubrics score – Mini Project Evaluation

The course outcome attainment and range chart is depicted in fig. 3. It is implied that 49 students have score more than 2.5 out of 4 in the assessment, accumulating to 81.67% course outcome attainment. Only one student obtained less than 1 point and the number of students in between 2 and 3 is found to be 25. 58.3% of the class excelled in mini-project assessment. At second year, it appears to be sound number. This depicts the interest and hard work of the students in doing such course-level projects.

6. Comparison of traditional pedagogy methods with PBL

Chalk and Talk, Power-point presentations, flipped-classrooms, lectures, among others are considered as traditional pedagogy methods. In order to understand the advantages of PBL courses, feedbacks are obtained from students of two

categories: (i) Set of students already completed a PBL course (P) (ii) Set of students not enrolled in any PBL course (P'). The set of students selected are ensured to be from same department. This is to ensure unbiased feedback entries. P is the set of students from 2017 batch who have taken Python Programming course in KARE-SCL mode in fourth semester and P' is the set of students from the same batch, who have not taken any course in KARE-SCL mode. The set of questions are used to collect the feedback online is depicted in Table 12. The questions surround on the certifications, design, debugging, coding skills, core knowledge on programming languages, communication and team work skills and experience on deliverable projects. These parameters are expected to be possibly obtained by a dedicated PBL practiced learner. Sufficient scaffolding is done by the course faculty to bring forth the above parameters in the students.

Table 11: Evaluation of Mini Project based on Rubric

Kalasalingam Academy of Research and Education									
School of Computing									
Department of Computer Science and Engineering									
2017-21 Batch									
CSE18R309 - Introduction to Python Programming									
Mini Project Evaluation Report									
S.No.	Register No.	Name	R1	R2	R3	R4	R5	Avg	Internal
1	9917XXXXXX	Student 1	3	3	3	3	3	3	11.25
2	9917XXXXXX	Student 2	4	4	4	4	4	4	15
3	9917XXXXXX	Student 3	2	2	2	2	2	2	7.5
4	9917XXXXXX	Student 4	4	4	3	3	3	3.4	12.75
5	9917XXXXXX	Student 5	4	4	4	4	3	3.8	14.25
6	9917XXXXXX	Student 6	4	3	3	3	3	3.2	12
7	9917XXXXXX	Student 7	3	3	3	3	3	3	11.25
8	9917XXXXXX	Student 8	4	4	4	4	4	4	15
9	9917XXXXXX	Student 9	4	3	3	3	3	3.2	12
10	9917XXXXXX	Student 10	4	4	3	3	3	3.4	12.75
11	9917XXXXXX	Student 11	3	3	2	2	2	2.4	9
12	9917XXXXXX	Student 12	4	4	4	3	3	3.6	13.5
13	9917XXXXXX	Student 13	3	2	2	2	2	2.2	8.25
14	9917XXXXXX	Student 14	3	3	3	3	2	2.8	10.5
15	9917XXXXXX	Student 15	3	3	3	3	2	2.8	10.5
16	9917XXXXXX	Student 16	2	2	2	2	1	1.8	6.75
17	9917XXXXXX	Student 17	3	3	3	2	2	2.6	9.75
18	9917XXXXXX	Student 18	4	4	4	4	4	4	15

