61.Regional Research Symposium on PBL

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Keynotes

Sl.no	Speaker	Title
1.	**Prof. Ron Ulseth** Director, Academics, and Research, Iron Range Engineering, Minnesota	PBL Innovations through Change: From the Iron Range model to the new Bell model
2.	**Prof. Dr. Khairiyah Mohd Yusof** Director, Centre for Engineering Education Universiti Teknologi Malaysia	Developing 21st Century Educators: How to successfully support faculty members
3.	**Prof. Anette Kolmos** Director, UNESCO -Aalborg Centre for Problem Based Learning in Engineering Science and Sustainability, Aalborg University, Denmark	The ugly duckling becoming a swan – a story of PBL in a changing world
4.	**Dr. Jens Myrup Pedersen** Associate Professor,Aalborg University, Denmark	PBL in a Digitised World - Opportunities and Challenges
5.	**Mr. Xavier Fouger** Senior Director, Learning Centers and Programs. Dassault Systemes – Learning Experience	New playgrounds for PBL

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KLE Technological University
Centre for Engineering Education Research

Regional Research Symposium on PBL,
November 22-23, 2019

Program Schedule

Day 0 : Nov 21 (Thursday)	Day 1 : Nov 22 (Friday)	Day 2 : Nov 23 (Saturday)
	8.00am: breakfast (Food Court)	**8.00am: breakfast (Food Court)**
8.30am: Registration desk opens	**8.30am: Registration**	**9.00am: Keynotes** K4: PBL Innovations through change (Prof. Ron Ulseth) K5: PBL in digitized world (Dr. Jens Myrup Pederson)
10.30am: Workshops (3 in parallel) W01: Introduction to PBL W02: Introduction to PBL W03: Introduction to PBL	**9.30am: Inauguration**	**10.30am: Workshops (4 in parallel)** W07: How can Digital Tools support PBL? (Dr. Jens Myrup Pederson, Location) W08: Students Reflections and Process Analysis (Mr. HenriK Routhe, Location) W09: Systems Thinking (Ms. Naini Dawar, Location) W10: Algorithm Development & Systems Modelling (Mathworks, Location)
	11.00am: Keynotes K1: The ugly duckling becoming a swan (Prof.Dr. Anette Kolmos) K2: Developing 21st century educators (Prof. Dr. Khairiyah Mohd Yusof)	
1.30pm: Lunch (Food Court)	**12.30pm: Lunch (Food Court)**	**1.30pm: Lunch (Food Court)**
3.00pm: Workshops (3 in parallel) W04: Problem Crafting (Prof. Dr. Khairiyah Mohd Yusof) W05: PBL and Assessment (Prof. Doc. Anette Kolmos) W06: Systems Thinking (Ms. Naini Dawar)	**1.30pm: Research Papers – Session 1 (Parallel)** R01: (Venue-To be notified) R02: (Venue-To be notified) R03: (Venue-To be notified)	**2.30pm: Research Papers – Session 2 (Parallel)** R4: (Venue-To be notified) R5: (Venue-To be notified)
7.30pm: Dinner (by invitation)	**3.30pm: Keynote** K3: New Playgrounds for PBL (Mr. Xavier Fouger)	**4.30pm: Valediction and announcement of Dassault Quiz Winner**
	4.15pm: PBL beyond RRSPBL – Panel	
7.30pm: Dinner for Delegates (Food court)	**7.30pm: Welcome Dinner (Food Court)**	

***The venues for the individual events will be notified soon.**

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Schedule of Paper Presentations

Research Track-R1	**Date**: 22-Nov-2019	**Time**: 1.30 to 3.00 pm	**Venue**: To be notified

Paper ID	Authors	Paper Title	Institute Name
9	Abhishek Patange, Anand Bewoor, **Suhas Deshmukh**, Sharad Mulik, Sujit Pardeshi and Jegadeeshwaran R	Improving Program Outcome Attainments Using Project Based Learning approach for: UG Course - Mechatronics	Govt College of Engineering, Karad, Maharashtra
38	**Sachin Magadum** and Randhir Patil	Collaboration of UG-PG Learners for Enhancement of Digital Design Verification Aptitude Using PBL Methodology	Rajarambapu Institute of Technology, Rajaramnagar (sakharale), Maharashtra
43	**Prakash Hegade**	One-Day Many-Problems: A Problem Based Learning Approach	KLE Technological University, Hubli, Karnataka
66	Lalita Admuthe, **Atul Shaha** and Sandeep Patil	Curriculum Design and Implementation of Project-Based Learning for Electronics Engineering Graduates	DKTE'S Textile & Engineering Institute, Ichalkaranji, Maharashtra
76	**Bhagyashri Panpat** and Charusheela Pandit	Project-Based Learning Approach in Undergraduate Engineering Course of Cryptography and Security in Computer Science	Vishwaniketan Institute of Management, Entrepreneurship and Engineering Technology, Khalapur, Maharashtra

*The presenting author's name is highlighted.

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Schedule of Paper Presentations

Research Track-R2	**Date**: 22-Nov-2019	**Time**: 1.30 to 3.00 pm	**Venue**: To be notified

Paper ID	Authors	Paper Title	Institute Name
13	**Suhasini Desai** and **Datta Dandge**	Adding element of competition to Multi-disciplinary PBL: Case study of Robocon Competition	MIT World Peace University, Pune, Maharashtra
18	**Santosh Naik,** Hema Mahajan and B Yakub	Implementing PBL to Enhance Technical Knowledge Through Design Thinking Process	Hyderabad Institute of Technology And Management, Hyderabad
36	**Rahul Bhedasgaonkar**, Mahesh Chavan, Pravin Kubade and Sayaji Patil	Course Level PBL-an Excellent Teaching Method for Increasing Skill Levels and Learning Motivation in First Year of Engineering Students	Kolhapur Institute of Technology, College of Engineering, Kolhapur,Maharashtra
49	**Gurubasu Hombal,** Sushma V, Shweta Koraddi, Sachin Angadi and Raju A B	Enhancing the Student Learning Outcomes in Electric Drives and Control by Integrating the Core courses through PBL Approach.	KLE Technological University, Hubli, Karnataka
59	**Charusheela Pandit** and Bhagyashree Panpat	Development of ICT Based PBL Platform	Vishwaniketan's Institute of Management, Entrepreneurship and Engineering Technology, Khalapur, Maharashtra

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Schedule of Paper Presentations

Research Track-R3	**Date**: 22-Nov-2019	**Time**: 1.30 to 3.00 pm	**Venue**: To be notified

Paper ID	Authors	Paper Title	Institute Name
15	Ravi Jagannathan and **Claire Komives**	Teaching by Induction: Project-Based Learning for Silicon Valley	San Jose State University,California, USA
16	**Vidya Srikanth**, Vimala Swamy and Vikas V Shinde	PBL For Sustainability: Pedagogical Approach In Vernacular Architecture	REVA University, Bengaluru, Karnataka
21	**Vikas Shinde**	Effectiveness of Project Based Learning models to achieve 6Ps in Vishwaniketan, India	Vishwaniketan's Institute of Management, Entrepreneurship and Engineering Technology, Khalapur, Maharashtra
27	**Vinod Kumar Ahuja**, Deepa Mandal and Swetha Tirumala	Inculcation of life skills through project based learning to promote sustainability	Hyderabad Institute of Technology And Management, Hyderabad
33	**Jayashree Awati,** Sushma Kulkarni and **Sachin Patil**	Energetic teaching activity Role play and round quiz: A case study	Rajarambapu Institute of Technology, Rajaramnagar (sakharale), Maharashtra
72	**Jyoti Bali**, Ashwini G K, Shilpa Tanvashi and Arunkumar Giriyapur	Problem solving in Integrated Laboratory using Hackathon Approach	KLE Technological University, Hubli, Karnataka

*The presenting author's name is highlighted.

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Schedule of Paper Presentations

Research Track-R4	**Date**: 23-Nov-2019	**Time**: 2.30 to 4.00 pm	**Venue**: To be notified

Paper ID	Authors	Paper Title	Institute name
14	Juebei Chen, **Anette Kolmos**, Aida Guerra and Chunfang Zhou	Aalborg UNESCO Certificate: Staff Development and Challenges in PBL Training Program	Aalborg University, Denmark
22	**Subodh Ingaleshwar** and Athar Jamadar	Enhancing faculty competencies through Engineering Exploration & Design Project Course	Rajarambapu Institute of Technology, Rajaramnagar (sakharale), Maharashtra
31	**Arati Phadke** and Sangeeta Kulkarni	Experience of Engineering Exploration Course in Audit Mode for Second Year.	K J Somaiya College of Engineering , Vidyavihar, Mumbai,Maharashtra
34	**Bhaveshkumar Pasi**, Vikas Shinde and Mayuri Chavan	Teacher's perception towards their role in Course Level Project-Based Learning environment	Vishwaniketan's Institute of Management, Entrepreneurship and Engineering Technology, Khalapur, Maharashtra
39	**Vishwanath Baligar**	Project Based Learning and Publishing Refereed Papers through Course Projects	KLE Technological University, Hubli, Karnataka

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Schedule of Paper Presentations

Research Track-R5	**Date**: 23-Nov-2019	**Time**: 2.30 to 4.00 pm	**Venue**: To be notified

Paper ID	Authors	Paper Title	Institute name
19	**Shivaprasad Mukhandmath,** Shivashankar Huddar, Rajashekhar Savadi, Gopalkrishna Joshi, B B Kottursheettar, Nalini Iyer and Ashok Shettar	An Experience of Teaching Engineering Design for Freshman Students	KLE Technological University, Hubli, Karnataka
25	**Vinod Kumar Ahuja,** Suguna Indukuri and Swetha Tirumala	Collaboration of industry institution interaction for delivering industry ready engineers	Hyderabad Institute of Technology And Management, Hyderabad
35	**Shilpa Deshpande** and Sandeep Kate	Development of ecosystem and learning spaces in effective implementation of PBL in Vishwaniketan's Campus	Vishwaniketan's Institute of Management, Entrepreneurship and Engineering Technology, Khalapur, Maharashtra
60	**Umesh Kamerikar**, Mahadev Patil and Snehal Watharkar	Project Based Learning- An Innovative approach to enhance higher order skills	Rajarambapu Institute of Technology, Rajaramnagar (sakharale), Maharashtra
26	**Vinod Kumar Ahuja** , Lavanya Yenugula and Swetha Tirumala	A case study: Journey of Student skill development Centre (SSDC) an interdisciplinary platform to actively engage millennial at HITAM	Hyderabad Institute of Technology And Management, Hyderabad

*The presenting author's name is highlighted.

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REGIONAL RESEARCH SYMPOSIUM ON PBL

Objective: To develop awareness about PBL and build critical mass of PBL practitioners in the region (Asia – Pacific, particularly India)

Dates: November 22-23,2019.

Registrations: Total number of 208 registrations from 26 institutions from 07 states on India.

Symposium events:

Inauguration: RRSPBL was inaugurated by Dr.Rajive Kumar, Member Secretary, All India Council for Technical Education (AICTE) on November 22,2019. Dr.Anette Kolmos was guest of honour and Prof.Ashok Shettar presided over the function.

Keynotes: Four keynotes were delivered by eminent from both industry and academia on topics of relevance to engineering education.

Panel Discussion:

A panel discussion on the theme "PBL beyond RRSPBL" was arranged as part of the symposium which explored the possibilities of building a movement of PBL practitioners in India. The panel consisted of representations from industry, academia and government & policy making.

Research Papers:

We received a total of 77 abstracts of which 26 full papers were accepted for presentation and were published in the proceedings of RRSPBL. The proceedings was brought out as a special issue by Journal of Engineering Education Transformations (JEET, Special Issue No.1 November 2019 Volume No.33 eISSN 2394-1707).

Workshops:

A total of 08 workshops were organised on various important PBL themes as part of the symposium. This opportunity was well utilised by the delegates resulting in 93% capacity utilisation.

Figure 1 Inaugural Function

Figure 2 Panel discussion

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Title: Introduction to PBL

Abstract:
This workshop will focus on an introduction to and the principles of problem-based projects (PBL). There will be a focus on the three dimensions of learning principles in PBL: organizing learning around the problems, the content of the discipline, and the team. The aim of this workshop is to build context on experiential learning, interdisciplinary learning, exemplary practice, and social learning all of which are aligned with the overall learning objectives in PBL.

A variety of adaptations and implementations of PBL from around the world will be presented and discussed. The participants will work on a case with integrating PBL competences into their current contexts.

After the workshop, participants will be able to discuss the elements of PBL, the contexts of PBL, various implementations of PBL, and have a sense of how to adapt PBL to their teaching.

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Workshop RRSPBL

Venue: CSC313

Problem Crafting in PBL:

An effective problem is the heart of problem-based learning (PBL). Problems play an important role in delivering learning outcomes, assessing learning process, providing learning context, stimulating thinking skills, and catering for teaching and learning activities. A properly crafted problem can also ensure that desired learning outcomes be attained through solving the problem. Crafting problems according to effective PBL problems criteria is a challenging task to problem crafters especially in engineering.

This workshop will provide participants with an overview on problem crafting, which includes the principles and a step by step guide to craft effective problems.

To know more about Problem Crafting in PBL, today we have a resource person Prof. Dr. Khairiyah Mohd Yusof.

Khairiyah Mohd Yusof is a Professor in the Department of Chemical Engineering and the Director of Universiti Teknologi Malaysia (UTM) Centre for Engineering Education (CEE), which promotes scholarly and evidence-based practices in engineering education. She is currently the President for the Society of Engineering Education Malaysia (SEEM). Khairiyah is passionate about implementing and promoting meaningful learning in higher education, especially in engineering. She has been invited to speak and conduct workshops throughout Malaysia and in various countries in Asia, Australia, Europe and North and South America. Her interest led her to take a scholarly path to deepen her knowledge, improve her practice and widen the impact through engineering education research, focusing on innovative teaching and learning practices, faculty development, curriculum design and Engineering Education for Sustainable Development. For her contribution in engineering education, she received several global awards, including the 2018 Duncan Fraser IFEES Global Engineering Education Award, the 2017 Student Platform on Engineering Education (SPEED) Mentorship Award and the 2015 Frank Morton Institution of Chemical Engineers (IChemE) Global Award for Chemical Engineering Education Excellence.

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RRSPBL-2019
Regional Research Symposium on PBL
Workshop RRSPBL

Venue: CSCL301

PBL and Assessment

Assessment is one of the most powerful elements in the curriculum and it can be hard to motivate students for more student- centred learning methods if we keep assessing students by individual written exams. Project-based assessments are an alternative to tests that allow students to engage with their learning in more concrete ways.

The aim of this workshop is therefore to give inspiration to apply other types of assessment methods in the courses that are aligned with the overall learning objectives in PBL. Special focus will be given to assessment of **skills and competences.**

To know more about PBL and Assessment , here we have presenter Prof. Anette Kolmos , she is Professor in Engineering Education and PBL, Director for the UNESCO category 2 Centre: Aalborg Centre for Problem Based Learning in Engineering Science and Sustainability. Chair holder for UNESCO in Problem Based Learning in Engineering Education, Aalborg University, Denmark. Guest professor at KTH Royal Institute of Technology and Guest Professor at UTM University Technology Malaysia 2011-2013.

President of SEFI 2009–2011 (European Society for Engineering Education). Founding Chair of the SEFI-working group on Engineering Education Research. Was awarded the IFEES Global Award for Excellence in Engineering Education, 2013 and the SEFI fellowship in 2015.

During the last 20 years, Dr. Kolmos has researched the following areas, primarily within Engineering Education: gender and technology, project based and problem based curriculum (PBL), change from traditional to project organized and problem based curriculum, development of transferable skills in PBL and project work, and methods for staff development. She is Associate Editor for the European Journal of Engineering Education and was Associated Editor for Journal of Engineering Education (ASEE). Involved in supervision of 19 PhD projects and published around 250 publications. Member of several organizations and committees within EER, national government bodies, and committees in the EU.

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Regional Research Symposium on PBL
Workshop RRSPBL

Venue: IT Studio, BT Department First Floor

How can Digital Tools Support PBL?

Project-based learning, or PBL, challenges students to design and engage in more authentic, extended, and complex learning. But while PBL is a trusted strategy for increasing student engagement and learning, it's not easy to orchestrate. There are tons of moving pieces, and if you're doing it right, students will be engaging in a variety of interest-driven projects all with various needs and on different schedules. So how do you manage it all? , So here we have a workshop on **"How can digital tools support Problem Based Learning?**".

Where the first part of the workshop focuses on Problem Based Learning and the Aalborg model, and serves as a background for the second part which explores how digital tools can be used to improve the learning outcomes in a Problem Based Learning setting. The last part of the workshop focuses on the participants to develop their own strategy for using digital tools.

Resource Person: Jens Myrup Pedersen

Jens Myrup Pedersen is Associate Professor at Aalborg University. His main research interest is Cyber Security, and along with the technical research he has been active in developing PBL with a special focus on digitisation, international student projects, and student projects on sustainability. He has been managing several Erasmus+ Projects on blended learning and international student projects, including COLIBRI (2014-2017) and EPIC (2017-2020). He is currently involved in the Global Students SDG Challenge, where students from Europe and South America work together on projects related to the United Nations Sustainable Development Goals. Since 2017 he has been project leader of the PBL Digital @TECH project,

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searching to digitise the educations at the Technical Faculty of IT and Design in Aalborg University.

Venue: CSC313

Student Reflections and Process Analysis

This workshop introduces student reflections and generation of a process analysis. There will be focus on four main areas for reflections: project management, group collaboration, cooperation with supervisor and the learning process. All related to PBL. The aim of this workshop is to introduce the framework for the reflections process related to PBL. It includes reflection on experiential learning, interdisciplinary learning, exemplary practice, and social learning all of which aligns with the overall learning objectives in PBL.

After the workshop, participants will be able to discuss the elements of the retrospective reflection process related to PBL, the process analysis and have a sense of how to adapt reflection processes to their teaching.

Henrik W. Routhe Aalborg University, Institute for planning Henrik W. Routhe (1964), M.Sc.EE and Graduate Diploma in Business Administration (Organization) has 30 years' experience as manager, leader and engineer in both private and public companies. Currently working with teaching, facilitating, product development, project management and consulting. Before that, worked almost 10 years with education management in a large political driven organization. Henrik W. Routhe's focus industries has been the electronics and telecommunications industries.

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Workshop RRSPBL

Venue: Microsoft Lab

Algorithm Development and System Modeling: A PBL Approach

PBL is a comprehensive teaching and learning approach that engages students in the investigation of authentic engineering problems. A problem may be solved at different levels of abstraction and using different implementation strategies. Hence System Modeling and Simulation becomes a crucial component to understand the development of algorithm for the real-world systems and processes. It brings about the logical thinking competencies when solving mathematical, scientific and engineering problems.

So, here we have Naini Dawar Education Technical Evangelist, MathWorks India Pvt. Ltd. Naini Dawar is an Educational Technical Evangelist at MathWorks India. She works with universities and educational institutes on adoption of MATLAB and Simulink in research and curriculum. She has over 3 years of experience of working with academics as an Assistant Lecturer and over 3 years in Industry. Prior to joining MathWorks, Naini has worked as a Senior Engineer in R&D in an Automotive Company, where she has worked on Model-Based Designing and auto code generation and integration using MATLAB and Simulink. Naini holds a bachelor's degree in Electronics and Communication from Kurukshetra University, Kurukshetra and a Master's degree in Electronics and Communication from Chitkara University, Punjab.

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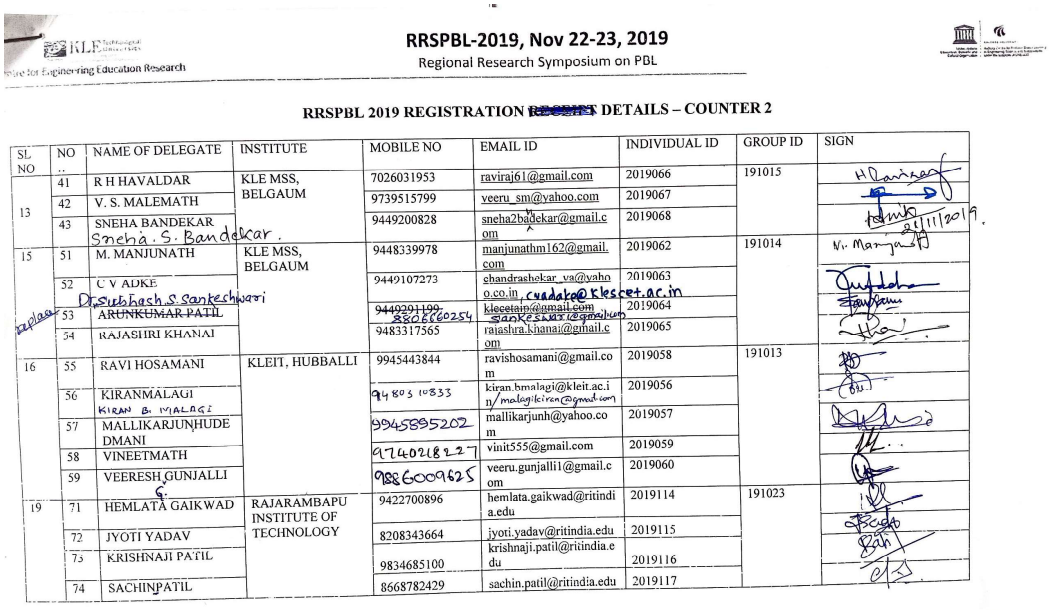

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RRSPBL 2019 REGISTRATION DETAILS – COUNTER 2

SL NO	NO	NAME OF DELEGATE	INSTITUTE	MOBILE NO	EMAIL ID	INDIVIDUAL ID	GROUP ID	SIGN
13	41	R H HAVALDAR	KLE MSS, BELGAUM	7026031953	raviraj61@gmail.com	2019066	191015	
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15	51	M. MANJUNATH	KLE MSS, BELGAUM	9448339978	manjunathm162@gmail.com	2019062	191014	
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16	55	RAVI HOSAMANI	KLEIT, HUBBALLI	9945443844	ravishosamani@gmail.com	2019058	191013	
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	58	VINEETMATH		9740218227	vinit555@gmail.com	2019059		
	59	VEERESH GUNJALLI G.		9886009625	veeru.gunjalli1@gmail.com	2019060		
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	72	JYOTI YADAV		8208343664	jyoti.yadav@ritindia.edu	2019115		
	73	KRISHNAJI PATIL		9834685100	krishnaji.patil@riiindia.edu	2019116		
	74	SACHIN PATIL		8668782429	sachin.patil@ritindia.edu	2019117		

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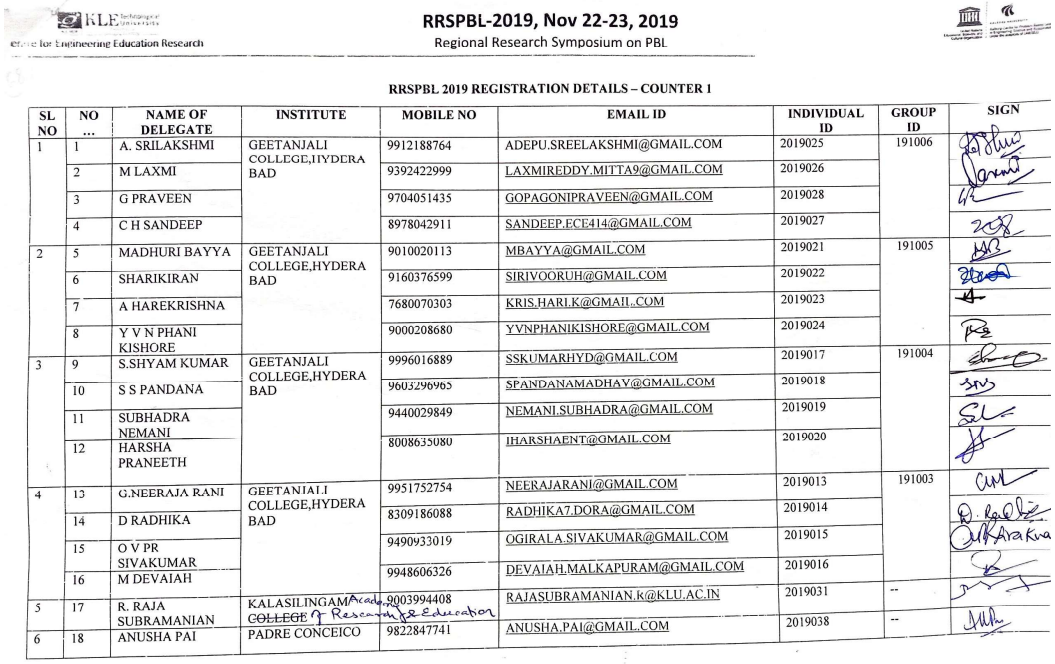

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RRSPBL 2019 REGISTRATION DETAILS – COUNTER 1

SL NO	NO ...	NAME OF DELEGATE	INSTITUTE	MOBILE NO	EMAIL ID	INDIVIDUAL ID	GROUP ID	SIGN
1	1	A. SRILAKSHMI	GEETANJALI COLLEGE,HYDERABAD	9912188764	ADEPU.SREELAKSHMI@GMAIL.COM	2019025	191006	
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	15	O V PR SIVAKUMAR		9490933019	OGIRALA.SIVAKUMAR@GMAIL.COM	2019015		
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6	18	ANUSHA PAI	PADRE CONCEICO	9822847741	ANUSHA.PAI@GMAIL.COM	2019038	--	

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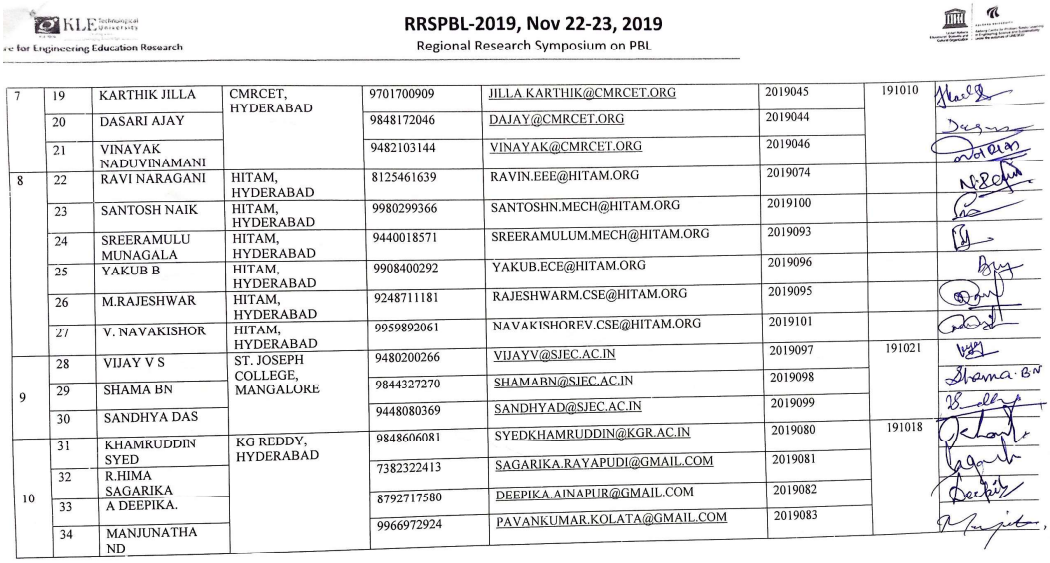

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7	19	KARTHIK JILLA	CMRCET, HYDERABAD	9701700909	JILLA KARTHIK@CMRCET.ORG	2019045	191010	
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	21	VINAYAK NADUVINAMANI		9482103144	VINAYAK@CMRCET.ORG	2019046		
8	22	RAVI NARAGANI	HITAM, HYDERABAD	8125461639	RAVIN.EEE@HITAM.ORG	2019074		
	23	SANTOSH NAIK	HITAM, HYDERABAD	9980299366	SANTOSHN.MECH@HITAM.ORG	2019100		
	24	SREERAMULU MUNAGALA	HITAM, HYDERABAD	9440018571	SREERAMULUM.MECH@HITAM.ORG	2019093		
	25	YAKUB B	HITAM, HYDERABAD	9908400292	YAKUB.ECE@HITAM.ORG	2019096		
	26	M.RAJESHWAR	HITAM, HYDERABAD	9248711181	RAJESHWARM.CSE@HITAM.ORG	2019095		
	27	V. NAVAKISHOR	HITAM, HYDERABAD	9959892061	NAVAKISHOREV.CSE@HITAM.ORG	2019101		
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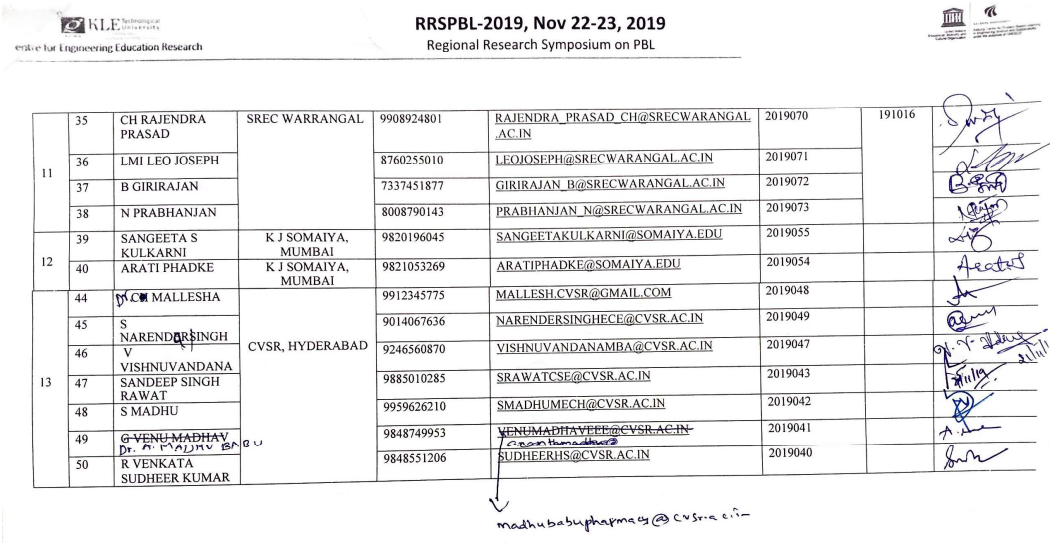
	29	SHAMA BN		9844327270	SHAMABN@SJEC.AC.IN	2019098		
	30	SANDHYA DAS		9448080369	SANDHYAD@SJEC.AC.IN	2019099		
10	31	KHAMRUDDIN SYED	KG REDDY, HYDERABAD	9848606081	SYEDKHAMRUDDIN@KGR.AC.IN	2019080	191018	
	32	R.HIMA SAGARIKA		7382322413	SAGARIKA.RAYAPUDI@GMAIL.COM	2019081		
	33	A DEEPIKA.		8792717580	DEEPIKA.AINAPUR@GMAIL.COM	2019082		
	34	MANJUNATHA ND		9966972924	PAVANKUMAR.KOLATA@GMAIL.COM	2019083		

61.Regional Research Symposium on PBL



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11	35	CH RAJENDRA PRASAD	SREC WARRANGAL	9908924801	RAJENDRA_PRASAD_CH@SRECWARANGAL.AC.IN	2019070	191016	
	36	LMI LEO JOSEPH		8760255010	LEOJOSEPH@SRECWARANGAL.AC.IN	2019071		
	37	B GIRIRAJAN		7337451877	GIRIRAJAN_B@SRECWARANGAL.AC.IN	2019072		
	38	N PRABHANJAN		8008790143	PRABHANJAN_N@SRECWARANGAL.AC.IN	2019073		
12	39	SANGEETA S KULKARNI	K J SOMAIYA, MUMBAI	9820196045	SANGEETAKULKARNI@SOMAIYA.EDU	2019055		
	40	ARATI PHADKE	K J SOMAIYA, MUMBAI	9821053269	ARATIPHADKE@SOMAIYA.EDU	2019054		
13	44	CH MALLESHA	CVSR, HYDERABAD	9912345775	MALLESH.CVSR@GMAIL.COM	2019048		
	45	S NARENDER SINGH		9014067636	NARENDERSINGHECE@CVSR.AC.IN	2019049		
	46	V VISHNUVANDANA		9246560870	VISHNUVANDANAMBA@CVSR.AC.IN	2019047		
	47	SANDEEP SINGH RAWAT		9885010285	SRAWATCSE@CVSR.AC.IN	2019043		
	48	S MADHU		9959626210	SMADHUMECH@CVSR.AC.IN	2019042		
	49	G VENU MADHAV Dr. G. MADHU BABU		9848749953	VENUMADHAVEEE@CVSR.AC.IN	2019041		
	50	R VENKATA SUDHEER KUMAR		9848551206	SUDHEERHS@CVSR.AC.IN	2019040		

madhubabupharmacy@cvsr.ac.in

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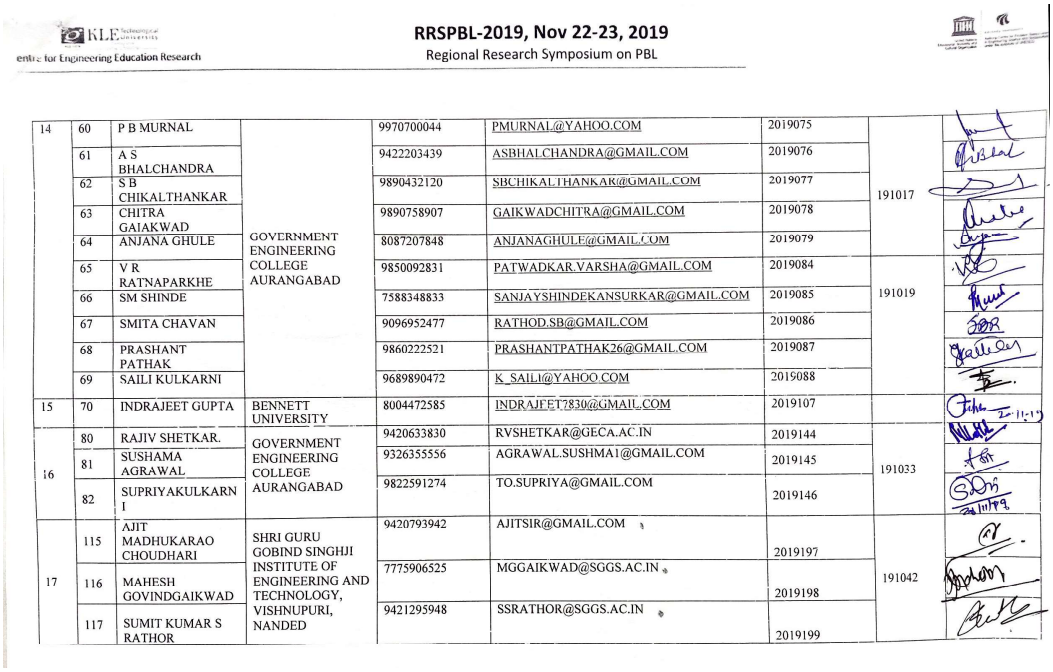

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14	60	P B MURNAL	GOVERNMENT ENGINEERING COLLEGE AURANGABAD	9970700044	PMURNAL@YAHOO.COM	2019075	191017	
	61	A S BHALCHANDRA		9422203439	ASBHALCHANDRA@GMAIL.COM	2019076		
	62	S B CHIKALTHANKAR		9890432120	SBCHIKALTHANKAR@GMAIL.COM	2019077		
	63	CHITRA GAIAKWAD		9890758907	GAIKWADCHITRA@GMAIL.COM	2019078		
	64	ANJANA GHULE		8087207848	ANJANAGHULE@GMAIL.COM	2019079		
	65	V R RATNAPARKHE		9850092831	PATWADKAR.VARSHA@GMAIL.COM	2019084	191019	
	66	SM SHINDE		7588348833	SANJAYSHINDEKANSURKAR@GMAIL.COM	2019085		
	67	SMITA CHAVAN		9096952477	RATHOD.SB@GMAIL.COM	2019086		
	68	PRASHANT PATHAK		9860222521	PRASHANTPATHAK26@GMAIL.COM	2019087		
	69	SAILI KULKARNI		9689890472	K_SAILI@YAHOO.COM	2019088		
15	70	INDRAJEET GUPTA	BENNETT UNIVERSITY	8004472585	INDRAJEET7830@GMAIL.COM	2019107		
16	80	RAJIV SHETKAR.	GOVERNMENT ENGINEERING COLLEGE AURANGABAD	9420633830	RVSHETKAR@GECA.AC.IN	2019144	191033	
	81	SUSHAMA AGRAWAL		9326355556	AGRAWAL.SUSHMA1@GMAIL.COM	2019145		
	82	SUPRIYAKULKARNI		9822591274	TO.SUPRIYA@GMAIL.COM	2019146		
17	115	AJIT MADHUKARAO CHOUDHARI	SHRI GURU GOBIND SINGHJI INSTITUTE OF ENGINEERING AND TECHNOLOGY, VISHNUPURI, NANDED	9420793942	AJITSIR@GMAIL.COM	2019197	191042	
	116	MAHESH GOVINDGAIKWAD		7775906525	MGGAIKWAD@SGGS.AC.IN	2019198		
	117	SUMIT KUMAR S RATHOR		9421295948	SSRATHOR@SGGS.AC.IN	2019199		

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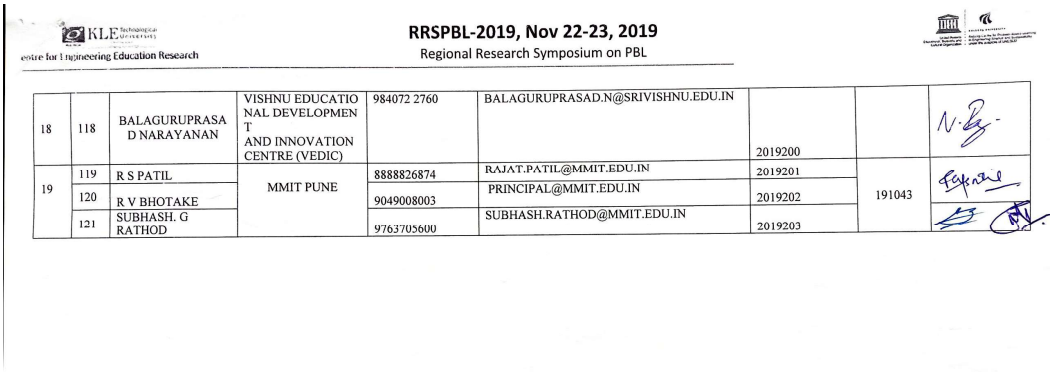

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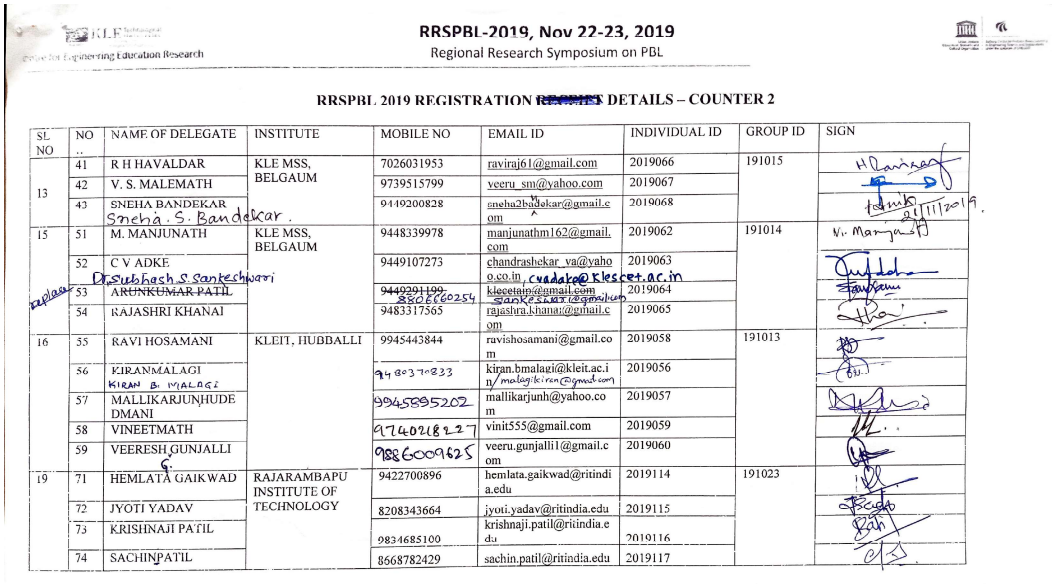
18	118	BALAGURUPRASAD NARAYANAN	VISHNU EDUCATIONAL DEVELOPMENT AND INNOVATION CENTRE (VEDIC)	984072 2760	BALAGURUPRASAD.N@SRIVISHNU.EDU.IN	2019200		
19	119	R S PATIL	MMIT PUNE	8888826874	RAJAT.PATIL@MMIT.EDU.IN	2019201	191043	
	120	R V BHOTAKE		9049008003	PRINCIPAL@MMIT.EDU.IN	2019202		
	121	SUBHASH. G RATHOD		9763705600	SUBHASH.RATHOD@MMIT.EDU.IN	2019203		

SIGNATURE OF THE COUNTER 1 INCHARGE

61.Regional Research Symposium on PBL



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Regional Research Symposium on PBL

RRSPBL 2019 REGISTRATION [redacted] DETAILS – COUNTER 2

SL NO	NO ..	NAME OF DELEGATE	INSTITUTE	MOBILE NO	EMAIL ID	INDIVIDUAL ID	GROUP ID	SIGN
13	41	R H HAVALDAR	KLE MSS, BELGAUM	7026031953	raviraj61@gmail.com	2019066	191015	
	42	V. S. MALEMATH		9739515799	veeru_sm@yahoo.com	2019067		
	43	SNEHA BANDEKAR Sneha. S. Bandekar.		9449200828	sneha2bandekar@gmail.com	2019068		
15	51	M. MANJUNATH	KLE MSS, BELGAUM	9448339978	manjunathm162@gmail.com	2019062	191014	
	52	C V ADKE Dr.Subhash S.Sankeshwari		9449107273	chandrashekar_va@yahoo.co.in cvadake@klescet.ac.in	2019063		
replace	53	ARUNKUMAR PATIL		9449291199 8806660254	kleeetain@gmail.com sankeshwar@gmail.com	2019064		
	54	RAJASHRI KHANAI		9483317565	rajashra.khanai@gmail.com	2019065		
16	55	RAVI HOSAMANI	KLEIT, HUBBALLI	9945443844	ravishosamani@gmail.com	2019058	191013	
	56	KIRANMALAGI KIRAN B. MALAGI		9480370833	kiran.bmalagi@kleit.ac.in/ malagikiran@gmail.com	2019056		
	57	MALLIKARJUNHUDEDMANI		9945895202	mallikarjunh@yahoo.com	2019057		
	58	VINEETMATH		9740218227	vinit555@gmail.com	2019059		
	59	VEERESH GUNJALLI G.		9886009625	veeru.gunjalli1@gmail.com	2019060		
19	71	HEMLATA GAIKWAD	RAJARAMBAPU INSTITUTE OF TECHNOLOGY	9422700896	hemlata.gaikwad@ritindia.edu	2019114	191023	
	72	JYOTI YADAV		8208343664	jyoti.yadav@ritindia.edu	2019115		
	73	KRISHNAJI PATIL		9834685100	krishnaji.patil@ritindia.edu	2019116		
	74	SACHIN PATIL		8668782429	sachin.patil@ritindia.edu	2019117		

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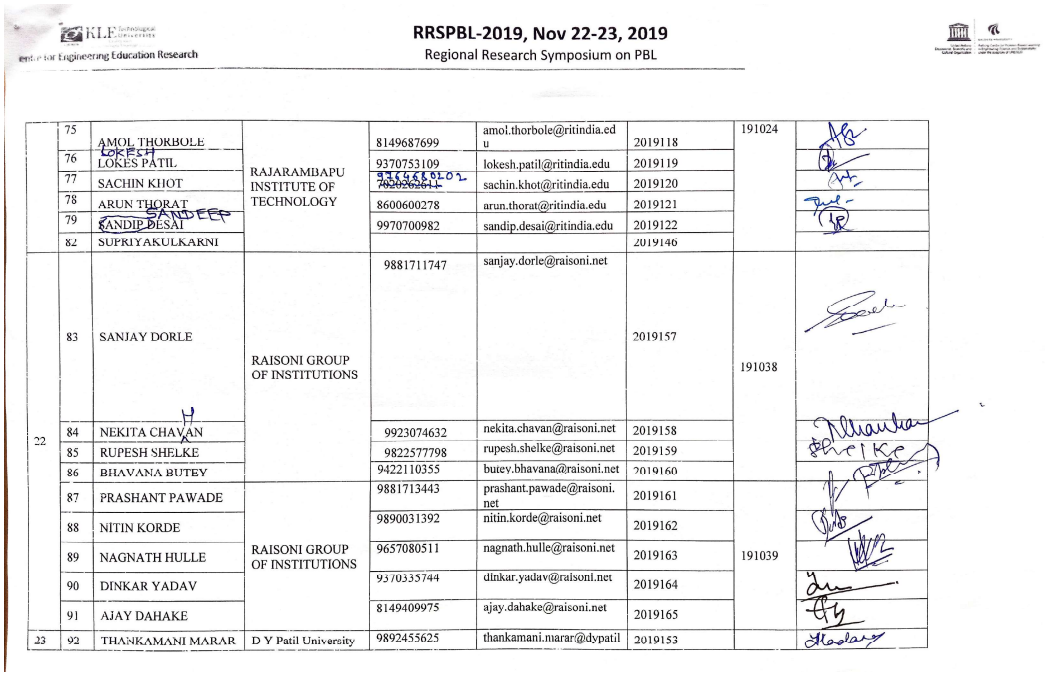

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	75	AMOL THORBOLE	RAJARAMBAPU INSTITUTE OF TECHNOLOGY	8149687699	amol.thorbole@ritindia.edu	2019118	191024	
	76	LOKESH LOKES PATIL		9370753109	lokesh.patil@ritindia.edu	2019119		
	77	SACHIN KHOT		[illegible]	sachin.khot@ritindia.edu	2019120		
	78	ARUN THORAT		8600600278	arun.thorat@ritindia.edu	2019121		
	79	SANDEEP SANDIP DESAI		9970700982	sandip.desai@ritindia.edu	2019122		
	82	SUPRIYA KULKARNI				2019146		
22	83	SANJAY DORLE	RAISONI GROUP OF INSTITUTIONS	9881711747	sanjay.dorle@raisoni.net	2019157	191038	
	84	NEKITA CHAVAN		9923074632	nekita.chavan@raisoni.net	2019158		
	85	RUPESH SHELKE		9822577798	rupesh.shelke@raisoni.net	2019159		
	86	BHAVANA BUTEV		9422110355	butev.bhavana@raisoni.net	2019160		
	87	PRASHANT PAWADE	RAISONI GROUP OF INSTITUTIONS	9881713443	prashant.pawade@raisoni.net	2019161	191039	
	88	NITIN KORDE		9890031392	nitin.korde@raisoni.net	2019162		
	89	NAGNATH HULLE		9657080511	nagnath.hulle@raisoni.net	2019163		
	90	DINKAR YADAV		9370335744	dinkar.yadav@raisoni.net	2019164		
	91	AJAY DAHAKE		8149409975	ajay.dahake@raisoni.net	2019165		
23	92	THANKAMANI MARAR	D Y Patil University	9892455625	thankamani.marar@dypatil	2019153		

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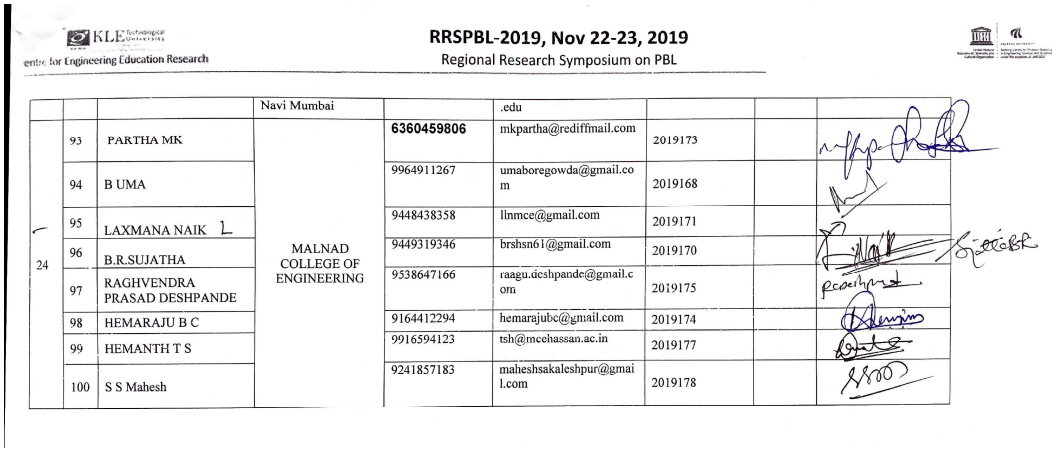

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Regional Research Symposium on PBL

			Navi Mumbai		.edu			
24	93	PARTHA MK	MALNAD COLLEGE OF ENGINEERING	6360459806	mkpartha@rediffmail.com	2019173		
	94	B UMA		9964911267	umaboregowda@gmail.com	2019168		
	95	LAXMANA NAIK L		9448438358	llnmce@gmail.com	2019171		
	96	B.R.SUJATHA		9449319346	brshsn61@gmail.com	2019170		
	97	RAGHVENDRA PRASAD DESHPANDE		9538647166	raagu.deshpande@gmail.com	2019175		
	98	HEMARAJU B C		9164412294	hemarajubc@gmail.com	2019174		
	99	HEMANTH T S		9916594123	tsh@mcehassan.ac.in	2019177		
	100	S S Mahesh		9241857183	maheshsakaleshpur@gmail.com	2019178		

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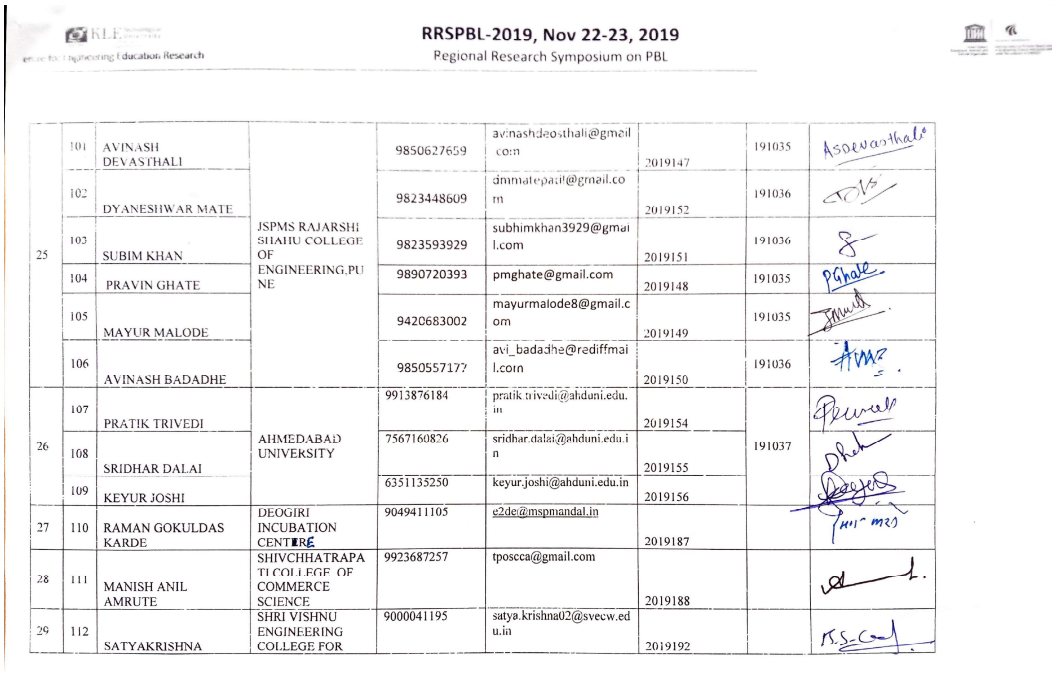

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25	101	AVINASH DEVASTHALI	JSPMS RAJARSHI SHAHU COLLEGE OF ENGINEERING,PUNE	9850627659	avinashdeosthali@gmail com	2019147	191035	
	102	DYANESHWAR MATE		9823448609	dmmatepatil@gmail.com	2019152	191036	
	103	SUBIM KHAN		9823593929	subhimkhan3929@gmail.com	2019151	191036	
	104	PRAVIN GHATE		9890720393	pmghate@gmail.com	2019148	191035	
	105	MAYUR MALODE		9420683002	mayurmalode8@gmail.com	2019149	191035	
	106	AVINASH BADADHE		9850557177	avi_badadhe@rediffmail.com	2019150	191036	
26	107	PRATIK TRIVEDI	AHMEDABAD UNIVERSITY	9913876184	pratik.trivedi@ahduni.edu.in	2019154	191037	
	108	SRIDHAR DALAI		7567160826	sridhar.dalai@ahduni.edu.in	2019155		
	109	KEYUR JOSHI		6351135250	keyur.joshi@ahduni.edu.in	2019156		
27	110	RAMAN GOKULDAS KARDE	DEOGIRI INCUBATION CENTRE	9049411105	e2de@mspmandal.in	2019187		
28	111	MANISH ANIL AMRUTE	SHIVCHHATRAPATI COLLEGE OF COMMERCE SCIENCE	9923687257	tposcca@gmail.com	2019188		
29	112	SATYAKRISHNA	SHRI VISHNU ENGINEERING COLLEGE FOR	9000041195	satya.krishna02@svecw.edu.in	2019192		

