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Implementation of Problem Based Learning to Solve Real Life Problems

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***Abstract*—** Problem based learning (PBL) has been used for many years and it is one of the effective educational methodologies applicable for distinguished engineering disciplines. It is a widely used student-centric approach through which students get engaged to solve real world problems by research, continuous study, and regular practices along with knowledge utilization during implementation. This study explores the PBL with an advanced computer engineering course of pre-final year students. This study centers around the implementation of a system to solve one of the real-life problems and distinguishes a portion of the difficulties that lie ahead for PBL. Here, to examine the impact of PBL approach for the specified subject, the result of B.Tech. (CE and IT branches) sixth semester students (A.Y. 2019-20 and 2020-21) are considered with various known parameters. Students' feedback is taken at the end of course study. Problem title, hook of the problem, background or history of the problem, clarifying/providing constraints, list of deliverables, strategy to solve the problem, assessment criteria/rubric etc. are provided well in advance to the students to be comprehensible for the problem. Learning sequence sessions are also arranged on a regular basis during problem solving by the facilitator to fill out the gap. As a result, the PBL approach is found to be intended more strongly for engineering students than for other students; in contrast, with traditional MCQ based examination students mostly focus on mug up of concepts rather than implementation and critical thinking. Engineering students are able to work smartly along with hard work, and as a result students have developed their technical skills, collaborative skills, self-learning approach with advanced computer engineering courses. Assessment pattern has changed into advancement with the proposed PBL approach over a traditional MCQ based approach. Continuous assessment is performed on covering all segments of the exam. Results found with traditional approach are contrasted with results found with PBL approach and tracked down that a more prominent number of students had secured more than over average score (>=60%) with the proposed PBL approach and statistically proven for the same. This correlation shows that students are more noticeable and curious about the PBL approach as opposed to robbing up hypothetical ideas and choosing the appropriate answers with a traditional MCQ based approach. In Addition, student's feedback is observed to be very satisfactory. It has been seen that through PBL, students' retaining level has extremely increased and their learning abilities and understanding level too has improved altogether. PBL plays out a fundamental role for achieving the student's involvement and commitment towards learning. Logical, critical thinking, teamwork, technical etc. skills for engineering students can be developed effectively with the PBL approach.

Keywords— Problem-based learning, Continuous assessment, PBL, self-regulated learning, self-directed learning

JEET Category—Practice

I. INTRODUCTION

WITH modern improvements in the engineering field, engineering education facilitators should understand the requirements of problems related to the engineering field. Engineering graduates ought to be skilled in recognizing problems theoretically and employing their knowledge to effectively solve real-world complicated engineering problems. One of the standard ways to solve the requirements of each engineering branch problem is to use PBL (K.N.L. Wee, 2004 and D. Jonassen, J. Stobel, and C.B. Lee, 2006). There are different sources from where problems can arise: personal or professional involvement, a hypothesis, the media, or other research studies. With minor editing and reference to the above sources will lead to better alternatives for the real-life problem solutions.

PBL is learning by addressing a massive, genuine issue. Sessions are replaced with laboratory/practical work that is combined with theory discussion. For our situation, faculty facilitated students in terms of problem understanding, technology solution etc. PBL has been characterized as follows (Mikhailovich, T. Y., & Yurievna, A. A., 2016 and D. Boud and G. Feletti, 1991): The main thought behind PBL is that the beginning stage for learning ought to be an issue, an inquiry, or a challenge that the student wishes to face.

PBL educates us about genuine problems, self-instructed learning, collaborative teamwork, and the faculty role is

converted into facilitator. Another definition, from Biggs (J. Biggs, 1999), students are divided into different small learning groups, after that they start discussion with facilitator, peers, and other stakeholders. The upgradation of courses into advanced levels in the computer engineering/IT branches can lead to PBL for learning by motivation, interest in new courses, easy and engaged learning, students' higher retention ratio, etc. Genuine real time problems can be assigned to students and can stimulate students for their own responsibility and, therefore, lighten up to decrease the disappointment and abstention rates.