19	9917XXXXXX	Student 19	3	3	3	2	2	2.6	9.75
20	9917XXXXXX	Student 20	3	3	3	3	2	2.8	10.5
21	9917XXXXXX	Student 21	3	3	3	3	3	3	11.25
22	9917XXXXXX	Student 22	3	3	2	2	2	2.4	9
23	9917XXXXXX	Student 23	3	3	2	2	2	2.4	9
24	9917XXXXXX	Student 24	4	4	3	3	3	3.4	12.75
25	9917XXXXXX	Student 25	3	3	3	3	2	2.8	10.5
26	9917XXXXXX	Student 26	3	3	3	3	3	3	11.25
27	9917XXXXXX	Student 27	4	4	4	4	3	3.8	14.25
28	9917XXXXXX	Student 28	4	4	4	4	4	4	15
29	9917XXXXXX	Student 29	3	3	3	3	2	2.8	10.5
30	9917XXXXXX	Student 30	3	3	2	2	2	2.4	9
31	9917XXXXXX	Student 31	3	3	3	3	2	2.8	10.5
32	9917XXXXXX	Student 32	4	4	4	3	3	3.6	13.5
33	9917XXXXXX	Student 33	3	3	3	3	2	2.8	10.5
34	9917XXXXXX	Student 34	3	3	3	3	3	3	11.25
35	9917XXXXXX	Student 35	4	4	4	3	3	3.6	13.5
36	9917XXXXXX	Student 36	3	3	2	2	2	2.4	9
37	9917XXXXXX	Student 37	3	3	3	2	2	2.6	9.75
38	9917XXXXXX	Student 38	3	3	3	2	2	2.6	9.75
39	9917XXXXXX	Student 39	2	2	2	2	2	2	7.5
40	9917XXXXXX	Student 40	4	4	4	3	3	3.6	13.5
41	9917XXXXXX	Student 41	4	4	3	3	3	3.4	12.75
42	9917XXXXXX	Student 42	4	4	3	3	3	3.4	12.75
43	9917XXXXXX	Student 43	3	3	2	2	2	2.4	9
44	9917XXXXXX	Student 44	4	4	4	3	3	3.6	13.5
45	9917XXXXXX	Student 45	4	4	4	4	3	3.8	14.25
46	9917XXXXXX	Student 46	4	4	4	4	4	4	15
47	9917XXXXXX	Student 47	3	3	3	3	2	2.8	10.5
48	9917XXXXXX	Student 48	4	4	4	3	3	3.6	13.5
49	9917XXXXXX	Student 49	3	3	3	3	2	2.8	10.5
50	9917XXXXXX	Student 50	4	4	3	3	3	3.4	12.75
51	9917XXXXXX	Student 51	3	3	3	3	2	2.8	10.5
52	9917XXXXXX	Student 52	3	3	2	2	2	2.4	9
53	9917XXXXXX	Student 53	3	3	3	3	2	2.8	10.5
54	9917XXXXXX	Student 54	4	4	3	3	3	3.4	12.75
55	9917XXXXXX	Student 55	4	4	4	4	4	4	15
56	9917XXXXXX	Student 56	4	4	4	4	4	4	15
57	9917XXXXXX	Student 57	4	4	4	3	3	3.6	13.5
58	9917XXXXXX	Student 58	4	4	4	4	4	4	15
59	9917XXXXXX	Student 59	4	4	4	3	3	3.6	13.5
60	9917XXXXXX	Student 60	3	3	3	3	3	3	11.25
61	9917XXXXXX	Student 61	3	3	2	2	2	2.4	9