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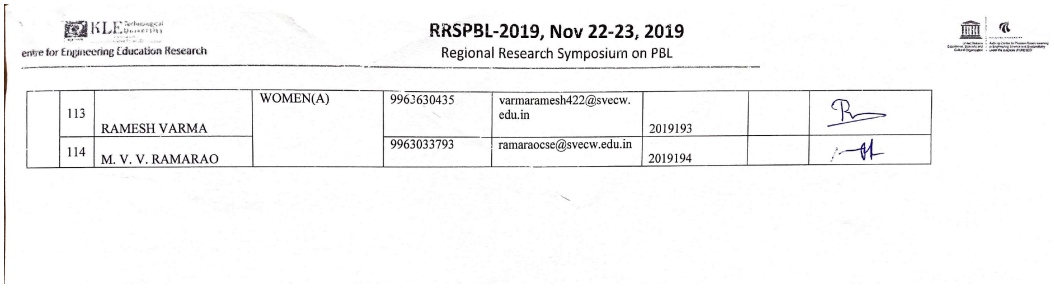

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	113	RAMESH VARMA	WOMEN(A)	9962630435	varmaramesh422@svecw.edu.in	2019193		
	114	M. V. V. RAMARAO		9963033793	ramaraocse@svecw.edu.in	2019194		

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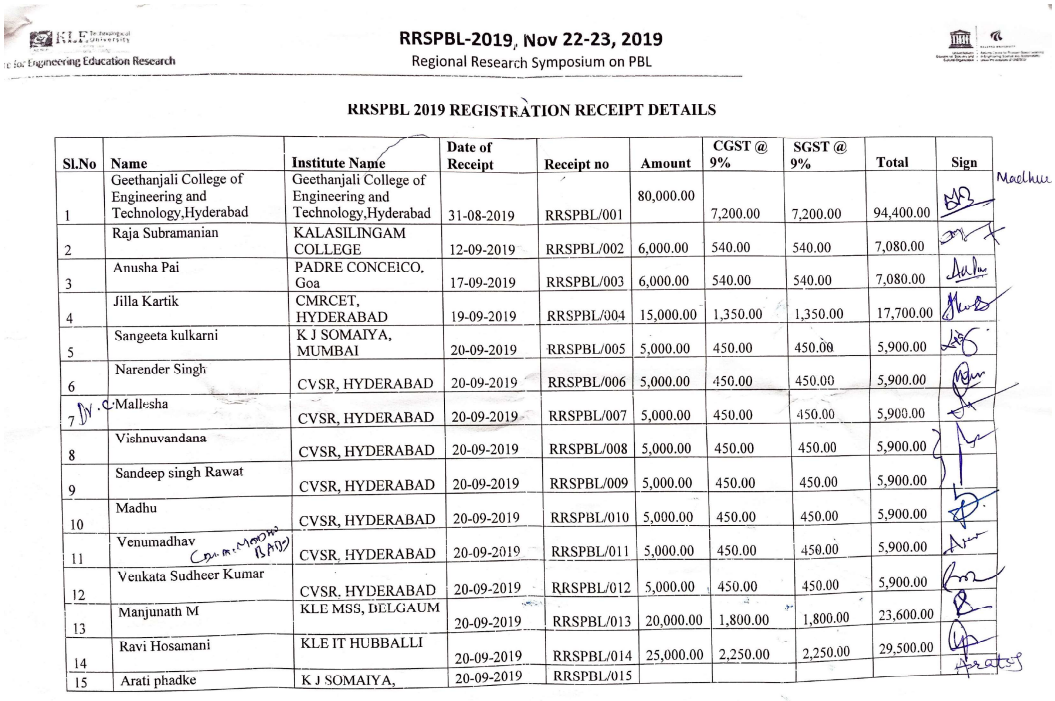

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RRSPBL 2019 REGISTRATION RECEIPT DETAILS

Sl.No	Name	Institute Name	Date of Receipt	Receipt no	Amount	CGST @ 9%	SGST @ 9%	Total	Sign
1	Geethanjali College of Engineering and Technology,Hyderabad	Geethanjali College of Engineering and Technology,Hyderabad	31-08-2019	RRSPBL/001	80,000.00	7,200.00	7,200.00	94,400.00	
2	Raja Subramanian	KALASILINGAM COLLEGE	12-09-2019	RRSPBL/002	6,000.00	540.00	540.00	7,080.00	
3	Anusha Pai	PADRE CONCEICO, Goa	17-09-2019	RRSPBL/003	6,000.00	540.00	540.00	7,080.00	
4	Jilla Kartik	CMRCET, HYDERABAD	19-09-2019	RRSPBL/004	15,000.00	1,350.00	1,350.00	17,700.00	
5	Sangeeta kulkarni	K J SOMAIYA, MUMBAI	20-09-2019	RRSPBL/005	5,000.00	450.00	450.00	5,900.00	
6	Narender Singh	CVSR, HYDERABAD	20-09-2019	RRSPBL/006	5,000.00	450.00	450.00	5,900.00	
7	N. C. Mallesha	CVSR, HYDERABAD	20-09-2019	RRSPBL/007	5,000.00	450.00	450.00	5,900.00	
8	Vishnuvandana	CVSR, HYDERABAD	20-09-2019	RRSPBL/008	5,000.00	450.00	450.00	5,900.00	
9	Sandeep singh Rawat	CVSR, HYDERABAD	20-09-2019	RRSPBL/009	5,000.00	450.00	450.00	5,900.00	
10	Madhu	CVSR, HYDERABAD	20-09-2019	RRSPBL/010	5,000.00	450.00	450.00	5,900.00	
11	Venumadhav	CVSR, HYDERABAD	20-09-2019	RRSPBL/011	5,000.00	450.00	450.00	5,900.00	
12	Venkata Sudheer Kumar	CVSR, HYDERABAD	20-09-2019	RRSPBL/012	5,000.00	450.00	450.00	5,900.00	
13	Manjunath M	KLE MSS, BELGAUM	20-09-2019	RRSPBL/013	20,000.00	1,800.00	1,800.00	23,600.00	
14	Ravi Hosamani	KLE IT HUBBALLI	20-09-2019	RRSPBL/014	25,000.00	2,250.00	2,250.00	29,500.00	
15	Arati phadke	K J SOMAIYA,	20-09-2019	RRSPBL/015					

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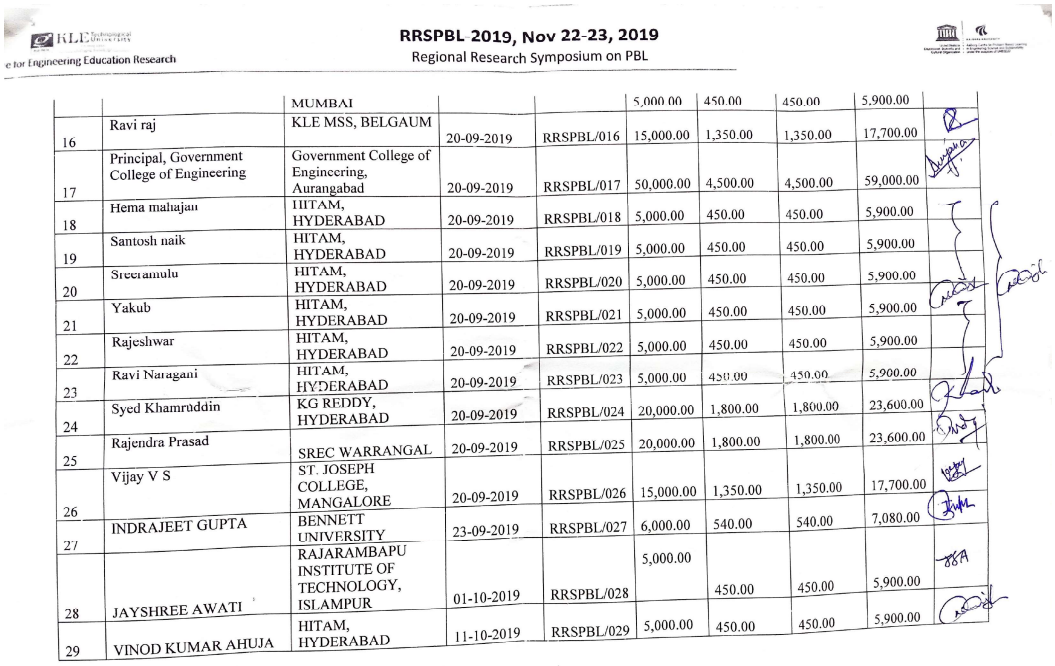

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		MUMBAI			5,000.00	450.00	450.00	5,900.00	
16	Ravi raj	KLE MSS, BELGAUM	20-09-2019	RRSPBL/016	15,000.00	1,350.00	1,350.00	17,700.00	
17	Principal, Government College of Engineering	Government College of Engineering, Aurangabad	20-09-2019	RRSPBL/017	50,000.00	4,500.00	4,500.00	59,000.00	
18	Hema mahajan	HITAM, HYDERABAD	20-09-2019	RRSPBL/018	5,000.00	450.00	450.00	5,900.00	
19	Santosh naik	HITAM, HYDERABAD	20-09-2019	RRSPBL/019	5,000.00	450.00	450.00	5,900.00	
20	Sreeramulu	HITAM, HYDERABAD	20-09-2019	RRSPBL/020	5,000.00	450.00	450.00	5,900.00	
21	Yakub	HITAM, HYDERABAD	20-09-2019	RRSPBL/021	5,000.00	450.00	450.00	5,900.00	
22	Rajeshwar	HITAM, HYDERABAD	20-09-2019	RRSPBL/022	5,000.00	450.00	450.00	5,900.00	
23	Ravi Naragani	HITAM, HYDERABAD	20-09-2019	RRSPBL/023	5,000.00	450.00	450.00	5,900.00	
24	Syed Khamruddin	KG REDDY, HYDERABAD	20-09-2019	RRSPBL/024	20,000.00	1,800.00	1,800.00	23,600.00	
25	Rajendra Prasad	SREC WARRANGAL	20-09-2019	RRSPBL/025	20,000.00	1,800.00	1,800.00	23,600.00	
26	Vijay V S	ST. JOSEPH COLLEGE, MANGALORE	20-09-2019	RRSPBL/026	15,000.00	1,350.00	1,350.00	17,700.00	
27	INDRAJEET GUPTA	BENNETT UNIVERSITY	23-09-2019	RRSPBL/027	6,000.00	540.00	540.00	7,080.00	
28	JAYSHREE AWATI	RAJARAMBAPU INSTITUTE OF TECHNOLOGY, ISLAMPUR	01-10-2019	RRSPBL/028	5,000.00	450.00	450.00	5,900.00	
29	VINOD KUMAR AHUJA	HITAM, HYDERABAD	11-10-2019	RRSPBL/029	5,000.00	450.00	450.00	5,900.00	

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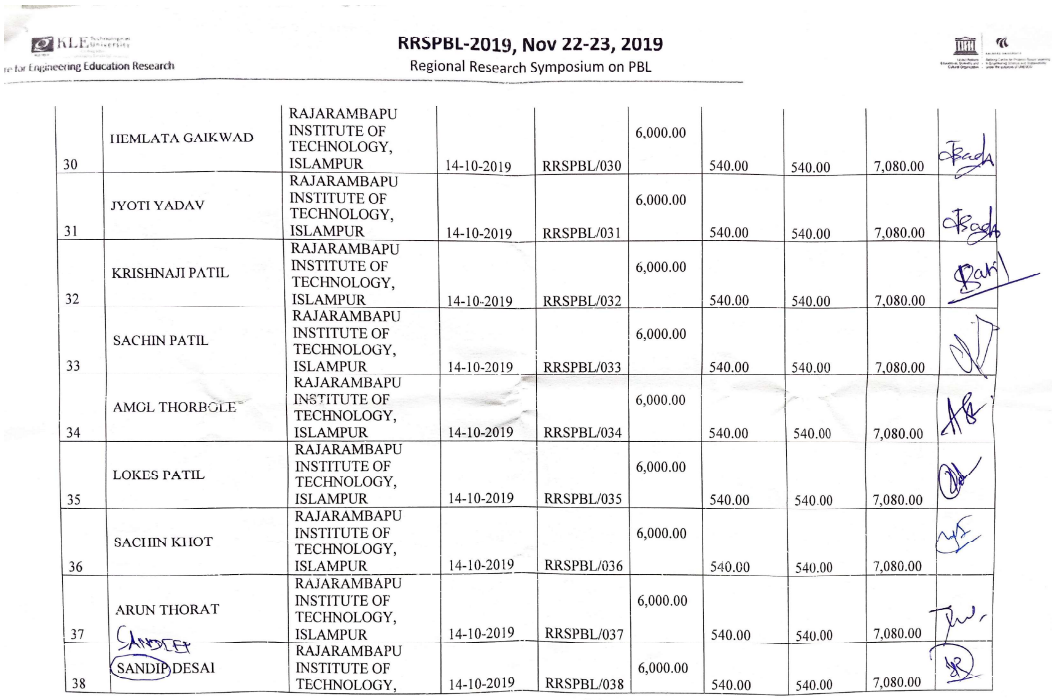

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30	HEMLATA GAIKWAD	RAJARAMBAPU INSTITUTE OF TECHNOLOGY, ISLAMPUR	14-10-2019	RRSPBL/030	6,000.00	540.00	540.00	7,080.00	
31	JYOTI YADAV	RAJARAMBAPU INSTITUTE OF TECHNOLOGY, ISLAMPUR	14-10-2019	RRSPBL/031	6,000.00	540.00	540.00	7,080.00	
32	KRISHNAJI PATIL	RAJARAMBAPU INSTITUTE OF TECHNOLOGY, ISLAMPUR	14-10-2019	RRSPBL/032	6,000.00	540.00	540.00	7,080.00	
33	SACHIN PATIL	RAJARAMBAPU INSTITUTE OF TECHNOLOGY, ISLAMPUR	14-10-2019	RRSPBL/033	6,000.00	540.00	540.00	7,080.00	
34	AMOL THORBOLE	RAJARAMBAPU INSTITUTE OF TECHNOLOGY, ISLAMPUR	14-10-2019	RRSPBL/034	6,000.00	540.00	540.00	7,080.00	
35	LOKES PATIL	RAJARAMBAPU INSTITUTE OF TECHNOLOGY, ISLAMPUR	14-10-2019	RRSPBL/035	6,000.00	540.00	540.00	7,080.00	
36	SACHIN KHOT	RAJARAMBAPU INSTITUTE OF TECHNOLOGY, ISLAMPUR	14-10-2019	RRSPBL/036	6,000.00	540.00	540.00	7,080.00	
37	ARUN THORAT	RAJARAMBAPU INSTITUTE OF TECHNOLOGY, ISLAMPUR	14-10-2019	RRSPBL/037	6,000.00	540.00	540.00	7,080.00	
38	SANDIP DESAI	RAJARAMBAPU INSTITUTE OF TECHNOLOGY,	14-10-2019	RRSPBL/038	6,000.00	540.00	540.00	7,080.00	

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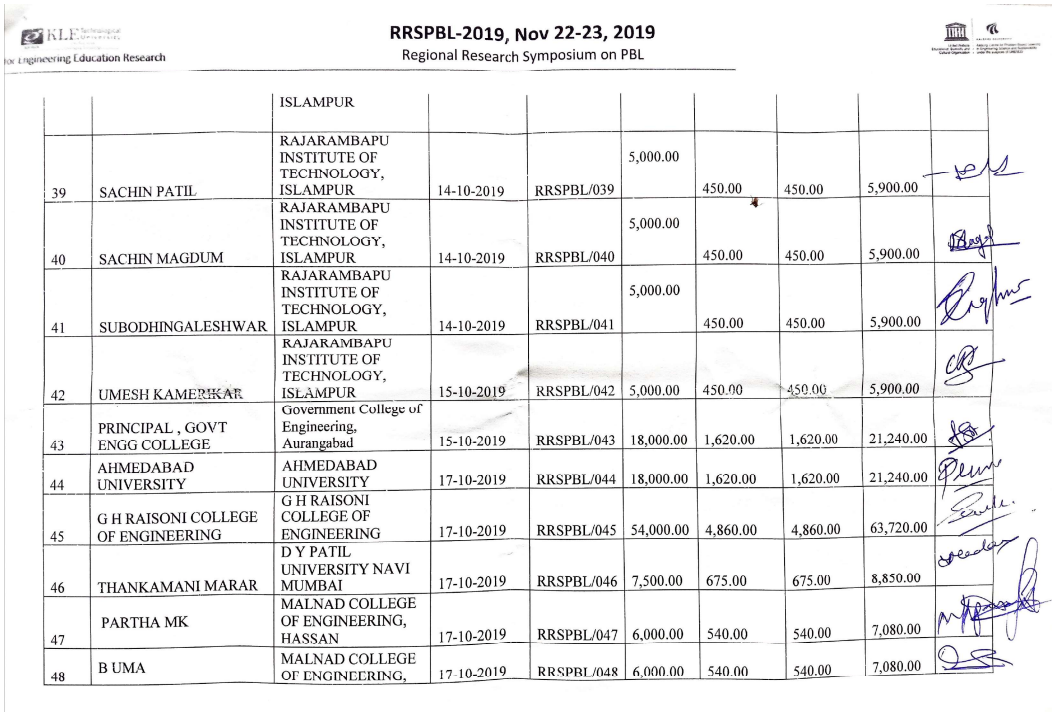

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		ISLAMPUR							
39	SACHIN PATIL	RAJARAMBAPU INSTITUTE OF TECHNOLOGY, ISLAMPUR	14-10-2019	RRSPBL/039	5,000.00	450.00	450.00	5,900.00	
40	SACHIN MAGDUM	RAJARAMBAPU INSTITUTE OF TECHNOLOGY, ISLAMPUR	14-10-2019	RRSPBL/040	5,000.00	450.00	450.00	5,900.00	
41	SUBODHINGALESHWAR	RAJARAMBAPU INSTITUTE OF TECHNOLOGY, ISLAMPUR	14-10-2019	RRSPBL/041	5,000.00	450.00	450.00	5,900.00	
42	UMESH KAMERIKAR	RAJARAMBAPU INSTITUTE OF TECHNOLOGY, ISLAMPUR	15-10-2019	RRSPBL/042	5,000.00	450.00	450.00	5,900.00	
43	PRINCIPAL , GOVT ENGG COLLEGE	Government College of Engineering, Aurangabad	15-10-2019	RRSPBL/043	18,000.00	1,620.00	1,620.00	21,240.00	
44	AHMEDABAD UNIVERSITY	AHMEDABAD UNIVERSITY	17-10-2019	RRSPBL/044	18,000.00	1,620.00	1,620.00	21,240.00	
45	G H RAISONI COLLEGE OF ENGINEERING	G H RAISONI COLLEGE OF ENGINEERING	17-10-2019	RRSPBL/045	54,000.00	4,860.00	4,860.00	63,720.00	
46	THANKAMANI MARAR	D Y PATIL UNIVERSITY NAVI MUMBAI	17-10-2019	RRSPBL/046	7,500.00	675.00	675.00	8,850.00	
47	PARTHA MK	MALNAD COLLEGE OF ENGINEERING, HASSAN	17-10-2019	RRSPBL/047	6,000.00	540.00	540.00	7,080.00	
48	B UMA	MALNAD COLLEGE OF ENGINEERING,	17-10-2019	RRSPBL/048	6,000.00	540.00	540.00	7,080.00	

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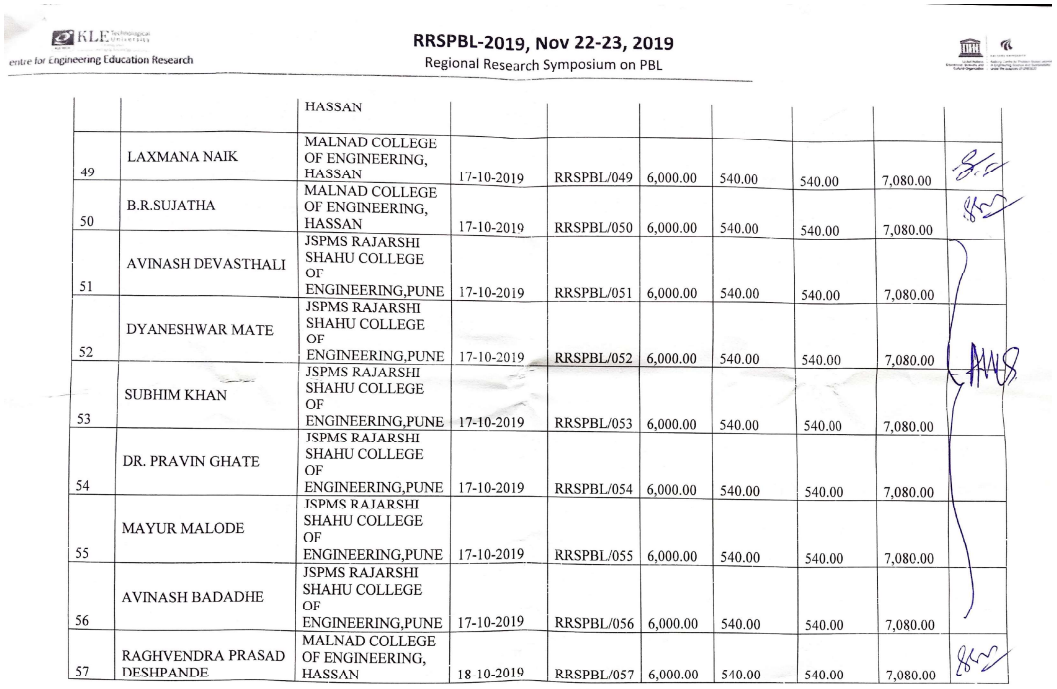

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		HASSAN							
49	LAXMANA NAIK	MALNAD COLLEGE OF ENGINEERING, HASSAN	17-10-2019	RRSPBL/049	6,000.00	540.00	540.00	7,080.00	
50	B.R.SUJATHA	MALNAD COLLEGE OF ENGINEERING, HASSAN	17-10-2019	RRSPBL/050	6,000.00	540.00	540.00	7,080.00	
51	AVINASH DEVASTHALI	JSPMS RAJARSHI SHAHU COLLEGE OF ENGINEERING,PUNE	17-10-2019	RRSPBL/051	6,000.00	540.00	540.00	7,080.00	
52	DYANESHWAR MATE	JSPMS RAJARSHI SHAHU COLLEGE OF ENGINEERING,PUNE	17-10-2019	RRSPBL/052	6,000.00	540.00	540.00	7,080.00	
53	SUBHIM KHAN	JSPMS RAJARSHI SHAHU COLLEGE OF ENGINEERING,PUNE	17-10-2019	RRSPBL/053	6,000.00	540.00	540.00	7,080.00	
54	DR. PRAVIN GHATE	JSPMS RAJARSHI SHAHU COLLEGE OF ENGINEERING,PUNE	17-10-2019	RRSPBL/054	6,000.00	540.00	540.00	7,080.00	
55	MAYUR MALODE	JSPMS RAJARSHI SHAHU COLLEGE OF ENGINEERING,PUNE	17-10-2019	RRSPBL/055	6,000.00	540.00	540.00	7,080.00	
56	AVINASH BADADHE	JSPMS RAJARSHI SHAHU COLLEGE OF ENGINEERING,PUNE	17-10-2019	RRSPBL/056	6,000.00	540.00	540.00	7,080.00	
57	RAGHVENDRA PRASAD DESHPANDE	MALNAD COLLEGE OF ENGINEERING, HASSAN	18-10-2019	RRSPBL/057	6,000.00	540.00	540.00	7,080.00	

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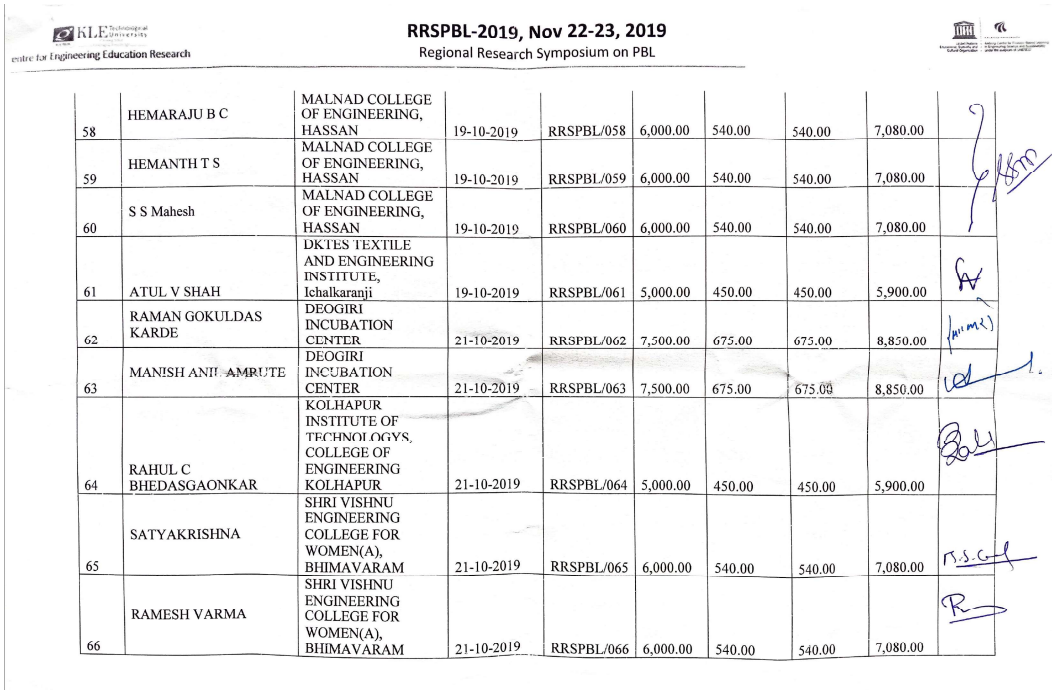

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58	HEMARAJU B C	MALNAD COLLEGE OF ENGINEERING, HASSAN	19-10-2019	RRSPBL/058	6,000.00	540.00	540.00	7,080.00	
59	HEMANTH T S	MALNAD COLLEGE OF ENGINEERING, HASSAN	19-10-2019	RRSPBL/059	6,000.00	540.00	540.00	7,080.00	
60	S S Mahesh	MALNAD COLLEGE OF ENGINEERING, HASSAN	19-10-2019	RRSPBL/060	6,000.00	540.00	540.00	7,080.00	
61	ATUL V SHAH	DKTES TEXTILE AND ENGINEERING INSTITUTE, Ichalkaranji	19-10-2019	RRSPBL/061	5,000.00	450.00	450.00	5,900.00	
62	RAMAN GOKULDAS KARDE	DEOGIRI INCUBATION CENTER	21-10-2019	RRSPBL/062	7,500.00	675.00	675.00	8,850.00	
63	MANISH ANIL AMRUTE	DEOGIRI INCUBATION CENTER	21-10-2019	RRSPBL/063	7,500.00	675.00	675.00	8,850.00	
64	RAHUL C BHEDASGAONKAR	KOLHAPUR INSTITUTE OF TECHNOLOGYS, COLLEGE OF ENGINEERING KOLHAPUR	21-10-2019	RRSPBL/064	5,000.00	450.00	450.00	5,900.00	
65	SATYAKRISHNA	SHRI VISHNU ENGINEERING COLLEGE FOR WOMEN(A), BHIMAVARAM	21-10-2019	RRSPBL/065	6,000.00	540.00	540.00	7,080.00	
66	RAMESH VARMA	SHRI VISHNU ENGINEERING COLLEGE FOR WOMEN(A), BHIMAVARAM	21-10-2019	RRSPBL/066	6,000.00	540.00	540.00	7,080.00	

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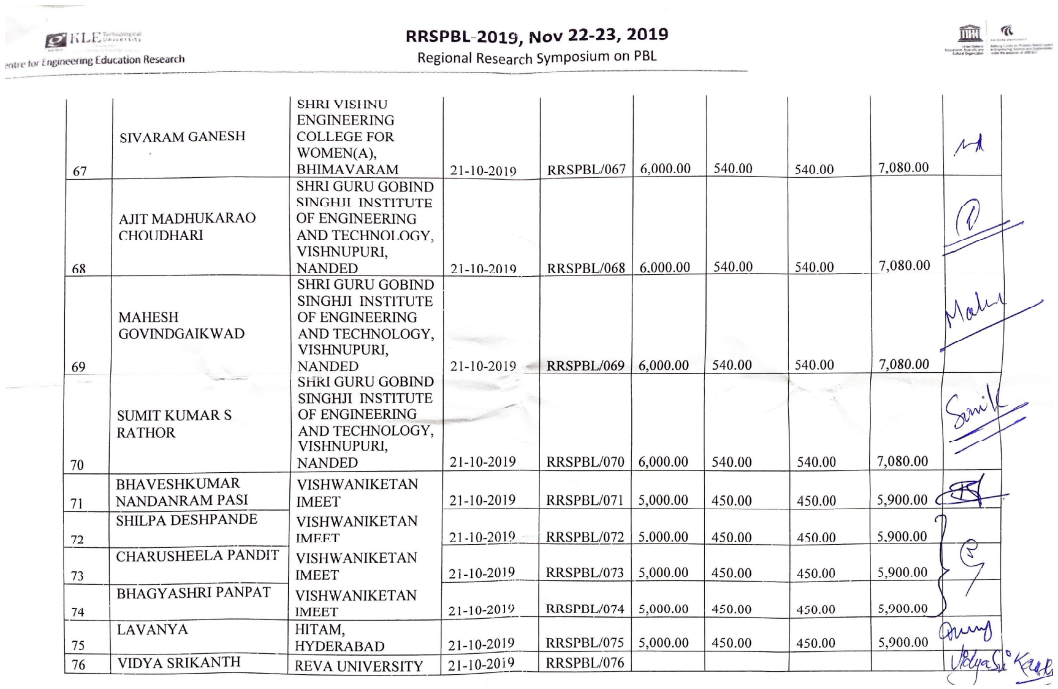

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67	SIVARAM GANESH	SHRI VISHNU ENGINEERING COLLEGE FOR WOMEN(A), BHIMAVARAM	21-10-2019	RRSPBL/067	6,000.00	540.00	540.00	7,080.00	
68	AJIT MADHUKARAO CHOUDHARI	SHRI GURU GOBIND SINGHJI INSTITUTE OF ENGINEERING AND TECHNOLOGY, VISHNUPURI, NANDED	21-10-2019	RRSPBL/068	6,000.00	540.00	540.00	7,080.00	
69	MAHESH GOVINDGAIKWAD	SHRI GURU GOBIND SINGHJI INSTITUTE OF ENGINEERING AND TECHNOLOGY, VISHNUPURI, NANDED	21-10-2019	RRSPBL/069	6,000.00	540.00	540.00	7,080.00	
70	SUMIT KUMAR S RATHOR	SHRI GURU GOBIND SINGHJI INSTITUTE OF ENGINEERING AND TECHNOLOGY, VISHNUPURI, NANDED	21-10-2019	RRSPBL/070	6,000.00	540.00	540.00	7,080.00	
71	BHAVESHKUMAR NANDANRAM PASI	VISHWANIKETAN IMEET	21-10-2019	RRSPBL/071	5,000.00	450.00	450.00	5,900.00	
72	SHILPA DESHPANDE	VISHWANIKETAN IMEET	21-10-2019	RRSPBL/072	5,000.00	450.00	450.00	5,900.00	
73	CHARUSHEELA PANDIT	VISHWANIKETAN IMEET	21-10-2019	RRSPBL/073	5,000.00	450.00	450.00	5,900.00	
74	BHAGYASHRI PANPAT	VISHWANIKETAN IMEET	21-10-2019	RRSPBL/074	5,000.00	450.00	450.00	5,900.00	
75	LAVANYA	HITAM, HYDERABAD	21-10-2019	RRSPBL/075	5,000.00	450.00	450.00	5,900.00	
76	VIDYA SRIKANTH	REVA UNIVERSITY	21-10-2019	RRSPBL/076					

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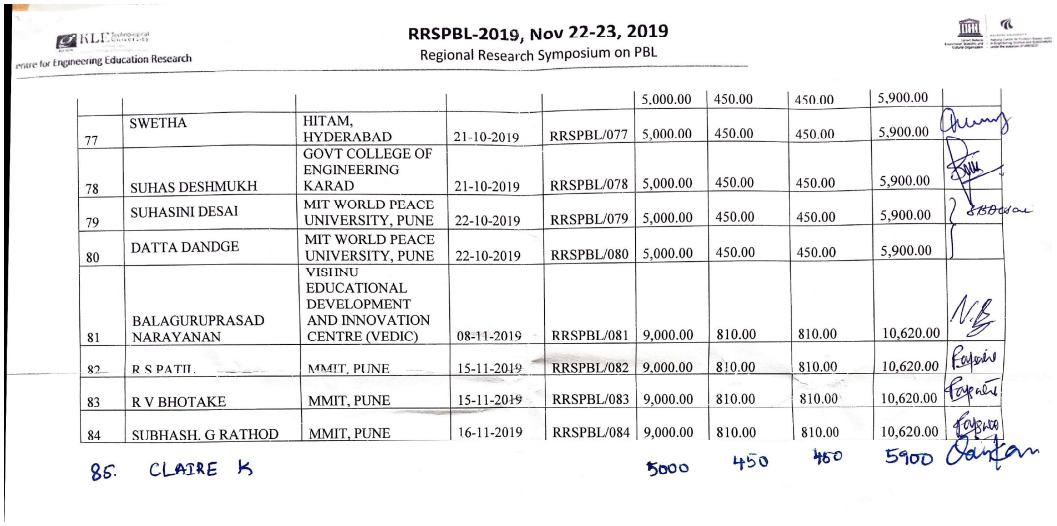

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					5,000.00	450.00	450.00	5,900.00	
77	SWETHA	HITAM, HYDERABAD	21-10-2019	RRSPBL/077	5,000.00	450.00	450.00	5,900.00	
78	SUHAS DESHMUKH	GOVT COLLEGE OF ENGINEERING KARAD	21-10-2019	RRSPBL/078	5,000.00	450.00	450.00	5,900.00	
79	SUHASINI DESAI	MIT WORLD PEACE UNIVERSITY, PUNE	22-10-2019	RRSPBL/079	5,000.00	450.00	450.00	5,900.00	
80	DATTA DANDGE	MIT WORLD PEACE UNIVERSITY, PUNE	22-10-2019	RRSPBL/080	5,000.00	450.00	450.00	5,900.00	
81	BALAGURUPRASAD NARAYANAN	VISHNU EDUCATIONAL DEVELOPMENT AND INNOVATION CENTRE (VEDIC)	08-11-2019	RRSPBL/081	9,000.00	810.00	810.00	10,620.00	
82	R S PATIL	MMIT, PUNE	15-11-2019	RRSPBL/082	9,000.00	810.00	810.00	10,620.00	
83	R V BHOTAKE	MMIT, PUNE	15-11-2019	RRSPBL/083	9,000.00	810.00	810.00	10,620.00	
84	SUBHASH. G RATHOD	MMIT, PUNE	16-11-2019	RRSPBL/084	9,000.00	810.00	810.00	10,620.00	
86.	CLAIRE K				5000	450	450	5900	

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			Pawan Kumar Fakatkar Mathworks and **Sanjeev Kavale** KLE TEchnological Univiersity
Date : 23/11/2019 Time 10.30am to 1.30pm			
7	W07: How can Digital Tools Support PBL?	CSC308 – Clite Building 2nd Floor	**Dr. Jens Myrup Pedersen** Associate Professor, Aalborg University, Denmark
8	W08: Student Reflections and Process Analysis	CSC301 Clite Building 2nd Floor	**Mr. Henrik W. Routhe** Institute for planning, Aalborg University, Denmark
9	W09: System Thinking: A Computational Approach using PBL	Lab 3 –Clite Building 1st Floor	**Pawan Kumar Fakatkar** Mathworks and **Sanjeev Kavale** KLE TEchnological Univiersity
10	W10: Algorithm Development and System Modeling: A PBL Approach	Microsoft lab Clite Building 1st Floor	**Naini Dawar** Education Technical Evangelist, MathWorks India Pvt. Ltd.

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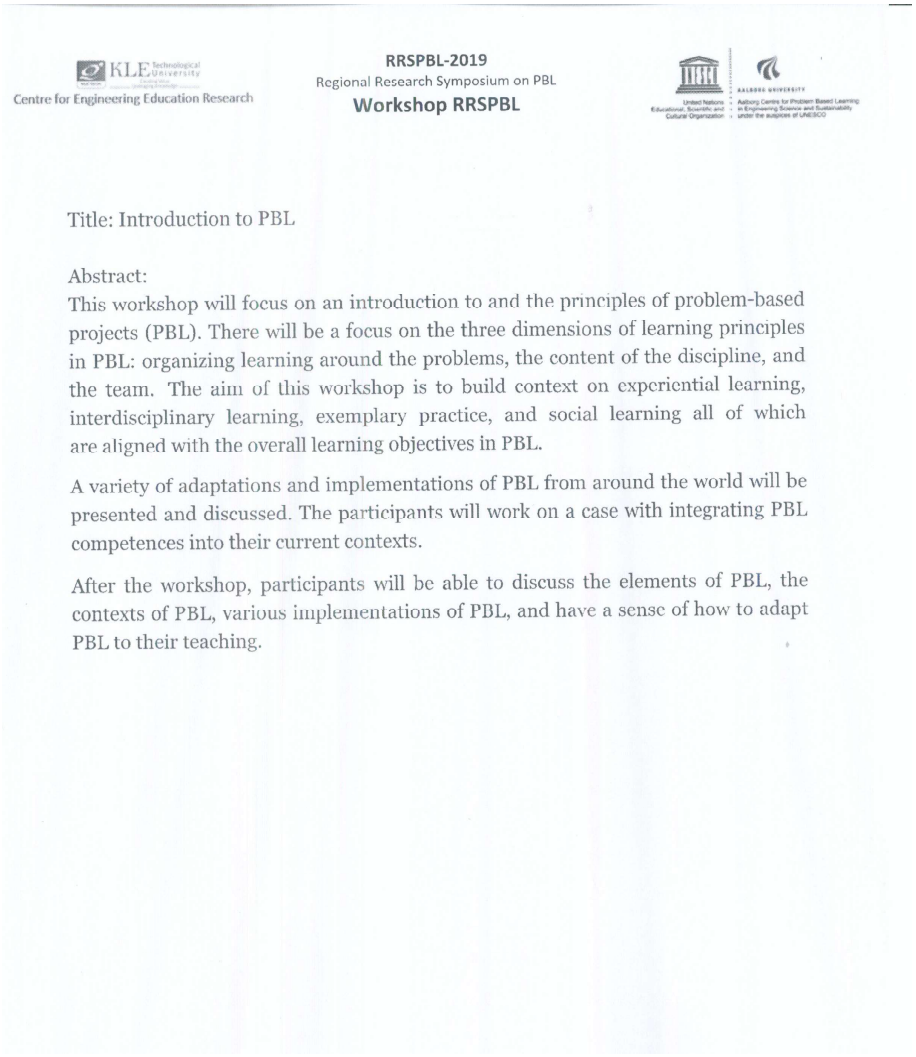

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Aalborg Centre for Problem Based Learning in Engineering Science and Sustainability under the auspices of UNESCO

Title: Introduction to PBL

Abstract:
This workshop will focus on an introduction to and the principles of problem-based projects (PBL). There will be a focus on the three dimensions of learning principles in PBL: organizing learning around the problems, the content of the discipline, and the team. The aim of this workshop is to build context on experiential learning, interdisciplinary learning, exemplary practice, and social learning all of which are aligned with the overall learning objectives in PBL.

A variety of adaptations and implementations of PBL from around the world will be presented and discussed. The participants will work on a case with integrating PBL competences into their current contexts.

After the workshop, participants will be able to discuss the elements of PBL, the contexts of PBL, various implementations of PBL, and have a sense of how to adapt PBL to their teaching.

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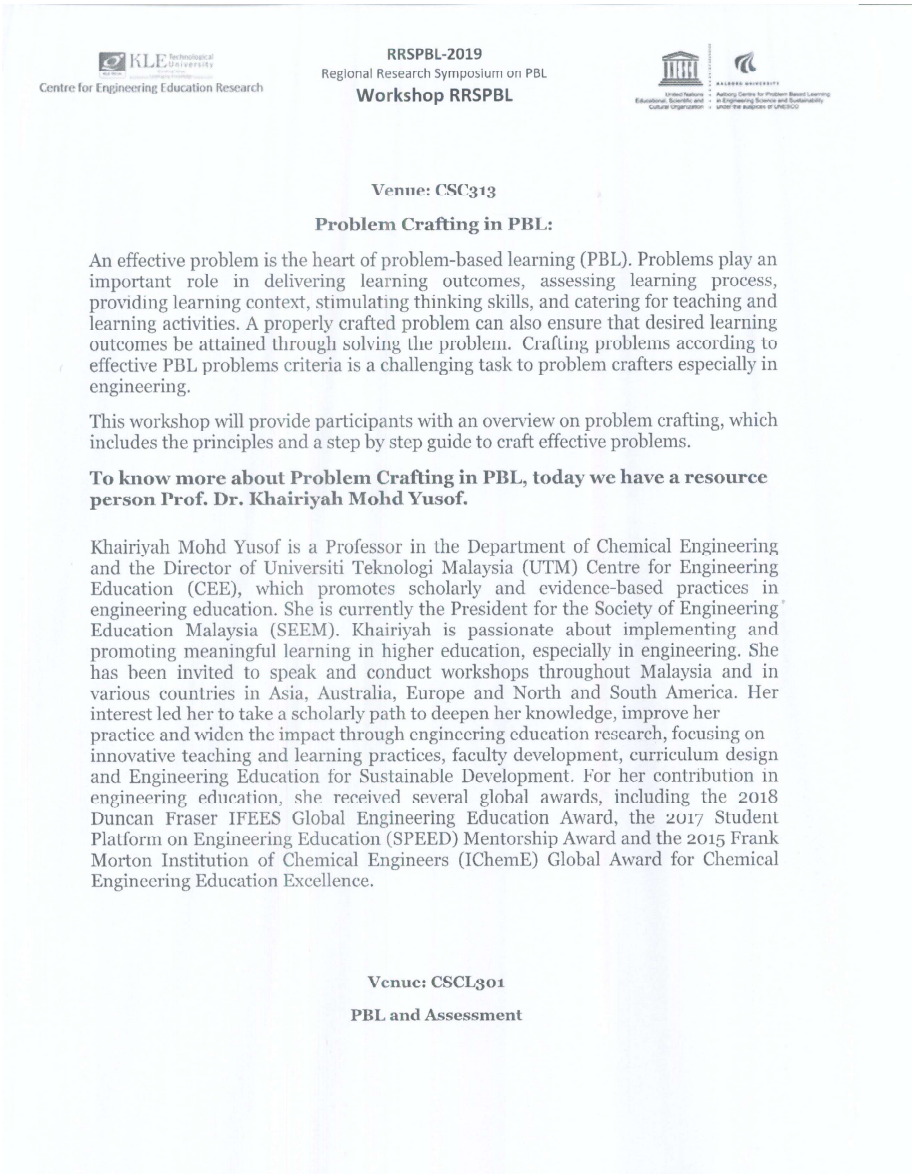

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Venue: CSC313

Problem Crafting in PBL:

An effective problem is the heart of problem-based learning (PBL). Problems play an important role in delivering learning outcomes, assessing learning process, providing learning context, stimulating thinking skills, and catering for teaching and learning activities. A properly crafted problem can also ensure that desired learning outcomes be attained through solving the problem. Crafting problems according to effective PBL problems criteria is a challenging task to problem crafters especially in engineering.

This workshop will provide participants with an overview on problem crafting, which includes the principles and a step by step guide to craft effective problems.

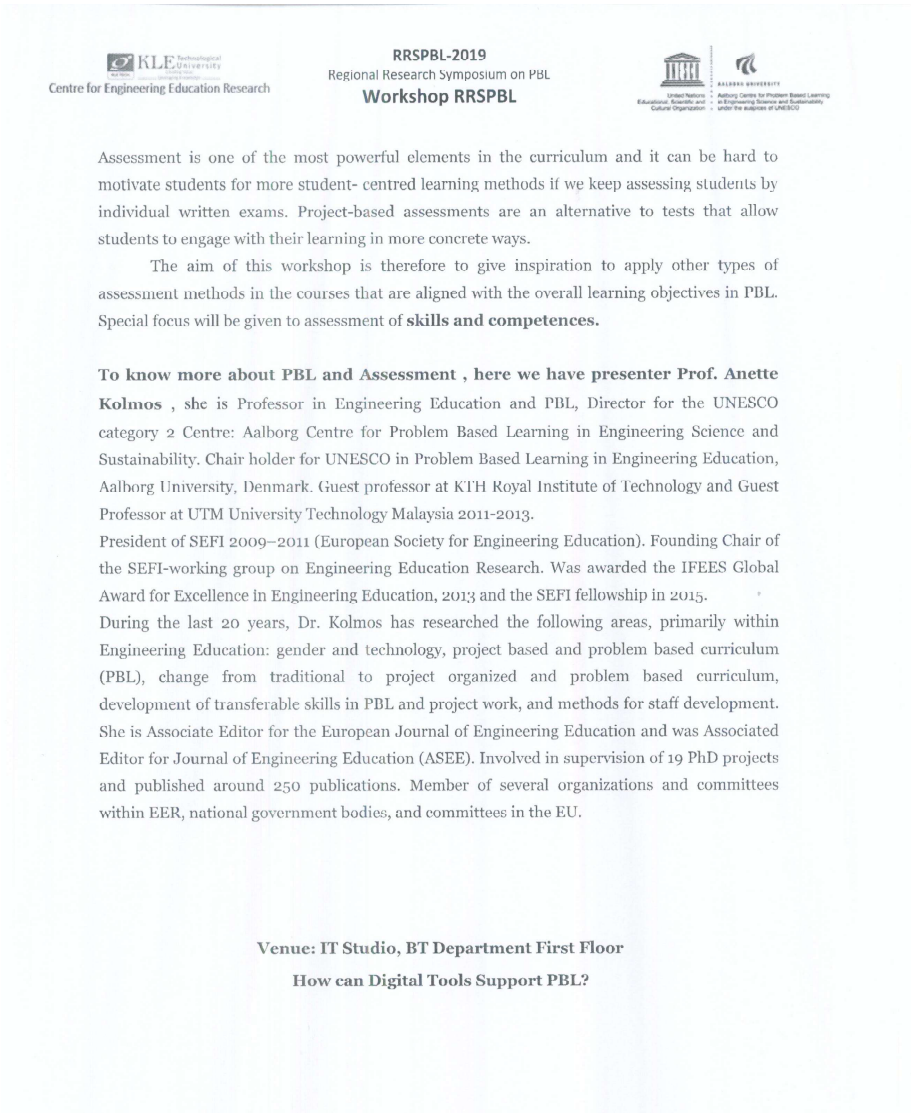
To know more about Problem Crafting in PBL, today we have a resource person Prof. Dr. Khairiyah Mohd Yusof.

Khairiyah Mohd Yusof is a Professor in the Department of Chemical Engineering and the Director of Universiti Teknologi Malaysia (UTM) Centre for Engineering Education (CEE), which promotes scholarly and evidence-based practices in engineering education. She is currently the President for the Society of Engineering Education Malaysia (SEEM). Khairiyah is passionate about implementing and promoting meaningful learning in higher education, especially in engineering. She has been invited to speak and conduct workshops throughout Malaysia and in various countries in Asia, Australia, Europe and North and South America. Her interest led her to take a scholarly path to deepen her knowledge, improve her practice and widen the impact through engineering education research, focusing on innovative teaching and learning practices, faculty development, curriculum design and Engineering Education for Sustainable Development. For her contribution in engineering education, she received several global awards, including the 2018 Duncan Fraser IFEES Global Engineering Education Award, the 2017 Student Platform on Engineering Education (SPEED) Mentorship Award and the 2015 Frank Morton Institution of Chemical Engineers (IChemE) Global Award for Chemical Engineering Education Excellence.

Venue: CSCL301

PBL and Assessment

61.Regional Research Symposium on PBL



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Assessment is one of the most powerful elements in the curriculum and it can be hard to motivate students for more student- centred learning methods if we keep assessing students by individual written exams. Project-based assessments are an alternative to tests that allow students to engage with their learning in more concrete ways.

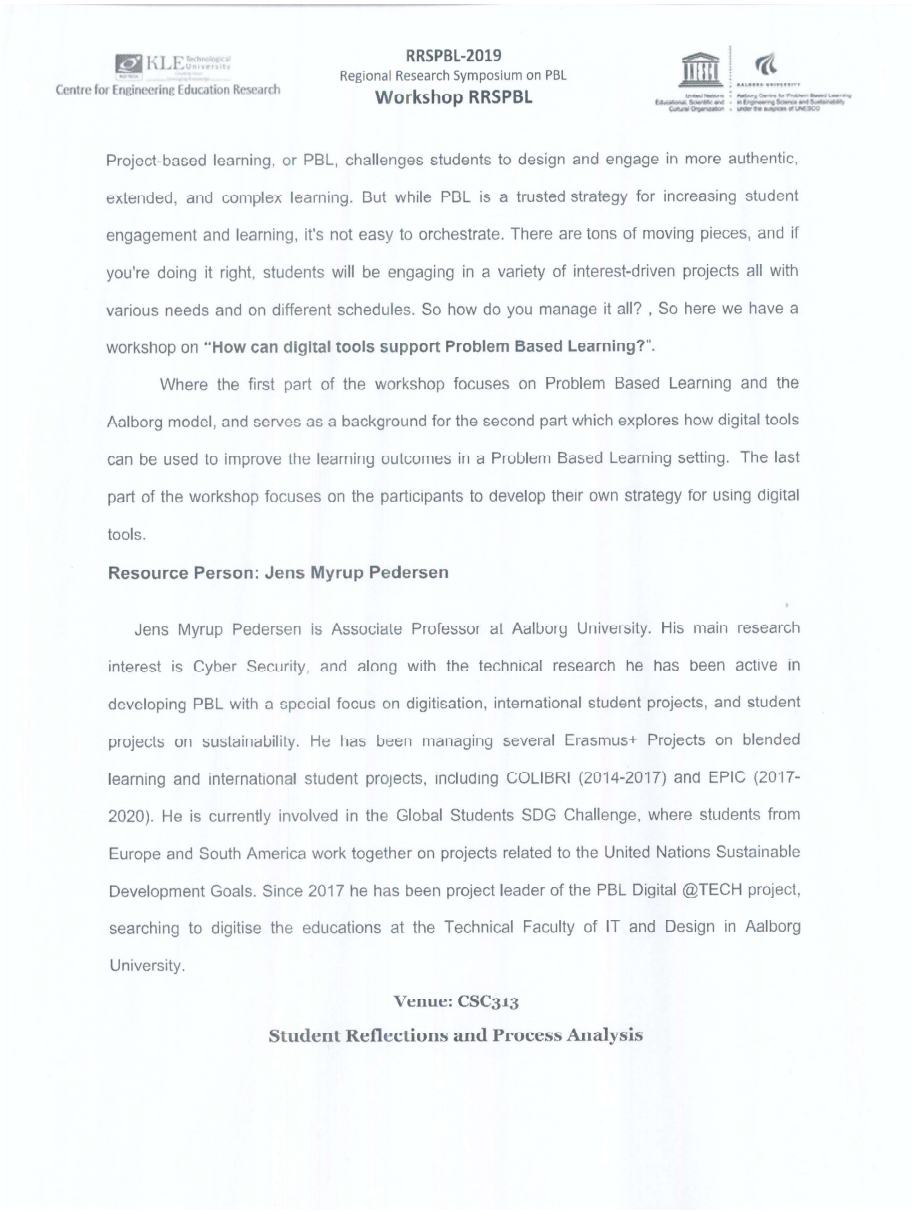
The aim of this workshop is therefore to give inspiration to apply other types of assessment methods in the courses that are aligned with the overall learning objectives in PBL. Special focus will be given to assessment of **skills and competences.**

To know more about PBL and Assessment , here we have presenter Prof. Anette Kolmos , she is Professor in Engineering Education and PBL, Director for the UNESCO category 2 Centre: Aalborg Centre for Problem Based Learning in Engineering Science and Sustainability. Chair holder for UNESCO in Problem Based Learning in Engineering Education, Aalborg University, Denmark. Guest professor at KTH Royal Institute of Technology and Guest Professor at UTM University Technology Malaysia 2011-2013.
President of SEFI 2009–2011 (European Society for Engineering Education). Founding Chair of the SEFI-working group on Engineering Education Research. Was awarded the IFEES Global Award for Excellence in Engineering Education, 2013 and the SEFI fellowship in 2015.
During the last 20 years, Dr. Kolmos has researched the following areas, primarily within Engineering Education: gender and technology, project based and problem based curriculum (PBL), change from traditional to project organized and problem based curriculum, development of transferable skills in PBL and project work, and methods for staff development. She is Associate Editor for the European Journal of Engineering Education and was Associated Editor for Journal of Engineering Education (ASEE). Involved in supervision of 19 PhD projects and published around 250 publications. Member of several organizations and committees within EER, national government bodies, and committees in the EU.