II. LITERATURE REVIEW

One of the important teaching techniques is PBL that leads students to learn concepts and principles by solving complex real-life problems contrasted to traditional approaches where facts and concepts are taught directly in an informative manner. PBL plays a major role for students to develop their critical problem-solving skills with deeper thinking, improvised abilities, and interpersonal skills. This also offers great opportunities by doing tasks in teams, discovering, and assessing findings, and life-long learning (Duch et al, 2001). Each subject has a wider scope with PBL by little creativity. Although, the basic problems will be different based on relevant discipline (Duch, Groh, and Allen, 2001).

The constructive learning approach is mainly based on the student-centric learning model that is being affixed by PBL (J. R. Savery and T.M. Duffy, 2011, C. E. Hmelo-Silver, 2004). With PBL, individuals play a major role for imposing their knowledge when in physical and social contexts seeking for the cognitive nature of process for solving problems (D.H. Schunk, 2004). Alternatively, knowledge is learned in the process of social mediation, and social interaction can help to learn many concepts. With the aid of present and preceding knowledge and experience, it becomes easy for each student to understand new concepts (J. R. Savery and T.M. Duffy, 2011).

One of the best outcomes that comes out through PBL is learning through deep-content i.e., being agreed by many authors (C. E. Hmelo-Silver et. al., 2004). Students have enhanced their best learning outcomes that can be found through much evidence by authors (D. Gijbels et. al., 2005 and E. Nuutila et. al., 2005). It is mostly found that students' performing and studying outcomes are correlated with PBL elements. The term "deep-content knowledge acquisition by students" is being determined with the quality of the problem that is into the form of theories, standards, and processes (W. Hung, 2006). Contrasting traditional approaches i.e., based on theory lecture-based approach, where learning becomes by memorization (D. Gijbels, 2005) of concepts and principles that may cause too many difficulties to bring out to the highest levels of implementation for learning. Facilitator responsibility (K.N.L. Wee, 2004) and assessment policy (D. Gijbels, 2005) aid students as helpful components for knowledge attainment.

Mantri et. al. (2008a) has formulated and assessed the course (i.e., Analog Electronics) with PBL approach. The researcher found substantial discrepancies among the mindsets of the PBL oriented group and control group. Also, PBL has played a vital role to improve the presentation and collaboration skills in the PBL subject. Mantri et. al. (2008b) had communicated with the HR persons of various companies who recommended foremost modifications in the education system that became necessary both in terms of curriculum design, and teaching learning methodology. Knowledge gain and skills assessment grades are compared for both conventional approach and PBL approach and positive results found with PBL approach. It is the need of today's era to train more faculties as facilitators so that PBL can become one of the best tools to provide satisfactory "Industry ready engineers" to the market.

Additionally, the authors (Dutt, S. et. al., 2009) have used the PBL approach to teach Digital Electronics courses and suggested its usage on a broader basis. It is, yet, essential to think about matters like a greater number of faculties involvement for PBL and the cost component, while the PBL is valuable in tiny division size, before turning across to PBL. Polanco et al. (2004) implemented PBL on earlier engineering subjects for first year students in Mexican University and had found that students got higher grades in succeeding semesters as well. CodeCraft (M. Ventura et al, 2015), had taught programming through PBL with the use of programming puzzles formulated to frame students through important concepts of programming and eCity (A. Andrade et al., 2015) i.e., a most knowing PBL-based city simulation, that implemented the theories and principles of maths, science, and engineering to solve problems concerned to the development of that city.

Nuutila et al. (2005) discussed the familiarity of PBL implementation in Helsinki University of Technology, Finland that's being more helpful as a tool to teach any engineering technological subject. Actually, authors have already started to use PBL since 1999 with the basic course on programming and through continuous practice they implemented PBL in 2008 for computer science courses for a central learning approach to benefit all the subjects and their students. In fact, they have supplemented the different on-going methods like troubleshooting, essays, conceptual mapping, case studies etc. with PBL approach.