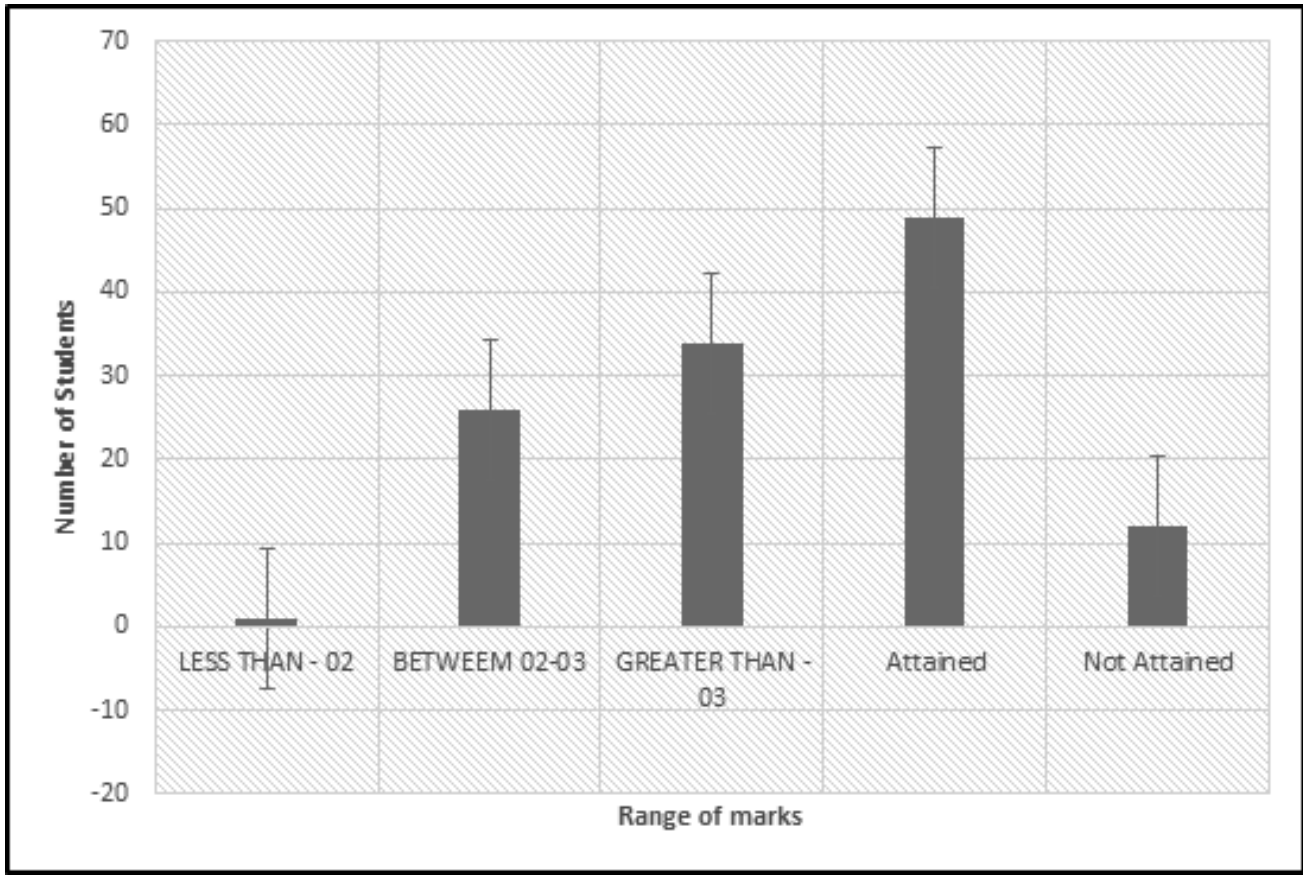


Fig. 3 : Attainment and Range chart – Mini Project Evaluation

Greenviz

Upload

* Upload your file *(.csv , .xlsx)

Successful

* Select your algorithm

* Select algorithm *

Linear Regression

Logistic Regression

Decision Tree classifier

Feature Selection

*Enter your features Below---

*Enter your Independent Variable(x) :

gender

height

weight

*Select

*Enter your Dependent Variable (y) :

Train and Test

* Enter your train and test percentage Below:

Enter your train percentage ::

Enter your test percentage ::

Project Description:

Greenviz is a python module for practicing machine learning algorithms and it is built by using the well -known packages in python (tkinter, sklearn, matplotlib, pillow, among others. The python project is converted into a package and uploaded in PyPi. The link of the package and the owner information can be referred in the link: <https://pypi.org/project/greenviz/>