Venue: IT Studio, BT Department First Floor

How can Digital Tools Support PBL?

61.Regional Research Symposium on PBL



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Project-based learning, or PBL, challenges students to design and engage in more authentic, extended, and complex learning. But while PBL is a trusted strategy for increasing student engagement and learning, it's not easy to orchestrate. There are tons of moving pieces, and if you're doing it right, students will be engaging in a variety of interest-driven projects all with various needs and on different schedules. So how do you manage it all? , So here we have a workshop on **"How can digital tools support Problem Based Learning?"**.

Where the first part of the workshop focuses on Problem Based Learning and the Aalborg model, and serves as a background for the second part which explores how digital tools can be used to improve the learning outcomes in a Problem Based Learning setting. The last part of the workshop focuses on the participants to develop their own strategy for using digital tools.

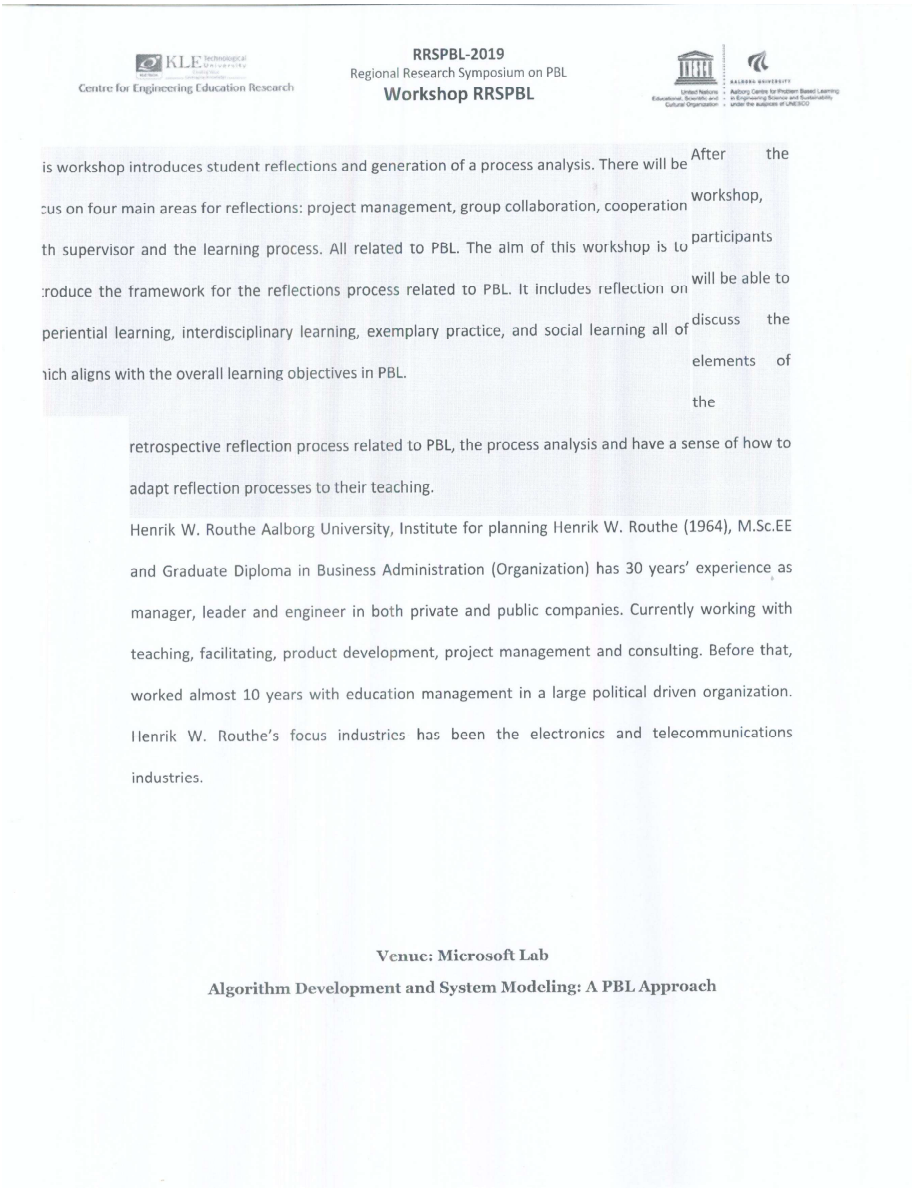
Resource Person: Jens Myrup Pedersen

Jens Myrup Pedersen is Associate Professor at Aalborg University. His main research interest is Cyber Security, and along with the technical research he has been active in developing PBL with a special focus on digitisation, international student projects, and student projects on sustainability. He has been managing several Erasmus+ Projects on blended learning and international student projects, including COLIBRI (2014-2017) and EPIC (2017-2020). He is currently involved in the Global Students SDG Challenge, where students from Europe and South America work together on projects related to the United Nations Sustainable Development Goals. Since 2017 he has been project leader of the PBL Digital @TECH project, searching to digitise the educations at the Technical Faculty of IT and Design in Aalborg University.

Venue: CSC313

Student Reflections and Process Analysis

61.Regional Research Symposium on PBL



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is workshop introduces student reflections and generation of a process analysis. There will be cus on four main areas for reflections: project management, group collaboration, cooperation th supervisor and the learning process. All related to PBL. The aim of this workshop is to roduce the framework for the reflections process related to PBL. It includes reflection on periential learning, interdisciplinary learning, exemplary practice, and social learning all of hich aligns with the overall learning objectives in PBL.

After the workshop, participants will be able to discuss the elements of the retrospective reflection process related to PBL, the process analysis and have a sense of how to adapt reflection processes to their teaching.

Henrik W. Routhe Aalborg University, Institute for planning Henrik W. Routhe (1964), M.Sc.EE and Graduate Diploma in Business Administration (Organization) has 30 years' experience as manager, leader and engineer in both private and public companies. Currently working with teaching, facilitating, product development, project management and consulting. Before that, worked almost 10 years with education management in a large political driven organization. Henrik W. Routhe's focus industries has been the electronics and telecommunications industries.

Venue: Microsoft Lab

Algorithm Development and System Modeling: A PBL Approach

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PBL is a comprehensive teaching and learning approach that engages students in the investigation of authentic engineering problems. A problem may be solved at different levels of abstraction and using different implementation strategies. Hence System Modeling and Simulation becomes a crucial component to understand the development of algorithm for the real-world systems and processes. It brings about the logical thinking competencies when solving mathematical, scientific and engineering problems.

So, here we have Naini Dawar Education Technical Evangelist, MathWorks India Pvt. Ltd. Naini Dawar is an Educational Technical Evangelist at MathWorks India. She works with universities and educational institutes on adoption of MATLAB and Simulink in research and curriculum. She has over 3 years of experience of working with academics as an Assistant Lecturer and over 3 years in Industry. Prior to joining MathWorks, Naini has worked as a Senior Engineer in R&D in an Automotive Company, where she has worked on Model-Based Designing and auto code generation and integration using MATLAB and Simulink. Naini holds a bachelor's degree in Electronics and Communication from Kurukshetra University, Kurukshetra and a Master's degree in Electronics and Communication from Chitkara University, Punjab.

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Attendance Sheet

Title of the Workshop: Introduction to PDL **Venue: CSL302**

Date: 21/11/2019 **Time: 10.30am to 1.30 pm**

Sl.No	Name	College Name	Registration ID	E-mail ID	Mobile Number	Signature
1	Mvv Rama Rao	Shri Vishnu Engineering College for Women	2019194	ramarao.cse@svecw.edu.in	9963783793	
2	Ramesh Varma	Shri Vishnu Engineering College for Women	2019193	varmaramesh422@svecw.edu.in	9963630435	
3	Vijay V S	St Joseph Engineering College	2019097	vijayv@sjec.ac.in	09480200266	
4	Ms Shama R N	St Joseph engineering college	191021	shamabn@sjec.ac.in	9844327270	
5	Bhaveshkumar Nandanram Pasi	Vishwaniketan's iMEET	2019203	bnpasi@vishwaniketan.edu.in	8976344067	
6	Dr. Sanjay Kotabagi	KLE Tech University, Hubli	2019228	sanjay_kotabagi@kletech.ac.in	9448564580	
7	Mallikarjun G Hudedmni	KLE Institute of Technology, Hubballi	2019057	mallikarjunh@yahoo.com	9945895202	
8	Khalida Muntasher	KLE Tech University, Hubli	2019210	khalida@kletech.ac.in	8073334562	
9	Prakash Hegade	KLE Tech University, Hubli	2019215	prakash.hegade@kletech.ac.in	9964437282	
10	Mouna M Naravani	KLE Tech University, Hubli	2019228	mouna.naravani@kletech.ac.in	9886962935	
11	Jayashree Mallidu	KLE Tech University, Hubli	2019225	jayashree.mallidu@kletech.ac.in	9740027601	
12	Satish Chikkamath	KLE Tech University, Hubli	2019224	chikkamath@kletech.ac.in	9620194478	
13	Sanjay Eligar	KLE Tech University, Hubli	2019221	eligar@kletech.ac.in	9008999091	
14	Sharanappa Achappa	KLE Tech University, Hubli	2019206	sharanappaa@kletech.ac.in	7411788464	
15	Jyoti Bali	KLE Tech University, Hubli	2019201	jyoti_bali@kletech.ac.in	09900142468	
16	Vinayak N Kulkarni	KLE Tech University, Hubli	2019233	vinayak_kulkarni@kletech.ac.in	9739146050	

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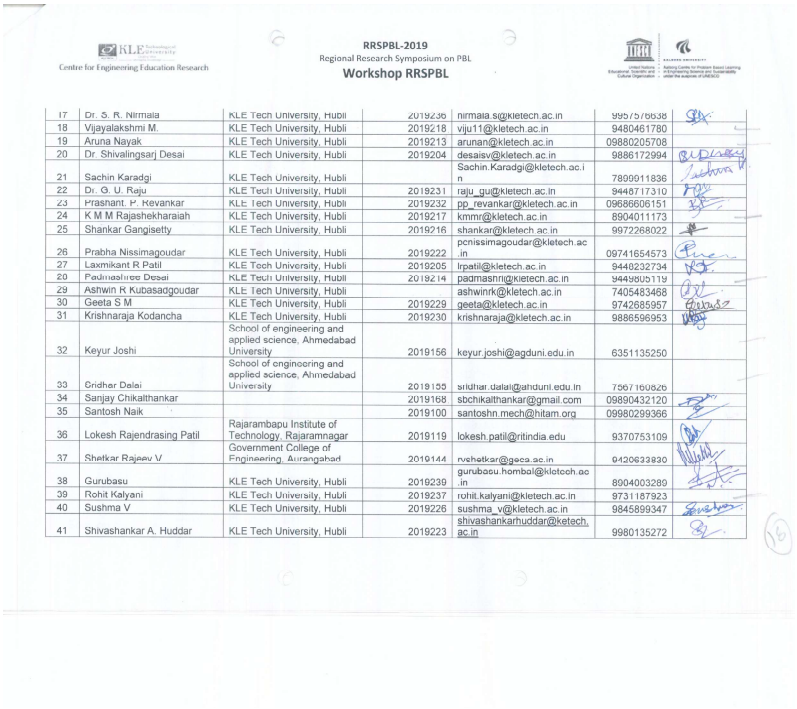

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17	Dr. S. R. Nirmala	KLE Tech University, Hubli	2019236	nirmala.s@kletech.ac.in	99575/8538	
18	Vijayalakshmi M.	KLE Tech University, Hubli	2019218	viju11@kletech.ac.in	9480461780	
19	Aruna Nayak	KLE Tech University, Hubli	2019213	arunan@kletech.ac.in	09880205708	
20	Dr. Shivalingsarj Desai	KLE Tech University, Hubli	2019204	desaisv@kletech.ac.in	9886172994	
21	Sachin Karadgi	KLE Tech University, Hubli		Sachin.Karadgi@kletech.ac.in	7899011836	
22	Dr. G. U. Raju	KLE Tech University, Hubli	2019231	raju_gu@kletech.ac.in	9448717310	
23	Prashant. P. Revankar	KLE Tech University, Hubli	2019232	pp_revankar@kletech.ac.in	09686606151	
24	K M M Rajashekharaiah	KLE Tech University, Hubli	2019217	kmmr@kletech.ac.in	8904011173	
25	Shankar Gangisetty	KLE Tech University, Hubli	2019216	shankar@kletech.ac.in	9972268022	
26	Prabha Nissimagoudar	KLE Tech University, Hubli	2019222	pcnissimagoudar@kletech.ac.in	09741654573	
27	Laxmikant R Patil	KLE Tech University, Hubli	2019205	lrpatil@kletech.ac.in	9440232734	
28	Padmashree Desai	KLE Tech University, Hubli	2019214	padmasnri@kletech.ac.in	9448905119	
29	Ashwin K Kubasadgoudar	KLE Tech University, Hubli		ashwinrk@kletech.ac.in	7405483468	
30	Geeta S M	KLE Tech University, Hubli	2019229	geeta@kletech.ac.in	9742685957	
31	Krishnaraja Kodancha	KLE Tech University, Hubli	2019230	krishnaraja@kletech.ac.in	9886596953	
32	Keyur Joshi	School of engineering and applied science, Ahmedabad University	2019156	keyur.joshi@agduni.edu.in	6351135250	
33	Gridhar Dalai	School of engineering and applied science, Ahmedabad University	2019155	sridhar.dalai@ahduni.edu.in	7567160826	
34	Sanjay Chikalthankar		2019168	sbchikalthankar@gmail.com	09890432120	
35	Santosh Naik		2019100	santoshn.mech@hitam.org	09980299366	
36	Lokesh Rajendrasing Patil	Rajarambapu Institute of Technology, Rajaramnagar	2019119	lokesh.patil@ritindia.edu	9370753109	
37	Shetkar Rajeev V	Government College of Engineering, Aurangabad	2019144	rvshetkar@geca.ac.in	9420633930	
38	Gurubasu	KLE Tech University, Hubli	2019239	gurubasu.hombal@kletech.ac.in	8904003289	
39	Rohit Kalyani	KLE Tech University, Hubli	2019237	rohit.kalyani@kletech.ac.in	9731187923	
40	Sushma V	KLE Tech University, Hubli	2019226	sushma_v@kletech.ac.in	9845899347	
41	Shivashankar A. Huddar	KLE Tech University, Hubli	2019223	shivashankarhuddar@ketech.ac.in	9980135272	

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43	Vishwanath P. Baligar	KLE Tech University, Hubli	2019238	vpbaligar@kletech.ac.in	9731841969	
44	Ashwini G K	KLE Tech University, Hubli	2019208	ashwini_gk@kletech.ac.in	7899853600	
45	Dr. Suneeta V. Budihal	KLE Tech University, Hubli	2019219	suneeta_vb@kletech.ac.in	9448821704	
46	Ujwala Patil	KLE Tech University, Hubli	2019220	ujwalapatil@kletech.ac.in	8971193624	
47	Supriya Kulkarni	Government College of Engineering		to.supriya@gmail.com	9822591274	
48	Balaguruprasad Narayanan	Sri Vishnu Educational Society	2019200	balaguruprasad.n@srivishnu.edu.in	9840722760	
49	M K Partha	Malnad college of engineering	2019173	mkpartha@rediffmail.com		
50	Rajat S Patil	MMIT, Lohgaon.	191043	rajat.patil@mmit.edu.in	8888826874	
51	Dr R V Bhortake	Marathwada Mitramandal's Institute of Technology, Lohgaon, Pune, Maharashtra 411047	2019202	principal@mmit.edu.in	9.19049E+11	
52	Subhash Gulabrao Rathod	MARATHWADA MITRAMANDAL'S INSTITUTE OF TECHNOLOGY(MMIT), PUNE	191043	subhash.rathod@mmit.edu.in	9763705600	
53	Sachin Magdum	Rajarambapu Institute of Technology		sachin.magdum@ritindia.edu	9535478999	
54	Dr. Avinash	JSPM, Pune	191150	avi-badadhe@rediff.com	9850557177	
55	Mayur	JSPM, Pune	191149	mayurmalode8@gmail.com	9420683002	
56	R. S. Lavadi	KleTech.		rajshekhar-s@kletech.ac.in	9738992074	
57	BALAGURUPRASAD	SVES			9840722760	
58	Sangeeta Kulkarni	KJ Somaiya	55	Sangeetakulkarni@somaiya.edu	9820196805	
59	Arati Phadke	KJ Somaiya COE	54	aratiphadke@somaiya.edu	9821053249	
60	Sachin Khot	RIT		sachin.khot@ritindia.edu	9764680202	
61	Ajit M. Chaudhary	SGGS		ajitsir@gmail.com	9420793942	
62	Mahesh Gaikwad	SGGSIE&T		mggaikwad@sggs.ac.in	7775906525	

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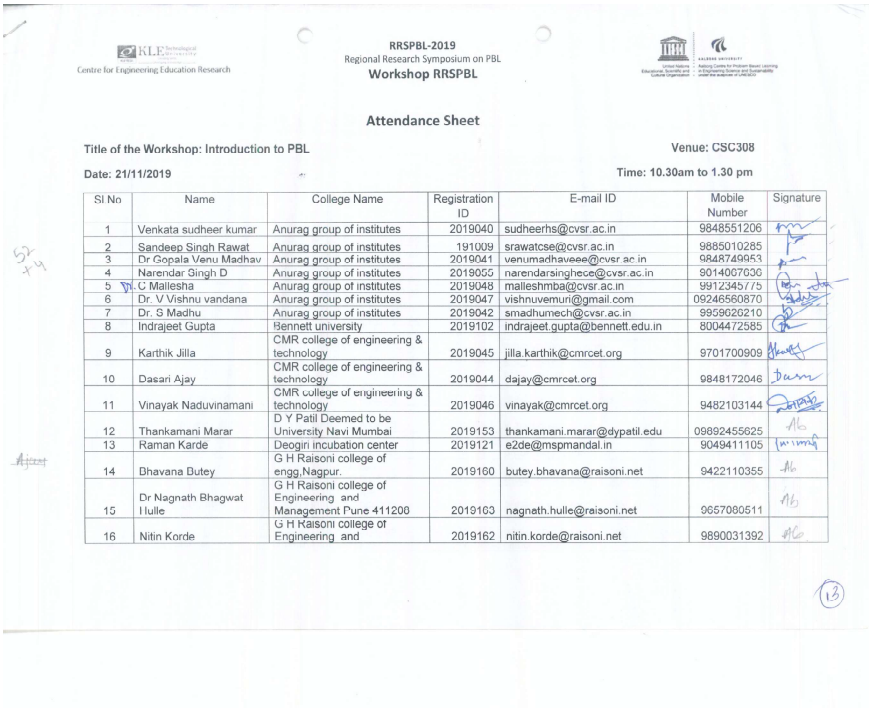

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United Nations Educational, Scientific and Cultural Organization — Aalborg University — Aalborg Centre for Problem Based Learning in Engineering Science and Sustainability under the auspices of UNESCO

Attendance Sheet

Title of the Workshop: Introduction to PBL — **Venue: CSC308**

Date: 21/11/2019 — **Time: 10.30am to 1.30 pm**

Sl No	Name	College Name	Registration ID	E-mail ID	Mobile Number	Signature
1	Venkata sudheer kumar	Anurag group of institutes	2019040	sudheerhs@cvsr.ac.in	9848551206	
2	Sandeep Singh Rawat	Anurag group of institutes	191009	srawatcse@cvsr.ac.in	9885010285	
3	Dr Gopala Venu Madhav	Anurag group of institutes	2019041	venumadhaveee@cvsr.ac.in	9848749953	
4	Narendar Singh D	Anurag group of institutes	2019055	narendarsinghece@cvsr.ac.in	9014007636	
5	G Mallesha	Anurag group of institutes	2019048	malleshmba@cvsr.ac.in	99123457?5	
6	Dr. V Vishnu vandana	Anurag group of institutes	2019047	vishnuvemuri@gmail.com	09246560870	
7	Dr. S Madhu	Anurag group of institutes	2019042	smadhumech@cvsr.ac.in	9959026210	
8	Indrajeet Gupta	Bennett university	2019102	indrajeet.gupta@bennett.edu.in	8004472585	
9	Karthik Jilla	CMR college of engineering & technology	2019045	jilla.karthik@cmrcet.org	9701700909	
10	Dasari Ajay	CMR college of engineering & technology	2019044	dajay@cmrcet.org	9848172046	
11	Vinayak Naduvinamani	CMR college of engineering & technology	2019046	vinayak@cmrcet.org	9482103144	
12	Thankamani Marar	D Y Patil Deemed to be University Navi Mumbai	2019153	thankamani.marar@dypatil.edu	09892455625	
13	Raman Karde	Deogiri incubation center	2019121	e2de@mspmandal.in	9049411105	
14	Bhavana Butey	G H Raisoni college of engg,Nagpur.	2019160	butey.bhavana@raisoni.net	9422110355	
15	Dr Nagnath Bhagwat Hulle	G H Raisoni college of Engineering and Management Pune 411200	2019163	nagnath.hulle@raisoni.net	9657080511	
16	Nitin Korde	G H Raisoni college of Engineering and	2019162	nitin.korde@raisoni.net	9890031392	

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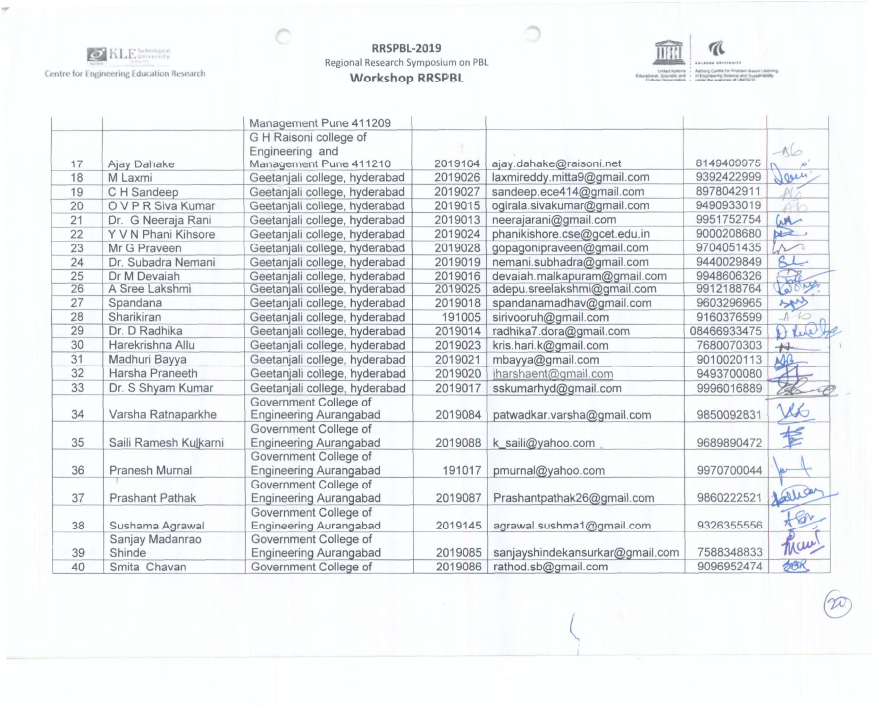

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17	Ajay Dahake	G H Raisoni college of Engineering and Management Pune 411210	2019104	ajay.dahake@raisoni.net	8149409975	
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20	O V P R Siva Kumar	Geetanjali college, hyderabad	2019015	ogirala.sivakumar@gmail.com	9490933019	
21	Dr. G Neeraja Rani	Geetanjali college, hyderabad	2019013	neerajarani@gmail.com	9951752754	
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24	Dr. Subadra Nemani	Geetanjali college, hyderabad	2019019	nemani.subhadra@gmail.com	9440029849	
25	Dr M Devaiah	Geetanjali college, hyderabad	2019016	devaiah.malkapuram@gmail.com	9948606326	
26	A Sree Lakshmi	Geetanjali college, hyderabad	2019025	adepu.sreelakshmi@gmail.com	9912188764	
27	Spandana	Geetanjali college, hyderabad	2019018	spandanamadhav@gmail.com	9603296965	
28	Sharikiran	Geetanjali college, hyderabad	191005	sirivooruh@gmail.com	9160376599	
29	Dr. D Radhika	Geetanjali college, hyderabad	2019014	radhika7.dora@gmail.com	08466933475	
30	Harekrishna Allu	Geetanjali college, hyderabad	2019023	kris.hari.k@gmail.com	7680070303	
31	Madhuri Bayya	Geetanjali college, hyderabad	2019021	mbayya@gmail.com	9010020113	
32	Harsha Praneeth	Geetanjali college, hyderabad	2019020	iharshaent@gmail.com	9493700080	
33	Dr. S Shyam Kumar	Geetanjali college, hyderabad	2019017	sskumarhyd@gmail.com	9996016889	
34	Varsha Ratnaparkhe	Government College of Engineering Aurangabad	2019084	patwadkar.varsha@gmail.com	9850092831	
35	Saili Ramesh Kulkarni	Government College of Engineering Aurangabad	2019088	k_saili@yahoo.com	9689890472	
36	Pranesh Murnal	Government College of Engineering Aurangabad	191017	pmurnal@yahoo.com	9970700044	
37	Prashant Pathak	Government College of Engineering Aurangabad	2019087	Prashantpathak26@gmail.com	9860222521	
38	Sushama Agrawal	Government College of Engineering Aurangabad	2019145	agrawal.sushma1@gmail.com	9326355556	
39	Sanjay Madanrao Shinde	Government College of Engineering Aurangabad	2019085	sanjayshindekansurkar@gmail.com	7588348833	
40	Smita Chavan	Government College of	2019086	rathod.sb@gmail.com	9096952474	

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41	Anjana Ghule	Government College of Engineering Aurangabad	2019079	anjanaghule@gmail.com	~~808720748~~ 7848	
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43	Anjali S Bhalchandra	Government College of Engineering Aurangabad	191017	asbhalchandra@gmail.com	9422203439	
44	V Navakishor	Hyderabad Institute of Technology and Management	2019101			
45	Ravi Naragani	Hyderabad Institute of Technology and Management	2019074	ravin.eee@hitam.org	8125461639	
46	Vinod Kumar Ahuja	Hyderabad Institute of Technology and Management	2019113	vinodkumara.ece@hitam.org	09032826620	
47	Chaitanya S.A	KLE Tech		chaitanya.a@kletech.ac.in	9538462675	
48	Kishor Upadhyaya	KLE Tech		kishor@kletech.ac.in	9902047144	
49	Vinayak S. Naikar	KLE Tech		vinayak.naikar@kletech.ac.in	998667206	(8)47790781
50	~~M V Chitawadagi~~	~~KLE Tech~~				
51	Nalini Iyer	KLE Tech				
52	Meena	KLE Tech.				
53	Khalida. M.	KLE Tech		Khalida@kletech.ac.in	7795335538	
54	Uma	KLE Tech.				
55	Sachin Khot	RIT		sachin.khot@ritindia.edu	9764680202	
56	SumitKumar S. Rathor	SGGSIE&T, Nanded		ssrathor@sggs.ac.in	9421295948	
57	Gaikwad Mahesh G.	SGGSIE&T, Nanded		mggaikwad@sggs.ac.in	7775906525	
58	Arit M. Chaudhari	SGGSIE&T, Nanded		ajitsir@gmail.com	9420793942	
59	Arun Thorat	Rajarambapu Inst. of		arun.thorat@ritindia.edu		
60	Sachin patil	—"— Tech.		sachin.patil@ritindia.edu	9970700925	
61	Krishnaji Patil	—"—		krishnaji.patil@ritindia.edu	8149250102	
62	Umesh Kamenkar	—"—		umesh.kamenkar@ritindia.edu	9920701770	
63	Dr. J.S. Awali	RIT, Sakharale		jsa.awali@gmail.com	8600009767	
64	Dr. BALAGURUPRASAD.	SVES		balaguruprasad.n@srivishnu.edu.in	9840722760	
65	Ms. Jyoti S. Yadav	RIT, Sakharale.		jyoti.yadav@ritindia.edu	8208343664	

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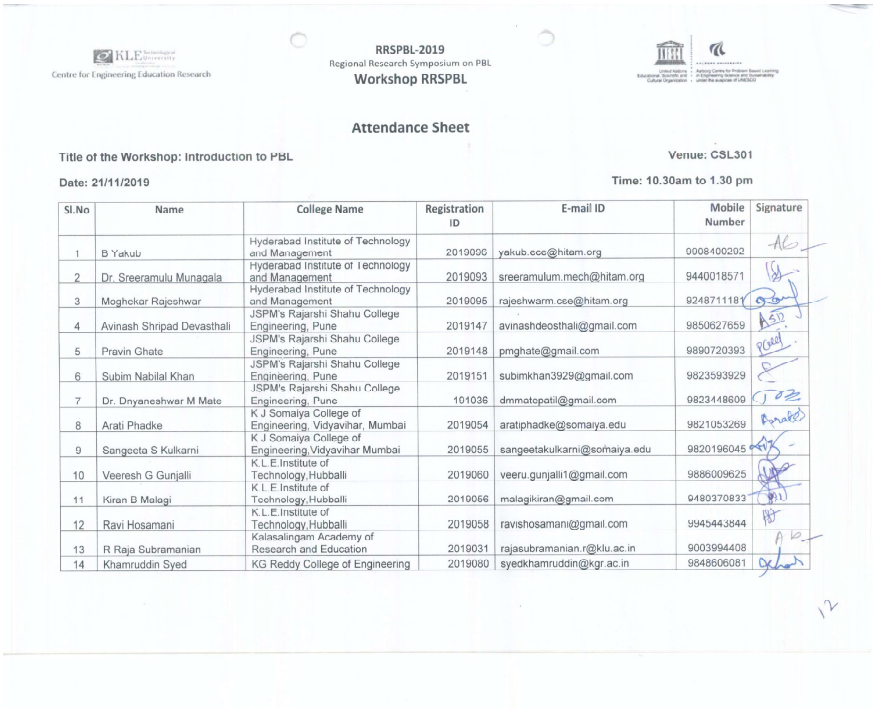

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Attendance Sheet

Title of the Workshop: Introduction to PBL — Venue: CSL301

Date: 21/11/2019 — Time: 10.30am to 1.30 pm

Sl.No	Name	College Name	Registration ID	E-mail ID	Mobile Number	Signature
1	B Yakub	Hyderabad Institute of Technology and Management	2019096	yakub.cse@hitam.org	9008400292	
2	Dr. Sreeramulu Munagala	Hyderabad Institute of Technology and Management	2019093	sreeramulum.mech@hitam.org	9440018571	
3	Moghekar Rajeshwar	Hyderabad Institute of Technology and Management	2019095	rajeshwarm.cse@hitam.org	9248711181	
4	Avinash Shripad Devasthali	JSPM's Rajarshi Shahu College Engineering, Pune	2019147	avinashdeosthali@gmail.com	9850627659	
5	Pravin Ghate	JSPM's Rajarshi Shahu College Engineering, Pune	2019148	pmghate@gmail.com	9890720393	
6	Subim Nabilal Khan	JSPM's Rajarshi Shahu College Engineering, Pune	2019151	subimkhan3929@gmail.com	9823593929	
7	Dr. Dnyaneshwar M Mate	JSPM's Rajarshi Shahu College Engineering, Pune	101036	dmmatepatil@gmail.com	9823448609	
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9	Sangeeta S Kulkarni	K J Somaiya College of Engineering,Vidyavihar Mumbai	2019055	sangeetakulkarni@somaiya.edu	9820196045	
10	Veeresh G Gunjalli	K.L.E.Institute of Technology,Hubballi	2019060	veeru.gunjalli1@gmail.com	9886009625	
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12	Ravi Hosamani	K.L.E.Institute of Technology,Hubballi	2019058	ravihosamani@gmail.com	9945443844	
13	R Raja Subramanian	Kalasalingam Academy of Research and Education	2019031	rajasubramanian.r@klu.ac.in	9003994408	
14	Khamruddin Syed	KG Reddy College of Engineering	2019080	syedkhamruddin@kgr.ac.in	9848606081	

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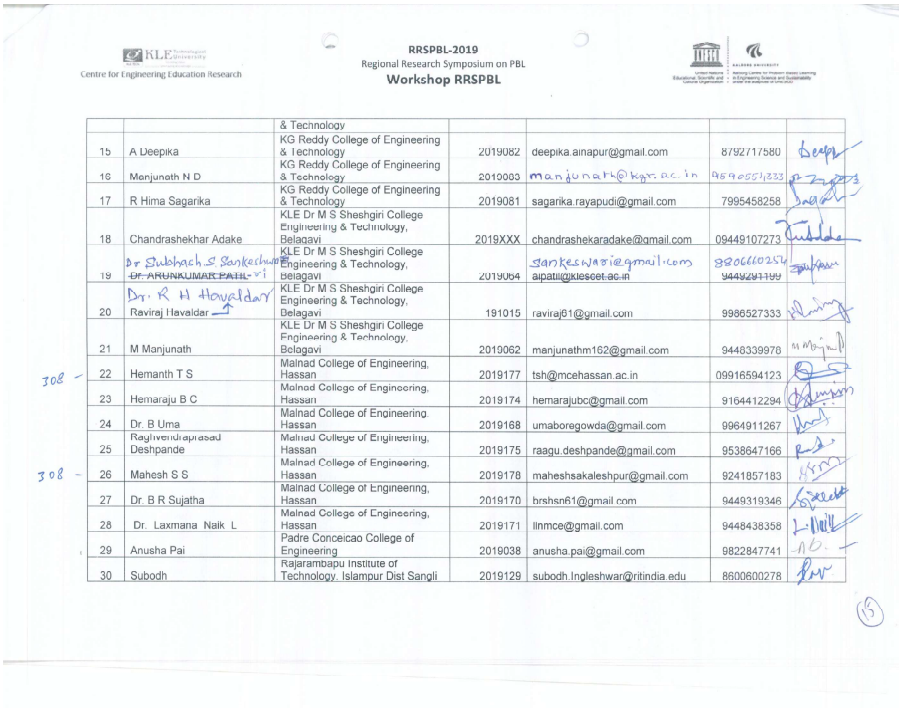

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		& Technology				
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17	R Hima Sagarika	KG Reddy College of Engineering & Technology	2019081	sagarika.rayapudi@gmail.com	7995458258	
18	Chandrashekhar Adake	KLE Dr M S Sheshgiri College Engineering & Technology, Belagavi	2019XXX	chandrashekaradake@gmail.com	09449107273	
19	~~Dr. ARUNKUMAR PATIL~~ Dr Subhash S Sankeshwari	KLE Dr M S Sheshgiri College Engineering & Technology, Belagavi	2019064	sankeshwarie@gmail.com aipatil@klescet.ac.in	9206110256 9449291199	
20	Raviraj Havaldar Dr. R H Havaldar	KLE Dr M S Sheshgiri College Engineering & Technology, Belagavi	191015	raviraj61@gmail.com	9986527333	
21	M Manjunath	KLE Dr M S Sheshgiri College Engineering & Technology, Belagavi	2019062	manjunathm162@gmail.com	9448339976	
308 22	Hemanth T S	Malnad College of Engineering, Hassan	2019177	tsh@mcehassan.ac.in	09916594123	
23	Hemaraju B C	Malnad College of Engineering, Hassan	2019174	hemarajubc@gmail.com	9164412294	
24	Dr. B Uma	Malnad College of Engineering, Hassan	2019168	umaboregowda@gmail.com	9964911267	
25	Raghvendraprasad Deshpande	Malnad College of Engineering, Hassan	2019175	raagu.deshpande@gmail.com	9538647166	
308 26	Mahesh S S	Malnad College of Engineering, Hassan	2019178	maheshsakaleshpur@gmail.com	9241857183	
27	Dr. B R Sujatha	Malnad College of Engineering, Hassan	2019170	brshsn61@gmail.com	9449319346	
28	Dr. Laxmana Naik L	Malnad College of Engineering, Hassan	2019171	llnmce@gmail.com	9448438358	
29	Anusha Pai	Padre Conceicao College of Engineering	2019038	anusha.pai@gmail.com	9822847741	
30	Subodh	Rajarambapu Institute of Technology, Islampur Dist Sangli	2019129	subodh.ingleshwar@ritindia.edu	8600600278	

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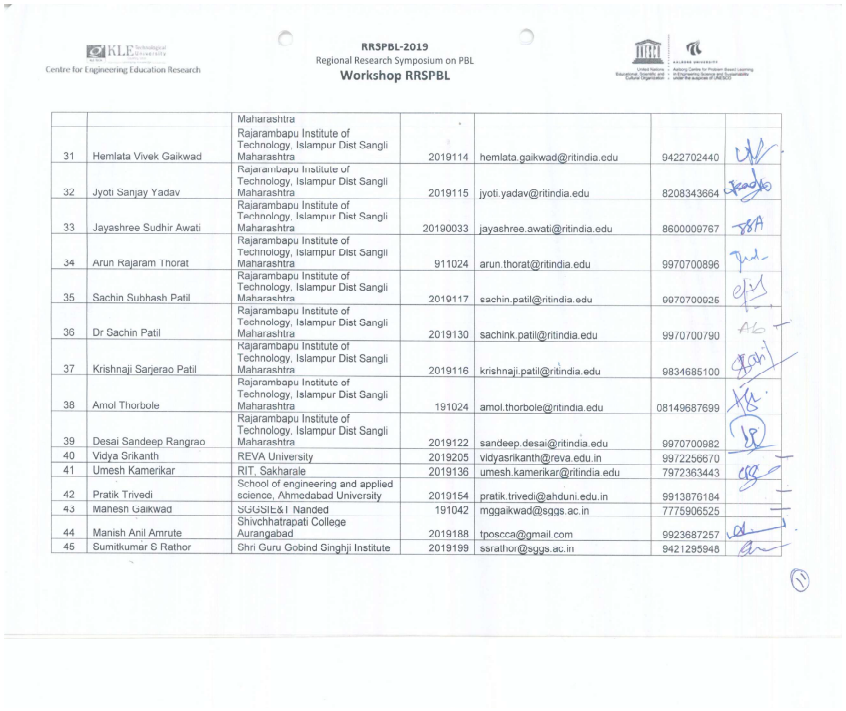

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		Maharashtra				
31	Hemlata Vivek Gaikwad	Rajarambapu Institute of Technology, Islampur Dist Sangli Maharashtra	2019114	hemlata.gaikwad@ritindia.edu	9422702440	
32	Jyoti Sanjay Yadav	Rajarambapu Institute of Technology, Islampur Dist Sangli Maharashtra	2019115	jyoti.yadav@ritindia.edu	8208343664	
33	Jayashree Sudhir Awati	Rajarambapu Institute of Technology, Islampur Dist Sangli Maharashtra	20190033	jayashree.awati@ritindia.edu	8600009767	
34	Arun Kajaram Thorat	Rajarambapu Institute of Technology, Islampur Dist Sangli Maharashtra	911024	arun.thorat@ritindia.edu	9970700896	
35	Sachin Subhash Patil	Rajarambapu Institute of Technology, Islampur Dist Sangli Maharashtra	2019117	sachin.patil@ritindia.edu	9970700025	
36	Dr Sachin Patil	Rajarambapu Institute of Technology, Islampur Dist Sangli Maharashtra	2019130	sachink.patil@ritindia.edu	9970700790	
37	Krishnaji Sarjerao Patil	Rajarambapu Institute of Technology, Islampur Dist Sangli Maharashtra	2019116	krishnaji.patil@ritindia.edu	9834685100	
38	Amol Thorbole	Rajarambapu Institute of Technology, Islampur Dist Sangli Maharashtra	191024	amol.thorbole@ritindia.edu	08149687699	
39	Desai Sandeep Rangrao	Rajarambapu Institute of Technology, Islampur Dist Sangli Maharashtra	2019122	sandeep.desai@ritindia.edu	9970700982	
40	Vidya Srikanth	REVA University	2019205	vidyasrikanth@reva.edu.in	9972256670	
41	Umesh Kamerikar	RIT, Sakharale	2019136	umesh.kamerikar@ritindia.edu	7972363443	
42	Pratik Trivedi	School of engineering and applied science, Ahmedabad University	2019154	pratik.trivedi@ahduni.edu.in	9913876184	
43	Manesh Gaikwad	SGGSIE&T Nanded	191042	mggaikwad@sggs.ac.in	7775906525	
44	Manish Anil Amrute	Shivchhatrapati College Aurangabad	2019188	tposcca@gmail.com	9923687257	
45	Sumitkumar S Rathor	Shri Guru Gobind Singhji Institute	2019199	ssrathor@sggs.ac.in	9421295948	

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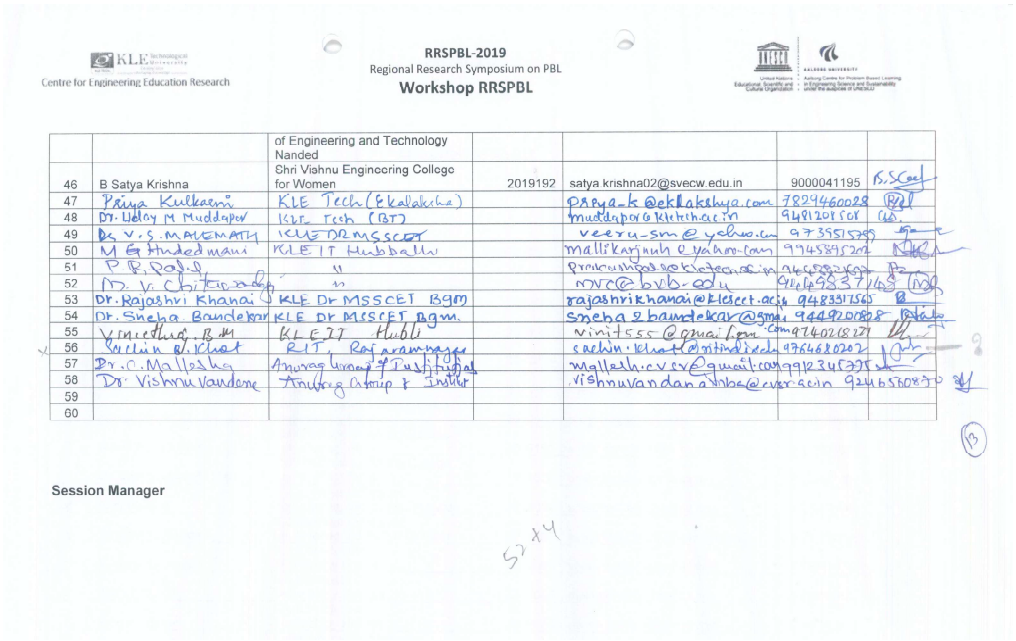

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		of Engineering and Technology Nanded				
46	B Satya Krishna	Shri Vishnu Engineering College for Women	2019192	satya krishna02@svecw.edu.in	9000041195	
47	Priya Kulkarni	KLE Tech (Ekalakshya)		Priya.k@ekalakshya.com	7829460028	
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50	M G Hundekmani	KLE IT Hubballi		mallikarjunh@yahoo.com	9745895277	
51	P.R.Patil	"				
52	Dr. V. Chitre	"		mvc@bvb.edu	9448933765	
53	Dr. Rajashri Khanai	KLE Dr MSSCET BGM		rajashrikhanai@klescet.ac.in	9448337565	
54	Dr. Sneha Bandekar	KLE Dr MSSCET Bgm.		sneha.bandekar@gmail.com	9449200858	
55	Vinaykumar B.M	KLEIT Hubli		vinit555@gmail.com	9740218179	
56	Sachin B. Khot	RIT, Rajaramnagar		sachin.khot@ritindia.edu	9766820202	
57	Dr. C. Mallesha	Anurag Group of Institutions		mallesh.cse@gmail.com	9912345775	
58	Dr. Vishnu Vardane	Anurag Group of Institutions		vishnuvandana.cse@anurag.edu.in	9246580870	
59						
60						

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61.Regional Research Symposium on PBL

KLE Technological University
Centre for Engineering Education Research

RRSPBL-2019
Regional Research Symposium on PBL
Workshop RRSPBL

Attendance Sheet

Title of the Workshop: PBL and Assessment — **Venue: CSC308**

Date: 21/11/2019 — **Time: 3pm to 6 pm**

Sl.No	Name	College Name	Registration ID	E-mail ID	Mobile Number	Signature
1	Venkata sudheer kumar	Anurag group of institutes	sudheernsi@cvsr.ac.in	2019040	9848551206	
2	Narendar Singh D	Anurag group of institutes	narendarsinghece@cvsr.ac.in	2019055	9014067636	
3	Sanjay Dorle	G H Raisoni college of engg,Nagpur.	sanjay.dorle@raisoni.net	2019157	9881711747	
4	Rupesh Shelke	G H Raisoni college of engg,Nagpur.	rupesh.shelke@raisoni.net	2019169	9822677799	
5	Nitin Korde	G H Raisoni college of Engineering and Management Pune 411209	nitin.korde@raisoni.net	2019162	9890031392	
6	PRASHANT PAWADE	G H Raisoni college of Engineering and Management Pune 411211	prashant.pawade@raisoni.net	2019161	9881713443	
7	Dr. G Neeraja Rani	Geetanjali College, Hyderabad	neerajarani@gmail.com	2019013	9951752754	
8	Dr. S Shyam Kumar	Geetanjali College, Hyderabad	sskumarhyd@gmail.com	2019017	9996016889	
9	Sanjay Madanrao Shinde	Government College of Engineering Aurangabad	sanjayshindekansurkar@gmail.com	2019085	7588348833	
10	V Navakishor	Hyderabad Institute of Technology and Management		2019101		
11	Ravi Naragani	Hyderabad Institute of Technology and Management	ravin.eee@hitam.org	2019074	8125461639	
12	B Yakub	Hyderabad Institute of Technology and Management	yakub.ece@hitam.org	2019096	9908400292	
13	Dr. Sreeramulu Munagala	Hyderabad Institute of Technology and Management	sreeramulum.mech@hitam.org	2019093	9440018571	
14	Subim Nabilal Khan	JSPM's Rajarshi Shahu College Engineering, Pune	subimkhan3929@gmail.com	2019151	9823593929	
15	Dr. Dnyaneshwar M Mate	JSPM's Rajarshi Shahu College Engineering, Pune	dmmatepatil@gmail.com	191036	9823448609	
16	Arati Phadke	K J Somaiya College of Engineering,	aratiphadke@somaiya.edu	2019054	9821053269	

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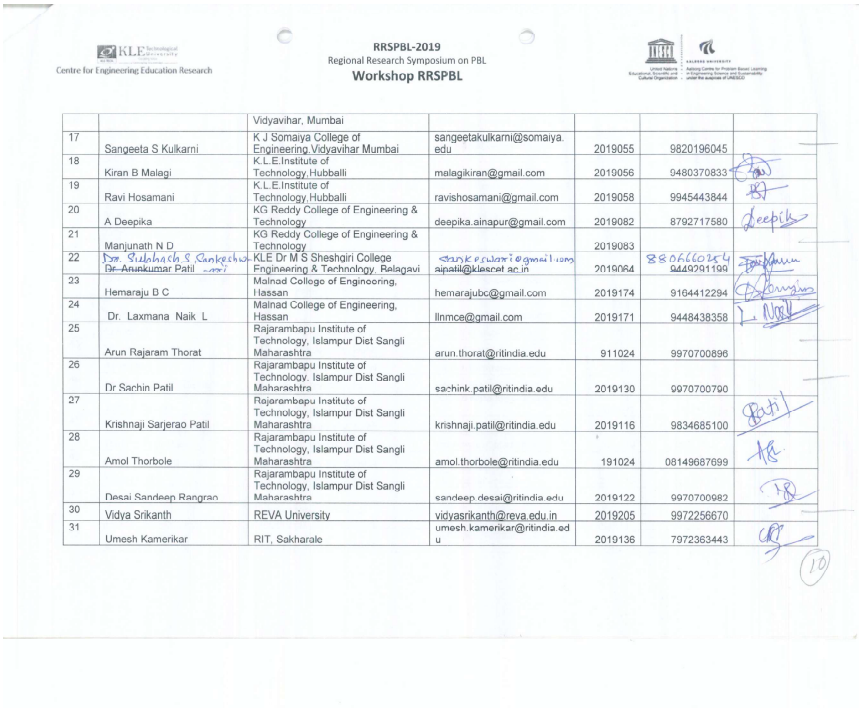

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		Vidyavihar, Mumbai				
17	Sangeeta S Kulkarni	K J Somaiya College of Engineering,Vidyavihar Mumbai	sangeetakulkarni@somaiya.edu	2019055	9820196045	
18	Kiran B Malagi	K.L.E.Institute of Technology,Hubballi	malagikiran@gmail.com	2019056	9480370833	
19	Ravi Hosamani	K.L.E.Institute of Technology,Hubballi	ravishosamani@gmail.com	2019058	9945443844	
20	A Deepika	KG Reddy College of Engineering & Technology	deepika.ainapur@gmail.com	2019082	8792717580	
21	Manjunath N D	KG Reddy College of Engineering & Technology		2019083		
22	Dr. Anupkumar Patil	KLE Dr M S Sheshgiri College Engineering & Technology, Belagavi		2019064	9449291199	
23	Hemaraju B C	Malnad College of Engineering, Hassan	hemarajubc@gmail.com	2019174	9164412294	
24	Dr. Laxmana Naik L	Malnad College of Engineering, Hassan	llnmce@gmail.com	2019171	9448438358	
25	Arun Rajaram Thorat	Rajarambapu Institute of Technology, Islampur Dist Sangli Maharashtra	arun.thorat@ritindia.edu	911024	9970700896	
26	Dr Sachin Patil	Rajarambapu Institute of Technology, Islampur Dist Sangli Maharashtra	sachink.patil@ritindia.edu	2019130	9970700790	
27	Krishnaji Sarjerao Patil	Rajarambapu Institute of Technology, Islampur Dist Sangli Maharashtra	krishnaji.patil@ritindia.edu	2019116	9834685100	
28	Amol Thorbole	Rajarambapu Institute of Technology, Islampur Dist Sangli Maharashtra	amol.thorbole@ritindia.edu	191024	08149687699	
29	Desai Sandeep Rangrao	Rajarambapu Institute of Technology, Islampur Dist Sangli Maharashtra	sandeep.desai@ritindia.edu	2019122	9970700982	
30	Vidya Srikanth	REVA University	vidyasrikanth@reva.edu.in	2019205	9972256670	
31	Umesh Kamerikar	RIT, Sakharale	umesh.kamerikar@ritindia.edu	2019136	7972363443	

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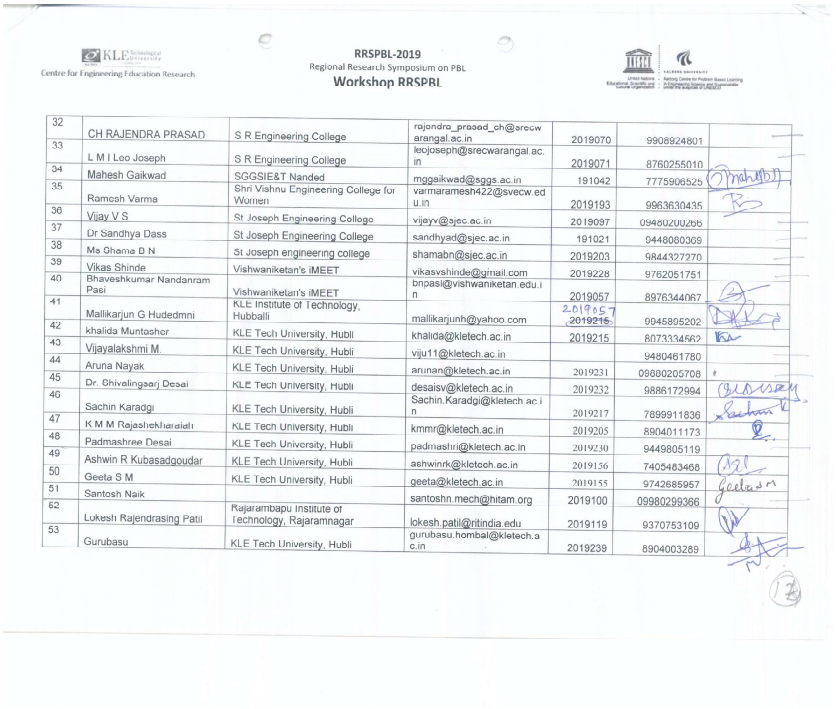