Kay et al. (2010) has also implemented PBL for computer courses and made comparisons between without-PBL approach (1996) and with-PBL approach (1998) and found significant expansion in terms of programming skills with PBL approach. Authors had implemented PBL to improve the competency in computer programming with the use of modern OOP languages and frameworks, also to improve the quality of programming codes with the use of proper techniques, capability to implement different concepts with critical thinking and problem-solving skills.

In 2018, a new PBL methodology was pioneered to the curriculum of BSc Information Systems at the Edge Hill College of Higher Education in the United Kingdom (Martins et. al., 2018). There were facilitators and their supporting team

to assist students and Beaumont and Fox (Martins et. al., 2018) indicated that students were involved through the problems and exhibited significant innovation and fortitude to solve the assigned problem. Mikhailovich, T. Y., & Yurievna, A. A. (2016) implemented PBL for laboratory tasks in a technical college and found remarkable involvement of students for learning via solving problems.

J. Biggs (1999) employed the PBL approach to instruct for Java program coding in computer labs which assisted students learning coding for an earlier stage. Learning programming skills with Java language through labs consisted of solving problems utilizing a computer and syntactic and semantic parts of computer languages. Each student had been evaluated, results generated accordingly and guided to them throughout PBL implementation to learn Java programming language. This way students get motivated to emphasize more on their thoughts and the assistance by the facilitator.

It is very important for universities to provide computer engineering professionals with the skills and abilities the IT industry needs to communicate these challenges (Mishra et al., 2007; Brodie et al., 2008). Furthermore, earlier findings have indicated that there is a large gap between the needs of the software industry and the education of future computer engineers (Beckman et al.,1997; Garousi et al., 2020). In 1995, the industry discovered that universities did not provide computer engineers that met its needs (Mengel, 1995), and in 2016, Universities in UK industry still believe that universities do not offer computer engineers who meet their needs (Shadbolt, 2016). The cause of this disparity is not clear. The study recommended that this dilemma could be syllabus issue, delivery of content, or both (Maguire et al., 2019).

A latest survey (Deep et al., 2019) has been conducted to discover and verify the effectiveness of PBL in enhancing and emerging college students' soft skills, where PBL is used to improve students' soft skills and group learning. Also, the author noticed that it had a considerable down strained communication conflict. THAKUR at. Al. (2021) discussed the need of Problem Based Learning in Education for Sustainable Development in India. Authors also discussed around 17 goals for sustainable development. The Author has also discussed Sustainable development i.e., it is not something that can be accomplished in a day or two, so it desires to be indoctrinated at an early age if possible.

As to deal with issues regularly and the world is brimming with promising circumstances and potential outcomes to make things better, our engineering education system should establish the reasons that can empower students to recognize, outline and resolve the problems. The proposed approach depends on the PBL approach. The proposed approach isn't only a variation in existing technique, it is an essential change in speculation; in approach; in objectives and results. It will change connections among facilitators and students; among learners themselves; and among society and organization.

PBL skills are valuable which may be possibly expected from students to get along with their CE/IT engineering degree. Generally teaching slots are allocated to students for developing their skills and facilitators assess them continuously. At the same time, it becomes possible to establish the learning within the context of computer-oriented branches along with the perspective of advanced java subjects (i.e., considered in this study).

III. METHODOLOGY

"If students do not learn to think with the knowledge they are stockpiling, they might as well not have it" ~ David Perkins.

To cope with the challenges of the education system, it's a need to work on National Education Policy 2020 i.e., for Higher Education Guidelines like towards a more holistic and multidisciplinary education, optimal learning environments and support for students, motivated, energized, and capable faculty etc.

By working on the implementation process, we found the following things as necessary in the form documents for implementing the PBL approach. (i) Problem Characteristics – Guide, (ii) Learning Sequence – Guide, (iii) Problem Design – Guide, (iv) Problem Design Template, and (v) Student Pack