Model Building

* Your response has been successfully Recorded

** Select algorithm * Model

* Train

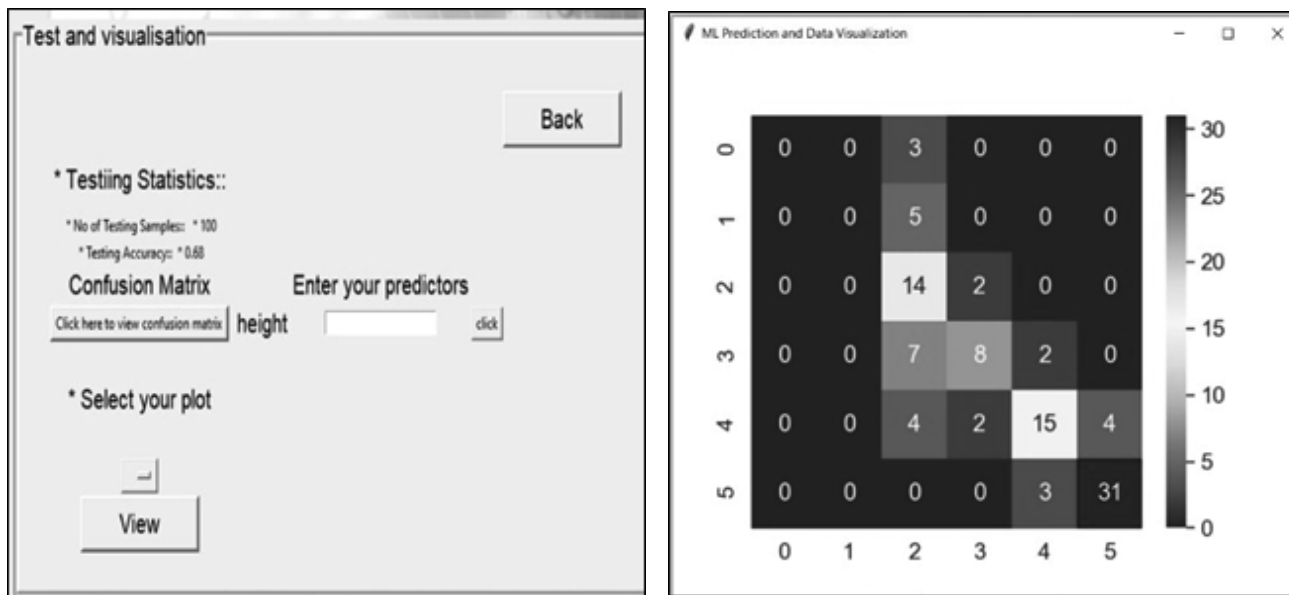


Fig. 4 : Screenshot demo of one of the Projects in CSE18R309 course – Greenviz

A screenshot of one of the best projects completed as part of CSE18R309 course is depicted in fig. 4. The project intends to develop a user interface for machine learning algorithms. The novelty of the proposed model for imparting PBL is evident in its liberty for the students and autonomy for the course teachers in aiding the self-learning, extendable learning beyond syllabus, design thinking, project management activities. In such a model, student found to be interested in developing python package for learning algorithms is provided with the insights on Machine Learning algorithms leveraging python and program to package development processes. Such a model doesn't stick towards teacher-centric teaching and

curricular prospects. The model aims to build up and quench technological thirst into the students. Hence a pure student-centric learning with sufficient scaffolding is modelled and practiced. Existing methods of PBL focus on choice-based courses, multi-disciplinary projects, among others. Whilst the KARE-SCL model inculcates such design thinking on to the students. It paves the student to quench a real-world problem. In addition, sufficient scaffolding will be provided to successfully complete the project pertaining to the problem. Hence the student doesn't solve problems with the learnt technology, student learn technology to solve problems.

Table 12 : Set of Feedback questions for traditional vs PBL pedagogy practiced students

S.No	Questions	Aspect
Q1	Have you done any certifications national/ international/ online?	Self-learning
Q2	Are you able to design an algorithm for any given computing problem statement?	Design thinking
Q3	Do you have complete core knowledge on any programming language like Python, Java, C, among others?	Technical Competency
Q4	Are you able to debug a program written in any programming language of your choice?	Technical Competency
Q5	Are you able to implement an algorithm efficiently in any programming language?	Problem Solving Skills
Q6	Are you able to work on a team to solve a technical problem or project?	Problem Solving Skills
Q7	Are you able to technically communicate on a problem statement?	Communication Skills
Q8	Have you completed and reported any deliverable computing project?	Project Management

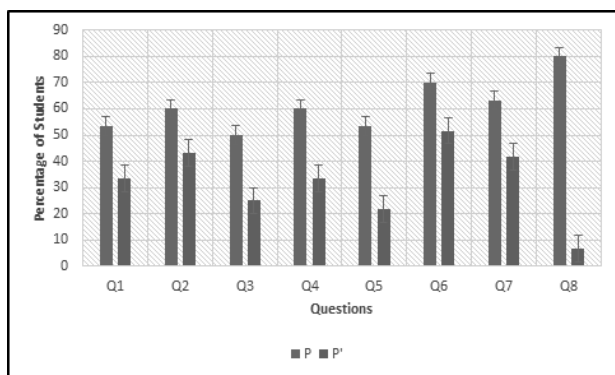


Fig. 5 : Comparison of traditional and PBL pedagogy practiced students through indirect survey