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32	CH RAJENDRA PRASAD	S R Engineering College	rajendra_prasad_ch@srecwarangal.ac.in	2019070	9908924801	
33	L M I Leo Joseph	S R Engineering College	leojoseph@srecwarangal.ac.in	2019071	8760255010	
34	Mahesh Gaikwad	SGGSIE&T Nanded	mggaikwad@sggs.ac.in	191042	7775906525	
35	Ramesh Varma	Shri Vishnu Engineering College for Women	varmarамesh422@svecw.edu.in	2019193	9963630435	
36	Vijay V S	St Joseph Engineering College	vijayv@sjec.ac.in	2019097	09480200266	
37	Dr Sandhya Dass	St Joseph Engineering College	sandhyad@sjec.ac.in	191021	9448060369	
38	Ms Ghama B N	St Joseph engineering college	shamabn@sjec.ac.in	2019203	9844327270	
39	Vikas Shinde	Vishwaniketan's iMEET	vikasvshinde@gmail.com	2019228	9762051751	
40	Bhaveshkumar Nandanram Pasi	Vishwaniketan's iMEET	bnpasi@vishwaniketan.edu.in	2019057	8976344067	
41	Mallikarjun G Hudedmni	KLE Institute of Technology, Hubballi	mallikarjunh@yahoo.com	2019215	9945805202	
42	khalida Muntashor	KLE Tech University, Hubli	khalida@kletech.ac.in	2019215	8073334562	
43	Vijayalakshmi M	KLE Tech University, Hubli	viju11@kletech.ac.in		9480461780	
44	Aruna Nayak	KLE Tech University, Hubli	arunan@kletech.ac.in	2019231	09880205708	
45	Dr. Shivalingaraj Desai	KLE Tech University, Hubli	desaisv@kletech.ac.in	2019232	9886172994	
46	Sachin Karadgi	KLE Tech University, Hubli	Sachin.Karadgi@kletech.ac.in	2019217	7899911836	
47	K M M Rajashekharaiah	KLE Tech University, Hubli	kmmr@kletech.ac.in	2019205	8904011173	
48	Padmashree Desai	KLE Tech University, Hubli	padmashri@kletech.ac.in	2019230	9449805119	
49	Ashwin R Kubasadgoudar	KLE Tech University, Hubli	ashwinrk@kletech.ac.in	2019156	7405463468	
50	Geeta S M	KLE Tech University, Hubli	geeta@kletech.ac.in	2019155	9742685957	
51	Santosh Naik		santoshn.mech@hitam.org	2019100	09980299366	
52	Lokesh Rajendrasing Patil	Rajarambapu Institute of Technology, Rajaramnagar	lokesh.patil@ritindia.edu	2019119	9370753109	
53	Gurubasu	KLE Tech University, Hubli	gurubasu.hombal@kletech.ac.in	2019239	8904003289	

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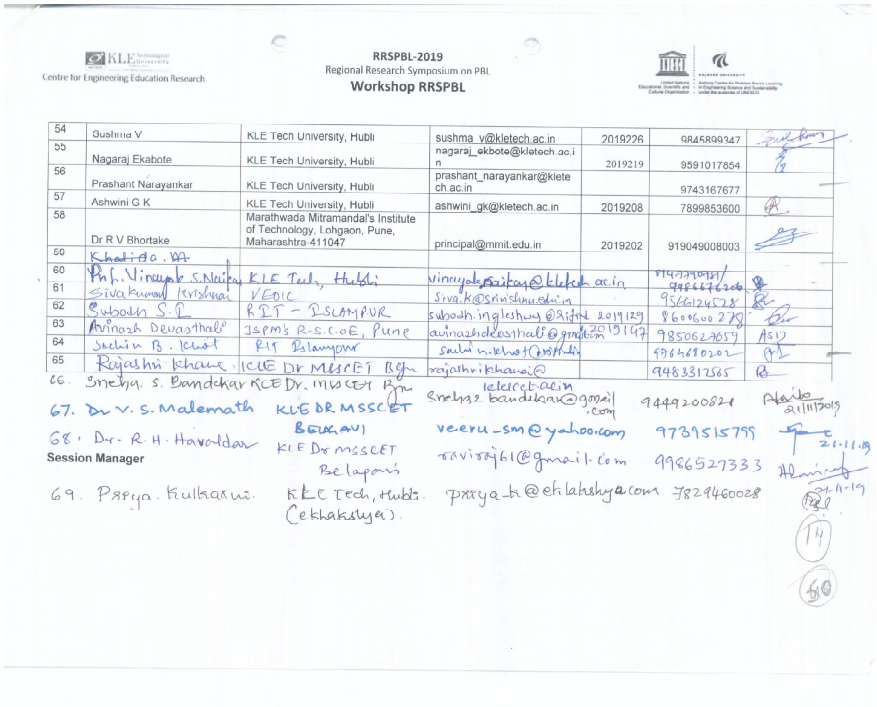

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54	Sushma V	KLE Tech University, Hubli	sushma_v@kletech.ac.in	2019226	9845899347	
55	Nagaraj Ekabote	KLE Tech University, Hubli	nagaraj_ekbote@kletech.ac.in	2019219	9591017854	
56	Prashant Narayankar	KLE Tech University, Hubli	prashant_narayankar@kletech.ac.in		9743167677	
57	Ashwini G K	KLE Tech University, Hubli	ashwini_gk@kletech.ac.in	2019208	7899853600	
58	Dr R V Bhortake	Marathwada Mitramandal's Institute of Technology, Lohgaon, Pune, Maharashtra-411047	principal@mmit.edu.in	2019202	919049008003	
60	Khatiga. BA					
60	Prof. Vinayak S. Nalini	KLE Tech, Hubli	vinayak_kaikay@kletech.ac.in		9448676206	
61	Sivakumar Krishnan	VEDIC	Siva.k@srinshinu.edu.in		9566124528	
62	Subodh S.I.	RIT - ISLAMPUR	subodh.inglesh@rit.ac.in	2019129	8605600278	
63	Avinash Devasthali	ISPM's R.S.C.O.E, Pune	avinash.devasthali@gmail.com	2019147	9850629057	
64	Sachin B. Khot	RIT Islampur	sachin.khot@rit.ac.in		9764880201	
65	Rajashri Khanai	ICCE Dr MSSCET Blr	rajashri.khanai@		9483317585	
66.	Sneha. S. Bandekar	KLE Dr. MSSCET Blr	sneha.bandekar@gmail.com		9449200824	
67.	Dr V. S. Malemath	KLE DR MSSCET BELGAUM				
68.	Dr. R. H. Havaldar	KLE Dr MSSCET Belagavi	ravirajh1@gmail.com		9986527333	
69.	Pooja Kulkarni	KLE Tech, Hubli (Chikkaraya)	pooja_k@chikkaraya.com		7829460028	

Session Manager

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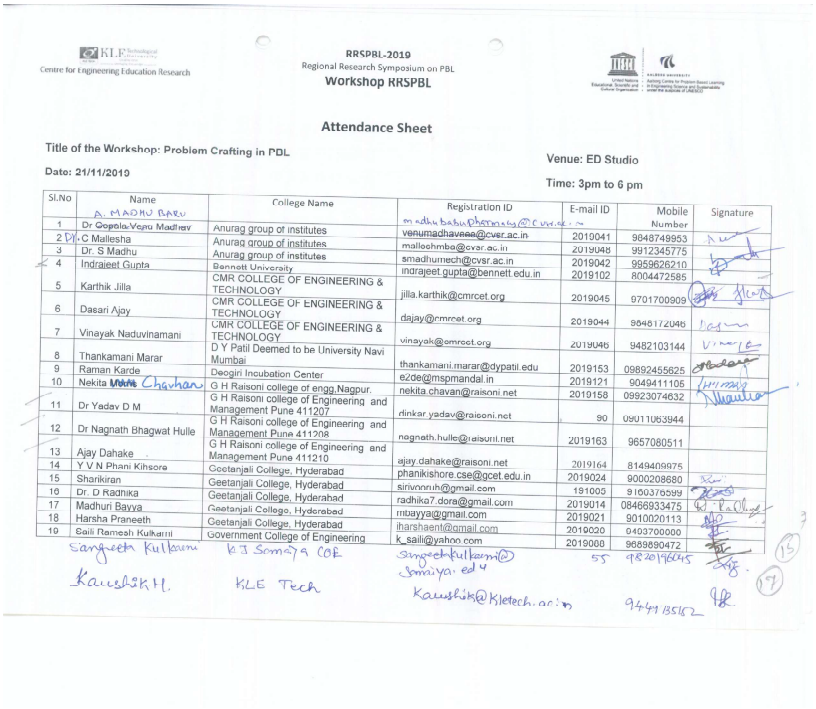

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Attendance Sheet

Title of the Workshop: Problem Crafting in PBL

Date: 21/11/2019

Venue: ED Studio

Time: 3pm to 6 pm

Sl.No	Name	College Name	Registration ID	E-mail ID	Mobile Number	Signature
1	Dr Gopala Vara Madhav	Anurag group of institutes	venumadhavece@cvsr.ac.in	2019041	9848749953	
2	C Mallesha	Anurag group of institutes	malloohmba@cvsr.ac.in	2019048	9912345775	
3	Dr. S Madhu	Anurag group of institutes	smadhumech@cvsr.ac.in	2019042	9959626210	
4	Indrajeet Gupta	Bennett University	indrajeet.gupta@bennett.edu.in	2019102	8004472585	
5	Karthik Jilla	CMR COLLEGE OF ENGINEERING & TECHNOLOGY	jilla.karthik@cmrcet.org	2019045	9701700909	
6	Dasari Ajay	CMR COLLEGE OF ENGINEERING & TECHNOLOGY	dajay@cmrcet.org	2019044	9848172046	
7	Vinayak Naduvinamani	CMR COLLEGE OF ENGINEERING & TECHNOLOGY	vinayak@cmrcet.org	2019046	9482103144	
8	Thankamani Marar	D Y Patil Deemed to be University Navi Mumbai	thankamani.marar@dypatil.edu	2019153	09892455825	
9	Raman Karde	Deogiri Incubation Center	e2de@mspmandal.in	2019121	9049411105	
10	Nekita Chavhan	G H Raisoni college of engg.Nagpur.	nekita.chavan@raisoni.net	2019158	09923074632	
11	Dr Yadav D M	G H Raisoni college of Engineering and Management Pune 411207	dinkar.yadav@raisoni.net	90	09011063944	
12	Dr Nagnath Bhagwat Hulle	G H Raisoni college of Engineering and Management Pune 411208	nagnath.hulle@raisoni.net	2019163	9657080511	
13	Ajay Dahake	G H Raisoni college of Engineering and Management Pune 411210	ajay.dahake@raisoni.net	2019164	8149409875	
14	Y V N Phani Kihsore	Geetanjali College, Hyderabad	phanikishore.cse@gcet.edu.in	2019024	9000208680	
15	Sharikiran	Geetanjali College, Hyderabad	sirivennuh@gmail.com	191005	9160376599	
16	Dr. D Radhika	Geetanjali College, Hyderabad	radhika7.dora@gmail.com	2019014	08466933475	
17	Madhuri Bayya	Geetanjali College, Hyderabad	mbayya@gmail.com	2019021	9010020113	
18	Harsha Praneeth	Geetanjali College, Hyderabad	iharshaent@gmail.com	2019020	0403700000	
19	Saili Ramesh Kulkarni	Government College of Engineering	k_saili@yahoo.com	2019008	9689890472	

Sangeeta Kulkarni KJ Somaiya COE sangeetkulkarni@somaiya.edu 55 9820196045

Kaushik H. KLE Tech Kaushik@kletech.ac.in 9449135162

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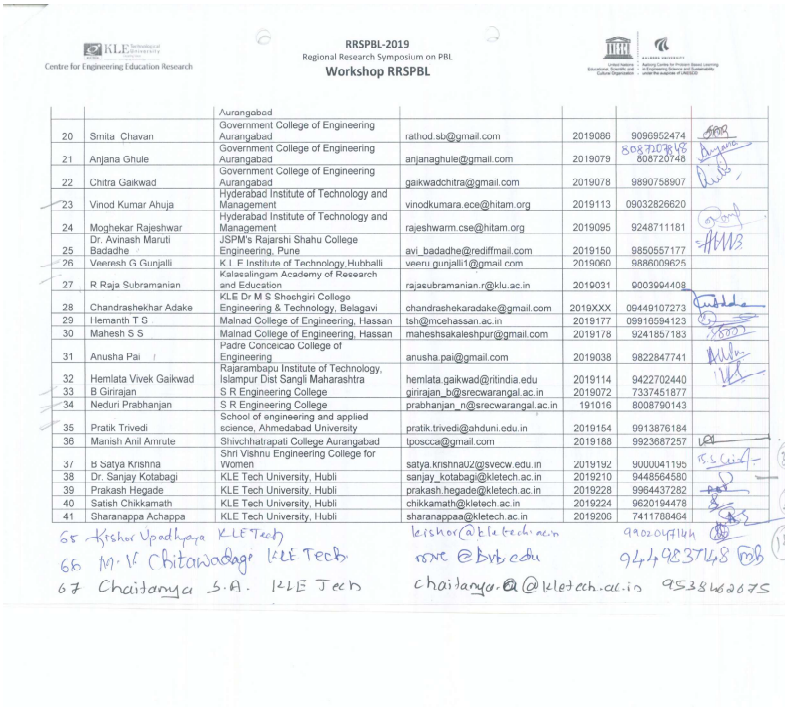

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		Aurangabad				
20	Smita Chavan	Government College of Engineering Aurangabad	rathod.sb@gmail.com	2019086	9096952474	
21	Anjana Ghule	Government College of Engineering Aurangabad	anjanaghule@gmail.com	2019079	8087207446 8087207446	
22	Chitra Gaikwad	Government College of Engineering Aurangabad	gaikwadchitra@gmail.com	2019078	9890758907	
23	Vinod Kumar Ahuja	Hyderabad Institute of Technology and Management	vinodkumara.ece@hitam.org	2019113	09032826620	
24	Moghekar Rajeshwar	Hyderabad Institute of Technology and Management	rajeshwarm.cse@hitam.org	2019095	9248711181	
25	Dr. Avinash Maruti Badadhe	JSPM's Rajarshi Shahu College Engineering, Pune	avi_badadhe@rediffmail.com	2019150	9850557177	
26	Veeresh G Gunjalli	K L E Institute of Technology,Hubballi	veeru.gunjalli1@gmail.com	2019060	9886009625	
27	R Raja Subramanian	Kalaslingam Academy of Research and Education	rajasubramanian.r@klu.ac.in	2019031	9003994408	
28	Chandrashekhar Adake	KLE Dr M S Sheshgiri College Engineering & Technology, Belagavi	chandrashekaradake@gmail.com	2019XXX	09449107273	
29	Hemanth T G	Malnad College of Engineering, Hassan	tgh@mcehassan.ac.in	2019177	09916094123	
30	Mahesh S S	Malnad College of Engineering, Hassan	maheshsakaleshpur@gmail.com	2019178	9241857183	
31	Anusha Pai	Padre Conceicao College of Engineering	anusha.pai@gmail.com	2019038	9822847741	
32	Hemlata Vivek Gaikwad	Rajarambapu Institute of Technology, Islampur Dist Sangli Maharashtra	hemlata.gaikwad@ritindia.edu	2019114	9422702440	
33	B Girirajan	S R Engineering College	girirajan_b@srecwarangal.ac.in	2019072	7337451877	
34	Neduri Prabhanjan	S R Engineering College	prabhanjan_n@srecwarangal.ac.in	191016	8008790143	
35	Pratik Trivedi	School of engineering and applied science, Ahmedabad University	pratik.trivedi@ahduni.edu.in	2019154	9913876184	
36	Manish Anil Amrute	Shivchhatrapati College Aurangabad	tpsccoa@gmail.com	2019188	9923687257	
37	B Satya Krishna	Shri Vishnu Engineering College for Women	satya.krishna02@svecw.edu.in	2019192	9000041195	
38	Dr. Sanjay Kotabagi	KLE Tech University, Hubli	sanjay_kotabagi@kletech.ac.in	2019210	9448564580	
39	Prakash Hegade	KLE Tech University, Hubli	prakash.hegade@kletech.ac.in	2019228	9964437282	
40	Satish Chikkamath	KLE Tech University, Hubli	chikkamath@kletech.ac.in	2019224	9620194478	
41	Sharanappa Achappa	KLE Tech University, Hubli	sharanappaa@kletech.ac.in	2019200	7411780464	

65 Kishor Upadhyaya KLE Tech — kishor@kletech.ac.in — 9902047144
66 M. V. Chitawadagi KLE Tech — mvc@bvb.edu — 9448283748
67 Chaitanya S.A. KLE Tech — chaitanya.a@kletech.ac.in — 9538462675

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42	Vinayak N Kulkarni	KLE Tech University, Hubli	vinayak_kulkarni@kletech.ac.in	2019213	9739146050	
43	Dr. S. R. Nirmala	KLE Tech University, Hubli	nirmala.s@kletech.ac.in	2019204	9957576638	
44	Dr. G. U. Raju	KLE Tech University, Hubli	raju_gu@kletech.ac.in	2019216	9448717310	
45	Prashant. P. Revankar	KLE Tech University, Hubli	pp_revankar@kletech.ac.in	2019222	09686606151	
46	Shankar Gangisetty	KLE Tech University, Hubli	shankar@kletech.ac.in	2019214	9972268022	
47	Laxmikant R Patil	KLE Tech University, Hubli	lrpatil@kletech.ac.in	2019229	9448232734	
48	Krishnaraja Kodancha	KLE Tech University, Hubli	krishnaraja@kletech.ac.in	2019168	9886596953	
49	Keyur Joshi	School of engineering and applied science, Ahmedabad University	keyur.joshi@agduni.edu.in	2019100	6351135250	
50	Sridhar Dalai	School of engineering and applied science, Ahmedabad University	sridhar.dalai@ahduni.edu.in	2019119	7567160826	
51	Sanjay Chikalthankar		sbchikalthankar@gmail.com	2019168	09890432120	
52	Vishwanath P. Baligar	KLE Tech University, Hubli	vpbaligar@kletech.ac.in	2019238	9731841969	
53	Dr. Suneeta V. Budihal	KLE Tech University, Hubli	suneeta_vb@kletech.ac.in	2019219	9448821704	
54	Ujwala Patil	KLE Tech University, Hubli	ujwalapatil@kletech.ac.in	2019220	8971193624	
55	Supriya Kulkarni	Government College of Engineering	to.supriya@gmail.com		9822591274	
56	Rajat S Patil	MMIT, Lohgaon.	rajat.patil@mmit.edu.in	191043	8888826874	
57	Sachin Magdum	Rajarambapu institute of Technology	sachin.magdum@ritindia.edu		9535478999	
58	Ajit M. Choudhari	S.G.G.S. IE&T.	ajitsir@gmail.com		9420793942	
59	Mayur M. Malode	JSPM's R.S.C.O.E.	mayurmalode98@gmail.com	2019149	9420683002	
60	Prashant .N	KLE Tech			[illegible]	
61	Subim Kban	RIS COE, Tathawade	subimkban3929@gmail.com		9823593929	
62.	Pravin Ghate	JSPM's RSCOE	pmghate@gmail.com	21-9-19	9890720393	
63.	Santosh Naik	Hyderabad Institute of technology & management	santoshn.mech@hitam.org	2019100	9980299366	
64	M. Devaiah	Geethanjali.	devaiah.malkapuram@gmail.com		9948606326	

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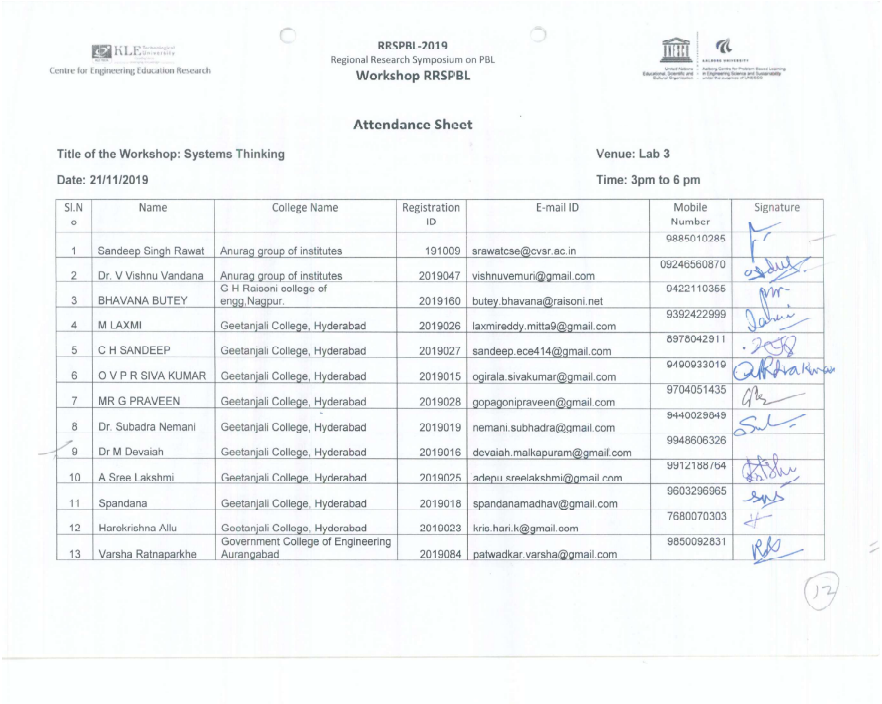

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Attendance Sheet

Title of the Workshop: Systems Thinking **Venue: Lab 3**

Date: 21/11/2019 **Time: 3pm to 6 pm**

Sl.No	Name	College Name	Registration ID	E-mail ID	Mobile Number	Signature
1	Sandeep Singh Rawat	Anurag group of institutes	191009	srawatcse@cvsr.ac.in	9885010285	
2	Dr. V Vishnu Vandana	Anurag group of institutes	2019047	vishnuvemuri@gmail.com	09246560870	
3	BHAVANA BUTEY	C H Raisoni college of engg.Nagpur.	2019160	butey.bhavana@raisoni.net	0422110365	
4	M LAXMI	Geetanjali College, Hyderabad	2019026	laxmireddy.mitta9@gmail.com	9392422999	
5	C H SANDEEP	Geetanjali College, Hyderabad	2019027	sandeep.ece414@gmail.com	6976042911	
6	O V P R SIVA KUMAR	Geetanjali College, Hyderabad	2019015	ogirala.sivakumar@gmail.com	9490933019	
7	MR G PRAVEEN	Geetanjali College, Hyderabad	2019028	gopagonipraveen@gmail.com	9704051435	
8	Dr. Subadra Nemani	Geetanjali College, Hyderabad	2019019	nemani.subhadra@gmail.com	9440029849	
9	Dr M Devaiah	Geetanjali College, Hyderabad	2019016	devaiah.malkapuram@gmail.com	9948606326	
10	A Sree Lakshmi	Geetanjali College, Hyderabad	2019025	adepu.sreelakshmi@gmail.com	9912188764	
11	Spandana	Geetanjali College, Hyderabad	2019018	spandanamadhav@gmail.com	9603296965	
12	Harakrishna Allu	Geetanjali College, Hyderabad	2019023	krio.hari.k@gmail.com	7680070303	
13	Varsha Ratnaparkhe	Government College of Engineering Aurangabad	2019084	patwadkar.varsha@gmail.com	9850092831	

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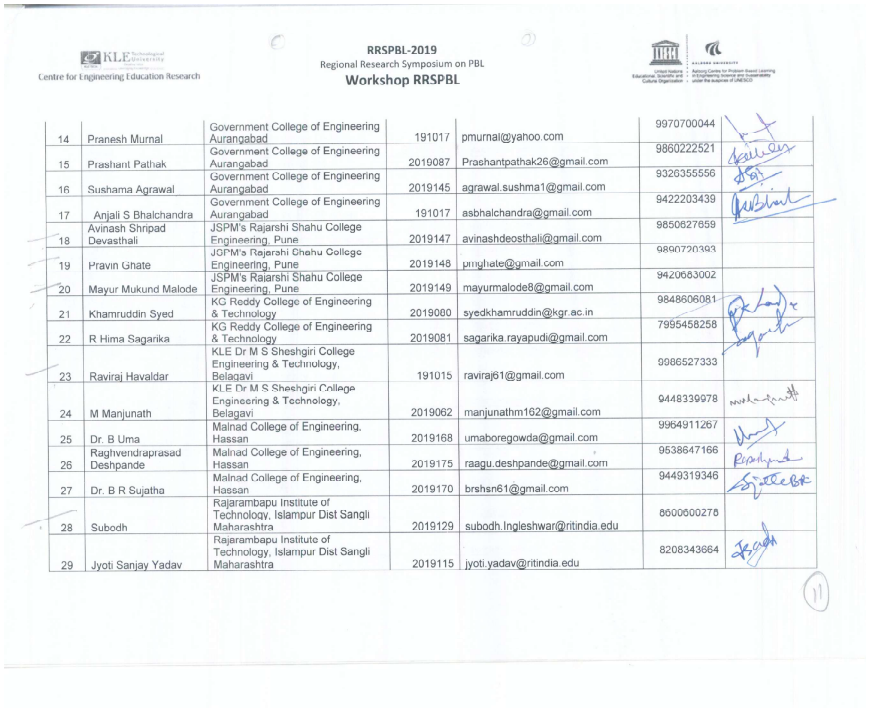

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14	Pranesh Murnal	Government College of Engineering Aurangabad	191017	pmurnal@yahoo.com	9970700044	
15	Prashant Pathak	Government College of Engineering Aurangabad	2019087	Prashantpathak26@gmail.com	9860222521	
16	Sushama Agrawal	Government College of Engineering Aurangabad	2019145	agrawal.sushma1@gmail.com	9326355556	
17	Anjali S Bhalchandra	Government College of Engineering Aurangabad	191017	asbhalchandra@gmail.com	9422203439	
18	Avinash Shripad Devasthali	JSPM's Rajarshi Shahu College Engineering, Pune	2019147	avinashdeosthali@gmail.com	9850627659	
19	Pravin Ghate	JSPM's Rajarshi Shahu College Engineering, Pune	2019148	pmghate@gmail.com	9890720393	
20	Mayur Mukund Malode	JSPM's Rajarshi Shahu College Engineering, Pune	2019149	mayurmalode8@gmail.com	9420663002	
21	Khamruddin Syed	KG Reddy College of Engineering & Technology	2019080	syedkhamruddin@kgr.ac.in	9848606081	
22	R Hima Sagarika	KG Reddy College of Engineering & Technology	2019081	sagarika.rayapudi@gmail.com	7995458258	
23	Raviraj Havaldar	KLE Dr M S Sheshgiri College Engineering & Technology, Belagavi	191015	raviraj61@gmail.com	9986527333	
24	M Manjunath	KLE Dr M S Sheshgiri College Engineering & Technology, Belagavi	2019062	manjunathm162@gmail.com	9448339978	
25	Dr. B Uma	Malnad College of Engineering, Hassan	2019168	umaboregowda@gmail.com	9964911267	
26	Raghvendraprasad Deshpande	Malnad College of Engineering, Hassan	2019175	raagu.deshpande@gmail.com	9538647166	
27	Dr. B R Sujatha	Malnad College of Engineering, Hassan	2019170	brshsn61@gmail.com	9449319346	
28	Subodh	Rajarambapu Institute of Technology, Islampur Dist Sangli Maharashtra	2019129	subodh.Ingleshwar@ritindia.edu	8600600276	
29	Jyoti Sanjay Yadav	Rajarambapu Institute of Technology, Islampur Dist Sangli Maharashtra	2019115	jyoti.yadav@ritindia.edu	8208343664	

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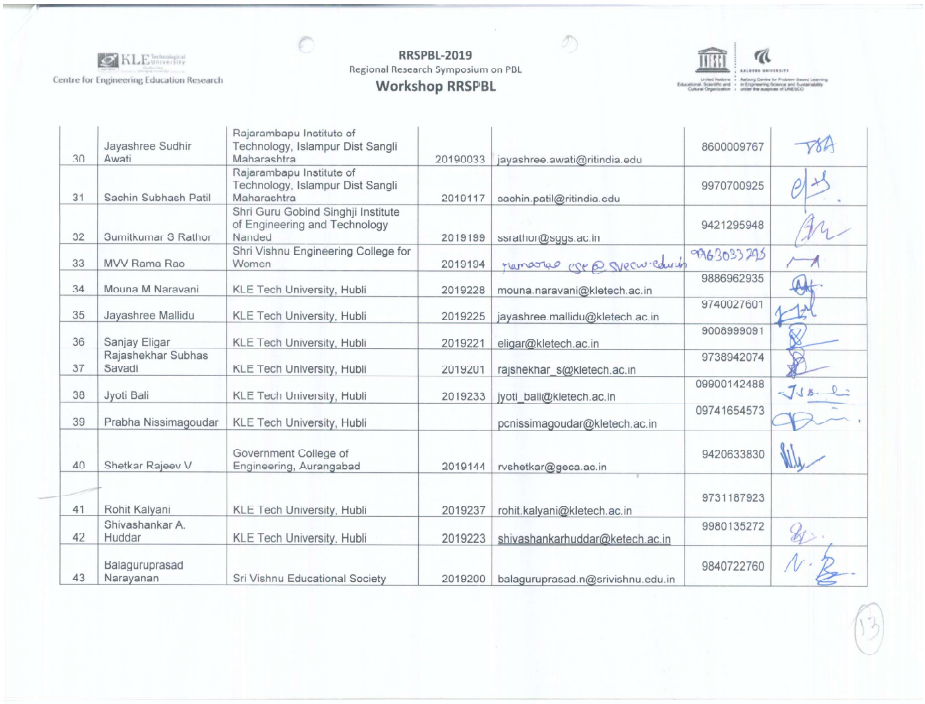

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RRSPBL-2019
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Workshop RRSPBL

30	Jayashree Sudhir Awati	Rajarambapu Institute of Technology, Islampur Dist Sangli Maharashtra	20190033	jayashree.awati@ritindia.edu	8600009767	
31	Sachin Subhash Patil	Rajarambapu Institute of Technology, Islampur Dist Sangli Maharashtra	2010117	sachin.patil@ritindia.edu	9970700925	
32	Sumitkumar S Rathor	Shri Guru Gobind Singhji Institute of Engineering and Technology Nanded	2019189	ssrathor@sggs.ac.in	9421295948	
33	MVV Rama Rao	Shri Vishnu Engineering College for Women	2019194	ramarao.cse@svecw.edu.in	9963033795	
34	Mouna M Naravani	KLE Tech University, Hubli	2019228	mouna.naravani@kletech.ac.in	9886962935	
35	Jayashree Mallidu	KLE Tech University, Hubli	2019225	jayashree.mallidu@kletech.ac.in	9740027601	
36	Sanjay Eligar	KLE Tech University, Hubli	2019221	eligar@kletech.ac.in	9008999091	
37	Rajashekhar Subhas Savadi	KLE Tech University, Hubli	2019201	rajshekhar_s@kletech.ac.in	9738942074	
38	Jyoti Bali	KLE Tech University, Hubli	2019233	jyoti_bali@kletech.ac.in	09900142488	
39	Prabha Nissimagoudar	KLE Tech University, Hubli		pcnissimagoudar@kletech.ac.in	09741654573	
40	Shetkar Rajeev V	Government College of Engineering, Aurangabad	2019144	rvshetkar@geca.ac.in	9420633830	
41	Rohit Kalyani	KLE Tech University, Hubli	2019237	rohit.kalyani@kletech.ac.in	9731187923	
42	Shivashankar A. Huddar	KLE Tech University, Hubli	2019223	shivashankarhuddar@ketech.ac.in	9980135272	
43	Balaguruprasad Narayanan	Sri Vishnu Educational Society	2019200	balaguruprasad.n@srivishnu.edu.in	9840722760	

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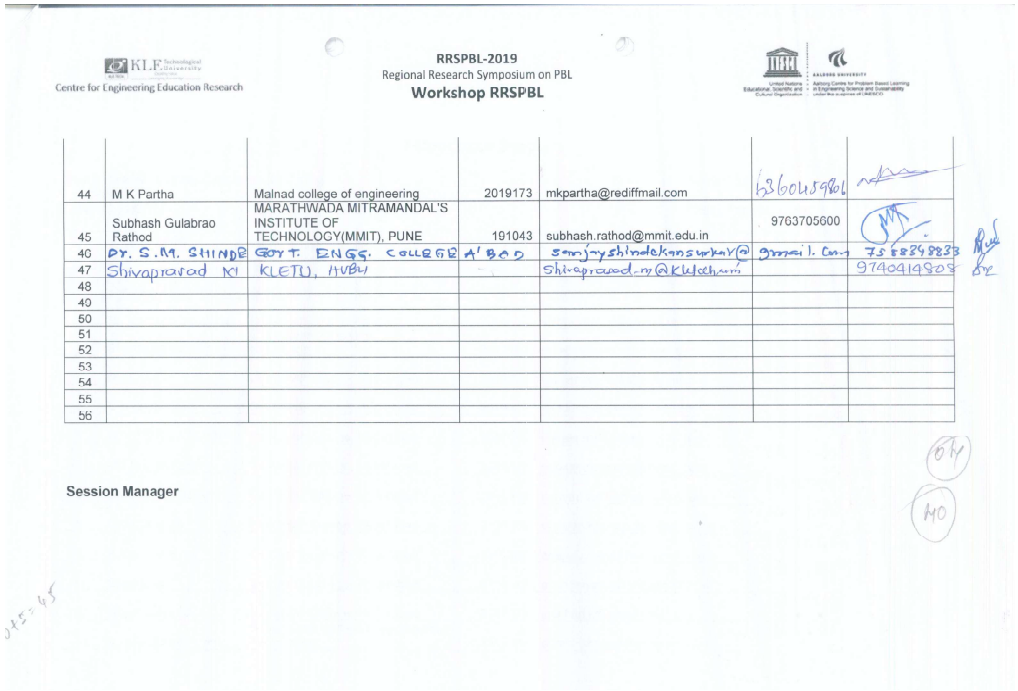

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Centre for Engineering Education Research

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Workshop RRSPBL

44	M K Partha	Malnad college of engineering	2019173	mkpartha@rediffmail.com	8360459861	
45	Subhash Gulabrao Rathod	MARATHWADA MITRAMANDAL'S INSTITUTE OF TECHNOLOGY(MMIT), PUNE	191043	subhash.rathod@mmit.edu.in	9763705600	
46	DR. S.M. SHINDE	GOVT. ENGG. COLLEGE A'BAD		sanjayshindekansurkar@	gmail.com	7588249833
47	Shivaprasad KI	KLETU, HVBU		Shivaprasad.ki@KLEtech.ac		9740419825
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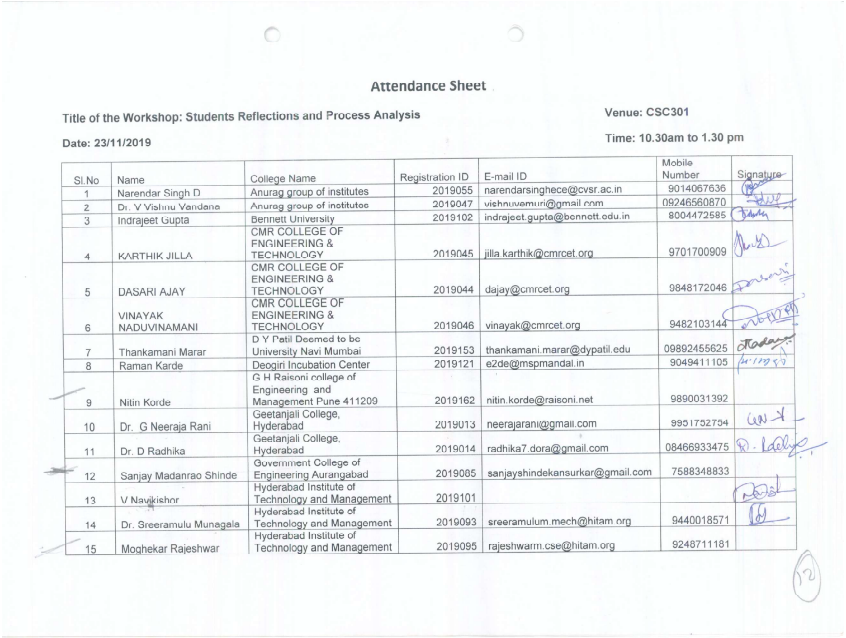

Attendance Sheet

Title of the Workshop: Students Reflections and Process Analysis **Venue: CSC301**

Date: 23/11/2019 **Time: 10.30am to 1.30 pm**

Sl.No	Name	College Name	Registration ID	E-mail ID	Mobile Number	Signature
1	Narendar Singh D	Anurag group of institutes	2019055	narendarsinghece@cvsr.ac.in	9014067636	
2	Dr. V Vishnu Vardana	Anurag group of institutes	2019047	vishnuvemuri@gmail.com	09246560870	
3	Indrajeet Gupta	Bennett University	2019102	indrajeet.gupta@bennett.edu.in	8004472585	
4	KARTHIK JILLA	CMR COLLEGE OF ENGINEERING & TECHNOLOGY	2019045	jilla.karthik@cmrcet.org	9701700909	
5	DASARI AJAY	CMR COLLEGE OF ENGINEERING & TECHNOLOGY	2019044	dajay@cmrcet.org	9848172046	
6	VINAYAK NADUVINAMANI	CMR COLLEGE OF ENGINEERING & TECHNOLOGY	2019046	vinayak@cmrcet.org	9482103144	
7	Thankamani Marar	D Y Patil Deemed to be University Navi Mumbai	2019153	thankamani.marar@dypatil.edu	09892455625	
8	Raman Karde	Deogiri Incubation Center	2019121	e2de@mspmandal.in	9049411105	
9	Nitin Korde	G H Raisoni college of Engineering and Management Pune 411209	2019162	nitin.korde@raisoni.net	9890031392	
10	Dr. G Neeraja Rani	Geetanjali College, Hyderabad	2019013	neerajarani@gmail.com	9951752794	
11	Dr. D Radhika	Geetanjali College, Hyderabad	2019014	radhika7.dora@gmail.com	08466933475	
12	Sanjay Madanrao Shinde	Government College of Engineering Aurangabad	2019065	sanjayshindekansurkar@gmail.com	7588348833	
13	V Navkishor	Hyderabad Institute of Technology and Management	2019101			
14	Dr. Sreeramulu Munagala	Hyderabad Institute of Technology and Management	2019093	sreeramulum.mech@hitam.org	9440018571	
15	Moghekar Rajeshwar	Hyderabad Institute of Technology and Management	2019095	rajeshwarm.cse@hitam.org	9248711181	

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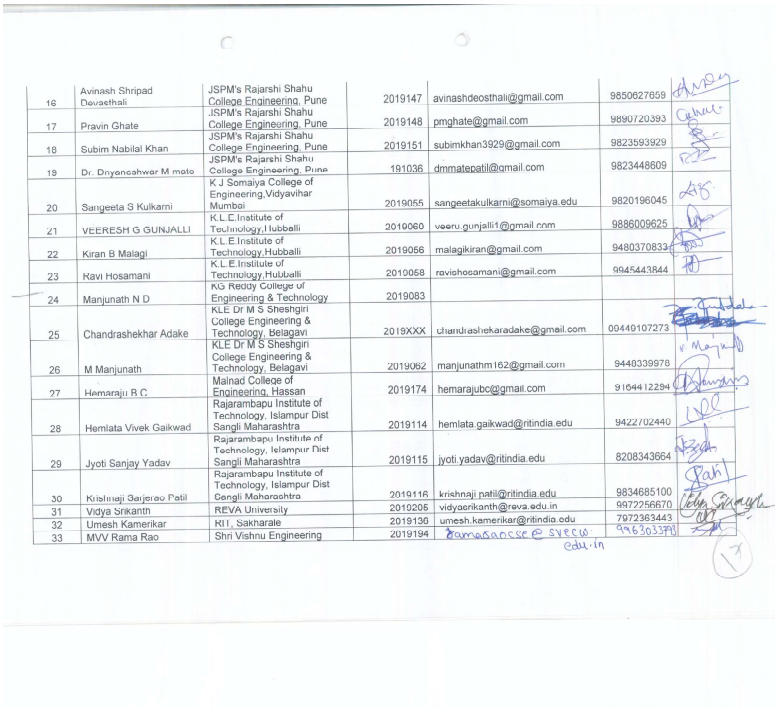

16	Avinash Shripad Devasthali	JSPM's Rajarshi Shahu College Engineering, Pune	2019147	avinashdeosthali@gmail.com	9850627659	
17	Pravin Ghate	JSPM's Rajarshi Shahu College Engineering, Pune	2019148	pmghate@gmail.com	9890720393	
18	Subim Nabilal Khan	JSPM's Rajarshi Shahu College Engineering, Pune	2019151	subimkhan3929@gmail.com	9823593929	
19	Dr. Dnyaneshwar M mate	JSPM's Rajarshi Shahu College Engineering, Pune	191036	dmmatepatil@gmail.com	9823448609	
20	Sangeeta G Kulkarni	K J Somaiya College of Engineering,Vidyavihar Mumbai	2019055	sangeetakulkarni@somaiya.edu	9820196045	
21	VEERESH G GUNJALLI	K.L.E.Institute of Technology,Hubballi	2019060	veeru.gunjalli1@gmail.com	9886009625	
22	Kiran B Malagi	K.L.E.Institute of Technology,Hubballi	2019056	malagikiran@gmail.com	9480370833	
23	Ravi Hosamani	K.L.E.Institute of Technology,Hubballi	2019058	ravihosamani@gmail.com	9945443844	
24	Manjunath N D	KG Reddy College of Engineering & Technology	2019083			
25	Chandrashekhar Adake	KLE Dr M S Sheshgiri College Engineering & Technology, Belagavi	2019XXX	chandrashekaradake@gmail.com	09449107273	
26	M Manjunath	KLE Dr M S Sheshgiri College Engineering & Technology, Belagavi	2019062	manjunathm162@gmail.com	9448039978	
27	Hemaraju R C	Malnad College of Engineering, Hassan	2019174	hemarajubc@gmail.com	9164412294	
28	Hemlata Vivek Gaikwad	Rajarambapu Institute of Technology, Islampur Dist Sangli Maharashtra	2019114	hemlata.gaikwad@ritindia.edu	9422702440	
29	Jyoti Sanjay Yadav	Rajarambapu Institute of Technology, Islampur Dist Sangli Maharashtra	2019115	jyoti.yadav@ritindia.edu	8208343664	
30	Krishnaji Sarjerao Patil	Rajarambapu Institute of Technology, Islampur Dist Sangli Maharashtra	2019116	krishnaji.patil@ritindia.edu	9834685100	
31	Vidya Srikanth	REVA University	2010205	vidyasrikanth@reva.edu.in	9972256670	
32	Umesh Kamerikar	RIT, Sakharale	2019130	umesh.kamerikar@ritindia.edu	7972363443	
33	MVV Rama Rao	Shri Vishnu Engineering	2019194	ramasansse@svecw.edu.in	9963033911	

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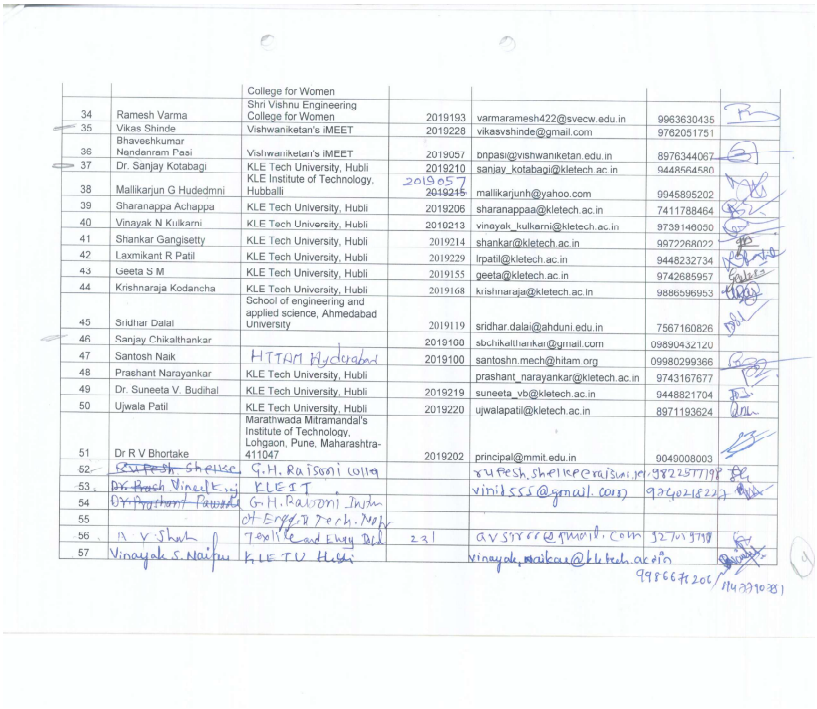

		College for Women			
34	Ramesh Varma	Shri Vishnu Engineering College for Women	2019193	varmaramesh422@svecw.edu.in	9963630435
35	Vikas Shinde	Vishwaniketan's iMEET	2019228	vikasvshinde@gmail.com	9762051751
36	Bhaveshkumar Nandeshram Pasi	Vishwaniketan's iMEET	2019057	bnpasi@vishwaniketan.edu.in	8976344067
37	Dr. Sanjay Kotabagi	KLE Tech University, Hubli	2019210	sanjay_kotabagi@kletech.ac.in	9448564580
38	Mallikarjun G Hudedmni	KLE Institute of Technology, Hubballi	2019057 2019215	mallikarjunh@yahoo.com	9945895202
39	Sharanappa Achappa	KLE Tech University, Hubli	2019206	sharanappaa@kletech.ac.in	7411788464
40	Vinayak N Kulkarni	KLE Tech University, Hubli	2010213	vinayak_kulkarni@kletech.ac.in	9739140050
41	Shankar Gangisetty	KLE Tech University, Hubli	2019214	shankar@kletech.ac.in	9972268022
42	Laxmikant R Patil	KLE Tech University, Hubli	2019229	lrpatil@kletech.ac.in	9448232734
43	Geeta S M	KLE Tech University, Hubli	2019155	geeta@kletech.ac.in	9742685957
44	Krishnaraja Kodancha	KLE Tech University, Hubli	2019168	krishnaraja@kletech.ac.in	9886596953
45	Sridhar Dalal	School of engineering and applied science, Ahmedabad University	2019119	sridhar.dalai@ahduni.edu.in	7567160826
46	Sanjay Chikalthankar		2019100	sbchikalthankar@gmail.com	09890432120
47	Santosh Naik	HITAM Hyderabad	2019100	santoshn.mech@hitam.org	09980299366
48	Prashant Narayankar	KLE Tech University, Hubli		prashant_narayankar@kletech.ac.in	9743167677
49	Dr. Suneeta V. Budihal	KLE Tech University, Hubli	2019219	suneeta_vb@kletech.ac.in	9448821704
50	Ujwala Patil	KLE Tech University, Hubli	2019220	ujwalapatil@kletech.ac.in	8971193624
51	Dr R V Bhortake	Marathwada Mitramandal's Institute of Technology, Lohgaon, Pune, Maharashtra-411047	2019202	principal@mmit.edu.in	9049008003
52	~~Rupesh~~ Shelke	G.H. Raisoni Univ		rupesh.shelke@raisoni.net	9822577198
53	~~Dr Rao~~ Vinod K...	KLE IT		vinit555@gmail.com	9764021522
54	~~Dr Prashant Pawar~~	G.H. Raisoni Inst			
55		of Engg. & Tech. Nagpur			
56	N V Shah	Textile and Engg Dept	231	avssrrr@gmail.com	9270199719
57	Vinayak S. Naik	KLE TU Hubli		vinayak_naikar@kletech.ac.in	9986621206 / 9477970381

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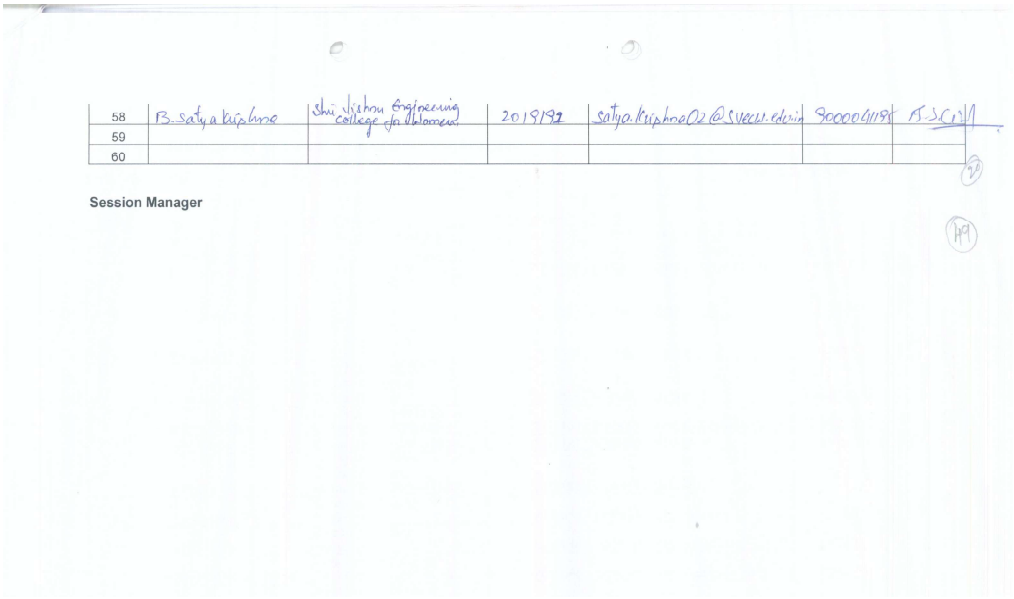

58	B. Satya Krishna	Shri Vishnu Engineering college for Women	2019192	satya.krishna02@svecw.edu.in	9000061198	
59						
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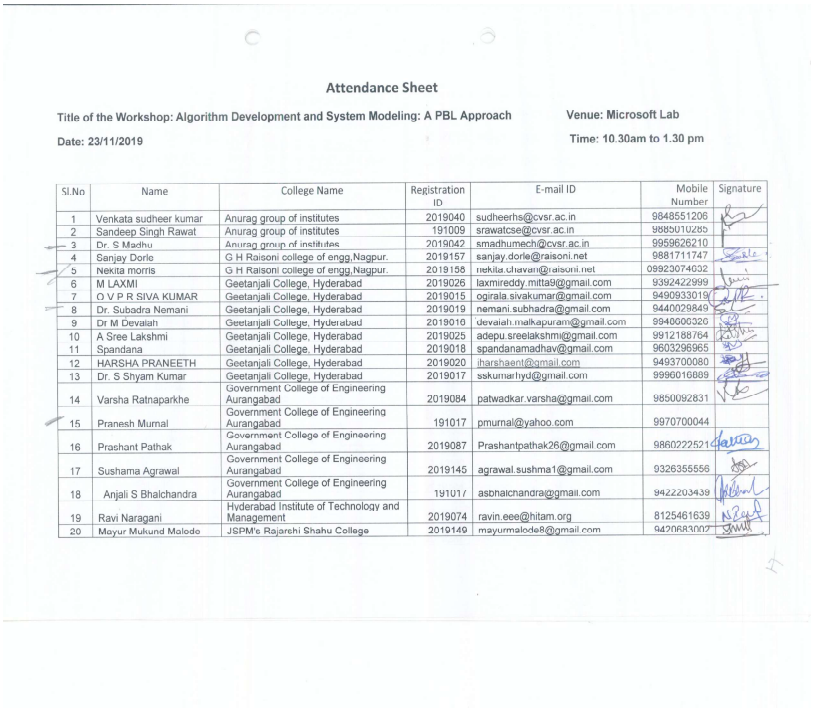

Attendance Sheet

Title of the Workshop: Algorithm Development and System Modeling: A PBL Approach **Venue: Microsoft Lab**

Date: 23/11/2019 **Time: 10.30am to 1.30 pm**

Sl.No	Name	College Name	Registration ID	E-mail ID	Mobile Number	Signature
1	Venkata sudheer kumar	Anurag group of institutes	2019040	sudheerhs@cvsr.ac.in	9848551206	
2	Sandeep Singh Rawat	Anurag group of institutes	191009	srawatcse@cvsr.ac.in	9885010285	
3	Dr. S Madhu	Anurag group of institutes	2019042	smadhumech@cvsr.ac.in	9959626210	
4	Sanjay Dorle	G H Raisoni college of engg,Nagpur.	2019157	sanjay.dorle@raisoni.net	9881711747	
5	Nekita morris	G H Raisoni college of engg,Nagpur.	2019158	nekita.chavan@raisoni.net	09923074032	
6	M LAXMI	Geetanjali College, Hyderabad	2019026	laxmireddy.mitta9@gmail.com	9392422999	
7	O V P R SIVA KUMAR	Geetanjali College, Hyderabad	2019015	ogirala.sivakumar@gmail.com	9490933019	
8	Dr. Subadra Nemani	Geetanjali College, Hyderabad	2019019	nemani.subhadra@gmail.com	9440029849	
9	Dr M Devaiah	Geetanjali College, Hyderabad	2019016	devaiah.malkapuram@gmail.com	9940006320	
10	A Sree Lakshmi	Geetanjali College, Hyderabad	2019025	adepu.sreelakshmi@gmail.com	9912188764	
11	Spandana	Geetanjali College, Hyderabad	2019018	spandanamadhav@gmail.com	9603296965	
12	HARSHA PRANEETH	Geetanjali College, Hyderabad	2019020	iharshaent@gmail.com	9493700080	
13	Dr. S Shyam Kumar	Geetanjali College, Hyderabad	2019017	sskumarhyd@gmail.com	9996016889	
14	Varsha Ratnaparkhe	Government College of Engineering Aurangabad	2019084	patwadkar.varsha@gmail.com	9850092831	
15	Pranesh Murnal	Government College of Engineering Aurangabad	191017	pmurnal@yahoo.com	9970700044	
16	Prashant Pathak	Government College of Engineering Aurangabad	2019087	Prashantpathak26@gmail.com	9860222521	
17	Sushama Agrawal	Government College of Engineering Aurangabad	2019145	agrawal.sushma1@gmail.com	9326355556	
18	Anjali S Bhalchandra	Government College of Engineering Aurangabad	19101/	asbhalchandra@gmail.com	9422203439	
19	Ravi Naragani	Hyderabad Institute of Technology and Management	2019074	ravin.eee@hitam.org	8125461639	
20	Mayur Mukund Malode	JSPM's Rajarshi Shahu College	2019149	mayurmalode8@gmail.com	9420683007	