As per PBL approach, problem should satisfy the different characteristics, like:

a) Lead to learning issues - Problems should be designed in a way which will help students to lead towards learning issues. It should lead to discovering learning objectives as well.
b) Trigger interest - Interest is a key parameter to do any task. Problems should be written in a way, which will generate an interest among students to discover solutions to them.
c) Be of suitable clarity and format - Problems should be written and presented clearly in simple format with clear instructions and possible directions, if any.
d) Stimulate critical reasoning - Problems should not have straight away readily available solutions. To solve a problem, students need to think critically about its possible solutions as an effective team member.
e) Promote self-directed learning - Solution of problems should not be messy and it should be from a domain which will ignite self-directed learning.
f) Be of appropriate difficulty - Problem neither should not be too complex or too easy. Design a problem in such a way that, learner will solve it by referring to available resources.
g) Enable application or use - Provide problems from the real world. Design problems in such a way that its solution will be used by people in real time.

h) Stimulate elaboration - Problems should be designed in such a way that it is easy to understand and specifies important keywords related to the problem.

i) Relate to prior knowledge - Design problems in such a way that it requires prior knowledge to solve. It will help learners to relate domain specific prior knowledge.

j) Promote teamwork - Design problems in a way which leads students to work in a team. It should be of the type which gives importance to each team member to get its solution.

It is also necessary to define the role of student in advance during PBL implementation and through our study it is found that student's role during PBL approach is: to understand the "problem" as an opportunity or challenge, to develop critical thinking to solve real world, complex and messy problems, to understand the importance of collaboration and teamwork, to practice self-directed learning, to develop problem solving approaches for professional practice, etc.

It is also necessary to define the role of facilitator in advance during PBL implementation and through our study it is found that facilitator role during PBL approach is : to guide the students to through a process of knowledge construction, to manage collaborative learning environment, to foster self-directed learning, to be as a process expert for a facilitator, not a content expert and make the necessary preparations to facilitate PBL, to provide structured learning environment for a potentially messy, ill-structured real world problem, to model suitable proficient practice, including being moral, authentic and rigorous, and accepting ongoing opportunities to study and grow as specialists.

PBL is not a mere series of lectures but it's going to be vital for many students' careers. So, it's necessary to provide adequate learning environment to students throughout the PBL implementation process like: (i) students should be given sufficient time to meet the desired learning outcomes, (ii) a learning cycle should comprise of time spent with the facilitator, in self-study and in collaboration with other students, (iii) the learning environment needs to mirror aspects of professional life but still be a safe learning environment where students can make mistakes, etc.

To implement the PBL approach in our university, it has been found for adequate prior knowledge and skills acquisition with aspects like : the learning of knowledge and skills are better achieved when anchored to a larger activity or problem, the learner is not a blank slate but brings past experiences and cultural factors to a situation; these should be built upon in the new learning activity, activation of prior knowledge is an important part of learning something new, knowledge should be justified and not merely accepted as true, knowledge and skills need to be practiced and applied in order to be mastered.

Through PBL implementation in our university, it has been found for facilitation and scaffolding that: the educator's role is that of a facilitator, students need time and space to learn; they do not necessarily learn just because they are told something, understanding is better achieved in a structured manner with learning aids provided at appropriate time, etc.

Through PBL implementation in our university, it has been found that: small teams act as an important support mechanism for students, knowledge evolves through social negotiation, through making mistakes and being able to resolve these mistakes, conflicting views stimulate discussions and facilitate learning, therefore diversity should be encouraged etc.

Through PBL implementation in our university, it has been found for self-directed learning that: independent study time has a positive impact on students' achievement, students need self-directed study time to determine knowledge gaps, to gather information, to process information and to reorganize information, etc.

Through PBL implementation in our university, it has been found that: reflection is necessary for learning to be deep and transformative; some form of reflection orientated questions or triggers should be used to help provoke students' reflection, how students acquire knowledge is as important as the knowledge itself, etc.

Through PBL implementation in our university, it has been found for assessment that : assessment needs to be meaningful to students and students should be regularly assessed in a holistic manner, the criteria for assessment should be made clear to students and should reinforce the focus on learning with a clear emphasis upon explaining, critiquing and defending, students' learning abilities should be developed and emphasized through assessment, feedback from the facilitator should be formative, continuous, timely and individualized to help students to improve.

As discussed, this study explores the PBL implementation with an advanced computer engineering course (i.e., advanced java) of pre-final year students.