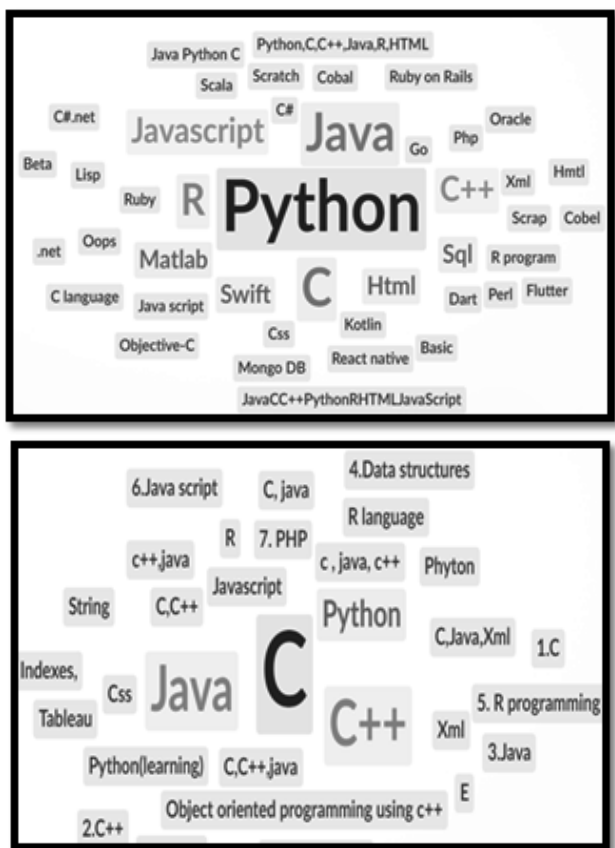


Fig. 6 : Word Cloud Analysis on the Programming competency of (a) PBL pedagogy practiced students and (b) Traditional pedagogy practiced students

The students' feedback on various questions are answered in five categories: strongly disagree, disagree, somewhat agree, agree, strongly agree. The cumulative percentage of students agreed and strongly agreed the questions is compared between traditional and PBL pedagogy practised students in fig. 5. It is evident that more than 50% of PBL practised students agreed all the questions. Especially

with respect to the certifications, core programming knowledge, coding skills, project experience, the percentage of PBL practitioners agreeing, surpassed the traditional pedagogy practised students by a large deviation. The project experience is obtained by 80% of students practised PBL, whereas less than 7% of traditional pedagogy practised students worked on projects. Course-level projects provide students with depth knowledge and greater exploration of subject. Hence PBL helps students to master the course to a greater extent, than the course learnt through traditional pedagogies. The programming competency of the students practicing PBL pedagogy in KARE-SCL mode and traditional mode is reflected in fig. 6. It is obvious that there is a transformation in the well-known language from C to Python. In addition, there are many opensource languages and technologies practiced by the students in KARE-SCL mode. This witnesses the fact that the new mode of teaching inculcated self-learning of various state-of-the-art technologies for problem solving and project development.

7. Conclusion

This paper presents an obvious design for implementing PBL in Engineering program. The definitions, uses and applications of PBL in various ground are elaborated. The KARE-SCL model for PBL depicts the best way of implementing PBL and to bring forth the necessary skills in students. The list of assessment methodologies and the rules of following the same, makes the implementation of PBL much easier in a student centric way. The pros of student centric PBL courses is explained through the case study of the PBL course in KARE, Introduction to Python Programming. The assessment methodologies, rubrics, attainment calculations, feedbacks are depicted in sufficient detail to serve as an essential reference for the starters of PBL. It is evident that the KARE-SCL approach of practicing PBL provides a great degree flexibility to enforce design thinking and problem-solving skills onto the students through appropriate scaffoldings. Hence the novel KARE-SCL model, unlike other PBL approaches, doesn't pave students to solve problems with the learnt technology, whilst make the students to learn necessary technologies to solve problems.

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