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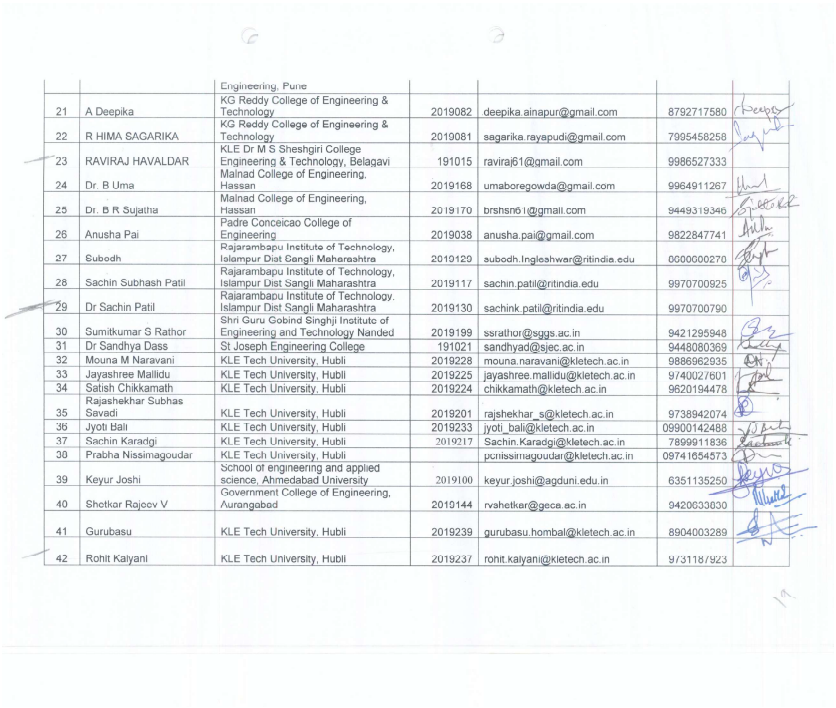

		Engineering, Pune				
21	A Deepika	KG Reddy College of Engineering & Technology	2019082	deepika.ainapur@gmail.com	8792717580	
22	R HIMA SAGARIKA	KG Reddy College of Engineering & Technology	2019081	sagarika.rayapudi@gmail.com	7995458258	
23	RAVIRAJ HAVALDAR	KLE Dr M S Sheshgiri College Engineering & Technology, Belagavi	191015	raviraj61@gmail.com	9986527333	
24	Dr. B Uma	Malnad College of Engineering, Hassan	2019168	umaboregowda@gmail.com	9964911267	
25	Dr. B R Sujatha	Malnad College of Engineering, Hassan	2019170	brshsn61@gmail.com	9449319346	
26	Anusha Pai	Padre Conceicao College of Engineering	2019038	anusha.pai@gmail.com	9822847741	
27	Subodh	Rajarambapu Institute of Technology, Islampur Dist Sangli Maharashtra	2019129	subodh.Ingleshwar@ritindia.edu	0000000270	
28	Sachin Subhash Patil	Rajarambapu Institute of Technology, Islampur Dist Sangli Maharashtra	2019117	sachin.patil@ritindia.edu	9970700925	
29	Dr Sachin Patil	Rajarambapu Institute of Technology, Islampur Dist Sangli Maharashtra	2019130	sachink.patil@ritindia.edu	9970700790	
30	Sumitkumar S Rathor	Shri Guru Gobind Singhji Institute of Engineering and Technology, Nanded	2019199	ssrathor@sggs.ac.in	9421295948	
31	Dr Sandhya Dass	St Joseph Engineering College	191021	sandhyad@sjec.ac.in	9448080369	
32	Mouna M Naravani	KLE Tech University, Hubli	2019228	mouna.naravani@kletech.ac.in	9886962935	
33	Jayashree Mallidu	KLE Tech University, Hubli	2019225	jayashree.mallidu@kletech.ac.in	9740027601	
34	Satish Chikkamath	KLE Tech University, Hubli	2019224	chikkamath@kletech.ac.in	9620194478	
35	Rajashekhar Subhas Savadi	KLE Tech University, Hubli	2019201	rajshekhar_s@kletech.ac.in	9738942074	
36	Jyoti Bali	KLE Tech University, Hubli	2019233	jyoti_bali@kletech.ac.in	09900142488	
37	Sachin Karadgi	KLE Tech University, Hubli	2019217	Sachin.Karadgi@kletech.ac.in	7899911836	
38	Prabha Nissimagoudar	KLE Tech University, Hubli		pcnissimagoudar@kletech.ac.in	09741654573	
39	Keyur Joshi	School of engineering and applied science, Ahmedabad University	2019100	keyur.joshi@agduni.edu.in	6351135250	
40	Shetkar Rajeev V	Government College of Engineering, Aurangabad	2019144	rvshetkar@geca.ac.in	9420633630	
41	Gurubasu	KLE Tech University, Hubli	2019239	gurubasu.hombal@kletech.ac.in	8904003289	
42	Rohit Kalyani	KLE Tech University, Hubli	2019237	rohit.kalyani@kletech.ac.in	9731187923	

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43	VISHWANATH P. BALIGAR	KLE Tech University, Hubli	2019238	vpbaligar@kletech.ac.in	9731841969	
44	Supriya Kulkarni	Government College of Engineering		to.supriya@gmail.com	9822591274	
45	M K Partha	Malnad college of engineering	2019173	mkpartha@rediffmail.com		
46	SUBHASH GULABRAO RATHOD	MARATHWADA MITRAMANDAL'S INSTITUTE OF TECHNOLOGY(MMIT), PUNE	191043	subhash.rathod@mmit.edu.in	9763705600	
47	DR. S.M. SHINDE	GOVT. ENGG. COLLEGE Aurangabad			7588348833	
48	R.RAJA SUBRAMANIAN	Kalasalingam Academy of Research & Education		rajasubramanian.r@klu.ac.in	9003994408	
49	Shivaprasad.N	KLE Tech Uni		S	9740616808	
50	Dr. A. MADHU BABU	madhubabupharmacy@cvsr.ac.in			7799432923	
51	Dr Sanjay Chikarthan	sbchikarthanicar@gmail.com			9890432120	
52	Sachin M Magadum	sachin.magdum@ritindia.edu		sachin.magdum@ritindia.edu	9535479999	
53	—	RIT, Islampur				
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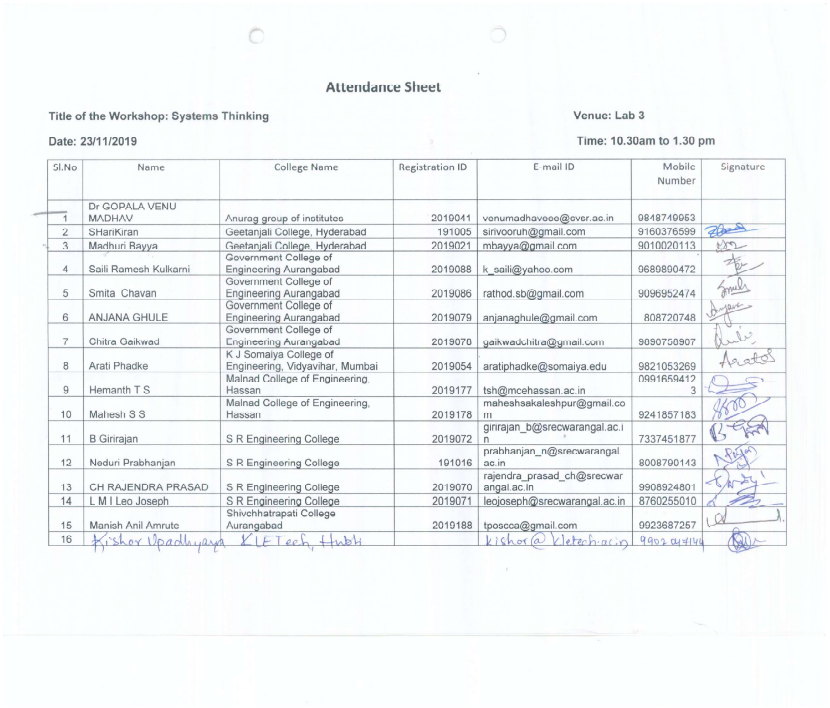

Attendance Sheet

Title of the Workshop: Systems Thinking **Venue: Lab 3**

Date: 23/11/2019 **Time: 10.30am to 1.30 pm**

Sl.No	Name	College Name	Registration ID	E mail ID	Mobile Number	Signature
1	Dr GOPALA VENU MADHAV	Anurag group of institutes	2019041	venumadhavccc@cver.ac.in	0848749063	
2	SHariKiran	Geetanjali College, Hyderabad	191005	sirivooruh@gmail.com	9160376599	
3	Madhuri Rayya	Geetanjali College, Hyderabad	2019021	mbayya@gmail.com	9010020113	
4	Saili Ramesh Kulkarni	Government College of Engineering Aurangabad	2019088	k_saili@yahoo.com	9680800472	
5	Smita Chavan	Government College of Engineering Aurangabad	2019086	rathod.sb@gmail.com	9096952474	
6	ANJANA GHULE	Government College of Engineering Aurangabad	2019079	anjanaghule@gmail.com	808720748	
7	Chitra Gaikwad	Government College of Engineering Aurangabad	2019070	gaikwadchitra@gmail.com	9090756907	
8	Arati Phadke	K J Somaiya College of Engineering, Vidyavihar, Mumbai	2019054	aratiphadke@somaiya.edu	9821053269	
9	Hemanth T S	Malnad College of Engineering, Hassan	2019177	tsh@mcehassan.ac.in	09916594123	
10	Mahesh S S	Malnad College of Engineering, Hassan	2019178	maheshsakaleshpur@gmail.com	9241857183	
11	B Girirajan	S R Engineering College	2019072	girirajan_b@srecwarangal.ac.in	7337451877	
12	Neduri Prabhanjan	S R Engineering College	191016	prabhanjan_n@srecwarangal.ac.in	8008790143	
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Session Manager

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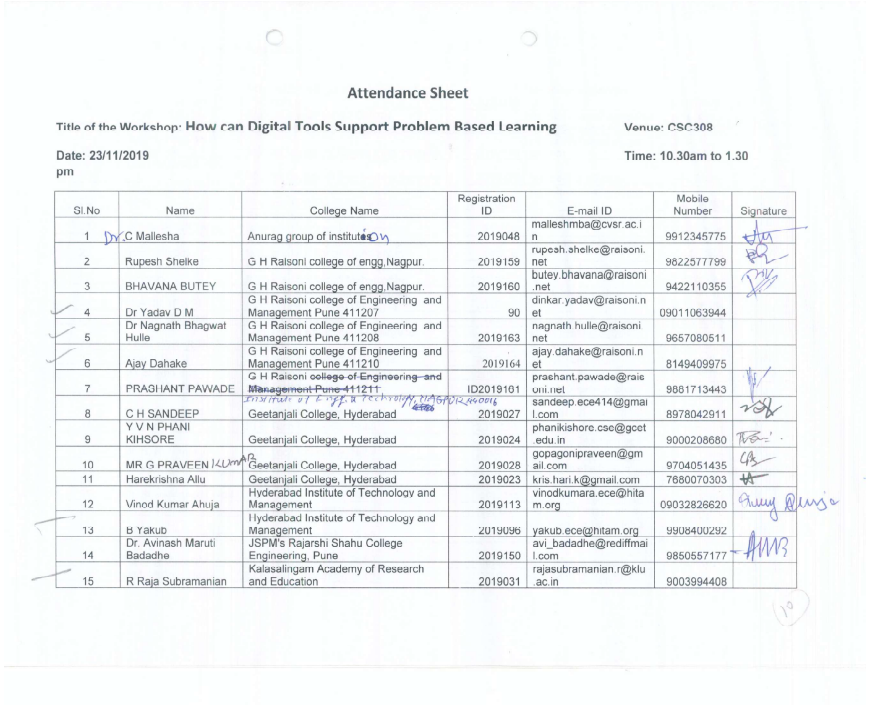

Attendance Sheet

Title of the Workshop: **How can Digital Tools Support Problem Based Learning** Venue: CSC308

Date: 23/11/2019 Time: 10.30am to 1.30 pm

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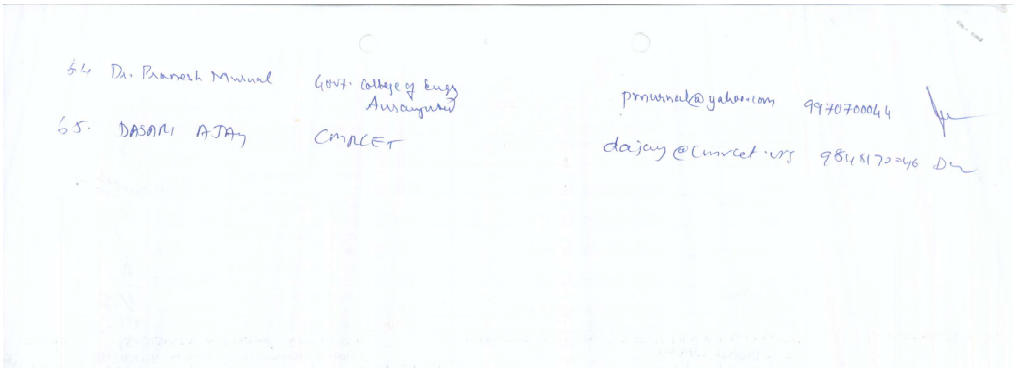

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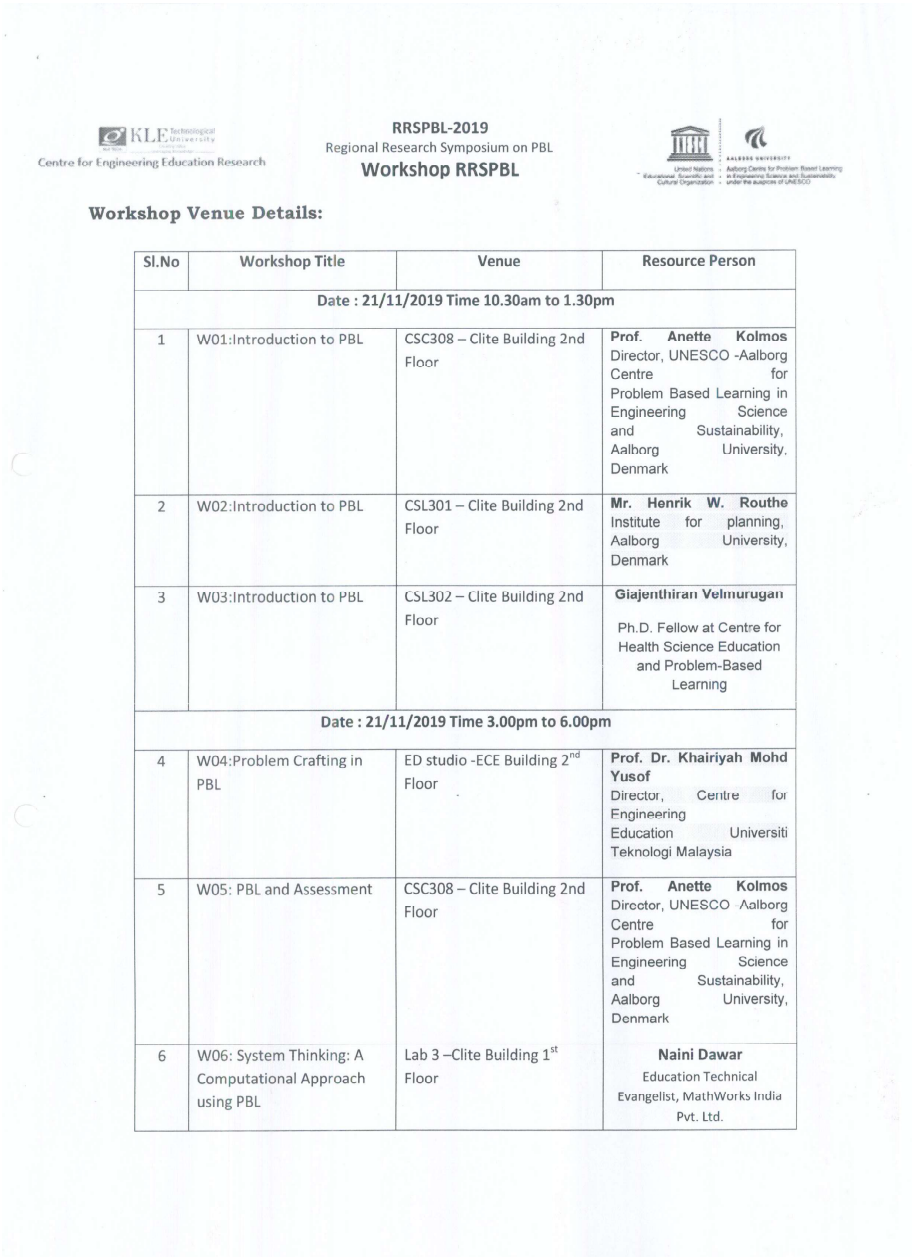

KLE Technological University
Centre for Engineering Education Research

RRSPBL-2019
Regional Research Symposium on PBL
Workshop RRSPBL

Workshop Venue Details:

Sl.No	Workshop Title	Venue	Resource Person
Date : 21/11/2019 Time 10.30am to 1.30pm			
1	W01:Introduction to PBL	CSC308 – Clite Building 2nd Floor	**Prof. Anette Kolmos** Director, UNESCO -Aalborg Centre for Problem Based Learning in Engineering Science and Sustainability, Aalborg University, Denmark
2	W02:Introduction to PBL	CSL301 – Clite Building 2nd Floor	**Mr. Henrik W. Routhe** Institute for planning, Aalborg University, Denmark
3	W03:Introduction to PBL	CSL302 – Clite Building 2nd Floor	**Gajenthiran Velmurugan** Ph.D. Fellow at Centre for Health Science Education and Problem-Based Learning
Date : 21/11/2019 Time 3.00pm to 6.00pm			
4	W04:Problem Crafting in PBL	ED studio -ECE Building 2nd Floor	**Prof. Dr. Khairiyah Mohd Yusof** Director, Centre for Engineering Education Universiti Teknologi Malaysia
5	W05: PBL and Assessment	CSC308 – Clite Building 2nd Floor	**Prof. Anette Kolmos** Director, UNESCO -Aalborg Centre for Problem Based Learning in Engineering Science and Sustainability, Aalborg University, Denmark
6	W06: System Thinking: A Computational Approach using PBL	Lab 3 –Clite Building 1st Floor	**Naini Dawar** Education Technical Evangelist, MathWorks India Pvt. Ltd.

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Regional Research Symposium on PBL

November 22-23, 2019

Organised by

Centre for Engineering Education Research, KLE Technological University, Hubballi, Karnataka (INDIA)

in Collaboration with

Aalborg Centre for Problem Based Learning in Engineering Science and Sustainability under the auspices of UNESCO, Aalborg University, Aalborg (DENMARK)

Edited by

Gopalkrishna Joshi
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Special Issue No.1 November 2019 Volume No.33 eISSN 2394-1707

Message

Prof. Ashok Shettar
Hon. Vice Chancellor
KLE Technological University
Hubballi, India

PBL approach has opened up exciting opportunity for engineering educators to motivate and engage students to develop deep disciplinary knowledge and competencies to meet the demanding needs of engineering profession. Across the world engineering institutions are making attempts to integrate PBL into curriculum to promote authentic learning experience that can bridge gap between theory and practice.

Globalisation of higher education is driving profound changes in Indian engineering education system. In recent years, large number of institutions are looking out for new ideas and innovative methods to engage the students in learning using their autonomy.

Although there is a significant level of interest in Indian Engineering Institutions in adopting active learning pedagogies like PBL, this approach is not yet widespread. Large size of classes, low budgets and lack of expertise are some of the challenges the institutions have to overcome to successfully implement PBL.

There is need to develop a network of practitioners in the region who have got not only sound understanding of concepts of PBL but also exposure to some of the best practices in implementing PBL pedagogy in engineering. It is in this context that Regional Research Symposium on PBL is an important step.

The symposium proceedings are designed to empower engineering education fraternity about PBL. I hope that, understanding the challenges and opportunities in the area will inspire faculty and institutions to experiment and innovate robust approaches that can positively impact engineering education in India and the region.

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Message

Prof. Anette Kolmos,
Director, UNESCO -Aalborg Centre for Problem
Based Learning in Engineering Science and Sustainability,
Aalborg University

The Aalborg Centre for Problem Based Learning in Engineering, Science and Sustainability under the auspices of UNESCO (The Aalborg UNESCO Centre) aim for establishing global and regional network for educators and other stakeholders who want to move engineering education in direction of sustainability and student centered learning. Both student centered learning and sustainability are key elements in creating lifelong capacity building for the individual engineer and qualify engineering graduates for today's challenges.

A key component in change processes is research in terms of documentation, evaluation, comparison with other research results, conceptualizations of new practices and improvements. The Aalborg UNESCO Centre has facilitated international research communities by a series of research symposia on PBL all over the world and we are looking forward to the first Regional Research Symposia on PBL hosted by Centre for Engineering Education Research, KLE Technological University, Hubli, INDIA. It is our hope that this event will become a cornerstone for developing engineering education for employability, sustainability and lifelong learning in India.

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Message

Prof. Gopalkrishna Joshi
Dean (Curriculum Innovation and Program Assessment)
Director, Centre for Engineering Education Research
KLE Technological University,
Hubballi, India

The idea of having a regional symposium on PBL was born during a conversation on the side-lines of 7th International Research Symposium on PBL (IRSPBL) held at Beijing during Oct 19-21 2018. We developed a proposal to have a regional symposium on PBL with the objective of developing a community of PBL practitioners and researchers in the Asia Pacific region and provide a platform for interactions and collaborations. India obviously has lion share in this endeavour because of its size.

PBL as a pedagogic practice in engineering education system needs much wider acceptance and empowerment in the region. Keeping this in mind Regional Research Symposium on PBL is organised. The deliberations of the symposium are designed to inspire and empower engineering educators of the region on PBL practices and connect them with researchers and practitioners for collaborations. Workshops on PBL practices, experience sharing in the form of keynotes form the major part of symposium.

We received a total of 77 abstracts for paper presentation track and we are able to reach the final count of 26 full papers through our peer reviewing process. Most of these papers fall in "best practices" category. All these 26 papers are published as a special issue of Journal of Engineering Education Transformations (JEET).

This symposium is made possible due to enthusiastic collaboration from UNESCO Centre for PBL in Engineering Education and Sustainability, Aalborg University, generous support from TEQIP – Government of India, All India Council of Technical Education and Indo Universal Collaboration for Engineering Education.

We trust that learning and collaborations through this symposium will create a critical mass of PBL practitioners impacting engineering education in the region.

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Content Sheet

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Keynote 1

Prof. Anette Kolmos,
Director, UNESCO -Aalborg Centre for Problem Based Learning in Engineering Science and Sustainability,
Aalborg University

Title : The ugly duckling becoming a swan – a story of PBL in a changing world

Abstract :
H.C. Andersen wrote the famous fairy tale of the ugly duckling. In this keynote the fairy tale will be used to illustrate the history of PBL – from the establishment of the very first reform universities to a widespread and accepted teaching and learning method. During the 80' and the 90' the core research question was if this new pedagogy worked or not. Today the research questions concern the quality of the PBL implementation in an institution – if the implementation strategy has been to implement it in single courses or it has applied in a systemic way, e.g. in a program. Especially the MIT-report on innovation in engineering education illustrate the level of acceptance and systemic curriculum developments.

But for each new institution starting out a new change process, it will be felt like the ugly duckling. There will be resistance, doubts, hope, and courage involved in the process. Academia and disciplines create their own knowledge base, boundaries and culture which very often do not reach out to companies and society where their graduates will be employed. New requirements as the sustainable development goals will have to be addressed in education implicating that there should be curriculum elements relating to society and companies. Variations of PBL can be applied for these purposes by educating engineers to become aware citizens in a more sustainable world. Also, in this respect the PBL turns out to become a swan.

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Keynote 2

Prof. Dr. Khairiyah Mohd Yusof
Director, Centre for Engineering Education Universiti Teknologi Malaysia

Title: Developing 21st Century Educators: How to successfully support faculty members?

Abstract:

The demand for 21st century outcomes in today's graduates result in various initiatives in institutions of higher learning worldwide. These outcomes do not only require the knowledge aspects of upcoming technologies, but also skills and character qualities. While much has been said about the required curricula as well as teaching and learning approaches to develop 21st century graduates, there is not much discussion on developing and supporting educators who can lead, design and implement the required transformation in higher education. This presentation will put forth the need for systematic and systemic support in developing educators who can drive higher education towards meaning change that is required.

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Keynote 3

Prof. Ron Ulseth,
Director, Academics, and Research,
Iron Range Engineering, Minnesota

Title: PBL Innovations through Change: From the Iron Range model to the new Bell model

Abstract:
The Bell program is a new project-based model of engineering education. The learning experience is centered on students working directly in industry through engineering apprentice (cooperative education/internship) employment. Students will work in industry, completing projects, for the last two years of their education while being supported in their technical and professional development by professors, facilitators, and their peers through use of digital communication. This new model focuses on learning being more imbedded in professional practice, in contrast to the more traditional model of engineering, where the learning about the profession is done in the abstract of a classroom. The innovative new model focuses on the development of transversal competences, a new set of teacher roles in PBL, industry-university collaboration, curricular design, continuous evaluation of practice, use of e-learning, and the students' learning processes. This presentation will describe the new model as well as the Iron Range Engineering program from which the Bell program is emerging. IRE has recently won the ABET Innovation Award (2017) and been named a top 5 emerging world leader in engineering education by the 2018 MIT Report, "Reimagining and rethinking engineering education."

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Keynote 4

Dr. Jens Myrup Pedersen,
Associate Professor,
Aalborg University

Title : PBL in a Digitised World - Opportunities and Challenges

Abstract :

Digital technologies are changing the way learning happens at universities: Students find online materials to support their learning, and digital tools are integrated into university courses. From a PBL perspective, digitisation has a strong potential: For example, problem based project work can benefit from digital learning resources that are available for the students when they need it, which allows for tailoring the content and the timing to each project group. Digital tools also facilitate collaboration in groups, even across distance. This talk will present an ambitious change project at Aalborg University, and include real-life examples to demonstrate opportunities and challenges.

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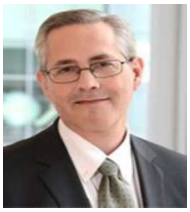
Keynote 5

Xavier Fouger
Senior Director, Learning Centers and Programs.
Dassault Systemes – Learning Experience



Title : New playgrounds for PBL

Abstract **:**
The trend towards digital "platformization" in industry, the ever enlarging scope of real time interactions across stakeholders in innovation projects, increasingly call for engineering graduates who are well train in interacting productively with colleagues in various disciplines. Project centric learning is an instrument of choice to develop this talent in students. New trends, such as the emergence of industry-inspired learning centers multiplies occasions for students to be involved in more authentic learning projects. The presentation provides an overview of this remarkable evolution, illustrated by examples from various countries.

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Improving Program Outcome Attainments Using Project Based Learning approach for: UG Course - Mechatronics

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Abstract: In the era of rapidly emerging technical society, engineering aspirants must be primed as globally competent. To respond, in recent years, inclusive reforms are being implemented to adopt Outcome-Based Education (OBE) approach and transform engineering education in India. The 12 Program Outcomes (POs) defined by NBA guides for development, execution & delivery of curriculum, evaluation of student learning and performance at various levels. The scope of mechatronics subject at colleges affiliated to Savitribai Phule Pune University (SPPU) in 2015 course was mostly restricted to theoretical and study approach, which do not exhibit involvement of students in creative, inventive and innovative thinking. This motivates to adopt Project Based Learning (PBL) at undergraduate level. Three large classes of 70+ students are grouped in to 3-5 students per batch. Project phases are defined; direct and indirect assessments are mapped with outcomes and it is carried out using pre-and post-intervention survey of students. It is observed that, the presented PBL framework has served as an efficient pedagogy. This approach not only ensured holistic development, teamwork, sustainability, improved higher-order cognitive skills, learning ability, soft skills, self-efficacy and communication but also accumulated near about 60 innovative prototypes in a mechatronics laboratory. It is projected that, PBL could enable students to acquire lifelong learning to tackle new difficulties arise in corporate/non-corporate life, thinking on future modification, filing a patent, converting prototype into commercial product.

Keywords: Program Outcomes, Project-Based Learning, Mechatronics.

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1. Introduction:

The engineering students must be prepared to be globally competent in view of rapid growing technical community. To respond, in recent years, inclusive reforms are being implemented to adopt Outcome-Based Education (OBE) approach and transform engineering education in India. OBE helps to execute higher-order learning and professional skills which are essential for Graduate Trainee Engineer (GTE) in the industry [1-2]. The 12 Program Outcomes (POs) defined by NBA guides for development, execution & delivery of curriculum, evaluation of student learning and performance at various levels. [3].

Specifically, a base aptitude is to be nurtured to engineering students and is achieved by strategic procedure, methodical analysis and testing of design solutions preceding execution. It is this body of knowledge – the practical, technical discipline of complex problem solving – that is most germane to a student's post-university working life. The ability to solve problems systematically, without guidance, is broadly applicable to engineering in many contexts in mechatronics and beyond [4].

In that context, a Project-Based Learning is considered to be the best platform for the students to attain noteworthy profundity of comprehension of ideas, more extensive information base, improved correspondence and relational/social aptitudes, upgraded authority abilities, expanded innovativeness, and improved composition abilities [5]. This paper advocates the use of PBL as a key pedagogical method for teaching a Mechatronics course in curricula of Third year-Mechanical Engineering (TE-ME), Savitribai Phule Pune University, Pune. The scope of mechatronics subject of TE-ME (2015 course) at colleges affiliated to SPPU was mostly restricted to theoretical and study approach, which do not exhibit involvement of

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students in creative, inventive and innovative thinking [6]. To bridge the gap in teaching-learning process for the said course, PBL approach is recommended. Recently, as per 2019 pattern of First Year Bachelor of Engineering Choice Based Credit System, course named 'Project Based Learning (110013)' is included for all first year engineering branches.

In first semester of academic year 2018-19, a different approach for teaching Mechatronics subject was employed, in which innovative design tasks were presented within the scheme – that is, the essence of the pedagogical approach in theory period and laboratory work – of project based learning. The students were introduced to the project based learning approach by educating them in development of problem to reach to the solution. The students are expected to undertake both the team-work gaining-by-dealing with dynamic, along with implication of the technical procedures and self-coordinated learning of problem based learning. The problems assigned are inferior to project layout itself, permitting students to adopt flexible methodology to achieve the objective in accordance with highest skill level and level of attainment. Hence PBL helps students to attain most of POs at high level [7-9].

This paper describes the framework of PBL for Mechatronics course, particularly, which is offered at third year mechanical engineering programme of SPPU. The effectiveness of use of PBL methodology to attain course outcomes (COs) and programme outcomes (POs) is presented here. Section1 introduces need and applicability of PBL as an effective pedagogy for Mechatronics course. Section 2 briefs about general design of PBL scheme. The construction of class and evaluation is given in section 3. In the 4th section, a case study incorporating the PBL scheme is elaborated to showcase the evidence of success. The 5th section includes detailed results and discussion. A conclusion is stated at the end of the paper.

2. Design of PBL scheme

The multi-dimensional features of PBL scheme include target-driven, adaptable, multi-resolutioner, gradual attainment, self-contained to tolerate failure etc. As far as the mechatronic domain is concern, it initiated with the goal of implementing multi-resolutions and reflected as self-explanatory due to target-derived approach. Adaptability of the scheme implies a venture where the objectives and methodology for achieving aim might be effectively altered or acclimated to comply with emerging aptitude levels or class targets. Multi-resolutioner describes how to organize the objective to allow a few (or unbounded) parallel arrangements that might be disparate from a desired or determined solution. Self-contained to tolerate failure explicitly gratifies the structure of mechatronic control system design and interface strategy, where minor mistakes may lead to can generous forfeit [10-11].

Three large classes of 70+ students are grouped in to 3-5 students per batch. Project phases are defined as; Identification of problem statement, literature review to find out research gap, Methodology proposal, Mechanical design, Electronic system design, Theoretical approach/numerical analysis, Software simulations, Mechatronic Integration, Prototype demonstration, delivery, service and repairs. In this PBL approach students are motivated to serve as a practical, productive in the learning, progressing in the direction of fulfilling one or more problem statements. The project tilted 'Development of Arduino based compact size pesticide spraying drone', 'Arduino based 3D Wire Bending Machine', 'Arduino based Robot Arm with Smartphone Control', 'Arduino based Robot Car with Wireless Control', Arduino based RFID Door Lock', 'IoT Based Patient Monitoring System using ESP8266' and 'Arduino Interface of MEMS sensors and Arduino for developing data loggers for temperature, acceleration, noise, power consumption, fluid flow' etc. were allotted to various groups as given in Annexure II.

The scheme proposed in this paper, differs from the classic theme as in implementing the PBL not only by demonstrating the prototypes but also with intention of holistic development of students and corresponding deliverables to the society. Within the context of a project/problem-based framework, specific well-scoped challenges were introduced to assess students based on additional aspects such as Budget, Quality of report, Communication, confidence, Application in terms of real time implementation, Publications, Appreciations if any for inspiring students to locate their degree of accomplishment.

3. Construction of class and Evaluation

Construction of class and evaluation are considered as the direct indicators and reflects how effectively PBL based system plan is executed. The problem statement of the project sets an end point for the students; many students might be relied upon prioritising marks over the educational objectives. Evaluation, consequently, ought to interlace, one to prove that PBL offers high quality and the procedure of appraisal is itself influential. In PBL based system configuration, class (where group cooperation and synergistic improvement techniques are to be focused) this fundamentally requires stability between the team work and individual evaluation.

The evaluation comprises of specialized technical reporting procedures to assess and analyse project growth (for example weekly reviews, presentations and report notes), which intent to furnish the student with a progressively certified instructive experience (that is, to be proportionate with expert designing practice) and acclimate them with modern procedures, both in on paper and verbal medium. The evaluation is incorporated to correlate objectives and efforts with the deliverables using pre-and post-intervention survey of students. The COs and POs for

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mapping to evaluation are as follows:

The COs of Mechatronics defined by SPPU is [6]:
At the end of course, graduate student will be able to:

1. Identify of key elements of mechatronics system and its representation in terms of block diagram
2. Use the concept of signal processing and interfacing systems such as ADC, DAC, digital I/O
3. Analyze interfacing of Sensors, Actuators using appropriate DAQ micro-controller
4. Analyze system model in Time and Frequency domain (for control application)
5. Install PID control on real time systems
6. Develop prototype for real life application

The POs defined by NBA are [3]:
At the end of program, graduate student will be able to:

1. Engineering Knowledge
2. Problem Analysis
3. Design/development of solutions
4. Conduct investigations of complex Problems
5. Modern tool usage
6. The engineer and society
7. Environment and sustainability
8. Ethics
9. Individual and team work
10. Communication
11. Project management and finance
12. Life-long learning

3.1 Direct Assessment

The direct assessment of the projects is carried our using aspects and respective evaluation scheme as stated in table 1. The rules were designed considering the CO of mechatronic course stated by SPPU and PO by NBA. The industry and academic expert team was designated for direct assessment of the projects. The students were asked to prepare PPT presentation for conducting the assessment along with the prototype demonstration. The performance evaluation is done using the scale of 100. The below expectation project were rated to < 40%. The projects meeting to the expectations were rated from 40% to 75%. The projects above expectations were rated > 75%. The performance indicators are stated in Annexure I.

Table 1: Rubric used for direct assessment

S.N.	Assessment aspects	CO	PO
1	Feasibility of methodology	6	7
2	Mechanical design	1,3	3
3	Electronic system design	1,3	3
4	Theoretical /numerical analysis	2,4	2
5	Use of software/simulations	2,4	5
6	Selection of various components	1,3	1
7	Mechatronic Integration	2,3,4,5	1
8	Prototype demonstration	6	3
9	Aesthetic and ergonomics considerations	6	3
10	Experimentation, testing and calibration, validation	6	3
11	Interpreting the results, conclusion	6	3
12	Budget	NA	11
13	Quality of report	NA	11
14	Communication, confidence	NA	10
15	Application in terms of real time implementation	6	7
16	Publications, appreciations	NA	6

3.2 Indirect Assessment

The indirect assessment is carried out by students survey post the PBL activity. The students were asked to rate themselves for self-assessment to check the satisfaction level and to attain the POs. The survey is carried out by using the aspects stated in table 2. The linkage of various aspects with the COs and POs is presented in the same table. This is helped in attaining the outcomes at course and program level. The performance evaluation is done using the scale of 100. The rating below 40% indicates 'strongly disagree', 40 to 75% indicates 'somewhat agree' and above 75% indicates 'strongly agree'.

Table 2: Rules used for indirect assessment

S. N.	Aspects	CO	PO
This activity enriched my technical abilities by:			
1	Reviewing the existing scenario to identify functional gap	1	1,4
2	Fulfilling defined problem statement	1	1
3	Fulfilling pre-defined objectives	1	1,4
4	Identifying the need of problem statement	1	6
5	Identifying the methodology	1,2	2,3
6	Analyzing the problem using software/simulations	2,4	5
7	Identifying various components required for developing prototype of mini project	1	2,3
8	Applying use of sensors, actuators	1	1
9	Reviewing the construction and working of sensors, actuators	1	1
10	Selecting various components w.r.t to required specifications	1	1
11	Developing interface of hardware and software	3,5,6	1
12	Developing the prototype	3,5,6	3
13	Performing the testing and calibration of prototype, validation	3,5,6	3
14	Interpreting the results, finding conclusion and learning from failures if any	3,5,6	3
15	Identifying and applying aesthetic and ergonomics considerations	1	6,7

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This activity enriched my project-management abilities by:			
1	Leading the team, inspiring others, setting the vision	NA	9
2	Negotiating the people and resolving conflicts by finding the win-win scenarios	NA	9
3	Employing scheduling, time planning for delivering desirables more successfully	NA	11
4	Formulating and implementing of resource planning	NA	11
5	Learning the finance, budgeting, costing, auditing	NA	11
6	Executing risk management	NA	11
7	Identifying pros and cons of solutions to problems and hence critical thinking	NA	11
8	Improving communication, confidence, willpower	NA	10
9	Learning quality management	NA	11
10	Identifying the real-world application & open-ended nature of the project motivated me	NA	6,7,12
This activity enriched curricular vitae/profile by:			
1	Applying thought process of converting a prototype into commercial product	NA	6,7
2	Participating in competition	NA	6
3	Filling of a patent	NA	6
4	Publishing journal papers	NA	6
5	Presenting work in conferences, workshops	NA	6
6	Organizing training programs	NA	6
7	Starting the consultancy	NA	6

4. Case study

The list of projects allotted to number of groups is given in Annexure II. The link of this assignment was shared to the students on webpage. One of the project as case study is discussed here. The project titled 'Development of low cost vibration monitoring system using open source hardware and software [12-15].

- *Title:* Development of low cost vibration monitoring system using open source hardware and software
- *Need:* Vibration analysis is important aspect in machine condition monitoring and is used for predicting and quantifying a significant change in process parameters which leads to failure.
- *International/national status:* Many types of vibration analysers are available for health monitoring of a machine but the overall cost is very high and may not be affordable to all.
- *Motivation:* In an era of low cost instrumentation it necessitates to develop a low cost system which will fulfil the entire requirement.
- *Problem statement:* To develop a vibration monitoring system which is easy to handle, low cost and has good accuracy during its life cycle.
- *Objective:* To display time and frequency domain graph to analyse trend of frequency.
- *Methodology:* To identify requirement of system in terms of specifications, identify sensor, microcontroller, find suitable software, design and simulate program, develop system, test, calibrate, conclude.
- *Selection:* A low cost microcontroller Arduino Mega 2560 is used here along with accelerometer ADXL335 and is integrated with MS-Excel to store & display the acquired data.

- *Mechatronic integration and prototyping :*

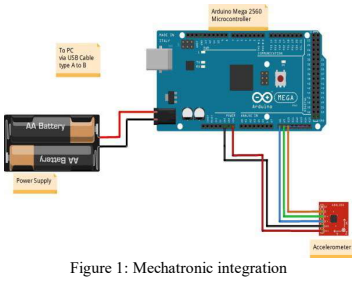

Figure 1: Mechatronic integration

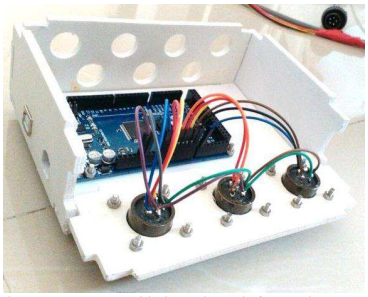

Figure 2: Prototype with three channels for accelerometer

- *Programming:* The programming to acquire data in MS-Excel, two software were used such as Arduino IDE and PLX-DAQ. The conversion of

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time domain response to frequency domain is carried out in Excel using FFT command in data analysis tool.

- Experimentation, validation: The system was experimentally tested on a cam jump apparatus at various speeds. The results (time domain and frequency domain responses) were recorded for each reading. The system is calibrated with existing system and was found to have an accuracy of 98.93%.
- Publication/appreciation: This group of 4 students attended and presented paper in national conference named 'National Conference on Research and Development in Mechanical, Electronics and Civil Engg (NCRDMECE-2018)' held at Pune in February 2018.

5. Result and discussion

The direct and indirect assessment is carried out using rules stated in section 3 for all the project groups (total 60). The result of direct assessment is shown in table 3.

Table 3: Result of direct assessment

SN	Assessment aspects	Expectation scale (No of groups out of 60)		
		(< 40%)	(40-75%)	(> 75%)
1	International and national status of the project	5	40	15
2	Need of the problem statement	12	37	11
3	Feasibility of methodology	8	44	8
4	Mechanical design	4	48	8
5	Electronic system design	2	40	18
6	Theoretical approach/ numerical analysis	10	42	8
7	Use of software /simulations	2	45	13
8	Selection of various components	0	45	15
9	Mechatronic Integration	2	48	10
10	Prototype demonstration	10	40	10
11	Aesthetic and ergonomics considerations	25	29	6
12	Experimentation, testing and calibration, validation	18	32	10
13	Interpreting the results, conclusion	20	32	8
14	Budget	2	50	8
15	Quality of report	30	20	10
16	Communication, confidence	15	35	10
17	Application in terms of real time implementation	14	30	16
18	Publications, appreciations	30	25	5

The result of indirect assessment is shown in table 4:

Table 4: Result of indirect assessment

SN	Aspects	Satisfaction scale (No of groups out of 60)		
		(< 40%)	(40-75%)	(> 75%)
This activity enriched my technical abilities by:				
1	Reviewing the existing scenario to identify functional gap	2	42	16
2	Fulfilling defined problem statement	12	33	15
3	Fulfilling pre-defined objectives	10	35	15
4	Identifying the need of problem statement	15	32	13
5	Identifying the methodology	6	45	9
6	Analyzing the problem using software/simulations	0	46	14
7	Identifying various components required for developing prototype of mini project	0	44	16
8	Applying use of sensors, actuators	2	40	18
9	Reviewing the construction and working of sensors, actuators	4	39	17
10	Selecting various components w.r.t to required specifications	5	40	15
11	Developing interface of hardware and software	5	35	20
12	Developing the prototype	10	35	15
13	Performing the testing and calibration of prototype, validation	15	33	12
14	Interpreting the results, finding conclusion and learning from failures	18	34	8
15	Identifying and applying aesthetic and ergonomics considerations	28	24	8
This activity enriched my project-management abilities by:				
1	Leading the team, inspiring others, setting the vision	5	15	40

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2	Negotiating the people and resolving conflicts by finding the win-win scenarios	10	24	26
3	Employing scheduling, time planning for delivering desirables more successfully	15	30	15
4	Formulating and implementing of resource planning	10	28	22
5	Learning the finance, budgeting, costing, auditing	1	25	27
6	Executing risk management	6	32	22
7	Identifying pros and cons of solutions to problems and hence critical thinking	12	38	10
8	Improving communication, confidence, willpower	20	35	5
9	Learning quality management	8	36	16
10	Identifying the real-world application & open-ended nature of the project motivated me	16	30	14
This activity enriched curricular vitae/profile by:				
1	Applying thought process of converting a prototype into commercial product	12	32	16
2	Participating in competition	35	20	5
3	Filling of a patent	40	12	8
4	Publishing journal papers	30	24	6
5	Presenting work in conferences, workshops	25	25	10
6	Organizing training programs	50	8	2
7	Starting the consultancy	39	15	6

The overview on the results inferred that both the mechatronic theory course and the PBL approach assisted students to enhance their aptitudes in regards of mechatronic domain. The results are self-explanatory and self-evident. It confers that specific objective of the course is being satisfies for most of the aspirants. The PBL is served as an proficient framework as it not only ensured holistic development, teamwork, collaboration, sustainability, improved higher-order cognitive skills, learning ability, soft skills, self-efficacy and communication but also accumulated near about 60 innovative prototypes in a mechatronics laboratory. What's more, PBL could enable students to acquire lifelong learning to tackle new difficulties arise in corporate/non-corporate life, thinking on future modification, filing a patent, converting prototype into commercial product.

5. Conclusions

This paper described the framework of PBL for Mechatronics course, particularly, which is offered at third year mechanical engineering programme of SPPU. The outline of the general PBL frameworks design is presented. Also the construction of class and evaluation which influence the project-problem scheme is elaborated. A case study incorporating this scheme is elaborated in detail as a evidence of success. The report of PBL outcomes using direct and indirect approach is presented. In the era of low cost instrumentation, this approach has become realistic due to the advances in MEMS technology, open source hardware and software etc. The cheering response from the students demonstrates that the application of PBL is a effective pedagogy to make our students ready to be globally competent. The students' involvement is raised to such level that they are thinking on future modification, filing a patent, converting prototype into commercial product etc.

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Annexure I

Performance indicators for assessment:

Sr. No.	Assessment aspects	No. of groups		
		Below expectations (below 40%)	At expectations (40-75%)	Above expectations (above 75%)
1	International and national status of the project	No literature review exists/No comparison with existing systems. No research gap exists.	Some of the aspects compared with existing systems. The solution may address the research gap for some of the aspects.	The problem has been recognized, researched, solved previously by other approaches. There exists research gap. The current problem addresses the research gap.
2	Need of the problem statement	Poor SWOC analysis	Average SWOC analysis	Perfect SWOC analysis
3	Feasibility of methodology	The methodology is doubtful to address the objective.	The methodology is certainly to address the objective.	The methodology is greatly to address the objective.
4	Mechanical design	Poor use of mechanical design principles	Partial use of mechanical design principles	Exact use of mechanical design principles
5	Electronic system design	Poor use of electronic design principles	Partial use of electronic design principles	Exact use of electronic design principles
6	Theoretical approach/numerical analysis	No execution of Theoretical approach/numerical analysis	Limited execution of Theoretical approach/numerical analysis	Proper execution of Theoretical approach/numerical analysis
7	Use of software/simulations	Fails to use software/ No simulations	Software programming partially executes the required output/ Simulations are average.	Correct designs of algorithms and implementation using software/ presented simulations
8	Selection of various components	Incorrect selection of components	Some of the components were selected as per requirement	Perfect selection of components as per required specifications/design
9	Mechatronic Integration	Fails to integrate various parts	Partially integrates the various parts	Accurately integrates the various parts
10	Prototype demonstration	No prototype developed	Limited working of the prototype	Prototype satisfies the defined objective
11	Aesthetic and ergonomics considerations	Aesthetic and ergonomics considerations were not considered	Some aesthetic and ergonomics considerations were employed	Professional consideration of Aesthetic and ergonomics aspects
12	Experimentation, testing and calibration, validation	Poor experimentation ability/ No calibration/ No validation	Carried experimentation but failed to calibrate and validate	Experimented, tested, calibrated and validated the model accurately
13	Interpreting the results, conclusion	Wrong results/ No conclusion	Partial results are correct but not reliable Limited conclusion	Correctly interpret the results and conclusion meets the objective
14	Budget	Poor	Average	Perfect
15	Quality of report	No report/Poorest quality	Satisfactory	Professional
16	Communication, confidence	Lack of Communication, confidence	Somewhat likely to communicate with average confidence	Sound communication with full of confidence
17	Application in terms of real time implementation	Fail to implement in real time application	Likely to implement in real time application	Perfect for implementation in real time application
18	Publications, appreciations	Fail to publish, present it to others	Neutral about presentations and publications	Presented and published in conference/journal Participated in competition

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Adding element of competition to Multi-disciplinary PBL: Case study of Robocon Competition

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Abstract: Project-based learning (PjBL) is a variation of Problem-Based Learning where learners are provided with specifications for a desired end product and the learning process is more oriented to following appropriate procedures leading to successful project. Technical competition such as Robocon poses a similar challenge to the students as encountered in a typical PjBL exercise with one unique differentiator, namely, an element of competition. We make and test the hypothesis in this paper that this differentiator adds a great value to PBL/PjBL in terms of outcomes attained and skills acquired. Research questionnaire for testing this hypothesis was designed and is shared. Survey results show that competition boosts the level of student engagement in the learning experience and participant's employability potential. It also helps in attaining crucial program outcomes such as solving complex engineering problems, being able to engage in self-learning and working in a multidisciplinary team. The study also offers an insight in how learning in a team happens when the team is focused on winning a competition. The survey results from this case study make it clear that competition-based PjBL has great potential to prepare industry-ready students in terms of their technical aptitude as well as positive attitude. The paper makes a strong argument to find ways in which element of competition can be added to regular PjBL exercise to boost its established outcome attainment potential.

Keywords: Problem Based Learning, Technical Competitions, Student Engagement, Engineering Education, Robocon, Project Based Learning

1. Background:

PBL has been gaining ground in India as an accepted delivery method in engineering education very recently. With a few exceptions, engineering pedagogy in India has remained mostly traditional and restricted to passive Learning of students that comes with classroom teaching. Industry has been ever complaining about the poor outcomes of this system. Nearly all employability surveys show that hardly 10-25% engineering graduates are employable [1][2]. Industry values Analytical thinking and innovation, complex problem-solving, critical thinking and analysis, active learning and learning strategies, creativity, originality and initiative, attention to detail, and trustworthiness [3]. It is encouraging to note that professional societies led by industry have been supporting Technical Competitions over past 15 years. These are essentially multidisciplinary team events of highly competitive nature where the competitors are challenged with a task to be completed under variety of constraints. Robocon is an example of such competitions supported by industry to promote the inculcation of skills required by industry. It is one of the premium robotics competitions in Asia-Pacific region and it has gained national importance in India. In this paper we have studied effectiveness of this technical competition from viewpoint of attaining crucial program outcomes by posing it as a case study in multidisciplinary PBL.

Since PBL's conception in medical education nearly 50 years ago by Barrows it has been employed in many learning and teaching contexts with varying success. The 'elastic' quality of PBL has allowed for different types and culturally variant versions of PBL with associated challenges and successes in implementation [4]. It is in vogue for over 30 years and being practiced in multiple disciplines. Project-based learning (PjBL) is a variation of problem-based learning in that the learning activities are organized around achieving a shared goal stated in form of a project [5]. In PjBL, learners are provided with specifications for a desired end product and the learning process is more oriented to following appropriate procedures leading to successful project. Technical competition such as Robocon [6] poses a similar challenge to the students as encountered in a typical PjBL exercise with one unique differentiator, namely, an element of competition. We hypothesize here that this differentiator adds value to PBL/PjBL in terms of outcomes achieved

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and skills acquired. Though there exist studies in competitions as source of learning [7][8][9], we hardly come across a study based on Indian data and with a focus on crucial program outcomes. This paper is an attempt to fill in this gap.

2. Choice of Robocon as a case study

Robocon is organized by Asia-Pacific Broadcasting Union (ABU), a conglomerate of over 20 countries of Asia Pacific Region.[6] The broadcasters of each participant country are responsible for conduct of their national contests to select the team which will represent their country in the International Contest. In India, Doordarshan, the national public service broadcaster organizes National Robocon event every year. First Robocon was held in 2002, in which only 3 teams had participated at IIT Kanpur. Going from strength to strength, this number has reached 66 in Indian National Robocon 2012 and 107 in 2018.

Competition has different themes each year, but generally they revolve around a theme of completing the specified task by two or more robots in an arena. One of the robots is manually controlled while the others are automatic. Teams need to have knowledge in programming, mechanical design, electronic circuit design, sensors etc and they need to work within constraints to win the competition.