At the beginning, PBL approach starts with a flow that contains problem title, hook, background/history of the problem, providing constraints, problem conclusion, assessment strategy, deliverables, evaluation guidelines, rubrics etc. These points helped a lot to the students for critical thinking. Even the actual workflow highlights the key scenarios for PBL implementation.

This PBL component deals with the student's ability to analyze, evaluate and apply the technical knowledge of programming language. This component will increase the student's ability to perform the desired tasks. This assessment component deals with students' ability to develop and design robust web-based applications.

Assigned Problem Flow:

Problem Title: Grocery Booking System for Retail Small Shoppers

Learning Outcomes with PBL: The list of expected outcomes was identified before implementation of PBL is discussed below.

After PBL approach, student will be able to:

- Understand the problem and its solution and apply critical thinking
- Identify the requirements for assigned problem solution
- Design the structure of web application and database to represent assigned problem
- Develop a web application using Servlet, JSP, and JDBC/Hibernate to implement PBL approach

Hook of the Problem: One day Dineshbhai was given a list to buy grocery items. This list comprises different items that are needed on a daily basis. But he was surprised by seeing the list i.e., it was a list of 24 items and these 24 items should be purchased from 4 different shops since these shops are famous for such items and others are not having those items in the shop or they are not preferred to sell it. Finally, Dineshbhai managed to purchase these items, but it took around 55 mins due to lots of traffic in shops and also, he has sanitized himself around 10 times and taken lots of care for social distancing. Dineshbhai wondered, "Only if there was an online grocery system, he could have all 24 items with utmost priority of safety and also delivery boys' free time should be utilized effectively. And he will also be happy to track his order status."

Background/history of the problem: COVID-19 is disrupting all of us in an unprecedented manner. To deal with this situation, social distancing and minimum contacts are expected for us. Grocery items are the primary needs. Also, many nearby shops provide good quality products as per our needs. Purchasing different items from separate shops is generally the habit of many housewives. Also, government guidelines and safety precautions matter a lot for us to safeguard ourselves. In fact, after this pandemic situation, the need will also be as usual since many people are working with tight schedules and they will not be free to do such tedious work. Rather people may think to save this time and utilize it for their development or for any other purposes. Also, few retail shops are having home delivery options while others are not having such facilities. One of the shops has a booking facility through phone but it takes too much time with ordering for both sellers and customers. Sometimes it also happens that delivery boys are free for a few hours from different shops. Usually such a need arises due to a busy schedule of life or with such pandemic situations. Also, some items like bread, cheese, particular brand, and variety of khakhara, farsan, etc. are not available in all the shops. To purchase such items which are part of our daily needs, should also require some additional time. As such, considering real life scenarios, solutions to such problems do not exist and can be proposed using appropriate use of technology.

Clarifying/Providing Constraints: There are many variables in the real scenario of managing Grocery Booking System for Retail Small Shoppers such as list of preferred shops available in the given nearby area/cluster, opening and closing time of different shops, list and price of items available in each shop, list of delivery boy from different shops, managing schedule of delivery boy, tracking of order status by customer etc. Given the complex nature of the problem, your goal is to design and develop a system (i.e., web application since its advanced java course) so that a buyer will be satisfied by purchasing the items from different shops and small shoppers will survive by getting enough customers. Also, delivery boys will get sufficient earnings with their work.

Assigned Problem Conclusion: This problem is aiming to provide the best possible solution by following two tasks that will help customers, small shops, and delivery boys to provide items from preferrable shops. As a solution, you need to design and develop a proposed system with design of a database followed by web application development using JSP, Servlet, JDBC and Hibernate which can be further converted to Android based mobile application as a future project. No need to develop an android based mobile application at this stage, however you need to work towards the design of the database and web application development for the said problem.

Deliverables: 1) Overall database design in MySQL for the proposed system to provide different items from different shops to customers at the right time. 2) Develop a web application using JSP, Servlet, JDBC and Hibernate and utilize the designed database as a back-end. Validate the system by putting sample data through the system.

Assessment Strategy and Notes:

1) Design of back-end database and 2) Development of a web application along with required validations at each stage.