3. Research Objectives:

Though Robocon task poses an open ended problem to the student team much like in PjBL, it is not consciously designed by its organizers as academic learning experience. At the same time, its effectiveness in attaining the crucial program outcomes for which PjBL is designed, appears to be no less in comparison with any other PjBL. We explore here the hidden aspects of its success, especially its appeal to the students that results in high student engagement level as also the particular outcomes being attained through this engagement. To this end, we formulate our research objectives as follows:

1. To identify the level of student engagement as also the key factors responsible for the same
2. To explore the role, if any, Robocon played in enhancing employability
3. To test the hypothesis that the following crucial program outcomes are attained at the highest level through Robocon:
   a) Ability to solve complex engineering problems
   b) Ability to be effective team member
   c) Ability to engage in self-learning
   d) Enhance communication skills
   e) Ability to manage an engineering project
4. To gain insight in how learning happens in a goal oriented team of students and to gain insight in natural scaffolding pathways in technical competitions
5. To explore in what way the learning based on this case study can add value to existing practices in PjBL as well as to explore effectiveness of such technical competitions as a valuable learning experience

4. Methodology

We chose to survey a sample of nearly fifty students picked up from nearly 250 students that participated in Robocon from our institute over last 16 years. Survey questionnaire (see Table 1) was designed so as to gather qualitative and quantitative data for analysis in order to meet the above stated research objectives. The questionnaire contained both qualitative open-ended (for Objectives 1 and 4) as well as quantitative close-ended questions (for Objectives 2 and 3).In interpretation of qualitative data, we have used empathic approach [10] where the aim is to get closer to the intended meaning of a text while using quantitative data we relied on conventional statistical methods.

Table 1. Survey Questionnaire

1	Name
2	Branch
3	Robocon Participation Year
4	How strongly will you rate Robocon as a memorable experience from your college days? (on Scale of 1-5)
5	Briefly describe your role in Team Robocon
6	Based on your recall, how well can you describe your own Robocon experience as-(on Scale of 1-5)
	Creative
	Learning
	Technical Challenge
	Project management
	Any other
7	In your opinion, to what extent following abilities are developed through Robocon? (on Scale of 1-5)
	Developing innovative ideas
	Completing project under constraints
	Working in a team
	Communication skills
	Self-learning
	Working on multidisciplinary issues
	Goal orientation
8	It is believed that knowledge sharing with seniors, juniors, and peers plays an important role in Robocon. Describe your experience.
9	Can you give an approximate estimate of time spent in Robocon in hours? Do you think you would have learnt more/less if you had spent the same time on conventional learning tasks?
10	What was your first placement /higher education?
11	Did your participation in Robocon have any role to play in your first placement or your Post-graduate admission? (on Scale of 1-5)
12	Please give elaborate comment on Q. 11 if the rating is 3 and above.
13	Please write your comments that will help us understand Robocon as a learning experience.

5. Results and Discussion

Out of approximately 250 students, 50 students were selected for collecting data. The results given below are premised upon 26 responses actually received by us.

A. Objective 1

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From the survey it is evident that students worked on an average 14-15 hours per day in Robocon laboratory for about 4-6 months of their respective Robocon year of participation. This is a strong indicator of level of student engagement in the project. In a very sharp contrast, students explicitly stated that learning in conventional classes is much less and does not offer any challenges. As against this, technical challenges and need to find viable solutions for winning the competition made them more inquisitive and research oriented. It is to be noted here that Robocon students engage in all the necessary laboratory work without any faculty intervention and take full responsibility of the project. In response to Q6 in the survey questionnaire which prodded them to select a two word phrase describing the lasting impression of Robocon competition with a weightage on a scale of 1 to 5, the overall order of preference calculated over all the twenty six responses came out to be Creative Experience > Learning Experience > Project Management >Technical Challenge. It is clear from the survey that students tend to be completely immersed in a learning experience when it challenges their creativity in order to solve a given problem in the best possible way and thus leading to a win. Another reason for high level engagement in Robocon seems to be lying in its team selection process which is very stringent and entirely designed and executed by students. Only highly motivated students become members and this ensures very high level of student engagement.

B. Objective 2

93% of the students surveyed have stated that Robocon had a major role in securing good employment as well as admission to higher studies. With an exception of one candidate out of twenty six surveyed, who has joined a family business, all other students have secured campus placements in core discipline industries or an admission to higher education institutions of international repute. Students have specifically mentioned that recruiters are more interested in projects (practical work) done by students once the academic criteria is met with. Many of the placement interviews were entirely based on the role played by them in Robocon project competition. It is also clear from the responses that apart from the technical skills gained during the project, the positive problem solving attitude imbibed by the students makes them more employable.

C. Objective 3

As per the perception of all the surveyed participants, abilities to develop innovative ideas, project completion within constraints, team work, working on multidisciplinary issues, self-learning and goal orientation were highly developed. Only 64% candidates opined highly in favor of development of communication skills. This result can be attributed to the nature of the Robocon competition described earlier which does not lay great emphasis on report writing or technical presentation and hence is not a part of learning experience that is offered through Robocon.

D. Objective 4

Knowledge transfer and building up on experience to upgrade products and performance has always been an essential part of any engineering project. Students have shared their experience of knowledge sharing very candidly and they clearly mention its importance in achieving success in the competition. Natural scaffolding and mentoring amongst team members proves crucial for this essentially collaborative activity. Uniqueness of knowledge transfer pathways in Robocon competition lies in the fact that the required skill set is transferred between consecutive batches and also amongst competing teams. Best practices are established and passed on in the larger 'Robocon community' of the students. Two representative narratives of learning-in-a-team process in Robocon are excerpted below from the many responses we obtained.

"*The cross-functional team chosen on the basis of merit was crucial to bring together the best of the minds; I met so many smart people and got many intellectual sparring partners who helped me learn many things outside of Robotics and Mechanical engineering. It also taught us to self-organize and work as a team in the face of tight timelines teaching us some aspects of project management and trade-offs between exploring and exploiting various paths we could take as a team*"

"Robocon as a learning experience is unmatched by any other method. It is the perfect combination of team work; self-learning and problem solving skills which play a very crucial role in the future career of the students. There is a stark difference between the students who have experienced Robocon and the ones who haven't, with students who participated in Robocon being well versed with the latest technologies and paradigms in the industry"

It is also found that students document the entire process very systematically and also conduct sessions to train the new entrants extensively. Such knowledge transfer pathways are totally lacking in regular PjBL. It will be worthwhile to explore the ways in which they can be made part of regular PjBL.

E. Objective 5

We find that technical competition like Robocon can add lot of value to regular PjBL because of its inherent multidisciplinary nature. This attribute itself makes the problem more complex, challenging and real life. Teamwork is deemed as more of a strategic necessity than just being mandatory grouping to be followed. Since the team is multidisciplinary, they naturally learn the complimentary roles of various disciplines in a project.

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Students develop project management skills such as knowing weaknesses and strengths of team members, strategizing the game plan based on strengths and bypassing/overcoming the weaknesses, setting the realistic time targets, dividing the work on many parallel lines complementing each other etc. These outcomes can hardly be attained in conventional non-competitive PBL.

6. Conclusions

Adding an element of competition to regular practice of Project-based Learning has the potential of attaining many crucial program outcomes which are otherwise unattainable. Most important of them are self-learning and team-learning skills, project management skills, and ability to solve multidisciplinary problem by accepting the role dictated by one's chosen discipline. It is also found that level of student engagement is at its highest possible due to the challenge posed to creativity of students and an incentive of winning in the competition. The survey results from this case study also make it abundantly clear that competition-based PjBL has great potential to prepare industry-ready students in terms of their technical aptitude as well as positive attitude. It is worthwhile to find ways in which element of competition can be added to regular PjBL exercise to boost its established outcome attainment potential.

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Aalborg UNESCO Certificate: Staff Development and Challenges in PBL Training Programme

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Abstract: Problem- and project-based learning (PBL) has been widely adopted in engineering education during the last 40 years because of its effectiveness in improving students' academic knowledge, teamwork skills, communication skills and leadership. However, in a PBL environment, not only students, but engineering staff, too, have faced the challenge of transferring their learning/teaching practice from traditional methods to innovative PBL strategies. In order to improve PBL implementation and promote curriculum change processes, it is important to provide PBL pedagogical training opportunities for engineering staff. In collaboration with the Northeastern University, China, the Aalborg UNESCO Centre set up a half-year certificate programme on the Basics of PBL and Curriculum Change for Academic Staff Development. Using a qualitative method, this research reports engineering staff's reflections, learning outcomes and challenges through the PBL pedagogical training programme. Suggestions are proposed to optimize PBL training programmes for engineering staff and promote curriculum change processes.

Keywords: PBL; staff training and development; challenges; curriculum change

1. Introduction

During the last 20 years, student-centred learning and, in particular, problem-based and project-based learning (PBL) has become a widespread teaching and learning methodology in engineering and science education. All over the world, PBL has been applied at a single course level and at a systemic programme level. This change is a response from engineering education to meet the requirement for new competences such as employability, and the complexity of the UN Sustainable Development Goals. Research indicates that utilization of PBL will educate engineers with a higher degree of employability skills such as collaboration, teamwork, project management, business understanding, and competences of analysing and solving complex problems (Edström & Kolmos, 2014).

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The educational change to PBL is slow and often ineffective in the way that changes to single courses by single teachers may lack long-term sustainability, as the change depends more on the single academic staff member than on the institutional structure. Academic staff development is an important part of a change process, but research also reports that the approaches to academic staff development and training seem to be insufficient, as they tend to be transmissive and lecture-based, and do not manage to move participants to a student-centred approach (Adams & Felder, 2008; Felder, Brent, & Prince, 2011; Hunzicker, 2011). Most training concerns theoretical ideas and is aimed at university teachers' development of motivation, values, attitudes and beliefs; it misses out the relationship to practice and reflection on the implementation of new practices in respect of both intended and implemented practice (Gibbons, 2018). There is no doubt that motivation is important; however, if the design of new practices is not combined with methods for implementation, the change might never take place.

Therefore, there is a need to provide PBL pedagogical training opportunities, and to design the training in an exemplary way for the practices the participants are going to utilize. The training should promote a community of new practices and a culture of ongoing organizational reflection and learning (Felder et al., 2011; Guerra & Spliid, 2018; Hunzicker, 2011). The Aalborg UNESCO Centre at Aalborg University (AAU, Denmark) has been running a variety of educational and training activities of shorter and longer durations, ranging from a one-year Master's programme to open online learning activities. The different activities represent different levels of teaching professionalization and development of knowledge and competences, and the learning objectives, training strategies and formats, participants' directedness, workload and academic staff support differ in the various activities (Aalborg PBL Centre, 2014a; see Figure 1). There are three levels: 'know what', 'know how', and 'know to be'. The first level, 'know what', provides basic knowledge regarding PBL and takes a more transmissive approach.

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The subsequent levels, 'know how' and 'know to be', become progressively more participant-directed and problem-oriented, moving from hands-on activities and workshops towards a collaborative research-based project for change (Guerra, Spliid, & Kolmos, 2018).

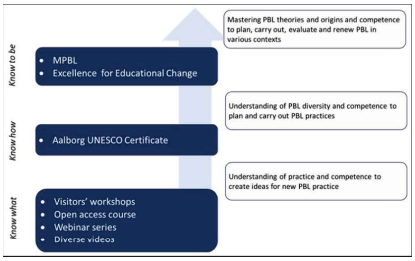

Fig. 1. Overview of Aalborg UNESCO Centre activities for academic staff and different levels of development of PBL knowledge and competences. MPBL refers to the Master's Programme on PBL for Staff Development (sourced from Guerra et al., 2018).

2. The Aalborg UNESCO Certificate

The Aalborg UNESCO Certificate on Basics of PBL and Curriculum Change is at the level of know how. The certificate was developed in 2017, emerging from the need to create a course that could provide more than the open access sources and visitors' workshops, and with a lower workload and shorter duration than the Excellence for Educational Change and MPBL programmes.

The overall goal of the Aalborg UNESCO Certificate is to provide basic knowledge and understanding of active learning methodologies with a focus on PBL practices, skills and implementation. The certificate's structure and activities are exemplary and follow a PBL approach—i.e. it is team-based, participant-directed, problem-oriented, project-organized, experiential and contextual. In spring of 2018, the Aalborg UNESCO Certificate was first piloted in collaboration with Universidad Nacional del Colombia (Bogotá, Colombia), its 23 participants coming mostly from engineering education. The programme was delivered in a blended mode, with face-to-face workshops and online activities, namely preparation, facilitation and group discussions (Guerra & Spliid, 2018; Guerra et al., 2018).

In autumn of 2018, and in collaboration with the Northeastern University (NEU) in China, the Aalborg UNESCO Centre set up a half-year certificate programme (equivalent to 10 ECTS) on the Basics of PBL and Curriculum Change for academic staff development. The course aims to train participants in PBL skills and to contribute to academic staff learning and change of practice. Through the training programme, participants are expected to obtain PBL theoretical knowledge, improve their facilitation skills, and develop an initial PBL design for a course or an institution. The participants are expected to develop the following learning outcomes (LO):

1) Understand active learning methodologies, in particular problem- and project-based learning;
2) Understand curriculum design and management;
3) Design a PBL intervention for implementation in the classroom;
4) Understand and experience PBL as a learning process and the learning of PBL skills;
5) Implement or plan an implementation of the intervention designed in LO3;
6) Document and reflect upon the curriculum/course change process.

The programme is organized in four modules and includes different types of learning activity, namely project work, seminars, and hands-on workshops (see Appendix 1). Furthermore, the programme has a strong reflexive component, as participants go through the different resources and materials, deliver the assignments proposed for each module, and document the learning process through a teaching portfolio.

3. Design of the Study

In order to facilitate a deeper understanding of the effectiveness of the PBL pedagogical training programme, this research will answer the following questions: 1) What are the motivation and experienced learning outcomes for engineering staff following the PBL pedagogical training programme? 2) What challenges do participants face in the PBL pedagogical training programme?

In this study, we followed a group of engineering staff from NEU who participated in the Aalborg UNESCO Certificate in autumn 2018–2019. NEU has a long tradition of engineering education and is one of top universities in China. Along with the recent higher education reform supported by the national government, NEU is trying to change from a traditional teacher-led education model to an innovation model with a core principle of student-centred learning. Among diverse new strategies, PBL is regarded as one potential solution to facilitate the changes.
Accordingly, in spring 2018, a cooperative research project, Designing, Participation and Facilitation of Problem and Project-Based Learning, was established, based on collaboration between NEU and AAU. Therefore, at beginning of the autumn semester in 2018, a group of engineering staff (with seven members) came to Denmark and started their half-year training programme. The seven members were selected from different disciplines: robotic engineering, software engineering, computer science, management science, environmental engineering, material engineering and mechanical engineering. Data collection in this study was carried out with six members of the NEU group who volunteered to participate and with a focus on identifying the participants' motivation, outcomes and challenges faced in designing a PBL course.

4. Methodology

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A qualitative thematic interview method was adopted to evaluate the development of engineering staff's learning outcomes through this training programme. This method enables researchers to hear the voices of individuals and explore their common experiences (Creswell, 2007). Qualitative data were collected through individual 30-minute semi-structured interviews, which were conducted in the middle (after two months' study) and at end of the programme (after six months' study) in order to track the development of participants' understanding of pedagogy, reflection on the learning process, and learning outcomes through the half-year programme. All the interviews involved in this study were transcribed and reviewed carefully. For the sake of privacy protection, pseudonyms are used for all interviewees: they are referred to as Martin, Lily, Jacob, Sophie, William and Sean by the researchers. In terms of the qualitative coding, a structured codebook was first built upon the analyses of three information-rich transcripts, which constitutes a relatively stable frame for coding (MacQueen et al., 1998). In developing the codebook, three categories—motivation, learning outcomes and challenges—were defined as a priori codes. Open coding was used to identify participants' experience within the three dimensions. After open coding, codes were collapsed and classified. In qualitative research, researchers are regarded as "the primary instrument for data collection and data analysis", and they need to be "responsive and adaptive" during this process (Merriam, 2002, p.5). For this research, we were involvedly in daily journaling and self-monitoring in conducting the data collection and analyses. To enhance the credibility of data analysis, auditing procedures were conducted. Codes were modified and refined for two rounds through the auditing process. A revised codebook was formed through this process, and then used for data analysis of the remaining transcripts of the two rounds of interviews. In the coding process, the researcher remained open to new codes as the data unfolded themselves. A comparison between the codes of the two rounds of interviews was conducted to track the development of interviewees' learning outcomes through the pedagogy training programme.

5. Findings

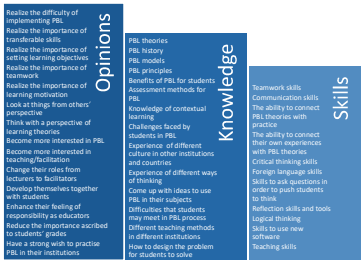
A. Motivations

Based on the first round of interviews, all six participants wished to apply the PBL method in their institution after this pedagogy training. Among all interviewees, William and Sean took the position of teaching directors and had responsibility for leading curriculum reform and improving teaching quality in their schools, which motivated them to learn pedagogy theories and new learning approaches. Four other teachers expressed that their enthusiasm for teaching and curiosity about PBL methods drove them to participate in the PBL training programme. With a background in specific engineering subjects, few had had systematic pedagogical training before: thus, they were keen to experience the PBL method and look at things from the new perspective of learning theories. Just as Martin described:

I have joined a one-week pedagogy training about active learning, but I cannot get the key point of active learning because of the short time. What I learned in that training programme was just some skills or methods to create an active classroom atmosphere, but ***it's not enough*** *for a cutting-edge computer science course. Then I read an article about PBL and became interested in this method. However, I'm not an expert in the field of education, and just a few articles cannot provide a big picture of PBL methods. Considering that* ***I need a systematic learning theory and effective practical methods, just like PBL, to guide me to optimize the course design and improve the quality of teaching****, I applied for this programme as soon as I heard about it.*

Meanwhile, participants also wished to improve students' learning experience and outcomes in their class after their pedagogy training. Several participants focused on learning teamwork theories, because when they added collaborative elements into their courses, they met many challenges of how to guide students to conduct effective teamwork and assess their learning outcomes in teamwork processes. Other participants were motivated by specific learning goals, such as how to design learning objectives for students, how to improve their course design, and how to help students learn actively. One participant, Lily, focused more on critical thinking skills:

Now we are trying to reform the professional courses and using English teaching materials. Those materials emphasize the importance of critical thinking in almost



every chapter. But I have little experience of critical thinking training, so ***I hope to know more about critical thinking, improve my critical thinking skills, and learn how to develop students' critical thinking skills****.*

Figure 2. Codes of engineering teachers' learning outcomes

B. Learning Outcomes

Codes for learning outcomes were identified based on the transcripts of the interviews, as shown in Figure 2. The figure illustrates a spectrum, where learning outcomes range from changes in opinions to knowledge and skills development. In the dimension of changes in opinions, engineering staff were found to change their attitudes or

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interest in relation to teaching methods. They began to transfer their roles from lecturers to facilitators, and became more aware of the benefits of learning together with the students. In the dimension of knowledge development, interviewees reported that they obtained knowledge about PBL history, models, principles and relevant learning theories. They also had the chance to experience possible challenges and difficulties that students may meet in the teamwork process in the PBL context. In the dimension of skills development, codes including teamwork skills, communication skills, critical thinking, foreign language skills and teaching skills were identified based on transcripts. The ability to connect PBL theories with their own experience and practice was also developed through workshops and teamwork projects.

Furthermore, we compared codes in the transcripts of the two rounds of interviews, aimed at finding and tracking development trends through the training programme. Differences between codes in mid-term interviews and final interviews were found and are reported below.

1) *Expectations of the training programme*

In the middle of the training programme, participants had attended four workshops and just formed groups for a project. In the mid-term interview, all interviewees expressed that the training had not yet met their expectations before coming to the Aalborg University. Although they learned many pedagogical theories, PBL principles, PBL models among universities across the world and so on, they still did not have the big picture of current PBL practice. For example:

*It is a hard job to **transfer current PBL models and theories into an effective practice** which is suitable for our institution and culture. How to inspire students' learning interests? How to design the project? I still **feel confused** and need more discussion. So now **it only reaches 60% of my expectation**. – Sophie*

*Now it **only reaches 30%**, or even less of my previous expectation, since we have only experienced half of the whole course. I **have lots of questions and really feel confused about PBL and interdisciplinary at the practical level**. How do we combine multiple subjects? How to design the interdisciplinary course? Is there any requirement for subjects if we want to combine two subjects in totally different fields? If someone asks me how to connect two subjects in a PBL design, I have no idea. – Martin*

In Sophie's and Martin's cases, both expressed confusion about PBL implementation and lacked guidance to help them connect PBL practice with the PBL theories they learned. This was the main reason why the training programme had not reached their expectations.

However, at the end of the programme, almost all interviewees reported that the training programme was beyond their expectations. The programme enabled the engineering staff to experience the AAU PBL model and work as a team to finish a project from the perspective of students, which also aroused their interest in teaching with PBL methods:

*It is a **great experience** for us to take the role of students to finish a project at Aalborg University, which gave us an opportunity to **develop a deep understanding of the AAU PBL model**. Our learning outcomes, including basic PBL and pedagogy knowledge, new learning methods and our own PBL design, were **greater than expected**. I cannot wait to redesign my course using PBL elements when we go back to China. – Lily*

Nevertheless, there was still one participant who was not fully satisfied with the agenda of this programme. In the interview, Jacob said:

*Throughout the whole program, it **only reached 75% of my expectation** because I think we did not dig deep enough into PBL. What we did in this programme still **differed from what Denmark's students experience**. It would be better to organize us to conduct a project with Danish students in one semester, but I understand it may be hard to carry out because of limited time and resources…Besides, **language barriers also had a negative influence on our understanding of PBL**. Thus, it didn't fully meet with my expectations and needs improvement. – Jacob*

According to Jacob's description, both external (activity arrangement) and internal (language barriers) factors influenced his learning experience, leading to some dissatisfaction. He expected the chance to be a real student and work with Danish students to finish a project, but the agenda in this programme mainly provided workshops and other learning activities aimed at staff training, which meant they had few opportunities to work with current students for a semester.

2) *Focus of learning outcomes*

Based on a comparison of the two rounds of interviews, we found differences in participants' focus in self-reported learning outcomes. In the first round, they mainly reported theoretical knowledge, such as pedagogy theories, learning principles, learning objectives and PBL models. In the second round of interviews, codes focusing on changes of attitude and opinion based on self-reflection showed more frequency in transcripts, including "think with a perspective of learning theories", "experience culture differences", "look at things from others' perspectives", "realize the importance of teamwork", "change their roles from lecturers to facilitators", "have a strong wish to practise PBL in their institution" and so on. For example:

*The most important thing I am learning now is **the practice of PBL in other institutions**, the whole student-centred PBL system. It is interesting to implement PBL from the top level, the management level in universities. Other things, such as salary levels, human resources and promotion standards, should be reformed to match the PBL curriculum… – Jacob in the first interview*

*The most important learning outcome is the **change of our teaching opinions and learning methods**, especially about **how to add PBL elements in our own institution**. We*

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cannot use the AAU PBL model in our school directly, but need to design a student-centred PBL curriculum within the Chinese culture. The most effective way to develop our understanding of PBL is ***group discussion****, which could* ***provide perspectives from others with different backgrounds****. In group discussion, we review our design together and propose critical comments to improve the design. As an engineering teacher, I always emphasize the logic, but a teacher with a social science background provided me a new thinking style—looking at things from the perspective of history and philosophy. – Jacob in the second interview*

In Jacob's case, his learning outcomes in the middle of the programme mainly focused on knowledge of the PBL system and practice. When finishing the whole training programme, his most important learning outcomes became how to use PBL with a new, personal understanding. He also pointed out the importance of teamwork and group discussion, affording him a new angle of social science to consider the curriculum design.

Meanwhile, a transformation from individual learning to collaborative learning was found among interviewees when comparing the two rounds of interviews. According to their description of their learning activities in the first interviews, they tended to learn and work individually. In the second interview, teamwork and its benefits were mentioned with higher frequency. They gradually realized the importance of teamwork and began to consider the meaning of teamwork within the Chinese culture, just as Martin said:

> *Although we always need to finish research projects together with our research group, we just* ***divided the tasks and worked individually****. In that case, we weren't familiar with others' work. But now,* ***we work as a real team****. We also* ***summarized three key points of 'Chinese teamwork'****. First, team members should take their responsibility actively, even if nobody asks them to do it. In the Chinese culture, we tend to save face and seldom point out one's, especially peers', mistakes directly. So, we always hope team members can be more active. Second, everyone needs to have a contract spirit, even though there is no punishment for those who don't finish their jobs on time. Last, the team leader needs to fully understand his/her obligation instead of only enjoying the benefits and power. I didn't realize those things before, but one of our team members comes from business administration, and he showed those new thoughts to us. It's* ***important for our teacher share our understanding of teamwork because we will be the facilitators to smooth students' teamwork****. – Martin in the second interview*

As can be seen from Martin's description, he developed his own understanding of teamwork through group discussion in the programme. Combined with the Chinese culture, he gave his definition of teamwork and emphasized the importance of understanding the meaning of real teamwork for those engineering staff.

In the second interview, more codes of changes in ways of thinking or opinions were found among participants, including sub-codes like critical thinking, multi-angle analysis and self-reflection. For example:

What I got most from the programme is ***self-reflection****. Now I begin to think about what issues are found in my course, what teaching methods I should use to help students learn better, and what learning objectives I should set when designing the course. Although I have not had an answer yet,* ***reflection enables me to see more possibilities and grow my teaching experience.*** *– Sophie*

As illustrated in Sophie's words, she realized the importance of reflection through the PBL training. In her opinion, reflection serves as an effective pathway to enable teachers to develop their teaching experience and improve teaching quality.

3) Future PBL implementation in their institutions

In the middle of the training programme, all six interviewees expressed that they still felt confused about whether they fully understood PBL methods and how to use PBL in their institutions effectively. Although they were learning many PBL models and tools across the world, they still needed more time and guidance to develop their own understanding of PBL and future PBL practice. Their confusion is illustrated below.

We have learned many theories and tools now, like how to help students identify the issues, but we have no practical experience, so ***I'm not sure if I can use those tools in effective ways*** *in my course. – William in the first interview*

Meanwhile, they could foresee the great barrier to generalizing PBL in their university, but they were not fully prepared to deal with the issue with a detailed proposal, as Jacob said:

The primary goal for us is to learn PBL and use it in our institution. Through the half-year's training, we are expected to propose a detailed curriculum design to senior managers in our university. ***However, how to promote the curriculum reform? If we adopt interdisciplinary PBL, there are too many things to consider****: class size, instructional design, salary system, resource distribution, hardware facilities and so on.* ***We are still in a mess now****. – Jacob in the first interview*

However, at the end of the programme, they developed their own understanding of PBL and came up with a detailed report, which demonstrated their plan to use PBL at course level and curriculum level in their major and the whole university. Based on group discussion and communication with their supervisors, they reached an agreement about future implementation of PBL, and then divided up the task of report writing. Each of them took charge of one chapter and used their own subjects and courses as examples. Two quotes concerning their PBL design are as follows:

> *Now* ***we have designed a curriculum change model for our university, combined with PBL principles****. The key elements in our model are learning goals, learning methods and assessment methods. We also illustrate the design at different levels, including student level,*

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*staff level, course level, resource and organization level and so on… **Last time, I said we were unclear about the details of future practice, but now we have the answer.** I **can see the feasibility of our design**. I could say it is a perfect plan. – Martin in the second interview*

*One of my learning outcomes is **the development from knowing nothing about PBL to having an initial idea of our future PBL practice**. In the learning process, those theories, methodology and tools struck a chord with me, which **inspired my interest to try something new. Now I have a plan to adopt PBL in my own course in the following semester.** I can't wait to put my idea into practice. – William in the second interview*

As illustrated by the quotes above, William and Martin had a plan to implement PBL in their institution at the end of the programme, and both showed a positive attitude towards the blueprints of their PBL design. Martin reported his confidence of future implementation of the design because it considered PBL practice at multiple levels. William expressed that his interest in learning new teaching methods was inspired by this programme, and he wanted to change the learning methods and adopt PBL in his course next semester.

C. Challenges

In the PBL training programme, engineering staff were required to take the role of students and finish a project in a team. On the one hand, learning in the role of students made them face similar challenges and difficulties to students in the teamwork process, such as challenges of team building, task division, negotiation and dealing with conflicts. On the other hand, they still had the role of engineering educators, which brought more challenges and pushed them to consider questions like how to use PBL in the future and how to deal with possible obstruction in practice. Based on qualitative data analysis, themes of challenges are reported below.

1) *Effective teamwork*

Teamwork challenges were frequently mentioned in interviews, especially in the first round. When they experienced PBL as students and conducted a project in a group, the engineering staff faced difficulties smoothing their teamwork with the team diversity. Many issues were reported, including "conflicts in group discussion", "ineffective communication", "becoming outsiders in groups", etc.

*Although we come from one university, we were strangers before, so at the beginning several participants **were too shy to express their true views, leading to ineffective teamwork**… **Someone cannot integrate into our discussion, influencing our working efficiency negatively**. – Martin in the first interview*

According to Martin's description, at the start of the project, they experienced ineffective communication because several group members did not put in the effort, or even became outsiders in the group meeting. One possible reason is that they were strangers before and were not familiar with each other's working modes.

Conflicting values was another challenge in the teamwork process. With diverse backgrounds and subjects, participants often held different or even opposite opinions. Working in their positions for at least a decade, the engineering staff had developed individual ways of thinking, and the paradigm of their subjects also shaped their beliefs and world views, which brought about gaps in their understanding of others' perspective, especially at the beginning of the teamwork process.

*Sometimes we just **stated our own thinking without negotiation** in group meetings because we **come from different subjects and hold totally different views**, which **made our conversation disjointed**. Our thoughts are mainly based on our own experience, **but now all of us need more reflection and to think out of the box**. I think those problems are quite common in teamwork, particularly at the beginning. – William in the first interview*

*We are from different schools and have worked for over ten years. **It's hard for us to change our conventional thinking and break the current paradigm of one subject in half a year**. Even though we have clear task division, we still have our own understanding of the course design and report writing. We have teachers from engineering and business management: those two groups often **look at things with totally different perspectives**. **Everyone hopes others will adopt their suggestions, and sometimes nobody is willing to compromise. It's really difficult to reach an agreement in that case**. – Jacob in the first interview*

As William and Jacob said, the diversity of their background caused conflicting values in group discussion. Sometimes, they faced the dilemma where nobody was willing to compromise, and they kept arguing with each other. While in such conflict, they had to think out of box and find ways to move forward on their project. One strategy to solve conflicts was to let both sides express their ideas and arguments, and then all team members had a vote:

*One challenge is **communication with other team members**. Different individuals always need time to smooth their teamwork and become a real team. When we came into conflict, **we stated our opinions and evidences one by one, then had a vote. It's hard to persuade everyone because of different backgrounds and ways of thinking, but what we can do is try to reach a balance**. – Lily in the first interview*

*We met twists and turns in teamwork because of no project experience, so we had a slow process at the beginning. **We have personal habits and individual views which are quite different from each other.** The good news is that we **share the same goal—**work hard and finish the project, **so we always can reach an agreement at the end.** – Sophie in the second interview*

According to Sophie's description, it took time for all team members to adjust their working codes, understand

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others' perspectives and smooth the teamwork process. She pointed out that sharing the same goal among team members enabled them to seek common ground while preserving differences and pushing the project forward.

2) *Language barriers*

Language barriers were found to be another challenge for participants on this international programme, mainly reported in the first-round interviews. On the one hand, as foreigners, living and studying in an English environment was not an easy job for those participants without overseas experience. On the other hand, without basic pedagogical knowledge, it was challenging for them to understand the terminology in the field of education, which brought learning barriers when talking with supervisors, attending courses and workshops, reading references and writing reports. For example:

*The biggest challenge for me is **language proficiency**. Sometimes those reading materials are too deep. I'm not very good at English, so I need to make more effort to understand those concepts, theories, and others' opinions. – Sean*

*One challenge is **communicating in English**. With different cultural backgrounds, we **learned English in different environments and use different codes of language**. Besides, **many proper nouns are used widely in education, but we didn't know them before**, so we need time to get used to this language environment. – Sophie*

*…**Reading articles in the fields of PBL and education is also a challenge**. If you want to have a deep understanding of this field, you need more information about the background, which cannot be fully shown in articles. **If we do not have chance to talk with the authors, it will be difficult for us to comprehensively understand authors' original intention or opinions.** – Jacob*

As illustrated by the quotes above, participants reported the challenge of foreign language proficiency in their learning processes. Facing a very different learning context with new language, new ways of thinking, new knowledge and new culture, participants with a limited English language level needed more time, effort and guidance to overcome language barriers and grasp the meaning of pedagogical concepts.

3) *Curriculum reform*

At the end of this training programme, participants were expected to design a detailed proposal for future PBL implementation in their university, which would be evaluated by experts in AAU as well as school leaders in NEU. Thus, participants considered the challenges of future curriculum reform more, where PBL would be used at course level, cross-course level and curriculum level in their institution. Compared with the first round of interviews, interviewees reported more challenges which focused on PBL design and curriculum reform instead of individual learning problems in the second round of interviews. They were acutely aware of how hard it could be to conduct curriculum and course reform with PBL in their university, and they hoped to find a pre-arranged plan for possible obstacles.

*It's impossible for us to reform our curriculum into the AAU PBL model and use PBL from top to bottom, so we have to transfer it to another model in the Chinese situation. There are too many **challenges for us to apply PBL methods or elements in our schools because of the large number of students**. How to design class size and the credit hours of each course? How to harmonize standards for assessment of students' learning outcomes? How to motivate teachers to make change? How to redesign the staff salary system?… **What we can do is design future PBL implementation at different levels and submit the proposal to college administrators**. – Jacob*

*In PBL, students become the centre of learning, and facilitators often ask questions like what do you want to do? How do you plan to solve your problems? Why do you think so? It's students who decide the learning content. But **in the traditional Chinese teaching culture**, teachers tend to tell students what to do and how to do it directly, and students are used to follow teachers' instructions. I have met students who were **unwilling to think for themselves and devote much effort to their courses** because they gave priority to internships and job hunting… **Not only teachers, but also students need to put in more time and effort in the PBL context, but not all people would like to make the change**. – William*

In Jacob's and William's cases, both realized the huge challenges of curriculum reform with PBL in their university. In order to deal with those challenges, they proposed a detailed plan for reforms at different levels. In terms of possible reasons for future obstacles in the curriculum reform process, factors including cultural background, teachers' and students' motivation, current incentive mechanisms, support and resources, and student numbers were reported in their interviews.

Meanwhile, through the half-year training, several participants showed their long-term vision for PBL practice. They began to consider how to keep pace with PBL development and learn from others' experience about future PBL practice in the global context when they finish this programme and return to work. They developed the passion for continuous learning in PBL and began to seek ways to update knowledge when there is no help or guidance from pedagogy experts. For example:

*What I'm concerned about is how to **keep updating knowledge about the development of PBL theories and models**. When we go back to China, we have little time, limited resources and no pathway to pay constant attention to cutting-edge PBL knowledge. If I meet difficulties in future PBL practice, I won't know whether someone has encountered the same issues or have a chance to learn from others' experience. – Martin*

Based on the differences in the challenges faced by participants reported in the two different rounds of interviews, we also found that the focus of challenges transferred from individual to collective. In the first round,

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challenges reported by interviewees mainly concentrated on individual issues in the learning process, such as conflicts in group discussion, ineffective teamwork, learning without a pedagogical background, and language barriers. However, in the second round, when asked about challenges they met on this programme, all six interviewees reported that the biggest challenge was PBL implementation and curriculum reform in the future. As mentioned above, in the second round of interviews, participants reported that they kept questioning and thinking about whether they fully understood PBL methods? How to generalize PBL methods to their colleagues? How to combine PBL with characteristics of their subject? What kind of barriers might they meet in course reformation? Someone might already have answers in their mind, but many of them said they would find an answer after they had returned to China and used PBL practically in their courses. Based on evidences from interviews, we can say that those participants had a deeper, broader and long-term view of the challenges of PBL practice through the half-year PBL training.

6. Discussion and Conclusion

This paper reports engineering staff's motivation, learning outcomes and challenges on an international PBL pedagogical training programme. The findings of this study offer insights for engineering educators in terms of the design of international PBL-based pedagogy training programmes.

Based on an empirical study, we provided evidences of the benefits and effectiveness of the PBL training programme for engineering staff. Through half-year training, engineering staff learned theoretical knowledge of PBL, as well as learning/teaching tools to help them activate students' learning and improve their teaching quality. Participants could learn to think from the angle of learning theories and understand the meaning of teamwork through self-reflection and communication with pedagogical experts and peers from different subjects. In addition, challenges that participants faced in teamwork and learning processes were also reported, such as conflicts in group discussion, language barriers for non-native speakers, and working with group members with diverse backgrounds, which were also faced by students in the PBL context and reported in previous research (Ahern, 2010; Bani-Hani, Al Shalabi, Alkhatib, Eilaghi, & Sedaghat, 2018; Kjellberg, Adawi, & Brolin, 2015). With the experience of learning as students, engineering staff could better understand students' feelings in the PBL process, foresee possible challenges for students, and provide effective guidance to facilitate students' teamwork based on their experience.

According to challenges and difficulties reported by participants, suggestions for the improvement of PBL training programmes are proposed by the researchers. Firstly, the participants' professional and cultural background, learning styles and language proficiency levels should be afforded more attention when designing the programme, especially for a study-abroad programme. Programme designers and team supervisors could have more communication with participants in order to reach an agreement about learning objectives and expected outcomes of the training programme. Secondly, for better understanding of PBL, opportunities to work with local students in teams could be provided for participants on those training programmes, which might enable them to experience those PBL models as students and improve their learning outcomes. However, this may require more support from the policymakers. Thirdly, it may be important for programme designers and team supervisors to understand the culture and educational systems of participants' home countries to better understand participants' thoughts and behaviours, construct a bridge for effective communication, and provide professional suggestions for participants' design of PBL practice in their own culture. Fourthly, the length of the programme is important, as there is a clear difference in the results from the midterm interviews and the interviews at the end. After 1.5 months, the participants still seem uncertain as to how their learning can be applied at the home institution, and there seems to be much more clarity at the end of the training. However, any change in the curriculum will also depend on home institutions' support for change.

In terms of the limitations of this study, there were only six participants in the interviews because of the small size of this training programme, which might influence the richness of the collected data. However, this joint training programme between AAU and NEU will be held every year, which enables researchers to continue this work-in-progress study and enrich our research findings. Future studies could draw attention to a comparison of learning outcomes and challenges between various groups of engineering staff, and explore impact factors of their learning outcomes from PBL training programmes.

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Teaching by Induction: Project-Based Learning for Silicon Valley

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Abstract: It is well known that there continues to be a shortage of women in technology jobs. The teaching methods and gender bias in K-12 education continue to favour boys progressing to engineering and technology positions. The project initiated by Ravi Krishnan Jagannathan in Silicon Valley, California, sought to prepare middle school and high school girls for success in high tech. The strategy used was to teach math and science inductively. The use of computers for teaching the girls both fundamental science and math in the middle school laid the foundation for teaching high school girls to apply Artificial Intelligence (AI) to develop solutions to current medical and ergonomic problems. This paper will discuss the inductive teaching strategy with the aim of motivating both parents and teachers to adopt a similar project that can help address the shortfall of women in tech.

Keywords: Inductive teaching, Women in technology, Artificial Intelligence (AI)

A. Introduction

There persists an imbalance between men and women in the high tech workforce. Only about 20% of the high tech workforce in the US is composed of women, even though about 50% of the workforce is women (Bose 2018). In India the percentage of women in tech is only slightly higher at 28%(Srinivas and Bansal 2018). In a recent interview with Catherine Ashcraft, the Director of Research and Senior Research Scientist for the National Center for Women & Information Technology (NCWIT), the causes of the shortage of women were cited to be societal influences and bias, workplace systems and also teaching methods at the primary and secondary levels (Welson-Rossman 2018).

Primary and secondary education continues to follow primarily the rote teaching method which is unfavourable to most learning styles in young people (Welson-Rossman 2018). In addition, teachers tend to call on boys more often than girls. For college admissions, a new trend is to reward students for demonstrated experience rather than potential. Thus, programs for girls at the middle school and high school levels should provide the opportunity to gain experience that can equip them for success in achieving their aspirations for a high tech career.

A recent article summarized the literature on teaching strategies in Science, Technology, Engineering and Mathematics (STEM) education that support the highest success for student learning (Thibaut et al. 2018). Open ended problems that the students themselves identify are the gold standard for learning STEM, and in particular the T in STEM. However, it has been shown to be more effective to lead the students up an inclined plane of project/problem complexity. When teachers present projects initially that are somewhat structured and utilize the students' skills, they are more apt to succeed at more challenging and open ended projects.

From 2014 to 2019, Ravi K. Jagannathan gave private classes to a group of mostly female students with the aim of giving them experience in programming and Artificial Intelligence (AI). The goal was to open the opportunity for the girls to pursue a career in high tech. Two of the participants were accepted to University of California Berkeley with the intent to study computer engineering.

In addition to various on-line tools described throughout the text, on-line courses were used to help design the program (EdX 2019; Dwarknath 2019; Sra 2019; Amazon 2019b).

B. Methodology

Students in middle school were introduced to python programming using the turtle function. Turtle is a built in

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library that does not require any installation. It can be moved on the screen using simple go up, go down, go left, go right commands. By moving the turtle on the screen, students were taught variables, functions, lists, objects, and for-loops that exist in all programming languages. Basic Cartesian Geometry was also needed to solve some of the problems. (Papert 1980).

In addition, students were enabled to explore the basic concepts of Newtonian physics, also with the turtle. Through this course, they learned how to represent the real world in the form of equations. Using the same turtle, but with a focus on velocity and movements by writing programs to simulate throwing the turtle and watching it fall using Newton's laws of Motion, students learned physics inductively. They then combined the programming and the physics to develop an *Angry Birds* game as a final project.

The advanced programming involved coding a "Hangman game," which showed the students concepts of programming a server hosted in the cloud and playing a multi-player game, via a browser over the internet. The course also covered networking concepts such as the use of IP addresses and routers (Downey 2019).

Finally, a course on logical argument was taught using games as a basis for teaching truth tables and propositional logic. All of the courses were entitled *Fun with X* to engage the students. (Smullyan 1992)

Starting in 2016, with their basic understanding of computer programming, physics, and logic, the students were given an introduction to the interface of hardware and software. They learned the fundamentals of Internet of Things (IOT) and wearable devices. This work prepared them to design and assemble their final project. They were able to develop a medical system comprising a wearable device. The device was to measure physical variables such as acceleration and temperature and was to be used to diagnose or treat a real medical problem.

The girls were asked to identify a real life problem, and then to build a small wearable Arduino device with sensors to address the problem. The instructor introduced to the adafruit.com sensor package which has various low-cost sensors that could measure temperature, capacitance, acceleration, air pressure, magnetic direction (compass), and moisture. A number of projects done by other hobbyists on the website were described to the girls. They were then left alone to discuss among themselves to identify a real world problem that was solvable with the given kit.

The girls came up with the following interesting problem. Babies under one year old often feel too hot or cold and start crying. Poor communication results in parents misdiagnosing the problem, such as to feed the child. The goal of the project was to communicate the actual source of the discomfort related to temperature.

The instructor-led discussion thereafter focussed on collecting the parts to build an effective solution. A flora board was used as shown in Figure 1, which has a small CPU, a built in LED, and a sensor to read the temperature.

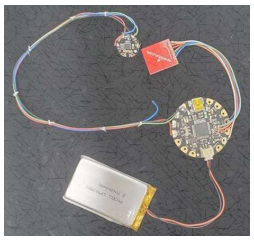

Figure 1. Sensor system

A program written in Arduino-C running on the CPU is capable of reading temperature measured by the sensor. The same program could blink the LED. The solution to the Baby problem, was to program the board so that the LED would blink fast (twice per second) when hot and steadily when cold. The students followed the instructions on the Arduino site to set up the device. They were able to program the correct temperature thresholds: greater than 80°F that identified hot and less than 55°F as cold. We tested this by bringing the device close to hot water and ice. The instructor identified the Adafruit platform containing numerous components, and then the girls correctly identified the 3-4 components required to solve the problem. The first version of programming was done by the instructor but the program was then modified by the students for setting temperature thresholds. Thus the instructor enabled the students by providing the learning opportunity for the students and initiating the coding.

In addition to the technical development, the students learned some of the business aspects. Defining minimum viable product (MVP) or refining a concept to its simplest form were example exercises. The students were presented with basic challenges such as whether or not a battery is required and if so, what size of battery is needed? Discussions about sales options were also carried out. For example, should just one device with one temperature threshold or rather five devices with five different thresholds be sold?

Students also practiced market research by taking their product to parents and friends and asking them how they would use it. Did they see a need for it and if so, how much would they pay for it?

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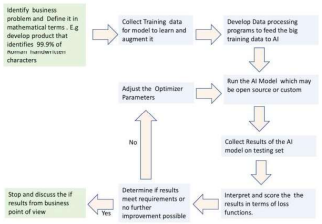
As a final presentation, the students presented the device to parents and other participants. The presentation involved pitching the device, as a start-up company would, and soliciting initial investment.

1) *Artificial Intelligence (AI) Course*

From 2017, the students were in high school and they were introduced to Artificial Intelligence. The earlier courses were the foundation for the AI courses. As there are numerous areas in AI, too many to cover them all, convolutional neural network (CNN) was chosen, as it deals with pictures. Pictures are more attractive to a wider group of young students than other types of data such as time series data and text. The students were challenged to use their



programming skills and combine it with statistics and mathematics to make an AI model that could recognize pictures.

As in the case of the IOT project, the teaching strategy was to lead the girls to do as much as they could, while the instructor contributed the complex parts. The skills covered in detail are those which allow an AI practitioner in industry to use an AI model, and evaluate the functionality of the model, without knowing all the internal details of the model. The strategy for AI development is shown in Figure 2.

Figure 2. AI Development Stages

The students learned enough to be able to prepare the images needed for training data. The statistics completed by the students included identifying the loss function, for example, if there are 90% correct predictions and 10% wrong, is it acceptable or not. Concepts such as confusion matrix, specificity, sensitivity and accuracy were introduced. Loss functions such as Jaccard, Hinge loss and cross entropy were also taught and programmed. This course gave a comprehensive introduction to the critical set of skills used in real world AI projects.

The actual programming of the CNN AI model was covered as theory, but not actually programmed by the students, as it would have been beyond the scope of the course.

At the end of the course, we reverse engineered an existing Keras AI model that solved diabetic retinopathy. Reverse engineering is to reproduce the product following detailed examination of its construction. From observation, the students understood the mission and strategy of the Keras program although they did not attempt to perform the complete programming. They were able to prepare data (images), feed it into the model and observe the output. Alternatively, there are many Keras models implemented in python that are solutions to various Kaggle competitions. Kaggle is a company that hosts learning tools for computational projects and competitions to solve machine learning problems (Kaggle 2019). The instructor could set up one of the solutions and let the students reverse engineer the solution including data manipulation and input presentation, students discussed various AI products on the market, broke them down to components, and presented how they might have been implemented.

Details of the course by module are described in the following paragraphs.

2) *Modules and Learning Outcomes of the AI Course*

The lesson plan was subdivided into the following modules data augmentation, big data processing, basic linear algebra, optimization, machine learning and cloud computing.

Training Data Augmentation: Developing an AI training set requires manipulation of images. The OpenCV library in python was taught for this purpose. This skill is used to create thousands of images for training the AI model from a smaller sample of hundreds of images. The students learned to select the following operations and perform these on images: Resize, flip, change to black and white, merge two pictures, cut slices out of the pictures. By iteratively performing multiple operations on the same image, they could generate hundreds of training images such as shown in Figure 3.

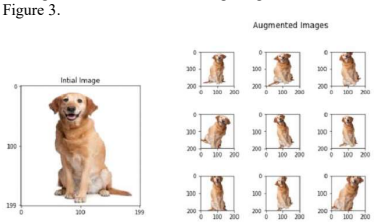


Figure 3. Training images (Contributors 2019a)

Big Data processing: The typical input to an AI or machine learning system is a large CSV file. It could have up to one hundred thousand rows or more of the following type.
"Figure #100, blood sugar level = 40, weight = 100, height = 175cms, male, age = 50, diabetes level = 3 where the last

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column is what we are predicting, and the first column refers to picture saved on the disk.

To manipulate such large data sets, the python Pandas library (https://pandas.pydata.org/) was taught. Pandas allows us to manipulate training data that are formatted as very large CSV files, running to hundreds of thousands of rows. The students were able to take a large CSV file and convert it into a pandas data frame. Given a data manipulation requirement in English, they were able to break down the problem statement and determine the sequence of aggregations needed, and write the code using the pandas manual as reference. Then they were able to write code to perform the aggregation functions Grouping, sum, min, max, sort, call NumPy functions on a groups of columns, and take slices of data defined from starting row, ending row, starting column, ending column and filtering data based within a dataframe based on conditions.

Cloud Computing: Expensive desktops are not available to all. Therefore AWS was taught as an inductive step to overcome the need for each student to have a functional computer(Amazon 2019a). The students were able to explain the difference between cloud and a desktop. They were able to identify the pros and cons of using a cloud server versus a desktop. The learning objectives for this module included creating an AWS account, bringing up a server for a fixed time, installing pandas and open CV tools, as well as utilizing AI software frameworks. The students were able to run the programs developed in the previous two sections on the rented server and shut it down after use.

Matrix Manipulations and basic linear algebra: AI is mostly as massive set of matrix multiplication operations and basic statistics. The matrix manipulation skills are taught using a numerical python NumPy library (SciPy 2019). This skill is needed to read a Keras program and understand optimizers. The learning objective for this module was assembling the rows and columns of n dimensional arrays. They were able to describe a picture (three-dimensions + one colour dimension) as a three-dimensional matrix. They were able to translate the training data of images as N dimensional arrays, for example, an array of three-dimensional pictures, or an array of batches of three-dimensional arrays. The students were able to interpret the required input as a series of indexing, slicing and sorting operations on arrays. In some cases, the student was able to write code to perform the above manipulations. In most cases the students were able to read code and explain it back to the class.

Machine learning tutorials are found in Scikit Learn(Contributors 2019b). Two algorithms were covered as lecture: logistic regression (YES / NO Binary classification); and random forest. The students were taught to identify the correct amount of training data. They were able to discriminate between too few features, too many features, too little data, too much data (almost never), and evaluate the correct amount for that problem set. They were able to identify which problems were suitable for logistic regression and write a python program that ran a logistic regression classifier on given data sets We used the U.C Irvine machine learning repository for this section. They were able to compare the classifier against the human result in the data set. In order to perform the comparison, the concept of loss function was inductively learned. The students were able to compare the functions and demonstrate by implementing them in programs, that each loss function gave a slightly different success score to the classifier.

Optimization Algorithms The goal is to understand an optimizer called Gradient descent (Ruder 2019). The course referred back to turtle, and developed an algorithm that helped the turtle search for hidden food on the two-dimensional computer screen, as shown in Figure 4.

The students were able to extend the two-dimensional food search algorithm into three-dimensions. Gradient descent was taught using animated videos. The students were able to

Do until food is reached
1 Go forward 10 steps
2 If smell is weaker
Turn left 90 degrees
3. If reached food stop

Figure 4. Algorithm for hidden food search

extend the two-dimensional food search algorithm into three-dimensions. Gradient descent was taught using animated videos. The students were able to recognize gradient descent as an N dimensional search, and compare the turtle food search algorithm against Gradient descent. The parameters of Deep learning (epochs and learning rate) were taught. The students once again explained the learning rate parameter as the turtle's stride length. They were able to contrast benefits of using large strides (quicker to reach closer target but may miss it) versus small strides, (turtle gets distracted often). Further they were able to correlate parameters of the turtle algorithm to the parameters of the learning rate decay concept taught in the optimization algorithms section. They explained it back as turtle would move faster when food smell is weak and far off, whereas it would move slowly and cautiously when food is near (Wikipedia 2019).

C. Results and Discussion

The course over the years identified combinations of subjects. This cleared confusion arising from thinking of STEM as silos. True science is not pure math or pure biology or pure physics, it is a combination of subjects. Specifically, biologists could benefit from AI which is programming and math. So biology medicine stream is as interesting as a CS engineering or pure science stream.

Inductive learning helped students go beyond the textbook, as in "what should I learn" and "how should I learn" rather

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than "I learn what is given to me". This confidence has long lasting effect on the choices the students make in the university.

Instead of trying to solve a new problem, it was more useful to take an existing solution and then guess how it could have been engineered. For example, ask the class how the Amazon face recognition, which is an existing AI solution in the market, may work. Reverse engineering is the process of taking an existing product, breaking it down to its components, and reconstructing and identical product ourselves. It is a key step in inductive learning, leading to building confidence in "I can build anything". Even though a student may not be ready to do the reconstruction part, they are often ready to deconstruct an existing solution.

Reverse engineering has another benefit as it is likely to succeed. One project that failed aimed to measure the theory that skin conductivity depended on hydration and measure the effect of various moisturizer products. The students summarized the scientific process of exploration by experimentation as an iterative process with no guaranteed result.

As a result of the AI course, students were able to articulate what professions would be replaced by AI and which could not. One such discussion focussed on whether it was worth spending ten years in studying medicine. This form of confident *look-ahead* thinking has a powerful impact on their career paths.

This was a multiyear project for a set of students in an extracurricular program. This content was designed to supplement their regular school work. Self-defined projects guarantee enthusiasm from students. Projects which were carried out only during the summer vacation, had a defined scope. The level of enthusiasm from the students was exceptional.

D. Conclusions

Students were given the opportunity to experience basic AI programming, aiding their entrance into good colleges to study computer engineering.

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A Comparative Pedagogical approach in Vernacular Architecture: Theoretical method vs PBL method

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Abstract:
The paper examines the comparative pedagogical approaches and corresponding learning outcomes in the course Vernacular Architecture in the undergraduate program of Architecture at REVA University, Bengaluru, India. The first adopts the conventional theoretical approach where instructional principles of the course are delivered through direct method, while evaluation is done through a semester end written examination. The second approach adopts Project based learning (PBL) where the course content is delivered through experiential and collaborative learning through a social environment, done by means of a Vernacular documentation study with direct applicability in the corresponding Design Studio.
Vernacular architecture is based on local needs, availability of materials and reflects local traditions. It is an architecture that is indigenous to a specific time and place and showcases the best examples of Climate responsive architecture. Sustainability is defined as avoidance of the depletion of natural resources in order to maintain an ecological balance. In Architecture, we can interpret sustainability as building with materials that are local, with minimal energy consumption yet offering thermal comfort, while serving the lifecycle pertaining to the need.
Surveys were conducted post completion of the course to understand learning outcomes and student satisfaction in both methods. The outcomes from the study suggests that Sustainability in Architecture is well comprehended and results in enhanced learning through the PBL method as it delivers the important link between 'theory' and 'praxis'.
Keywords: Vernacular architecture, sustainability, project-based learning, Blooms taxonomy

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1. Introduction

Vernacular architecture is normally taught in schools of architecture as a conventional theory-based course, heavy in content, attempting to give a broad perspective on the diversity of styles across India.
Emphasis is placed on understanding spatial planning of the units represented through plans, sections and details, the settlement pattern, construction techniques and response of built forms to Climate.
The theory-based approach has its limitation, in that the relevance of learning about vernacular and its application in today's architecture is left untouched and unexplored. This approach also fails to highlight the feature of Sustainability or low carbon foot print that is a vital learning from vernacular architecture.

The practical approach is through the pedagogy of Project based learning (PBL) which is highly successful in bridging the gap between 'Theory' and 'Praxis', especially in a discipline like Architecture which is a synthesis of Art and Science and draws from the Humanities, Management and Building technology.

The paper starts with a brief insight into current research in PBL for architectural studies, setting the basis for the pedagogical model proposed in this paper. This is followed by a detailed description of the two methods, participant survey and findings for each method. The last part of the paper discusses the findings and scope for further research.
The paper is limited to establishing the correlation of pedagogical tools to learning outcomes through the course delivery and does not examine the evaluation methods.

2. Objective

The objective of the paper is to

i. Compare theoretical method vs. PBL method for the course Vernacular Architecture

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ii. Evaluate learning outcomes using participant survey through both methods
iii. Present and discuss the findings and suggest a pedagogical toolkit through an integrated PBL model

3. Background Study: PBL and Architecture Education

Project Based learning is rooted in the Constructivist theory (Dewey et al, 1973) which states that learning is by doing and experiencing, learning is by trial and error and puzzlement and more importantly learning is through interactions of the self with the environment. It has 3 main domains of learning:

- Cognitive: Using the intellect to learn by themselves
- Content: The Theory or content that is given by the Faculty to help in solving the problem.
- Social: The learning that comes from interaction with peers in a social environment.

Architecture Studio pedagogy historically relies on cognitive and intuitive learning. There is a large component of learning-by- doing through models and through trial and error in the interactive process of design where in flaws in the planning are reworked several times to arrive at a satisfactory solution. Recent studies have revealed that PBL can be successful in multi-disciplinary courses such as Software technology with architecture design studio (Kuhn 2001), PBL in social work education (Fulmer K.2017), PBL approach for structural engineering and architecture (McCrum P. 2017).

This is encouraging as architecture also borrows from many other disciplines and a similar methodology can be adopted for Vernacular architecture that is closely related to Environmental engineering and Sustainability. This paper deploys a similar approach (Integrated PBL, Banerjee and De Graaf 1997) by presenting a problem in the Design studio and delivering the content of the vernacular architecture course simultaneously, whereby the outcomes in the problem presentation are unique to each individual.

4. Instructional Principle I- Direct or Theoretical Method

The course Vernacular architecture was delivered in 2017 and 2018 as a theory-based approach to students of the 5th semester B. Arch at REVA University Bangalore. It was a 4-credit elective course with 52 hours of teaching spread over a 16-week semester. The students learned about Vernacular architecture as a process, the different approaches to studying vernacular architecture, elements that constitute, methodology to study vernacular and the need for architects today to understand traditional construction techniques of the past.

Examples from different geographical regions of India, from single cell units to the multi cell mansions of the Nattukottai Chettiars were detailed out. Instructional environment was the classroom, with use of visual aids like PPT and videos. Inquiry based learning (Constructivist theory, Dewey et al 1970) that involved students researching few topics and presenting their understanding to the class as a seminar was also attempted (Flipped classroom, King 1993, Peer instruction Mazur 1997). Still other examples were understood with the help of models (Learning by doing, Dewey 1938) as seen in Table 1, figures 1and 2

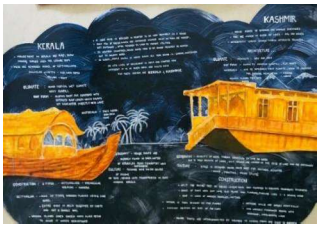

Fig 1: Panel on differences and similarities of houseboats in Kerala and Kashmir, source: Aishwarya and Chinmayi, 5th Semester, REVA University. Pedagogical tool- learning by discovery.

Fig 2: Comparative study on Courtyards in Vernacular architecture,
source: Deeksha and Meghana, 5th Semester, REVA University. Pedagogical tool- learning by discovery

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4.1 Faculty Role in Course Delivery

Pedagogy adopted in delivering the course was innovative and diverse in nature, taking into account differentiated learning and outcomes that matched the Blooms levels of
Taxonomy. The same is discussed in the table 1 below.

Table 1: Pedagogy in the Theoretical approach to the course

2016 & 2017

METHOD ADOPTED	PEDAGOGICAL TOOLS	BLOOMS TAXONOMY LEVEL
Research paper readings- around the world in a nutshell	Inquiry based learning	Analysis
Model making/panel presentations: Fig 1,2	Learning by doing, learning by discovery	Comprehension
Use of exit cards	Safe environment assessment	Knowledge
Use of videos	Sensorial learning- visual and aural	Knowledge
Invited lecture from expert faculties	Enhancing course delivery	Comprehension
Walk through a vernacular settlement	Experiential learning	Comprehension

Source: author

4.2 Survey Responses

A survey was conducted among students post completion of the course using the theoretical approach. Questions posed were aimed at understanding initial response to the course; topics that were retained and recalled the most; understanding of the spatial planning, dimensions, terminology through drawings; course delivery method that made the most impact; learning from the examples discussed and finally if they were convinced about sustainability in Vernacular architecture. Some of the pertinent responses are shown below.

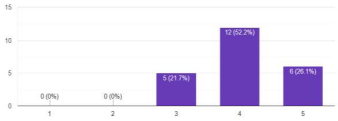

Fig 3: Overall understanding of Plans, sections and elevations of the various vernacular styles across India on a scale of 1 to 5

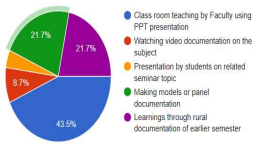

Fig 4: Medium of course delivery that impacted most on learning

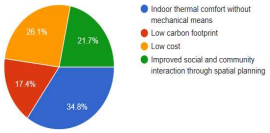

Fig 5: Feature or element in Vernacular feasible to achieve in design

When asked where they perceive maximum opportunity to apply their learning in design, 47% responded for Resorts and Eco-Tourism, 21 % for low rise community housing, 17% for Residential in non-urban context and only 13% for public buildings. When asked if the course inspired them to work with architects who practiced sustainability, 100% answered positively.
Finally, when asked what methods could have been introduced to make the course more relatable, 73% responded with live experiments at a vernacular site to measure temperatures, humidity, and thermal gain, making prototypes and testing using simulation software.

4.3 Summary of Findings

From the survey it can be inferred that the instructional principle of direct method has its benefits in that dissemination of information on all topics are equal and a good understanding of spatial

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planning is achieved. The learning is further reinforced through the hands-on approach of making panels or models (Fig 1,2). Students rate high on memory recall on all topics. This goes to prove that the Blooms taxonomy level of Comprehension is satisfied. However, the students did not rate high on application of learning and also on understanding of Climate responsiveness and sustainability in Vernacular architecture. The lack of practical experience at a site is attributed to this.

5 Instructional Principle -II: PBL Approach

An alternate method was adopted in 2019 with students of the 4th semester by the same Faculty member. The opportunity to integrate Vernacular architecture (Integrated PBL, Savery 1995) within the design studio presented itself whereby a new pedagogical approach of Project based learning was attempted. The problem was to study the Vernacular settlement at two locations in the Udupi district. 74 Students accompanied by 4 faculty members were taken to Barkur and Brahmavar, two ancient settlements that date back in History to the Tuluva dynasty in coastal Karnataka. The climatic region was classified as Hot-Humid with high annual rainfall and high summer temperatures.

5.1 Project Brief:

The 16-week semester was divided in four stages:
i)**Pre-site visit**: Direct briefing to students, procuring necessary base maps, instruments, grouping of students according to allotted tasks prior to visit.

ii)**On-site:** Detailed outline of multiple tasks and activities during the period of stay at the chosen location. Faculty intervention at end of each day to help tally, correlate and understand the data recorded.

iii)**Post site visit Studio Documentation:** Translation of learning at site into report, video, drawings. Analysis of findings that make the basis for delineating the problem.

iv)**Detailed solution development using PBL**: using the method of studio pedagogy in the Lodge design whereby the learnings from the documentation and analysis is applied into the Design. This ensures a holistic learning and connection between theory and praxis

5.2 Activities to achieve Learning Goals:

The vernacular documentation was carried out over two days at both locations. Students conducted primary survey with questionnaire on living conditions, occupation, infrastructure, age and condition of houses; collected secondary data from Taluk office on demography; Landuse, street character, activity mapping, identification of nodes, interaction spaces; detailed documentation of religious heritage to study linkages in history, community and culture; detailed documentation of residential typologies in terms of Plans, sections, elevation and details of different income and occupation characteristics; vernacular methods of construction details and materials both structural and non-structural; video documentation of the settlement; climatic analysis focussing on passive methods adopted that improve indoor thermal comfort through spatial planning. The figures below represent the activities carried out at the location.

Fig 6: Measuring and sketching at temple Brahmavar, experiential learning

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Fig 7: Mediated learning: Faculty discussing the data collected
at site and reinforcing the learning

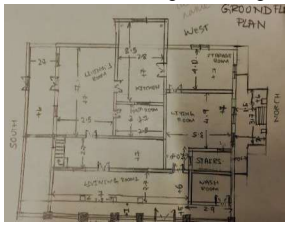

Fig 8: On-site sketching Residential typology- translating into plan

Fig 9: Understanding shading and Sun path in Temple courtyard,
Discovery learning.

5.3 Formulation of project brief:
After the completion of the on-site study, a site was identified for proposing a Lodge at Barkur to facilitate accommodation of tourists during the 'Alupotsava' festival and during annual temple 'Rathothsava' festival. The total site area was 900sqm and the design constraint was to utilise 50-60% ground coverage and achieve a solution to accommodate the space program. The purpose was to present students with a problem that was specifically 'Context-driven', which is the basis for all Vernacular architecture as stated earlier in the paper. The table below gives a brief description of spatial requirements for the problem

Table 2: Design requirements of the project

S.NO	DESIGN REQUIREMENT	AREA IN SQM
1	Reception lobby, waiting, manager room, luggage room, tourist information kiosk	60
2	Restaurant, kitchen	100
3	Rooms- single, executive, luxury- 20 no with attached toilets	400
4	Multi-purpose hall for small gatherings	150
5	Circulation spaces, services and ancillary	200
6	Parking for 15 cars and 50 two wheelers	250
	Total built-up area spread over 2/3 floors	About 1200-1400 sqm

Source: author

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5.4 Faculty role in Course Delivery:
The pedagogical strategies deployed during the pre-site visit, on-site study and post site visit studio work can be summarised below.

Table 3: Pedagogy Deployed from stages 1 to 4 of Project

METHOD ADOPTED	PEDAGOGICAL TOOLS	OUTCOMES
Pre-visit context sensitisation- familiarising students with geographical area, delineated study area, task allocations, creation of base maps	Collaborative and cooperative learning	Tasks allocated were completed as per expectations on-site as students worked on their inherent skills
Lecture on Climatology by subject expert- Passive methods in Hot-Humid regions using examples	Direct method, Integrated PBL	Students were able to identify the role of materials and passive methods in achieving indoor thermal comfort
On-site work: video documentation, interviews, public performance viewing of Yaksha gana, primary survey, measured drawings of religious and residential typologies: *fig 6,7,8*	Experiential learning/ Sensorial learning / learning through environment/ Theory of multiple intelligences	Understanding impact of socio-economic structure, sustainability, culture, traditions, climate on the spatial planning of residential typologies, street character and vernacular style
On-site measurement of indoor-outdoor temperatures, humidity, wind direction, speed using weather monitoring station, measurement and observation of shadow patterns: *fig 9*	Discovery learning	Deeper understanding and validation of learnings through lecture on climatology
Post-site visit studio work: Translation of drawings from paper to software by Intensive workshop on AutoCAD, adobe photoshop conducted by faculty members	Direct method- using software lab /Integrated PBL	Creating a software data base of all drawings eased sharing among groups for analysis and made end semester output simpler and more enhanced.
Mid-semester Jury by expert on cultural landscape of the region to review analysis of findings - Religious heritage, Landuse and street character, Residential typologies, Construction techniques and Climatic analysis were the broad topics: *figures 10, 11*	Inquiry based learning/ Mediated learning experience	Comments specific to each group on the data analysed by external expert helped understand in totality the connections in the documentation exercise among the groups. Positive reinforcement of the work by an external member increased confidence and enhanced final output
Support through expert sessions on Structures, services, climatology at the design resolution stage	Mediated Learning	Outcomes were differentiated: Higher thinkers integrated the learnings from all cross disciplinary courses into the design while others could integrate only few
Detailing the design problem: Site analysis and climatic understanding, integrating services like water supply, sanitation, electricity, resolving high temperature and sun angles owing to orientation, assuring wind flow and ventilation, understanding roof forms: fig 12,13	Iterative learning/ learning through social interaction/learning by trial and error	The analysis helped students to come up with a strong concept that was responded to context in terms of materials, form, spatial planning. Applying the learnings into the design completed the learning cycle

Source: author

5.5 Problem presentation by students: Analysis and Design

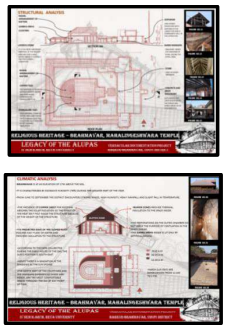

Fig 10,11 Analysis of Study: Religious heritage, typologies, Construction details, Street study, source: Students of 4th Sem REVA University

5.6 Differentiated Learning: Design solutions through PBL Method

Solutions offered were unique to each student with varying levels of complexities achieved, taking into account the collaborative learning at site, in the studio and subsequent analysis. Lectures given in short capsules also helped in the design development. All were presented in the form of drawings and models.

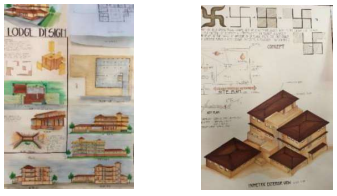

Fig 12,13: Design Solution to Problem: Graphical representation, Students of 4th Semester, REVA University

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Table 4: Level of complexity achieved in Problem solving by students using PBL method

SL	PROBLEM CHALLENGE	SOLUTION - MODERATE ACHIEVERS	SOLUTION- HIGH ACHIEVERS
1	Hot-Humid Climate: High rainfall	Courtyard planning, sloped roofs	Passive cooling through water bodies, Jaali openings for forced air, elevation of living spaces on stilts, design of shading device as per sun angle
2	High Thermal gain	Use of local materials Laterite walls with Lime plastering, deep eaves projections, High Plinth	Balconies for buffer, clear-storey openings, double insulated walls, filler slabs for roofs
3	Response to Context-surrounding temple, temple Kalyani	Replication of Colonnaded verandah as seen in temple, use of Gajaprastha profile in Plan	Conceptual abstraction of temple form, staggering in plan, relation of built unbuilt, ground water recharge to facilitate water table near Kalyani
4	Horizontal and vertical planning, façade treatment in heritage precinct	Mangalore tiles, timber columns in elevation, staggering of plan with courtyards	Achieving connectivity though semi-open corridors, changing quality of light, use of local materials

Source: author

5.7 Survey Findings

A post course completion survey was undertaken to assess how the pedagogical tools impact learning outcomes in the PBL method.

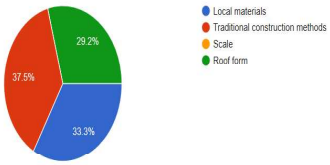

Fig 14: Visual quality of Vernacular experienced

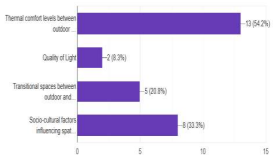

Fig 15: Physical quality of vernacular experienced

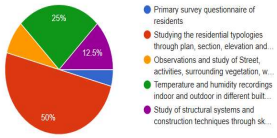

Fig 16: Method deployed that had most impact on learning outcome

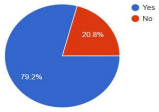

Fig 17: Whether the problem offered the opportunity to apply the learnings

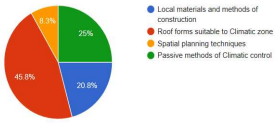

Fig 18: Element applied in problem presentation

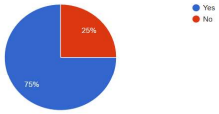

Fig 19 : Efficacy of providing Climatology theory lecture in problem resolution

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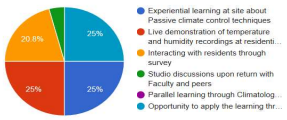

Fig 20: Pedagogical tool deployed that maximised learning outcomes

5.8 Summary of Findings:

The PBL method validates the constructivist theory that learning through social interactions (Vygotsky1978) results in understanding multiple issues at once. Certain intangible elements like Socio-cultural factors reflected in spatial planning were internalised by students only when physically placed in the learning environment.
Interactions with the residents through primary survey helped many students perceive the sustainable eco system existing and to attempt similar solutions in their design problem, like open wells and maintaining the larger temple tanks.
Similarly, Passive methods of Climatic control were easily understood and replicated in the Design solution instead of resorting to solutions like air-conditioning. The most important findings through the survey was that a strong correlation of theory to practice was achieved in the PBL method as all students tried at least one or more elements of Vernacular to be applied to the Design problem as can be seen in table 4. Moderate achievers applied direct methods, while some high achievers applied a combination of active and passive methods of climate control with innovative solutions for shading devices and roof insulation.

6.1 Conclusion and Recommendations:

The findings on learning outcomes of both approaches reveal that in the conventional method the learning outcomes are good communication skills through drawings, sound knowledge on diversity of styles across regions and broad awareness on Climate responsiveness of Vernacular architecture.
In the PBL method, using the toolkit of pedagogical approaches, students presented the extended learnings by applying the knowledge to the Lodge design. Features like passive methods for Climate control, use of local materials, contextual learnings through roof forms and interpreting the local features in a modern representation were evident in the Design.
Another important reflective learning for the students in the PBL method were the intangible aspects like socio-cultural factors, relation of built to un-built and scale.

The objective of the research and the premise that the PBL method would bring them closer to understanding Sustainability in Vernacular architecture was validated as seen in the innovative passive measures for preventing thermal heat gain, Green walls and orientation towards prevailing winds. Furthermore, this method encourages continued learning, leading to further research by the individual, as observed in the innovative shading device design attempted by the higher achievers.

6.2 Scope for further research:

The experiment with contrasting approaches was successful as the Faculty member handling the course was same and had conducted two rural documentation studios in different Climatic zones in Karnataka. This pilot study can be replicated to other theory-based courses which can be integrated into the Design studio with an end goal of application through the modified PBL practice.
Further, this pilot study has opened up possibilities of taking the analysis to the next step by introducing the simulation software for assessing building performance. Since the documented drawings are available as AutoCAD drawings, the same can be tested by students using simulation software like Design Builder to assess the performance level and energy efficiency of the building and assess sustainability in Vernacular architecture. The same simulation model can be applied to the Design solutions proposed, where students have suggested innovative modern-day solutions like green walls, shading devices and new materials based on the learnings from vernacular study. This will reinforce faith in the traditional vernacular methods and encourage them to build using this knowledge that will be the new sustainable architecture of tomorrow.

Acknowledgement:

The author wishes to thank the team of Faculty members of the Architectural Design studio for their support in carrying out the study. The author acknowledges the efforts of the students of the batch of 2015, 2016 and 2017 of the school of architecture REVA University for being enthusiastic learners and for completing the survey questionnaire. This research is part of an on-going doctoral research by the author on Pedagogical approaches in Architecture education

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Implementing PBL to Enhance Technical Knowledge through Design Thinking Process

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Abstract: The traditional method of teaching is no longer effective so every instructor wants to use new pedagogy to enhance students learning and knowledge. Many challenges are faced by the instructors in teaching to Mechanical Engineering graduates where grabbing students' interest towards the concepts is difficult. Hence, there is a need to have different methodologies to understand course concepts. Moreover, without the knowledge of course content the practical implementation from lab to industry becomes a herculean task. Renewable Energy is one of the subjects in mechanical engineering for III year I semester that needs practical application to understand the importance of the subject and its impact in our daily life. Therefore, instructor has conducted PBL (Project Based Learning) for solving society based problems by following design thinking process. This paper gives insight on the conduct of the activity planned, executed and its success by following the design thinking process. The impact of this activity encouraged many students to implement the same way of learning in renewable energy subject.

Keywords: PBL, teamwork, solar cordless grass cutter

1. Introduction

Project based learning is a dynamic approach of learning during which students actively explore real world issues and challenges and acquire a deeper knowledge. The PBL process not only focuses on defined solution, but it also allows the development of other desirable skills and attributes.

S K. Khamuruddeen and AzeemUnnisa[1] have implemented PBL for digital image processing course where they tried to boost students' learning through sensible implementation. They have given different modules to the group of students and asked them to implement mini projects on those modules. Modules were Histogram Equalization, Median filtering, Image Addition, subtraction, multiplication and Division. Weekly 5 hours were assigned for this subject which is distributed into 4 tutorial classes and one practical class wherein they taught topics of 4 tutorial classes to implement in one practical class. In this study they have discovered students' confidence in the data collection which in turn created a great impact on their learning. After using this methodology students attendance has increased in the class. Students participated actively during this activity compared to the traditional approach of learning.

Roohshad Mistry et al [2] has studied the importance of PBL over the traditional approach. These authors have mentioned that curriculum design courses with some simple problem solving methods, but they did not help in solving the real world problems students could not gain any experience through it.

Implementing PBL on Automobile Design and Manufacturing has given the required exposure to the actual need and its implementation. The object of the PBL is to simulate real-world engineering design projects and their related challenges which they can accomplish by participating in any competition. The agenda behind this study was to participate in the SAE and FSAE competitions which are core associated challenges of the mechanical branch, where students have scope to get even placement opportunities. The PBL is implemented for 25 students for 6 months duration. This activity facilitated the collaboration of seniors with their juniors, which helped the students to find the group of their interest for implementation. The activity was a successful achievement by the students, it also helped in attaining a number of the graduates attributes which was the final outcome of the activity.

Reshmi Devi T.V [3] has expressed the success story of the impact of the PBL on mechanism of fluid course in Civil Engineering branch. The study has greatly emphasized more on the practical implementation that is required for solving daily life problems which will give a great scope for students learning. They have framed the rubrics to assess student's progress and might be used for

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Continuous Internal Evaluation (CIE). Experiential learning and critical thinking of the teams were evaluated through model demonstration, viva-voce and reports. On the other hand, soft skills like team work and communication were evaluated through peer evaluation. Interestingly, they have formed the heterogeneous groups of 8-9 students in which each group must contain one female and at least one student who has completed Diploma in civil Engineering. It was found that the students liked PBL and improved their knowledge on core concepts.

Edson et al [4] have focused more on the challenges that are faced while implementing PBL. After identifying the challenges, they have found alternatives to deal with those challenges. Through PBL, they desired to enhance students' practical knowledge in addition to participation in Baja SAE Competition. The PBL is categorized in to various modules for learning and then working in teams to utilize their knowledge to form buggy so that they can participate in SAE competition. They have conducted assessment at three different phases to evaluate the students learning.

Shrutika S Sawant [5], in this paper the implementation of PBL has discussed and course is analyzed with direct and indirect attainment of course outcomes. After applying the PBL, methodology students' results have improved.

Srinivasa Pai P [6], 2018 has explained about the issues faced by the faculty while implementing the PBL methodology. They have further mentioned corrective actions should be taken by the instructor to overcome the challenges. They proved through their experience that students are learning the concept taught fast in comparison to traditional method.

Azeem Unnisa et.al [7] 2018, stated that the new model of problem solving game based pedagogy was successfully implemented by the instructor. Students have learned problem solving skills by game based learning that was edutaining to understand technical concepts.

Therefore, PBL is very important to include in the curriculum to implement active learning in class room. Every course has outcome, PBL is one of the best outcomes to prove students learning in the respective subject. It is not only to enhance students learning but also give them confidence to solve real world problems. Renewable energy resource is one of the courses in the mechanical branch where we can implement project based learning to teach students core concepts. This paper shows the impact of design thinking process to solve real world problems that we need to know from the community and solve by providing engineering solutions. The main objective of this paper is to solve society based problems through PBL by incorporating design thinking process.

2. Method

For project based learning, instructor applied design thinking process to know each and every step in the process and to gain practical knowledge on the renewable energy resources course. Design thinking Process has the following module.

- Problem Identification

It was decided by the instructor to solve the real time problem through the design thinking process. By following design thinking process in PBL, community partner was identified and the related problems were addressed through renewable energy resources course. Our Community Partner Mr.Souraih is a 67 year old person a resident of Gowdavelli village and working as a gardener in HITAM College. His work is to trim & clean the grass of the lawn alternate days. While doing this work, he faces problems to push the heavy weight machine by carrying a direct AC power supply wire all over the lawn. It is time consuming work and cumbersome for him. Due to his age & other health issues, he is facing problem with the existing machine. On interaction with him, we came to know that he requires a machine which can reduce his workload.

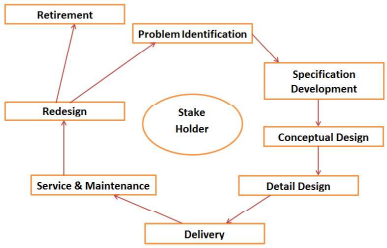

Fig.1 Design process

Fig.2. Grass cutter

- Specification development

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Table.1 Product survey

Product name	Patent number	Key features	Draw back
Ride on grass cutter	US 2865159 A	1) More manoeuvrability 2) Better handling	Not suitable for small fields a it is bigger in size 1) Requires fossil fuels whicl in-turn emits toxins 2) Cost for maintenance is hi 3) Mess with oils and lubricants 4) Risk with the oils
Automated grass cutter	US 5974347 A	1) Operating time can be set 2) No emissions 3) Saves time	1) Requires a perimeter wire 2) Hard to maintain 3) Loss of jobs due to comple automation 4) Battery consumption is mo
Hybrid remote control grass cutter	US 7677344 B2	1) Can be operated from a safe place	1) Engine is used to rotate th blades which requires fossil fuels 2) Emission of toxins 3) Mess with oils 4) Expensive 5) Cost for maintenance is hi

After understanding the problem of community partner, the product survey was done and searched for the grass cutter which suits his requirement. Many grass cutters are available in the market but they have their own limitations which will not fulfil the requirement of him. The following table shows the existing grass cutter with its limitation.

- Conceptual Design

Table. 2 Decision matrix

Criteria	Weights	Idea#1	Idea#2	Idea#3	Idea#4	Idea#5	Idea#6
Maintainability	5	5	4	3	3	4	3
Economical	5	5	4	5	5	4	5
Feasibility	5	5	5	5	5	5	5
Sustainability	5	4	4	3	3	4	3
Physical Effort	5	5	5	3	2	5	2
Work Time	5	5	5	3	2	5	2
Sum	150	145	135	110	100	135	100

Fig.3 Prototype

After doing product survey students have come up with multiple ideas to solve the problem. To fill the gap of existing products in the market with the required product as a team they have decided to provide a solution for the community partner by which he can do his work easily and efficiently. Students have done two working prototypes and done the decision matrix to know about which idea is getting maximum efficiency that idea was implemented from prototype to product conversion.

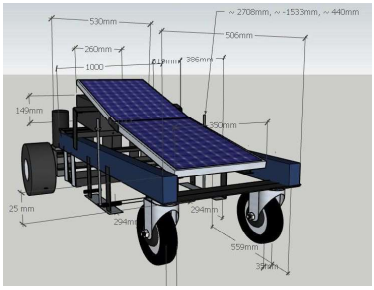
- ❖ Possible Ideas:
  - ➢ Solar Powered Cord less grass cutter
  - ➢ Cord Less grass cutter
  - ➢ Grass cutter with wired remote.
  - ➢ Pushover grass cutter with attachment.
  - ➢ Bluetooth controlled grass cutter.
  - ➢ Pedal operated grass cutter.

From the above decision matrix it has come to know that Idea1 i.e. solar powered grass cutter was the best idea available for implementation.

- ➢ It is easy to maintain and it does not contain the complicated parts, easy wiring and easy to recharge every day.
- ➢ Economical: - By considering the environmental aspects it gets recharge by solar panel therefore no expenses of electricity.
- ➢ Feasibility: - due to the less complexity, product can be manufactured and used.
- ➢ Sustainability: - Sustenance is easy because of the specifications used for making the project.
- ➢ Physical Effort: - As it can be controlled by a remote control, it results in less fatigue.
- ➢ Work done: - Blades and motors will make task easier and faster.

- Detail Design

Cordless Grass Cutter is a machine with the advanced capabilities than the regular grass cutters. This machine is controlled by radio frequency signals.



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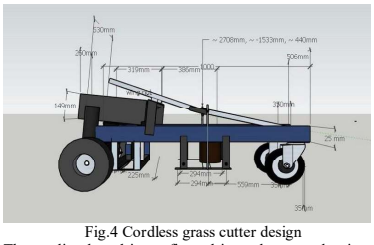

Fig.4 Cordless grass cutter design

The aurdino board is configured in such a way that it can receive the RF signals from the transmitter using a receiver, then drive the motors which are attached to the wheels and a blade. The board is connected to a motor driver, this motor driver which is intact with the motors. The board is powered by a battery which is rechargeable. The control signal is generated in the remote, when the user decides on how to handle the cutter. There are three (3) motors in this machine, two (2) motors are used to drive the wheels of the chassis and the one (1) motor is used to drive the grass cutting blade. The batteries are coupled with a solar panel so that the solar power can be used as backup power source to run the machine.

- Delivery

Fig.6 shows the PBL project is delivered to community partner. Taken the feedback from the community partner and he felt it is very easy to handle and to rotate in all directions. He also told that safety measurements should be taken for safety. Our solution will provide best device which will reduce the human effort and difficulty while doing their job. Apart from this saving electricity is also our concern which is very important for our bright future. While dealing with new technical machines, we generally forget about electricity consumption. Therefore our product will minimize that problem by replacing solar energy for recharging the batteries.

Fig.5 Cordless grass cutter

Fig.6 PBL Project delivered to community partner

- Service & Maintenance.

Yearly two times machine performance will be checked and rechargeable battery will be changed after two years.

Review of the project was conducted in three different phases and each phase has its designated rubrics which were shared with the students before the commencement of the project. Table no 2, 3, 4 are the rubrics of phase 1,2,3 respectively. The main objective of rubrics was to ensure the final product of the project which can be delivered to the community partner that will be achieved through rubrics.

Results

PBL methodology is successfully implemented in the renewable energy resource course. Students also learnt about design thinking process and how to solve real time problem and team work. Following are the team experiences from PBL approach

- Acquiring experience
- Understanding the value of each activity
- Develops the ability and skills of thinking and doing the activities
- Acquiring the skills and qualities of Group activity
- User involvement
- Clear Statement of Requirements
- Proper Planning

Fig.7 The evaluation done by external

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Table.2 Rubrics the evaluation Phase 1

PROBLEM IDENTIFICATION	Community Interaction with the concerned Project Team (3 Points)	3 points. = Clear representation of the community interaction by the team members with appropriate documentation with visuals	2 points. = Clear representation of the community interaction by team members with an appropriate document	1 point. = Oral representation of community interaction (no evidences)
	Necessitate of the problem identified (3 Points)	3 points. = Clearly addressing the problem by statistical representation of either human, educational, health or environmental community	2 points. = Mentioned without statistical representation.	1 point. = Does not mentioned the clear need of the community
	Stakeholder Identification (3 points)	3 points. = Clearly identifies a specific and real user or organization, by name, which can provide feedback/suggestions for the team and receive the project once completed.	2 points. = Mentioned the community but not a specific user who can provide suggestions or feedback over the project	1point. = No clear details of community or specific user
SPECIFICATION DEVELOPMENT	Measurable requirements (3 points)	3 points. = Clearly describes at least 5 measurable requirements	2 point. = Less than 4 described specifications or	1 point. = At least 2 specifications listed
		depending on the project	the ones described are not measurable	
	Identification of existing solutions (3 points)	3 points. = Identification of existing solutions addressing the similar problems with appropriate documentation	2 point. = Identification of existing solutions addressing the similar problems with no appropriate documentation.	1 point. = No clear identification of existing solutions.
	Gaps in existing solutions (3 points)	3 points = A clear explanation / analysis of gaps with the documentation by using the appropriate case studies.	2 points = A marginal explanation/ analysis of gaps by using the appropriate case studies.	1 point = No appropriate case studies for justification of gaps.
	Poster Presentation (Mandatorily) (3 points)	3 points = Creative poster presentation	2 points = Good oral presentation	1 point = Either Creative poster or good oral presentation

Table.3 Rubrics the evaluation Phase 2

Assessment parameter	Good	Average	Poor
Sketches of five concepts (5M)	Novel ideas with clear sketches (5M)	Ideas are novel but sketches are not clear (2.5M)	Ideas copied from other sources (1M)
Relevant images of paper models (5M)	At least 3 mock-up models from those	At least 1 mock-up model from those	1 mock-up model but not appropria

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	five sketches (5M)	5 sketches (2.5M)	te (0.5M)
Concept selection table (PUGH'S table) (2M)	Concept selection based on any design tool (2M)	Concept selection without any tool (1M)	concept selection without any logic (0.5M)
Product Architecture (physical and functional) (10M)	Both physical and functional decomposition with neat sketches (10M)	Only 1 (physical/ functional) decomposition sketch (5M)	Not having clear idea about product architecture (1M)
Product details (components/material, dimensions, manufacturing technology and cost) (10M)	Complete details of the product clearly written (10M)	Partial details of the product written clearly (5M)	Product details are not presented clearly (2M)
Poster (3M)	Poster representing all the parameters of assessment and also having good design (3M)	Poster representing all the parameters of assessment and not a good design (1.5M)	Poster representing some parameters of assessment and also not a good design (0.5M)

Table.4 Rubrics the evaluation Phase 3

Assessment Parameter		Good	Average	Poor
Design (15 M)	Product architecture (5M)	Product architecture manual with measurement 2D or 3D (5M)	Without manual and measurement or Related Proofs (3M)	Without manual /only Architecture(2M)
	Design skills (5M)	Providing proofs of number of Iterations covered (5M)	Number of iterations without proofs (3M)	Not covering number of Iteration directly jumping in to design (2M)
	Working status (5M)	Working of the product	Partially working (3M)	Not working (2M)
		(5M)		
Testing (10 M)	Product demonstration(3M)	Product demonstration (3M)	Without product demonstration only video presentation (2M)	No video or product demonstration (1M)
	User testing (4M)	Efficiency and safety usability to community partner (4M)	Not mentioned the safety and usability (3M)	No safety and life span of product (2M)
	Feedback (3M)	Details of providing community partner feedback ,NGO and photo (3M)	No community partner feedback but only photo (2M)	No community partner feedback and photo (1M)

Discussion

S K. Khamurudden et.al [1] stated that project based learning methodology was successfully implemented for final year students. After using this methodology, students' attendance has increased in the class. Students have actively participated in this activity compared to traditional approach. However, the impact of the project on student's learning was not mentioned clearly.

Roohshad Mistry et.al [2] 2017 has explained about the FSAE project under PBL. Students focus was more towards core jobs than the public sector. Nevertheless, author didn't mention that how many students got placed by implementing the PBL?

Reshmi Devi T.V [3], 2017 mentioned that PBL is implemented for III yr. semester civil engineering course and all have actively participated in the course while working on the real time application. However paper didn't mention even single example which showcased the real time application done by students.

This paper has followed the rubrics in all the phases involved right from identifying the problems until the delivery of the product, all areas of individual and team work performance was taken into consideration. Its impact is seen in the delivery of the product to the community partner and he is satisfied with it. It became more successful as other gardeners also asked students to provide similar devices to make their job comfortable.

Conclusion

Renewable energy resources course always needs practical implementation to prove students efficient understanding and learning. PBL is an additional approach to reinforce

the technical knowledge of the students. This study has verified that by incorporating the design thinking process in PBL, the projects made are effective and are very helpful. However, following design thinking method shapes students understanding the actual requirement and dealing on the distinctive resolution that is not in existence. PBL gives students great scope for employement.

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An Experience of Teaching Engineering Design for Freshman Students

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Abstract:
In recent years design thinking has taken center stage in the engineering curriculum. The driving force being the society and industries who need graduate engineers who can design, innovative, and creative products to help solve the real-world problems. The current paper discusses the experiences of a systematic approach in defining, teaching, and assessing the engineering design process to freshman engineering students at KLE Technological University (KLETU). The paper begins by defining 'design thinking' followed by briefly reviewing the role of engineering design and its importance in the engineering curriculum. Design is hard to learn but hardest to teach. Efforts have been made, in this work, to bring in the perspective of the pedagogy of activity-based teaching and its challenges and opportunities in teaching engineering design process at the freshman engineering level. This pedagogical approach, for freshman level, resulted in enhanced students learning.

Keywords: Design, Freshman Engineering, Activity, Learning

I. Introduction

Design is at the core of any engineering discipline and is the heart of engineering practice. Engineering experts consider design being synonymous with engineering (Mourtos NJ et al., 2012). Presently in most of the engineering institutes, designing is taught at the sophomore or senior semesters and is finally realized in the form of course project or capstone project. Bringing in design thinking at freshman level will not only enhance student's ability to think creatively and bringing innovative alternatives but also helps the student to put the entire engineering curriculum into perspective.

To describe the background of introducing design thinking at freshman level in KLETU goes back to 2015-16 when institute joined hands with Virginia Technological University (VT), USA. This collaboration helped in understanding and adapted engineering exploration course, which was earlier taught at VT for freshman engineering students(McDonald WM et al.). Globally, many efforts have been made even before to teach engineering design course at different levels in engineering institutes. Which are mostly project-based learning approach is followed (Ambrose SA et al., & Genco N, Hölttä-Otto K, 2012). The work presented in this paper is first of its kind in the Indian context, where activity-based learning pedagogy was followed to infuse design thinking. Here the authors have given their experiences in defining, designing, delivering, and assessing engineering design content for first-year students in the course Engineering Exploration. The data presented here tracks pedagogical efforts for the academic year 2015-16 and 2016-17 (odd & even semester).

The study conducted with the following research question:

How do the design process and pedagogy influence students' ability in problem formulation and solution methodology?

II. Background literature survey

Julie D. Burton & Daniel M. White, 1999 reviews eight methods for teaching design for freshman engineering

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students which were the outcome of survey of about 43 ABET-accredited Engineering Schools/ Universities across USA. The methodologies include Reverse Engineering, Creating Something Useful, Full-Scale Project, Small Scale Projects, Case Studies, Competitions, Non-Profit Project and Re-design of a Local Project.

Payton L. N, 2005 illustrates a general approach of first-year students working in multidisciplinary teams in building production aircraft. Designing, production, and testing were the principal stages in building a production aircraft which had to meet statistical quality control performance parameters set by the customers.

Kinda Khalaf et al., 2013 discuss a design-and-build course at the freshman level for early engineering design education. The course adopts project-based learning (PBL) pedagogy and prescriptive design cycle as a mode of design teaching.

Sanjay E. et al., 2015 reports curriculum design and delivery, course outcomes, and attainments of an undergraduate course for electric sciences. They adopted domain-specific case studies, laboratory exercises in laboratory, activity-based learning, and course projects as pedagogical methods for teaching.

Arun Y Patil et al., 2016 present their efforts in teaching design for post-graduate students in Integrated Product Design (IPD) course. They relied on laboratory sessions to impart design tools viz., Industrial Design Sketching, Six sigma techniques with the aid of MINITAB software and course project as an outcome.

Many efforts have been made in teaching engineering design at freshman engineering as well at higher levels. The major methodology followed is through full-scale projects or activities. A new methodology where integrating activity-based learning followed by a full-scale project can be done to reinforce classroom learnings.

III. Thinking 'Design'

Design problems vary from those requiring relatively routine solutions based on generally well-developed knowledge and existing systems to those demanding highly innovative solutions.

To begin, in solving any design problem is to acknowledge that there exists a problem. The first step in any design effort resulting in a better product/process is to identify and understand the end-user needs. Design always begins with identifying undesirable and desirable situations of customer needs and ends with devising a plan which tries to fulfill the needs of the end-user

The design is a blueprint- a plan for change from undesirable to desirable situation. Again, a matter of perception- whose, where, and when- plays a crucial role in identifying the undesirable situation. In a nutshell, designing is all about problem understanding and problem-solving.

The next question would be what design means in the context of engineering? Hubka V and Eder WE, 2003, describe the design in the context of engineering. The authors state that 'Engineering design is a systematic, intelligent process in which designers generate, evaluate, and specify designs for devices, systems, or processes... achieve client's objectives and user's needs while satisfying a specified set of constraints'. This definition sets the direction for the course. This definition describes the design as a thoughtful process. Wherein a designer has to generate multiple solutions, evaluate the alternatives for the best solution against the identified constraints, and specified technical values to achieve the user's needs ultimately.

IV. Challenges

One cannot be a good designer if he/she does not wet one's feet. Teaching, as well as learning design for a novice, is a challenging one. Authors have observed several challenges in teaching this course to first-year students:

- Handling mass classes associating with faculty with different discipline background.
- In teaching design, both theory and practice need to be involved. Hubka and Eder, 2003 have identified four types of knowledge required in a design process, namely object knowledge, theory knowledge, practice knowledge, and process knowledge.
- One more vital point to be considered is the competency of teacher teaching engineering design.
- Designers, at times, work alone within a discipline, e.g., Mechanical, Electrical or Computers or in a combination of them. At some other times, they must work in a team. Designing may need human conflict resolution, overcoming 'group think,' detecting, and avoiding errors. (Hubka V and Eder WE, 2003). Developing a curriculum for engineering design has to consider these aspects. Students have to be given a flavor of these components so that they can appreciate the importance of the multi-disciplinary nature of engineering design and teamwork in such a scenario.

V. Methodology

The following sections discuss the course structure of course "Engineering exploration" followed by Engineering design module content, its delivery, and assessment. This section also includes various activities that were part of the module.

A. Course Design

The course Engineering Exploration had a total of nine modules, and Basics of engineering design & multidisciplinary nature of engineering design is one among them. The module covered 12 hours of the whole course. Table 1 shows course content which contains nine modules, and the module of the current paper appears at serial number

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5 - Basics of engineering design and Multidisciplinary nature of it.

Table 1. Course Content

Chapter #	Name	Sessions (In hrs.)
1	Introduction to Engineering and Engineering study	3
2	Role of Analysis in Engineering	3
3	Analysis Methodology	3
4	Data Analysis and Graphing	6
5	Basics of Engineering Design	6
	Multi-disciplinary nature of Engineering design	6
6	Project Management	3
7	Sustainability in Engineering	3
8	Ethics	3
9	Course Project focusing on Sustainability in Engineering	12

B. Module Content and Delivery

The following goals were considered to design the content for the engineering design module.

- Explain the engineering design process
- Identification & Prioritization of Design problem's objectives
- Know-How- Identifying sub-systems and functions
- Identify multi-disciplinary facet of design
- Develop multiple solutions/concepts
- Decision making in design
- Build proposed mechanical/mechatronic system

Design problems are always ill-structured and non-formulaic (Stojcevski A, 2014). The client/customer, when poses his/her needs to the design engineer, will be verbose and descriptive. This descriptive problem lacks technical detail from which the designer has to define the engineering problem statement. This phase is very critical as this drives further design efforts.

Designing is intricate in many respects. The usual first difficulty is starting to design, where and how to begin, overcoming a natural fear of reaching into the unknown (Hubka V and Eder WE, 2003). This definition necessitates a structured design process which a novice designer can follow to solve problems. The structure of the engineering design varies slightly from one model to another or one organization to the other. A simple 5 step design process, as shown in Figure 1, was adopted. This simple process eased students' learnability and applied it to the given real-world problem.

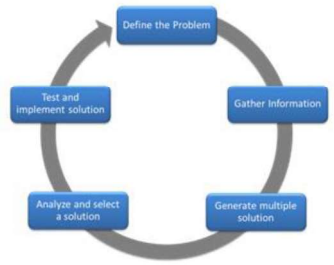

FIGURE 1: Design Process

A group activity was conducted to convey the design process. It was followed by one more reinforcement activity to enrich students' understanding of the design process, and it is utility in solving real-world design problems.
Numerous activities were conducted to address all the identified module objectives and corresponding outcomes, as listed in Table 2.

Table 2. Activities and expected outcomes

Activity #	Activity	Outcome
1	Building a structural block	Demonstrate need of structured design process
2	Catapult design & build– mathematical treatment to the design problem	Apply the engineering design process
3	Power supply design	Identify the multidisciplinary nature of engineering design
4	Pair-wise Comparison Chart method	Identify design objectives and prioritization
5	Robot building	Building a mechatronic system
6	Know-How: Reverse engineering activity	Identify functional blocks in a system
7	Identify functional blocks in a system Electronic system & gearbox	Able to generate multiple solutions for the defined problem statement and select - the better one.
8	Safe landing pad Activity	Students would carry out the activity applying all the learning of the Engineering Design Module

The idea was to give incremental learning of the design concepts to students as they are a novice to the engineering problem solving, which are mostly real-world issues. To exemplify, activity 1 had the objective of building a structural block using fragile items, and successful design has to carry the highest weight. The students had to follow a

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layman approach since no discussion on the philosophy of engineering design, or any techniques of developing alternative solutions was done. As the module progressed, students introduced to various methods of identifying constraints, design objectives/client needs. Discussed a methodology to develop alternative concepts and evaluating them for best design against prioritized objectives. Students exposed to other activities with increased scope for applying design learning.

Many times studying the existing system can give better cues to enhance the system or create a new design entirely. Reverse engineering activity prompts novice designers (students) to think about design alternatives.

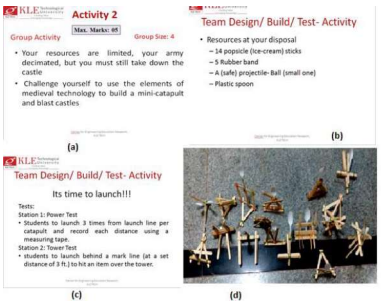

FIGURE 2: (a-c) Description of Catapult design activity; (d) various models built by students

A sample case of design activity presented in Figure 2(a-d). Student groups were given with a description of the activity from which group had to formulate their definition of the problem and relevant objectives, constraints to solve the problem. While applying the learning of the design module, the group had to come up with solution alternatives. Evaluate them for a better solution against objectives/constrains and finally build and test the design artifact for given test condition.

C. Rubrics and Evaluation

Students were assessed both in an individual and in a group. The quiz conducted at an individual level and activities for group assessment. Rubrics for various activities shown in Table 3 and Table 4 (Appendix-A). The rubrics prepared with an eye on the students' adherence to the design process. The weight was fixed based on both teachers experience of handling design course at the sophomore level and importance of a particular step in the process. The rubrics also indicate the associated Performance Indicators' (PI's) addressed through design activities. The PI's derived from Program Outcomes (PO's) adapted at KLETU, which are equivalent to Graduate attributes of ABET. In this work PO- 3 is addressed. PO-3 corresponds to the *Design/development of solutions. Described as Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations*."

Multiple choice quizzes were conducted to assess the multidisciplinary facet of engineering design. A representative set of questionnaires listed in Table 5.

Table 5 Sample Quiz questionnaires

• The engineering analysis process involves
• Do engineers always to be blamed for failure that occurs?
• Rectification is the conversion of_____
• In the given circuit(in Engineering Exploration), Mention the value of Resistor "R"
• Calculate N2 for the given data of a Gear. N1=5000,T1=20,T2=50

VI. Results and Discussion

A mandatory course, "Engineering Exploration" introduces an engineering design process to freshman students by activity-based learning pedagogy. Authors have taught this course since its inception at the institute and have the experience of teaching large classes of Engineering design courses at a sophomore level over the years in their respective disciplines. This experience helped them to counter many challenges listed in this paper.

Students admitted to engineering courses after their pre-university science studies face difficulty when posed with real-world design problems. Their previous curriculum did not give them the chance to address any real-world scenarios at least from the designer's point of view. With this background, students were introduced to do the designing task. Activity-based learning with simple design process gave students an upper-hand to solve real-world problems. Here, as students evaluated the given customer need statement, analyzed it to understand the scenario using learned techniques, develop multiple alternative solutions, and propose best engineering solutions to it. This pedagogical approach of activity-based learning with structured design process enhanced students learning. This claim is reinforced by their pre and post responses, as shown in Figure 3 and the outcome of the course project.

Table 6 Questionnaire for Pre and Post-test

1.	Knowledge about Engineering Design Process
2.	Knowledge of Analysis in Engineering design
3.	Multidisciplinary aspects of Engineering Design and its importance
4.	Mechatronics system and its components
5.	Conversion from AC to DC Power
6.	Design of DC regulated the power supply
7.	Usage of Digital multi-meter and Breadboard operation
8.	Design of mechatronics system that converts electrical into mechanical energy
9.	Know-how of Reverse Engineering

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10. Types of drives and gears
11. Assembly and Disassembly of a gearbox
12. The building of mechatronics system like automatic mobile robot

Table 6 lists questionnaires for Pre and Post-tests. The responses ordered categorical (ordinal) data. The mode calculated for each response, for both pre and post-tests responses, and graphs are plotted.

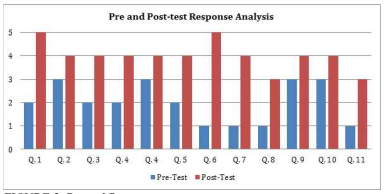

FIGURE 3: Pre and Post-test response

VII. Conclusions and Future Work

Globally many efforts have been made to teach designers. Teaching design at academia, at different levels, has always been the focus as the design is at the core of engineering discipline. Here in this manuscript, the authors experience in design, delivery, and assessment of engineering design for first-year students has been presented. The content was a module of a mandatory course "Engineering Exploration." This is one kind of study where an active and collaborative learning ecosystem can be created, and students are made to learn design. This methodology also eases the teacher in teaching design philosophy at an early stage of engineering studies. Pre and Post-tests also reinforce this claim as more students indicated enhanced learning. Results from this inference of students' feedback have been used to refine the content of future delivery of the same course and other dependent courses. Activity based-learning with structured design process pedagogy was used in infusing design thinking. Many challenges in developing and delivering the content have been identified and presented. Different activities and their respective outcomes are exemplified.

In this paper, authors have shared their experience of designing and delivering engineering design as a module for freshman engineers at KLETU. This course is being used as starting-point in enhancing the Engineering Design Curriculum at subsequent senior semesters. This would be achieved by having a collective content across departments like Electronics & Communication Engineering, Mechanical Engineering, Computer Science Engineering, and Automation & Robotics, etc. The present content is also currently undergoing various structural changes in subsequent iteration with faculty experience and student's feedback (course feedback and focus group discussion) gained in the first and second iteration.