Note: Assessment will be based on demonstration and no need to prepare a separate presentation.

- This component deals with the student's ability to analyze, evaluate and apply the technical knowledge of programming language.
- Assessment will be conducted regularly as well as during the week of regular exam schedule.
- The assigned work should be completed in specified duration i.e., within four weeks.
- The completed work should be submitted through Canvas LMS by following evaluation guidelines.

Evaluation Guidelines:

i. During 1st Week, designing of all the UI screens should be completed. In this week, students should explore the problem, identify the requirements relevant to the assigned problem and then design the UI screens. At the end of 1st Week, Students need to submit a pdf file that contains snapshots of all UI screens designed.

ii. During the 2nd Week, Database Design should be completed. In this week, students should explore the

problem by concerning the database, identify the relevant tables for the requirements/UI screens relevant to the assigned problem and then design all the tables along with all required fields, constraints, relationships etc. At the end of 2nd Week, students need to submit a pdf file that contains snapshots of all database tables designed. All snapshots should clearly show the fields with size, constraints, relationships etc.

iii. During 3rd and 4th Week, Database Connectivity along with Implementation code should be completed. In these weeks, students should write the code for proposed UI screens. At the end of 3rd Week, students should share the progress on implementation, and it is expected to complete around 50% of the code. At the end of 4th Week, students should share the progress on implementation, and it is expected to complete the remaining work.

iv. During the week of the regular exam schedule for the subject, students should also demonstrate the whole project and assessment will be done by the faculty coordinator.

Rubric for PBL Implementation (Total Marks: 40):

There are three significant parameters which are considered for PBL implementation through web application: database design, UI design, and database connectivity. Let's go through individually for all such parameters.

Database Design:

Not Satisfactory (0-3): Only a few tables, validation constraints and referential integrities are provided for the proposed solution and overall database design is not satisfactory.

Average (4-7): Some tables, validation constraints and referential integrities are supposed to be revised for the proposed solution.

Satisfactory (8-10): All tables, validation constraints and referential integrities are provided for the proposed solution and overall database design is satisfactory.

UI Design:

Not Satisfactory (0-3): Only a few UI Screens are designed and lots of revisions are required to make it appropriate.

Average (4-7): Some UI Screens are proper and it's acceptable but not up to mark as overall application design.

Satisfactory (8-10): All UI Screens are designed and it's up to the mark.

Database Connectivity:

Not Satisfactory (0-8): Only a few required UI Screens are connected with the database and lots of revisions are required to make it appropriate.

Average (9-13): Some required UI Screens are connected with the database and its acceptable but not up to mark as overall connectivity of all required UI Screens.

Satisfactory (14-20): All required UI Screens are connected with the database and it's up to the mark.

Student Pack:

Student pack consisted of problem title, facilitator name, learning outcomes of the problem, scenario, assessment strategy, evaluation guidelines, assessment rubric etc. Student pack was shared well in advance before starting the implementation of PBL. It plays an important role for students to get early knowledge of a problem and its solutions execution process.

Learning Sequence:

In Problem Based Contextual Work, students have responsibility for their own learning by identifying their learning issues and needs. The students work with the following learning materials:

- the problem situation
- a list of objectives that the student is expected to master while working on the problem
- a reference list of materials that pertain to the basic objectives
- questions that focus on important concepts and applications of the knowledge base

Time allotted to each group is fixed and students have worked on the problem solutions in groups. Students are evaluated by instructors using a demonstration assessment method.

Table: 1 Learning Sequence Sessions Summary

Phase	Learning Sequence	Suggested Duration
1	Introducing the problem & its rationale	1 session
2	Exploration **Overview**: Problem is read, minor ambiguities or uncertainties are addressed **Initial discussion**: Free discussion on different requirements and its solution for database design, UI templates, coding technologies etc. **Systematization:** Ideas are screened and structured into three different parts like (i) Database Design (ii) UI Design & (iii) Database Connectivity **Knowledge Gathering**: Group work focused on learning for Servlet/JSP and Hibernate.	5 sessions

	Doubt Solution: Students doubts for different application development concerns will be addressed.	
3	Demonstration and assessment of deliverables	4 sessions
4	Concluding session on process and its execution	1 session

Expected Benefits from Proposed Approach: This PBL component will increase the student's ability to understand the requirements and provide solution along with critical thinking.

Expected Challenges of Proposed Method: Students may submit answers in similar pattern that will make assessment cautious. This component does not include code optimization techniques. Problem definition should cover all the aspects that should cover the relevant syllabus. Students must be familiarized to solve the given problem during lab sessions and extra work.

IV. RESULTS AND DISCUSSION

To examine the impact of PBL approach for Advanced Java subject, the result of B.Tech. (CE and IT branches) sixth semester students (A.Y. 2019-20 and 2020-21) are measured and highlighted in the Table 2 with distinct factors (Ganesh, 2018). Result of the academic year (A.Y. 2019-2020) indicates about 43% students who had secured more than over average score with traditional method-based examination whereas the result of the academic year (A.Y. 2020-2021) which was implemented with problem-based learning approach shows like around 88% students had secured more than over average score i.e., highlighted in Fig. 1. This evaluation illustrates that students are more noticeable and intriguing about solving PBL problems instead of raiding up theories and composing the solutions with traditional approach.

Table: 2 Result Analysis Comparison for Advanced Java course

Advanced Java Result Analysis (For AY 2019-20 & 2021-21)			
Level	**Grade**	**% Students with Traditional MCQ Based Exam (AY 2019-20)**	**% Students with Problem Based Learning (AY 2020-21)**
Outstanding	A+	10.14	30.50
Excellent	A	15.32	23.54
Very Good	B+	8.14	16.85
Good	B	9.22	16.78
Above Average	C+	25.29	6.29
Average	C	19.05	3.46
Poor	D	8.82	2.58
Fail	F	4.02	0.00

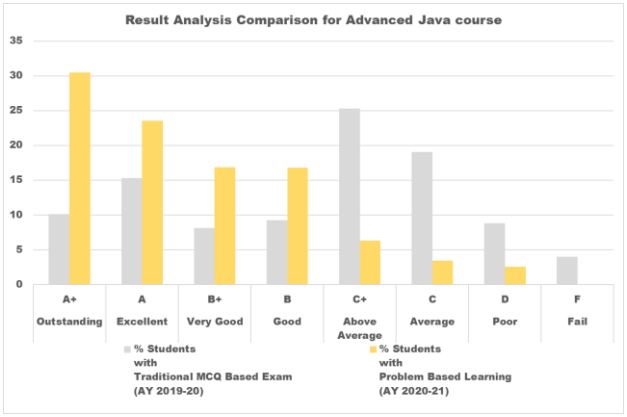

Fig. 1. Result Analysis Comparison (A)

As shown in Fig. 1, result improvement for the proposed method is clearly found compared to the traditional written approach.

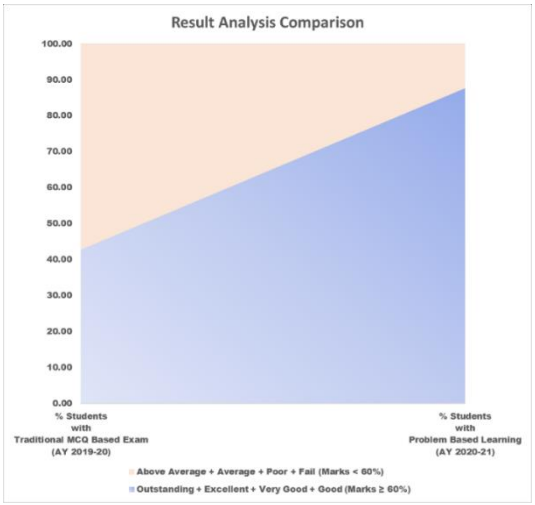

Fig. 2. Result Analysis Comparison between ">=60% Students Group" & "<60% Students Group"

Fig. 2 highlights the increasing number of students with grades (>=60%) for the PBL approach compared to the traditional MCQ based approach.

The Control group and test group are set up to evaluate the effect of the proposed approach on student's knowledge. The control group i.e., traditional MCQ based approach (A.Y. 2019-20 Exam Evaluation i.e., given in last second column of Table 2) and experimental group (AY 2020-21 Exam Evaluation i.e., given in last column) i.e., proposed approach is compared against each other in this experiment. The descriptive analysis was utilized to illustrate the mean and the standard deviation of the score. Since the secured marks for traditional and proposed approach exams were collected for the same subject in two different years, the paired t-test was utilized to test the significant distinction for both exams' score. The paired t-test was conducted to test the hypothesis.

Table 3 shows the combined tests' measurements of traditional MCQ based approach and proposed PBL approach. The overall result shows that there is around 2 times improvement with the proposed PBL approach for grades (>=60%).

Table: 3 The Paired Samples Statistics of Traditional and PBL Approach

Level	Traditional MCQ Based Approach (%)		Problem Based Learning Approach (%)	
	Mean	Standard Deviation	Mean	Standard Deviation
Grades >=60%	10.71	3.18	21.92	4.3
Grades <60%	14.30	9.64	3.08	2.59

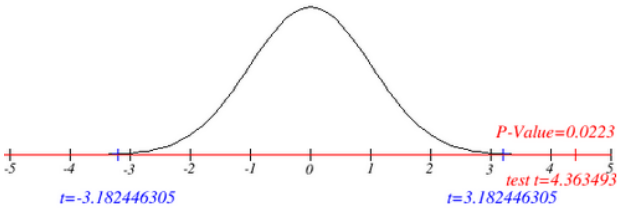

Fig. 3. Results of Paired Samples t-Test over Grades (>=60%)

Table: 4 Results of Paired Samples T-Test of Traditional and PBL Approach

Level	Paired Differences (%)		t-test result
	Mean	Standard Deviation	(2-tailed)
Grades >=60%	11.21	1.11	0.022

The hypothesis testing with paired sample t-test was utilized for this study. The results are anticipated to suggest higher mean value for PBL approach than traditional MCQ based approach.

The null hypothesis H0: There's no distinction in mean for the proposed approach than the traditional MCQ based approach.

Elective hypothesis H_1: There's a distinction in meaning for the proposed approach than the traditional MCQ based approach.

Table 4 and Fig. 3 show the findings of paired t-test for grades (>=60%). At 5% significance level, all null hypotheses are rejected and t-test result i.eP-value indicates that with proposed approach results have been improved undoubtedly compared to traditional MCQ based approach. In such a way, it can be concluded that there is a statistically remarkable contrast between mean score of the traditional MCQ approach and proposed PBL approach. Subsequently, it is noticeable that the proposed approach can upgrade the students' functional skills essentially.

Post Implementation

Student Feedback:

For the proposed approach, the feedback was conducted from students' groups and 92% students showed positiveness towards the PBL approach. This feedback shows the students' understanding of the concepts and enthusiasm for the PBL approach towards advanced java subjects.

Facilitator Reflection:

For the proposed approach, the reflection from the facilitator was conducted and found more positive towards the PBL approach. This feedback indicates the favorableness towards the PBL approach for advanced java subjects.

V. CONCLUSIONS

This research looks at the use of PBL in the education process, which is suitable for real-life applications development needs related to undergraduate students of Computer Engineering and Information Technology branches. Use of PBL in Advanced Java course, allowed students to develop the skills like recognize the actual attributes of problem through critical thinking, identify requirements for the system development, design the system flow and database, implement the concepts of advanced java to develop web application (for problem solution) etc. i.e., according to the reports and monitoring of the students during the activities related to the project, and the results observed by the facilitator. The results of this research suggest that the implementation of PBL in Advanced Java at School of Engineering, RK University sheds light on a positive and promising finding that PBL motivates the process of 'learning'. and develop soft, logical, practical etc. skills which lead to the hypothesis of an engineering education that aims to reduce the gap between theory and practice in learning advanced courses in higher semesters of computer-oriented branches in engineering. This research contributes to a newer approach i.e., delivery method for Advanced Java course in the Computer Engineering and Information Technology branches.

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