Acknowledgments

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Appendix-A

Table 3. Rubrics for Catapult Design Activity

Assessment Parameters	Weightage	Excellent (10 marks)	Good (6-8 marks)	Needs Improvement (2-4 marks)	PI's
Understand the need and Gathering Information	20%	The team is able to clearly state the aim of the problem and list the constraints	The team is able to state the aim of the problem but has no clarity about the constraints	The team is able to develop an understanding of the problem with the instructor's help	3.1.6
Generate multiple solutions and select the best	40%	The team is able to generate at least two solutions – with concept ketches/ descriptions and is able to choose the best design after analysis of the alternatives	The team is able to generate at least two alternative solutions- with sketch/descriptions but is unable to do right kind of parameters for analysis	The team is able to complete the task with the instructor's help	3.2.1
Build the model as per the design and Test it	40%	The team is able to build the model as per the proposed plan/design and is able to test and clearly state the shortcomings in the design for further improvement	The team is able to build the model as per the proposed plan/design and is able to test and but is unable to state the shortcomings in the design for further improvement clearly	The team is able to complete the task with the instructor's help	3.2.2

Table 4. Rubrics for Landing Pad Design Activity

Assessment Parameters	Weightage	Excellent (10 marks)	Good (6-8 marks)	Needs Improvement (2-4 marks)	PI's
Understand the need and Gather Information	10%	The team can state the aim of the problem clearly and lists all the constraints	The team can state the aim of the problem but has no clarity about the constraints	The team can develop an understanding of the problem with the instructor's help	3.1.6
Generate multiple solutions	30%	The team can generate at least four solutions – with concept sketches/ descriptions	The team can generate at least two alternative solutions with sketch/ descriptions	The team can complete the task with the instructor's help	3.2.1
Analyze and select the solution	10%	Able to list relevant design criteria and can choose the best design after analyzing the alternatives	The team can select relevant design criteria but unable to select the best solution after analyzing the alternatives	The team can complete the task with the instructor's help	3.3.1
Build model as per design	40%	The team can build the model as per the proposed concept/solution.		The team can complete the task with the instructor's help	3.2.2
Test and identify short comes/evaluate for failures		Test and clearly state the shortcomings in the design for further improvement.		Tests but unable to analyze and clearly state the shortcomings in the design for further improvement	3.4.1

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Effectiveness of Project Based Learning models to achieve 6Ps in Vishwaniketan, India

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Abstract:
Indian engineering education sector is looking for the suitable alternative for curricular and teaching learning practices to achieve its goal to align itself for outcome based education. Project Based Learning (PBL) approach has been considered as a suitable alternative to improve the learning outcomes and employability skills of the graduate engineers. ViMEET is an engineering institute established in the year 2012-13, with an vision to implement PBL. It has developed four different PBL models for improving quality of engineering graduates. In this paper, these models are discussed in detail. Also, focus of this paper is to investigate effectiveness of PBL models to achieve Performance, Placements, Products, Patents, Publication and Public Image. These parameters are shortly noted as 6Ps. To check effectiveness of PBL models, a quantitative data is collected from different departments with various methods and student's feedback is taken in the form of survey. Students mentioned that PBL model has been a key element for their personal achievements and largely accept that they learned better in PBL environment. Although thoughtfully designed, PBL models could not lead to expected number of patents and publications, more work would be required to refine these models to get better results. Overall, it is concluded that PBL approach has been accepted by the students and promises to be excellent practice to achieve 6Ps.

Keywords: PBL, Performance, Placements, Products, Patents, Publications and Public.

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1. Introduction

India boasts on the roots of "Guru Shishya Paramapara" since its ancient history. Education in those days were focused on passing knowledge "Dnyan" to the "Shishya " by "Guru". It was well supported by the principals in Gurukul premises. In fact, India had first international university in the name of "Nalanda Vishwavidyalaya". During those days Indian education was largely based on art and culture. Accordingly society had various artists and groups of skilled people. Professional Technical education was started at the time of British ruled India where East India Company first started Gun carriage factory in Guindy. Since, then till date we are following education system inherited from British India (Shinde et al 2014).

Currently Indian education system is the third largest in the world with 399 state universities, 126 deemed to be universities, 48 central universities & 334 private universities (UGC, 2019). Gross enrolment in higher education is around 25.8% which is less than developed countries. Most of these universities are practicing traditional teaching learning practices and outcomes of these universities are not as per the global standard (thestateman, 2019).

Various National reports on Indian engineering education claimed that graduate engineers lack critical employability skills. Blom & Saeki, 2011 reported that there is a gap between graduate engineers skills and the industry demands. This inconsistency or mis-match is attributed to curriculum design and existing teaching-learning practices (Rao, 2006, Pal, 2009, NKC, 2010, Blom & Saeki, 2009).

As per Yashpal, Rao Knowledge commission reports , most of the institution in India focus on rote learning; where focus is on "remember and reproduce". It's commented than curricular practices; Teaching, learning & assessment do not promote for skill development. Especially in higher education, it's needed that the education focus on essential skills such as design, problem solving, teamwork, and communication skill. Technology patents & employability is also questioned in recent times. It's our belief that our education must be tuned with current Industrial requirements and should be able to address problems of society. Government of India started a scheme like "Start up India" and "Make in India". Success of these schemes largely depends on outcomes from education systems. Unless and until, we create systematic change in the educational philosophy & practices, global ranking and success of Government schemes seems to be difficult goal

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to achieve. In this research paper, we treat PBL as a suitable alternative to achieve these objectives. However, there is a need to understand PBL philosophy and elements of PBL curriculum design in order to implement PBL effectively in the Indian context. This paper focus on discussing PBL principles and effective use of these principles to design different PBL models having different targeted outcomes. Also, effort has been made to evaluate designed models and this paper presents the report of evaluation.

2. Research Context and objectives

Recently, Indian educational institutes are facing serious issue of attracting students towards engineering education. This may be because of outdated curriculum, traditional teaching learning practices which mostly promote rote learning or lack of sufficient engineering jobs to absorb outcome of huge number of engineering graduates. This situation demands systematic change so that students get attracted towards engineering and new types of engineering jobs creation. In addition, accreditation agencies which largely responsible for maintaining quality conformance in the country failed desolately to promote quality education culture in the country. Most of the institutes opting for accreditation are preparing documents for compliance without much attention on adapting quality practices. In view of all above mentioned issues and challenges, Problem and Project based learning (PBL) strategy has been considered as a suitable alternative (Shinde, 2011).

We assume that without changing towards Problem Based Learning approach this cannot be achieved to the greater penetration. PBL is considered as suitable alternative for achieving this and Vishwaniketan is a place where various experiments on PBL are carried out since its inception in 2012-13. Vishwaniketan is an educational non-profit trust established in 2012-13. Currently, it runs Engineering, Architecture & Design professional courses. Vishwaniketan's Engineering courses are affiliated to University of Mumbai & approved by competent statutory bodies. We aim to create competent design professionals who can create novel products and solve social and National issues keeping global context in mind. Institute has its educational philosophy developed on Project Based Learning philosophy & practice. It has created PBL Centre of Excellence which works for PBL Training and consultancy. So far, through PBL-COE; six institutes have been trained to implement PBL & more than 63 workshops have been arranged & headed by PBL-COE Team. This way PBL-COE has created pathway towards transforming traditional institutes into PBL Institutes.

This research is carried out in ViMEET which is an engineering institute in Vishwaniketan campus, located in Khalapur, India. ViMEET has designed and practiced four different PBL models. This paper discusses these PBL models practiced in Vishwaniketan and its outcomes. To assess PBL models, we developed 6P framework which include parameters like Performance, Placements, Products, Patents, Publications and Public; combined together considered as 6Ps in this paper. Thus, objective of this paper is to investigate effectiveness of PBL in achieving 6P. The rest of the paper is organized in following manner; Section 3, describes methodology adapted for assessment for PBL models, Section 4 is dedicated to a PBL: Philosophy and Practice at ViMEET, an Section 5 elaborates outcomes of assessment of PBL models.

3. Methodology

The aim of this paper is to investigate effectiveness of PBL practice. A case study approach is used. The outcome assessment is carried out based on theoretical insights in PBL practice and the past reports of the institute. Student's Performance is judged based on academics, competitions inside and outside institute. Placements are judged based on actual placements data and employability of students based on industry feedback. Products are counted based on the number of the projects which are completed as prototypes and number of start-ups. Analysis and simulation projects are excluded from the list. Patents are counted based on actual patents filed, and potential patents. Publication data is collected for the last three years which include both staff and students' publications. Public is a factor which represents parents, partner industries, local people and academicians. Their opinion about PBL models are collected and analysed. The data collected from all the sources are combined together, analysed and discussed.

4. Problem and Project based Learning

PBL practice which is originated in McMaster University in 1968 for medical education has now been practiced in many professional fields. Many institutes have developed PBL models and practices suitable for their educational culture. However, it's been observed that most of the PBL models uses similar principles for learning (Kolmos et al 2009). Cognitive principle states that problem is a driver for the learning process and students learn while solving the posed problem. Content principle depicts exemplary practice adapted to achieve learning objectives and puts problem in the contextualised setting. Social principle puts an emphasis on learning in team setting where cooperative and collaborative learning principles are used for promote learning. These principles are effectively used to develop four models listed below.

4.1 Problem Based Learning Cycle

Fig.01 shows Project Based Learning (PBL) cycle which (PBL) focuses on curriculum development based on current contextualised problems. These problems may be adapted from industry or societal needs or it can be global issue or future technology demands. Thus, PBL curriculum has a problem at the centre and syllabus content is developed based on this problem. Appropriate assessment methodologies are used to assess and evaluate student's performance in PBL curriculum.

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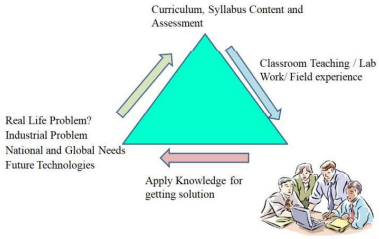

Fig. 1 Typical PBL cycle

Once the curriculum is developed basic fundamentals and prerequisite knowledge required to solve the problem is provided by using various instructional and teaching-learning strategies. Thus, in PBL students receive basic pre-requisite knowledge required for solving the problem. Since, most of the time the problem under investigation is complex and require interdisciplinary knowledge, students' teams with various disciplines work together. This way, students in PBL environment learn to practice problem solving, team work and design skills during the process itself. Thus it promotes problem solving and novel product development which is a need for strengthening quality of engineering education in India.

However, PBL is not rooted in Indian Education system. Surprisingly none of the universities is practising PBL to its fullest potential. This may be because; PBL philosophy has an origin in the western world, where the educational culture and values are different than those in India. May be Indian educators are not sufficiently trained to practice scientific PBL. Thus, need for one representative PBL institute would be required where PBL has been successfully experimented. ViMEET has been created to serve as model institute and has been continuously experimenting with PBL practice. It has adapted PBL by customising exiting academic culture and infrastructure; called as PBL ecosystem. Following section provides insight into ViMEET PBL models.

4.2 Types of PBL models practiced at ViMEET

4.2.1 Value Addition PBL

ViMEET is an affiliated institute to Mumbai University (MU) and it practices curriculum designed and developed by it. Through MU curriculum analysis, we understood that University curriculum do not have enough focus on future technologies such as Machine learning and Artificial intelligence etc. So, institute decided to integrate future technologies with PBL practice. Accordingly institute identify key technologies and industry partner for training. These industries provide list of problems which is discussed with the students in detail. Once the students approve particular technology, institute signs a Memorandum of Understanding with the industry partner.

According to the technology each department organise VA-PBL training for students in each semester. Fig-02 shows this pre-processing cycle.

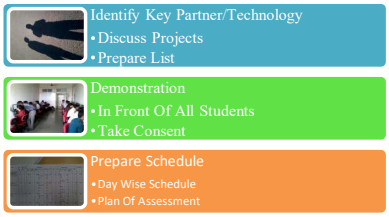

Fig. 2 VA-PBL Pre-processing

As shown in the fig. 03, at the beginning of every semester, industry expert gives training to the students on future technology. Usually this training is conducted for 60-70 hours. After training, students are divided into groups and topic for a project is given to the students which they are expected to work on throughout the semester. Students are allowed to apply knowledge to solve problems given by industry trainer during the entire semester. At the end of the semester, the projects are evaluated by the external members, faculty and the trainer. Students are graded based on the rubrics developed for the projects. To conduct training, lab infrastructure is provided along with one faculty coordinator who ensures smooth conduction of the VA-PBL for whole semester. This practice is followed till sixth semester.

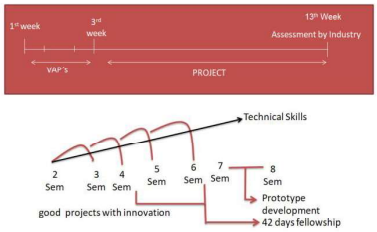

Fig. 3 VA-PBL cycle

4.2.2 *Course level PBL* model

This model is designed to improve content learning of the students. Every semester, PBL is implemented and practiced in the one course or multiple courses (Fig.04) of the second and the third year of each programme of the institute. Faculty allocate projects to the students. The project topics were selected in such a way that course content also learned with real life problems solutions. It is assumed that such practice will help students to learn relevance of classroom learning in the real life contest.

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Fig. 4 CL-PBL cycle

4.2.3 Industrial PBL

Depending upon the student's interest and their achievement in above two models, some of the students are allowed to work on the real industrial problems. This model provides industrial problem solving experience to the students. Fig 5 shows industrial PBL cycle.

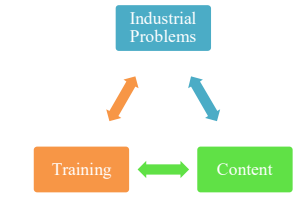

Fig. 5 Industrial PBL cycle

To support this model industry has sponsored labs to the institute with tailor-made practice and mentoring sessions. Institute supports it through finance, space and logistics. Following fig. 6 shows, one semester plan of Industrial PBL cycle. Before actual start of the project, team of the interested students is selected and trained on the project requirement. Usually, this training is offered by the sponsoring industry. After training, students apply their knowledge to solve the given problem. During the process faculty and industry mentors are provided to keep the track of the project work. During and after project work continuous assessment and evaluation is done. Since, this is industrial PBL cycle; non-disclosure agreement is signed with the industry, institute and the students.

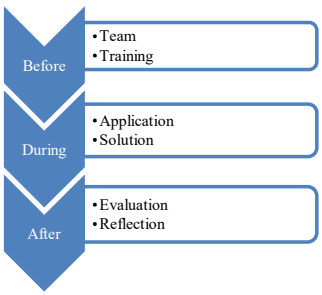

Fig. 6 Typical PBL cycle

4.2.4 Undergraduate fellowship

This programme is also known as international project based summer internship. Depending upon the student's achievements and interest to pursue international career, some of the students are allowed to work on the international projects. Every year the students from India are sent to the foreign universities which have signed collaboration agreement with ViMEET. Due to this model, the students get an opportunity to explore the foreign university courses and also learn innovative things. The aim of this model is to help students to get an exposure in international universities. Since, its start this programme has benefitted 800+ students and faculty from India.

Fig 7 shows this model in which students are sent to the international university for 42 days during summer. During 42 days of stay, students work on the projects provided by the professor from that particular university. These projects are either research projects or sponsored projects. This way student's gets an international project based learning experience.

Fig. 7 International Project based summer Internship

In summary, it can be understood that ViMEET has developed different PBL models for benefit of their students and faculty. However, auditing of these PBL models have not been done so far. Thus it was needed to conduct research to investigate an effectiveness of these PBL models.

To start the performance audit, a case study approach is used. One department is chosen to collect the data. Various tables and formats are prepared to collect the data. The outcome assessment is carried out based on theoretical insights in PBL practice and the past reports of the department. Student's Performance is judged based on academic performance. Employability of students is judged based on industry Placements data. Products are counted based on the number of the projects which are completed as prototypes and number of start-ups. Analysis and simulation projects are excluded from the list. Patents are counted based on actual patents filed, and potential patents. Publication data is collected for the last three years which include both staff and students' publications. Public is a factor which represents parents, partner industries, local people and academicians. Their opinions about PBL models are collected through informal discussions and platforms. The data collected from all the sources are combined together, analysed and discussed.

5. Results and Discussion

In this section, efforts have been made to analyse the data provided by the mechanical engineering department for primary analysis. It may be noted that this department is the largest department in the institute with annual intake

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capacity of 120 students per year. Thus, this department is chosen to represent the institute. This data collection is still in progress and data for beneficiary for each model is still in progress. Other, departments may have better data than this department. Mean while, to meet the deadline for submitting the paper, preliminary data is used for this paper. This data collection is still in progress and subjected to change. Since more data is expected but not received on time, detailed analysis will be made available for the next version of this paper.

5.1 Performance

In this part, student's performance in the final year examinations is discussed. In general, it has been found that the results are better in all years except few students failing to pass the examination. However, these results cannot be attributed to PBL alone and neither it reflect quality of the result.

Table 1 Students performance in the final year examination for Mechanical Engineering department

Academic Year	Number of students appeared in the examination	Number of students passed the examination	Passing %
2018-19	134	130	97
2017-18	141	134	95
2016-17	138	136	99

5.2 Placements

In this part, student's performance in placement activity is tabulated for the final year students. Students' employability is reflected in actual placements and quality is reflected in the number of eligible students for placements. From the data, it is understood that placement is on positive side or within acceptable range but the number of eligible students are less. Thus, focus must be made to improve academic performance of the students. Placement performance can be attributed to various PBL activities. As per the feedback from placement department, industry is happy with technical skills of the students but advised to focus on communication skills of the students.

Table 2 Placement data for Mechanical Engineering department

Placement Year	Number of eligible students	Number of students placed	% placement
2018-19	68	56	82.35
2017-18	77	47	61.03
2016-17	53	37	69.81

5.3 Products

Products are the outcomes of the complete PBL process and choice of the problem statements made by faculty and the students. Data provided suggests that almost 55% project are inclined towards product development cycle, which can be considered as a good performance.

Table 3 Project data for Mechanical Engineering department

Academic Year	Total Number of projects	Total Number of prototypes	% Prototypes
2018-19	32	18	56
2017-18	29	17	58
2016-17	28	15	53

5.4 Patents

Patents are the technology right for the producer of the good projects. In general, it indicates innovative contribution made by the students. Although, in the table 3, suggests that almost 55% project are inclined towards product development cycle, number of prototypes having potential patent possibility are very less, which shows that lack of innovations in project making.

Table 4 Patent data for Mechanical Engineering department

Academic Year	Total Number of expected patents	Total Number of patents filed	Number of potential patent prototypes
2018-19	5	1	4
2017-18	5	0	3
2016-17	5	0	3

5.5 Publications

Publication data suggests the students' capacity to do research and write in good quality technical language. The data suggest students are inclined towards conference publications and less towards journal publications. Also, journals in which papers are published are national journals. In this category, department can think of adding some activities to enhance publication quality.

Table 5 Publication data for Mechanical Engineering department

Academic Year	Conference Papers	Journal Papers
2018-19	13	19
2017-18	9	7
2016-17	13	3

5.6 Public

Institutes public image can be judged through its interaction with various stakeholders through formal and informal interactions. Institute has in total number 48 MoUs with industries out which mechanical department has 7, which is considered to be good number for the department. ViMEET has 16 international collaborations which is an exceptional number considering the age of the institute is only 6 years.

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Mechanical department has conducted six Parents meet through which parents informed their satisfaction about department activities. Through two Alumni meet it is understood that PBL environment helped students in their professional life. Through students exit survey it's understood that most of the students are inclined more towards project based learning approach.

6. Conclusions

ViMEET has developed different PBL models for benefit of their students and faculty, however, effectiveness of these PBL models to achieve its desired goal were not conducted. Through this paper, an effort has been to create framework for PBL model audit to investigate its effectiveness. Six performance parameters are considered and analysed using Mechanical Department case study. Through case study data, its understood that although PBL is been practiced in the department, there is a scope for improvement in the performance. May be some changes in administration of PBL activities is needed.

Students experienced that PBL model has been a key element for their personal achievements and largely accept that they learned better in PBL environment. Although thoughtfully designed, PBL models could not lead to expected number of patents and publications, more work would be required to refine these models to get better results. Overall, it is concluded that PBL approach has been accepted by the stakeholders and promises to be excellent practice to achieve 6Ps. Further research would be required to give concrete conclusions on effectiveness of PBL models. In future, similar data can be collected from all departments and also institute level survey can be conducted to improve PBL practice.

Acknowledgement

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Enhancing faculty competencies through Engineering Exploration & Design Project Course

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Abstract:
It's a well known fact that enhancing students' competency is directly proportional to enhancing faculty competency. Motivation for this paper is how to enhance faculty competencies in this competency driven education system? Changing times are transforming the nature of competencies that have been valuable throughout history, such as communication and collaboration. A teacher is responsible for the developing or deteriorating interest from a course. If teacher takes such a task unprepared then whole bunch of students may suffer its consequences. Scope of this project/paper is facilitating faculties who wants to deliver a multi disciplinary, PBL pedagogy based course effectively. This papers attempts to enhance 21st century competencies into faculties by a taking a case study of Engineering Exploration and Design Project Course hosted for freshman year students. The subjects in our research are Faculties Teams from seven different disciplines. The data is collected through Questionnaire. Lastly the data is verified with students feedback to whom these faculties are delivering the course.
Major finding of our study are with appropriate, team driven policies we can imbibe 21st Century Competencies among faculties.

Keywords: Engineering exploration, Design project, communication and collaboration.

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1. Introduction

The role of a teacher in higher education is an important dimension of the academic profession. In modern times, teachers who have appropriate qualifications and are having an experience in academic activity are expected to take a series of professional roles throughout their career, including those of a teacher, researcher, manager and community contributor [6]. In this paper we are sharing our experience with respect to role of teacher in delivering a course introduced in freshman year of Bachelor of Technology with an intention of making students realise the 21st century need of engineer, as solution provider.

The demographics of higher education have changed in these modern times and are regularly updating day by day with the invention & invocation of technology. Today's degree seekers are more diverse than at any other point in our educational history. Many more are part time workers while attending college. A major driver of this demographic shift has been the evolution of competency-based learning, which provides non traditional students with newfound flexibility and opportunity to realise their potential and channel it into progressive direction. This transformation is not, of course, without profound challenges and considerations. Among them, how should the role of faculty evolve in a competency-based learning model?

Dr. Richard Senese [6], in his article mentioned, curriculum and instruments used to measure and evaluate student competency have to be developed by the faculty, who are ultimately responsible for providing feedback to students on their competency assessments. Our faculty expertise is also enhanced through the assignments and as mentors, who help students, navigate both academic concerns and non-academic aspects. The multidisciplinary team provides more time and energy for faculty members to focus on the individual learner when providing feedback on the demonstration of the competencies addressed in the authentic assessment. Faculty members should see the distribution of these roles as a positive aspect of their involvement in this delivery model.

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2. Related work

Competencies in the views of [2] are the certain characteristics or abilities of an individual that enable them to perform appropriate specific actions. It represents the capability that an individual brings to the job and when the responsibilities of the job to produce the desired results require the demonstration of specific actions, the individual draws from inner resources for the capability to respond.

Competency enhancement on the other hand is a term used to describe measures taken within a course, program, or institution to enhance or strengthen quality (www.lfhe.ac.uk/governance/hefastfacts/jargon.html). It involves steps and measures taken by a person or groups of persons in order to heighten; increase, (especially to increase or improve in value) quality and desirability. Competency enhancement is a topic of great interest in today's academic society and one of the tools we need to utilize if we are to solve the lingering problem facing the educational sector [3]. Thus according to [4] Human asset is one of the most important resources available to any organization, and employee competence as well as commitment largely determines the objectives that an organization can set for itself in relation to the extent she can achieve success in them.

The "Competency-based" approach to human resource management has become integral during the last thirty years, with „Competency" encompassing the knowledge, skills, abilities, traits and behaviours that allow an individual to perform a task within a specific function or job [5]. Finally we can summarise, competencies are the effective combination of Skills, Knowledge and Abilities combined to increase or improve the value of work at hand.

In this paper we have discussing the different competencies developed among a multidisciplinary team of faculties jointly came to deliver a multi faculty delivery course known as Engineering Exploration & Design Project (EEDP) introduced for Freshman year students. We are effectively concluded that with appropriate policies defined, sufficient resources at hand and good understanding of outcomes we are able to attain the overall improve or increase the value of work at hand.

The outline of the paper is as follows. The section 2 describes the various definitions competencies given at their individual time period and its definition at the end Section 3 represents the EEDP Course details along with different activities conducted. Section 4 describes competencies areas in teaching, problems encountered and measures taken to overcome along with policy scheme. Section 5 discusses the results in terms individual faculty feedback and authenticated by the students feedback.

3. EEDP Course Details

The EEDP Course is designed by a group of faculties from KLE Technological University and offered under NETRA(R) (National ESDM Technology Research Academy) as Vertical Engineering Exploration.

3.1 Course Description:

The Engineering Exploration & Design Project is introduced as 2 credit course in first year for students enrolled in all discipline. Course contents can be described under

a. Introduction to engineering & engineering study concepts with a centralised theme based on on critical thinking, creativity, teamwork, communication, and working across different engineering disciplines.
b. Students will be introduced to various disciplines and their integration for a developing a solution provider mindset. Contents centrally based on concept of engineering design process through a semester-long project, providing a design-built-test experience.
c. EEDP Course makes students familiar with Project management concepts and Constraints Management, Multi-disciplinary nature of engineering, problem solving approach via Platform Based Design (PBD), Data Acquisition Analysis (DAA), Team Building, and Engineering Ethics & Sustainability.

The EEDP course delivery mechanism is activity based delivery with ideal goal of not delivering a monologue beyond 10min. Students are expected to complete the Design Project parallel to the delivery of course by practically applying the engineering concepts/principles taught in the course. Need statements are carefully selected by experts with brain storming, modular implementation and practice by faculties. Students are taught to convert this need statement into Problem statement. The task is group task, form a team of four students, and implement the project with project management tools in multi-disciplinary engineering field under the guidance of course teachers. The continuous assessment of the Project work will be carried out by evaluating project work.

3.2 Course Learning Outcomes:

After successful completion of the course, the students will be able to,

1. Explain the role of an Engineer as a problem solver.
2. Design engineering solutions to complex problems utilizing multi-disciplinary systems approach.
3. Examine a given problem using process of engineering problem analysis.
4. Build simple systems/prototypes using engineering design and development process.
5. Analyse engineering solutions from ethical and sustainability perspectives.
6. Apply basics of engineering project management skills in project development.

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Uniqueness of this course is its activity based delivery by a team of multidisciplinary teachers. These teachers are trained under PBL Pedagogy and Active Learning Techniques. Formation of team along with development of roles and responsibilities of each member is very much crucial for the success of this course. Fig 3.1 shows the hierarchical representation of EEDP Course delivery team .

To promote peer learning we extend the invitation to various student association who has contributed to the remarkable improvements in the quality of Design Projects.

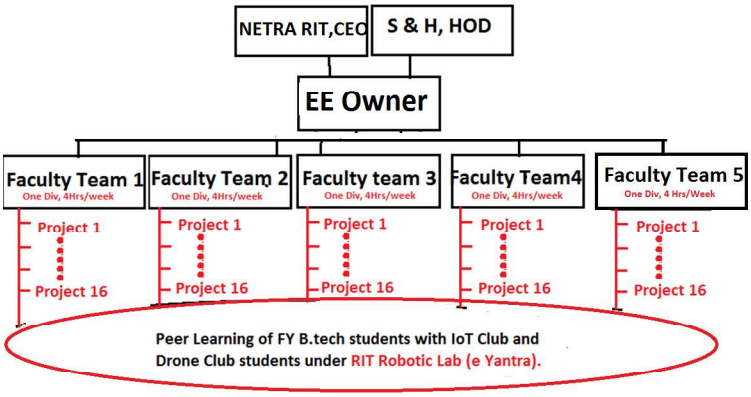

Fig.3.1 The Hierarchy diagram of EEDP Course struuture

In Outcome Based Education, Peer learning has bidirectional advantages. The learning peers as well as teaching peer both are benefitted in the interaction.

3.3 Roles and Responsibilities:

EE Owner: EE Team Leader will be responsible,
1) For presentation of EEDP RIT to outside worlds.
2) For tangible outcomes like Publications, FDP's.
3) For Managing and Finalizing the need statements.
4) For checking the quality of Modules prepared by Module Owners.
5) For checking the quality of Module Delivery.
6) Improves the quality of Design Project Implementation.
7) Check the Activity prepared will suit the purpose or not.
8) Activities prepared by Faculty Teams should be approved by EE Owner.
9) Responsible to maintain weekly updates from EE Team Leader.

EE Team Leader: EE Team Leader will be responsible,
1) For implementation of Modules as per approvals from EE Owner.
2) For facilitating fellow member's activity preparation.
3) For sorting our queries of fellow member's Design Project Implementation.
4) For procurement and distribution of materials for activities and Design Project.
5) For integrating & preparing team efforts in the form of paper.

EE Team Member: EE Team Leader will be responsible,
1) For delivering modules in strict format of activity based delivery.
2) For checking with lab assistants preparation of materials required for delivery of modules.
3) For contributing in the paper be based on selected theme.

4. Competency areas in teaching

As compiled by different experts in higher education teaching learning in their hand book [1], below are the competency areas to be inculcated among faculties when they are teaching to higher education,

1. Mastery of academic discipline in service of the teaching process.
2. Professionalism and professional development of higher education teachers.
3. Curriculum planning and development in higher education.
4. Learning and students.
5. Planning, organising and implementing the teaching process.
6. Assessment and self-assessment of student achievements.

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7. Mentoring & application of new technologies in teaching
8. Communication and social skills

EEDP course content covers an extended curriculum starting from Introduction to Engineering & Engineering study, to contents derived from Mechanical, Electronics, Computer Science and Civil Engineering also. Hence faculties have to be thoroughly prepared before going for delivery. Based upon mutual analysis of course contents and delivery, the EEDP course touches upon all nine areas mentioned above but we are concentrating mainly on four areas namely 3, 5, 6 & 7 whose analysis can be done effectively.

Since the course has been hosted first time that is in AY 2018-19 for first year freshman students, the percentage contribution assigned by us decided by mutual discussion for each area is given below,

Area 3: Curriculum planning and development in higher education.
Percentage assigned 35%.

Area 5: Planning, organising and implementing the teaching process.
Percentage assigned 35%.

Area 6: Assessment and self-assessment of student achievements.
Percentage assigned 35%.

Area 8: Application of new technologies in teaching.
Percentage assigned 10%.

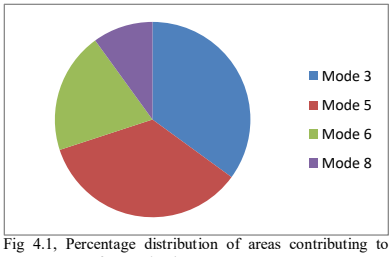


Fig 4.1, Percentage distribution of areas contributing to EEDP Course for Academic Year 2018-19.

Fig. 4 shows the same in pie chart form. The percentage contribution can be varied based on your delivery team discussions and conclusion. Next academic year we may not require 35% for area 2; hence we may modify and concentrate mainly on area 3 and area 4 which benefits in the form of improvement in the quality of projects.

5. Results

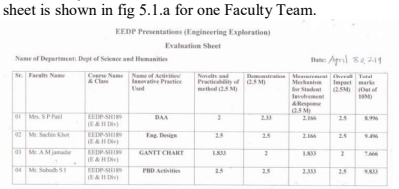
Results of faculties involved in the delivery of the course is quantified by two ways,

5.1 Method 1: Organised Presentations in-front of Expert Committee:

Each faculty has to present in-front in front of a committee known as Best practices committee, the overall contribution to the course via different criterion like,

a) Novelty: Carries weight-age of 2.5M/10M
b) Demonstration: Carries weight-age of 2.5M/10M
c) Tools used to quantify students involvement & response: Carries weight-age of 2.5M/10M
d) Overall Impact: Carries weight-age of 2.5M/10M

One Faculty Team includes four faculties and one such sheet is shown in fig 5.1.a for one Faculty Team.



EEDP Presentations (Engineering Exploration)

Evaluation Sheet

Name of Department: Dept of Science and Humanities

Date: April 8 2019

Sr.	Faculty Name	Course Name & Class	Name of Activities/ Innovative Practice Used	Novelty and Practicability of method (2.5 M)	Demonstration (2.5 M)	Measurement Mechanism for Student Involvement &Response (2.5 M)	Overall Impact (2.5M)	Total marks (Out of 10M)
01	Mrs. S P Patil	EEDP-SH189 (E & H Div)	DAA	2	2.33	2.166	2.5	8.996
02	Mr. Sachin Khot	EEDP-SH189 (E & H Div)	Eng. Design	2.5	2.5	2.166	2.5	9.496
03	Mr. A M jamadar	EEDP-SH189 (E & H Div)	GANTT CHART	1.833	2	1.833	2	7.666
04	Mr. Subodh S.I	EEDP-SH189 (E & H Div)	PBD Activities	2.5	2.5	2.333	2.5	9.833

Fig 5.1.a Expert Committee evaluation Sheet

In fig 5.1.b, Expert committee evaluation for all criterions is shown. The bar chart is plotted for max. Of 2.5Marks

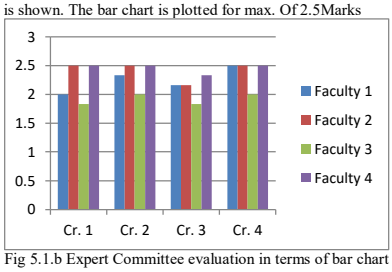


Fig 5.1.b Expert Committee evaluation in terms of bar chart

Fig 5.1.c shows the criterion wise Team Average, again calculated for max. Of 2.5Marks.

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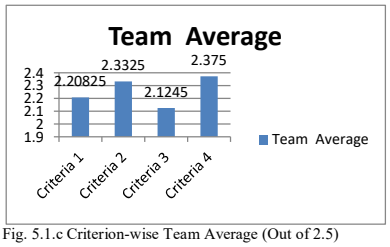

Fig. 5.1.c Criterion-wise Team Average (Out of 2.5)

Fig 5.1.d shows the criterion wise Team Average, calculated in percentage.

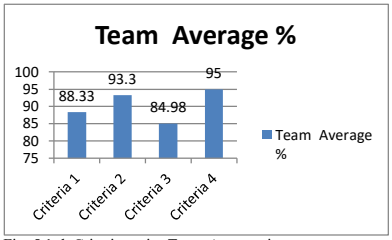

Fig. 5.1.d, Criterion wise Team Average in percentage.

5.2 Method 2: Students Feedback

In this method, we have taken feedback of students for the same criterion mentioned in Method 1. This analysis is of 59 students of one division where the above said Faculty team has delivered this course. Fig 5.2.a shows criterion wise student's feedback in percentage.

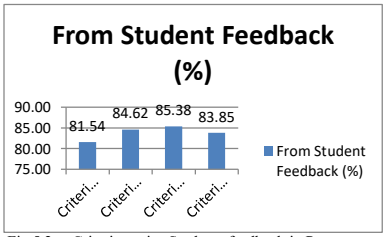

Fig.5.2.a, Criterion-wise Students feedback in Percentage

Fig 5.2.b shows the comparison of data analysis of both methods. Comparison shows students feedback has out grown the feedback calculated from experts committee.

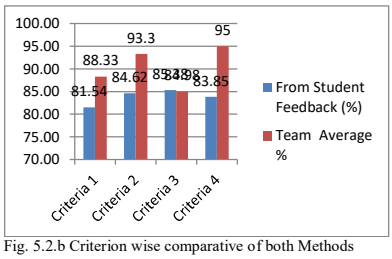

Fig. 5.2.b Criterion wise comparative of both Methods

6 Conclusions

From the above proposition we can conclude that the faculty competencies are significant part of Teacher in role of teaching. Hence an assessment method is discussed which shows that faculty competencies are to be enhanced continuously for the proper direction & success of the course.

ACKNOWLEDGEMENT:

Firstly, we are indebted to NETRA RIT Chapter for creating a space where courses of such dimension can be accommodated. Their constant support and encouragement will always motivate us to constantly evolve for betterment of Engineering Exploration.

Secondly, we are grateful to Dr. G H Joshi and his Team, KLE Tech university, by assisting us in all possible ways including resource sharing, mentoring, tutoring and empowering us to devise our own strategies suitable for our institutes needs and constraints.

Lastly, we are indebted to our Institute Hon. Director, Management, Deans and all HODS's for making us part of this team and supporting us in all possible manners.

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The collaboration of industry institute interaction for delivering industry ready engineers

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Abstract: Boost in technological advancements drives demand for electrical and electronics engineering. However, employment is predicted to mitigate, which is a primary concern. The expectations that the companies have from their candidates and the traits that engineering graduates have do not match, which indeed forms a massive gap between industry expectation and student's skill set level. PBL is one such platform which provides the means for the students to enrich their knowledge and skills. In-depth knowledge and real-time practical exposure are a few among the required skills. This paper emphasizes on effective implementation of PBL via the collaboration of SSDC (Student Skill Development Center) and industry to dilute the bridge between industries and engineering education. The outcomes of this approach include enhancement in self-directional learning, self-assessment, time-management and lifelong learning along with the increased ability to develop other skills. Statistical analysis showed significant improvement in projects been developed and enhanced engineering traits among students. This approach created interest among students to solve real-time projects than just doing engineering for results. Eventually, they are suitable to be chosen by the industries.

Keywords: Industry Institution Interaction (3-I), Problem-based learning (PBL), Self-Directional learning (SDL), SSDC (Student Skill Development Center), lifelong learning.

I. INTRODUCTION:

In average, around 1.5 million engineers are graduated every year. However, as many as 97% of graduates need jobs either in software or core companies. But, only 3 percent have appropriate skills who can get in the software or product peddle, and only 7 percent can tackle core engineering tasks [1]. Lack of hardware and software skills, rote-learning methods, and shortage of faculty who are qualified are few among the problems. Students are graduated every year in spite of not being skilled, and it is expected that nearly 2.4 million positions will be left unfilled over the decade [11].

II. FACTORS AFFECTING EMPLOYABILITY:

LACK OF QUALITY TEACHERS: According to the modern report on the All India Survey on Higher Education, there are 799 Universities, 39,701 colleges and 11,923 standalone institutions in India [1].There are not enough qualified teachers for all of these educational institutes.

1) **LACK OF INNOVATION AND RESEARCH:** There were only 216 researchers per million out of 1.3 billion population of India in 2015. India spend 0.62 percent of GDP in research which is very less compare to other countries percent like United States spends 2.74 percent of its GDP and France spends 2.25 percent of its GDP on research; both countries have 4,300 researches per million population[3].

2) **LACK OF HARDWARE AND SOFTWARE SKILLS:** Significant problems graduates face is their inadequate knowledge of basic concepts.

3) **LACK OF COMMUNICATION SKILLS:**

A study found that 73.63 percent of candidates lack in communication skills and 57.96 percent has low analytical and quantitative skills which are the primary reason for unemployment [5-6].

Hyderabad Institute of Technology and Management (HITAM) established a center called SSDC collaborated with Elegant Embedded Solutions Pvt Ltd located in S.R nagar Hyderabad, India and Embinsys Technologies Pvt Ltd located in Hi-Tech city, Hyderabad, India. . The faculty undergone training for six months on the on-going technologies by the industry experts and extending their learning's to students.

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SSDC (Student Skill Development Center) - "a process of moulding professional out of student" involves Project-based learning (PBL), which is the most effective way to prepare students for industries[4][7]. It initially focusses on making the students proficient in ARDUINO, 8051, raspberry pi as processing units coupled with various sensors (ultrasonic sensor, heartbeat sensor, soil moisture sensor, etc.) and actuators (LED, LCD, seven-segment display, buzzer, etc.). It helps students to integrate and apply knowledge gained theoretically under the active supervision of faculty and industry experts. To showcase their talent we conduct project expos, project presentations. All these add up to eradicate stage fear, boost up the confidence and enhances communication skills.

III. PROJECT-BASED LEARNING

PBL emphasizes student learning rather than instructor teaching. PBL students due to their learning competencies, problem-solving, self-assessment methods score better than students in regular or traditional courses because it emphasizes lifelong learning by developing the potential students to lead their goals, allocate resources for learning and assume responsibility for what they need to know [2]. SSDC implements PBL wherein the students from three disciplines (ECE, CSE, and EEE) were grouped together and are assigned with real-time projects. Faculty provide scaffolding, which helps students to build knowledge relevant to the project. Each member of the group takes the initiative to study on one particular aspect of the overall project. After initiating, the student works independently in a self-directed study to research the identified problems. Each of these would take turns to teach others in the group on what they learned, then create, design and work on the project to develop a product. Students themselves resolve the problems and take more interest and responsibility for their learning. At the same time technology will allow them to search in more beneficial ways which results in students to have practical exposure, hand-on experience, technical knowledge, the importance of teamwork, communication, self-directed learning and also forces a much in-depth learning. Through all these processes faculty guide the students and assess them on their performance. At the end of the project, students were provided with inputs from faculty and industry experts.

Fig 1: Evaluation of projects by industry expert

Project expo was conducted in college where students put up their project work and the projects were evaluated by the industrialist.

IV. INDUSTRY INTERACTION:

Institutes promulgate the fundamental knowledge and skill, but the Industry-Institute Interaction gives an outlook to staff and students of the industry. Frequent interaction of faculty and students with industry builds a healthy relation. This will help to educate and construct students to be future-ready. The different kind of interactions practiced in the given industry-institute model works as follows:

1) The assistance of industry experts in project expos with valuable feedback.
2) Workshops and conferences with joint participation of the faculty and the industries.
3) Industrial visits, Industrial trainings and internships help students to experience the industrial environment and know the needs of the industry so they can practice and acquire knowledge related to that particular employment.
4) Industrial exposure to Faculty is beneficial to guide students about recent industrial practices so they can implement projects for the technologically driven economy.
5) Networking among industries and other organizations.

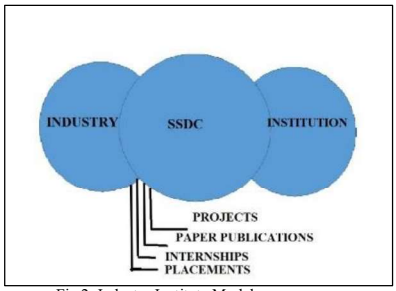

Fig 2: Industry Institute Model

SSDC helps to bridge the gap between industry and institution. The students who have undergone training under SSDC had higher utility as follows:

1. Placements
2. Projects
3. Internships

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4. Paper publications

In our fresh interaction with industry, students were given exposure of latest industrial focus on Internet of things, Linux, artificial intelligence, device drivers, etc. Students started exploring them and practiced peer learning. Every week students give a presentation in SSDC on their learning, faculty and industry experts keep a track of their learning's. Students are assessed on all aspects internally and externally in view of placements as mentioned in rubric below in table1.

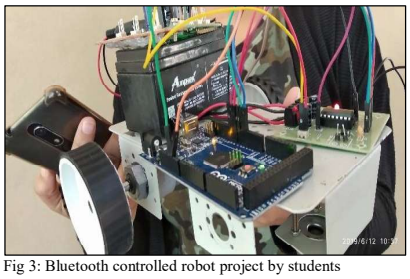

Fig 3: Bluetooth controlled robot project by students

Students did projects on Arduino, raspberry pi, IOT and with few sensors and actuators. There were around twenty projects that students worked on.

Fig 4: Bluetooth controlled robot competition, students design similar robot

V. ASSESSMENT

The assessment of student projects is done based on a rubric as shown in Table 1. In SSDC students are assessed throughout the academic semester through their activities and performance. Rubrics incorporates key attributes such as:

1. Creative and innovation where students come up with innovative ideas to build a product.
2. Self-Directional learning where students do all the research on the idea developed to proceed further.
3. Develop a plan to solve a community based problem related to health care example SSDC designed smart stick for blind people- students choose the best way to solve and implement the product from the research done.
4. Technical skills involve hardware and software knowledge.
5. Teamwork plays a very important role in the successful completion of any project. Team comprises of three to four students and there are 19 teams. One's a student graduates and takes up a job, he/ she must contribute and be able to work for the team.
6. Presentation skills help students to develop their communication, impromptu speaking that fills the pauses among their pondered ideas and be able to express their understandings about the project.

Fig 5: Students working with expertise

Table 1: Rubric

Criteria	Exceed Expectations (8-10)	Meets Expectations (4-7)	Couldn't meet the expectations. (1-3)
TECHNICAL SKILLS (Hardware & Software)	Design and evolution of the project along with appropriate use of software and hardware	Partially designed and developed another project along with proper use software and hardware	No plan and evolution of the project and inappropriate use software and hardware

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DEVELOPING A PLAN TO CRACK THE ISSUE	Student develops a clear and pithy plan to resolve the issue, with an alternative strategy and tracks the project to a conclusion.	Students develop a satisfactory plan and progress with it to a conclusion.	Students don't develop a consistent plan to solve an issue
TEAMWORK	Almost regularly listens to shares, and uphold the efforts of others. Always tries to keep everyone working well together.	Usually listens and shares with, uphold the efforts of others. Couldn't cause "waves" in a group.	Rarely hears to shares with, and uphold the efforts of others. Often it isn't a good team player.
CREATIVE & INNOVATION	Uses idea-originating techniques to grow several originals ideas for the products. Uses resourceful and imaginations outside usual boundaries, when moulding ideas into a product.	Develops some identical thoughts for the product's, but could generate more with better utility of idea-originating techniques. Shows few imaginations when moulding thoughts in terms of a product, but may stay within usual boundaries.	Stay within remaining frameworks; doesn't use idea-originating techniques to develop new identical ideas for production. Reproduces existing ideas; does not imagine new ones
SELF LEARNING	Applies strategies oneself for self-learning, solving issues and seeking proper help only if required. Students, when given topics, learn and use them in their projects. These require guidance only when encountering issues.	Applies strategies, problem-solving with incidental cause of teacher/appropriate guidance	Lacks skillful use of learning rarely engages in problem-solving or pursue help.
PRESENTATION SKILLS	Presents information, findings, arguments, and supporting evidence logically and concisely; the spectators can easily follow the line of reasoning. Completely and clearly addresses the alternative or opposing perspectives.	Presents information, findings, arguments, and holding evidence in such a way that which is not always clear, pithy, and logical; and reasoning is occasionally hard to follow. Attempts to address alternative or opposing perspectives, but not understandably or completely.	Presents no information, idea, arguments, or findings, logically and concisely; argument lack supporting evidence; the audience cannot attend the lines of reasoning. Could not be able to address alternative or opposing perspective.

After completion of course offered by SSDC, students applied for an internship, and 30 students got opportunity to work for elegant embedded systems Pvt ltd located in S.R Nagar, Hyderabad, Telangana, India. We collected the data of internship from the industry to see how well SSDC students contributed to the industry. The outcome of the measurement of the performance of 30 students individually in a team is shown in Table 2. On completion of the contest, a test was conducted where students can self-assess their understandings of theoretical and practical knowledge which helps students to gain in-depth knowledge. With the help of industry experts, students could develop some higher skills. This contest helped students to realize where they stand when competing among others.

Table 2: Measurement of the effectiveness of contest

Criteria	Exceed Expectations (8-10)	Meets Expectations (4-7)	Couldn't meet the expectations. (1-3)
TECHNICA	23	7	0

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L SKILLS (Hardware & Software)			
DEVELOPING A PLAN TO CRACK THE PROBLEM	21	9	0
TEAMWORK	30	0	0
CREATIVE & INNOVATION	17	13	0
SELF LEARNING	25	5	0
PRESENTATION SKILLS	22	8	0

Fig 6 depicts the performance of students in elegant embedded solutions Pvt Ltd internship certification exam for the academic year 2018- 2019.

PBL helped students to get more hands on experience on hardware and software which was reflected in the contest on how well students were able to perform their tasks.

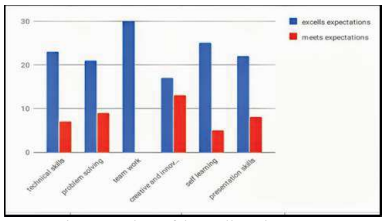
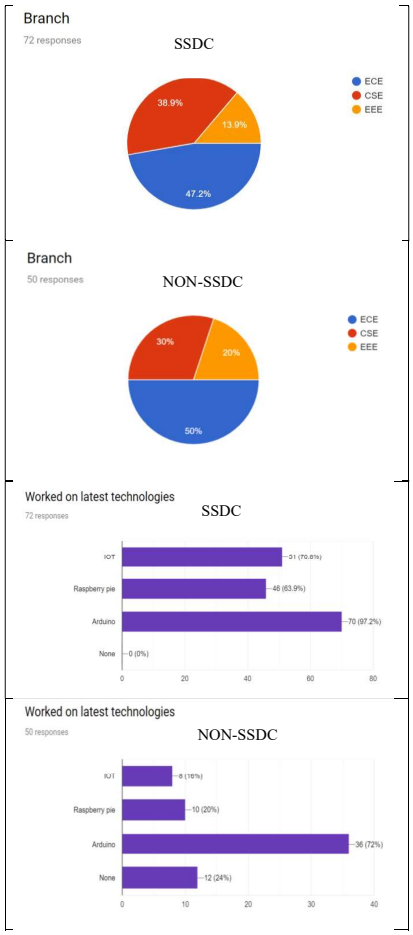


Fig 6: Bar chart of data collected on contest

A survey of 122 students from 3rd year ECE, CSE, EEE conducted is conducted to know how students of SSDC complement other students. Survey consists of questions on their number of projects done, papers published, languages known and technologies worked on is depicted in Table 3.

Table 3: Survey on SSDC and NON-SSDC students



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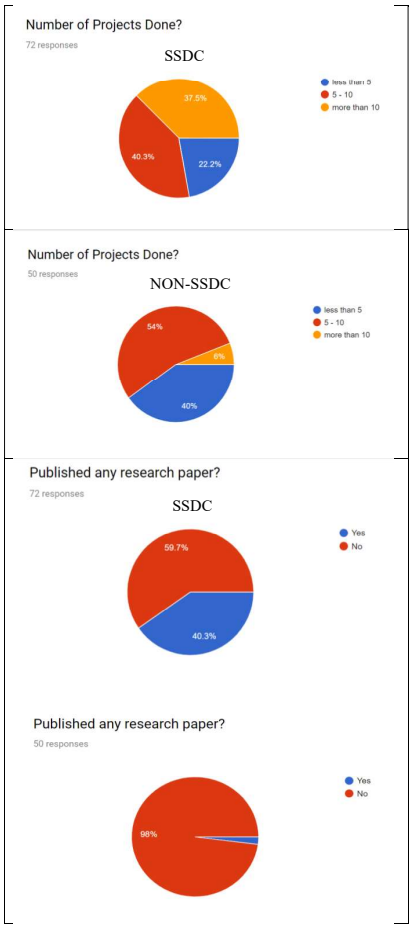

VI. CONCLUSION

Industry institute interaction provides a different learning experience from that of classrooms. Statistical data of student's performance and their learning process is demonstrated. With regular interaction and feedback, it enabled to bridge the gap between industry and institution. It empower students to be conscious on their skills and provides an opportunity to improve them. It also empowers faculty to be conscious on industry expectations & mould students to intersect these expectations. PBL results in self-directed learning, self-assessment, problem-solving and lifelong learning. With the conduction of regular workshops, project expos, competitions students improved the standard of projects. This paper has outlined the approach at HITAM, which established a center to promote doing engineering rather than study engineering. The outcomes through this process, students acquired a few skills such as programming, hardware, communication, self-learning which will help them to become successful professional in future. Students published research papers and students were offered with paid internships. This approach will help the institution to deliver industry-ready engineers because students have undergone extensive training in the latest technologies, designed projects, participated in the design competition.

VII. ACKNOWLEGEMENT

We would like to express our special gratitude and thanks to Elegant Embedded solutions Pvt LTD. For their continuous support to the center. We would like to acknowledge the management of HITAM College for encouraging students by conducting workshops, project expos to enhance the learning of students.

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A case study: Journey of Student skill development Center (SSDC) an interdisciplinary platform to actively engage millennial at HITAM

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Abstract: Research says that the retention span of millennials in class is about 10-15 min [1]. In this paper, the author shares his experience in engaging millennials actively.At HITAM, we introduced the Student Skill Development Centre (SSDC), which is a student-centered approach, combining two different learning methods: Problem-based Learning (PBL) and Interdisciplinary Learning. In SSDC, students work in groups and build open-ended projects. Project Based Learning in SSDC provides students an industrial experience, which makes them comfortable in understanding the real-time problems faced by the industry and helps them to gain experience in solving the issues [4]. So, designing a project becomes easy for the group because the group consists of students from different disciplines.

Keywords: Interdisciplinary Learning, Project Based learning, Student Skill Development Centre.

I. INTRODUCTION:

Interdisciplinary learning at SSDC involves students from different streams working together to design a project. Project-Based Learning (PBL) is easy with a interdisciplinary approach because it includes different streams of students who have prior knowledge in their respective streams[2]. In this approach, every student in the group will apply their core knowledge of their discipline to bring out the outcome of the project, which will help them to complete the project efficiently. So, we can say that PBL at SSDC is a form of integrating technology into projects in a meaningful way [3]. Since we are an affiliated college, we introduced SSDC to only selected students initially as an audit course.

II. SSDC PROCESS TIMELINE:

There are six steps in SSDC for the selection of the student.

Step 1: CREATING AWARENESS: As a part of creating awareness, the mentor conducts an introduction session and explains to students in detail the technologies and modules on which students will get trained, such as sensors, actuators, processing devices like Arduino, Raspberry Pi, 8051 controllers, Node MCU, etc. Mentor also discuss the benefits of SSDC training like paper publication by students, participating in design competitions conducted by other institutions, employment opportunities, teamwork, etc.

Step 2: REGISTRATION AND SELECTION PROCESS: In this step, the entire process of short listing the student for SSDC is bifurcated into four main sections. They are online registration, online examination, interview, and results.

Fig.1 Interview and Online Examination

Step 3: LAB SESSIONS: After the selection process is completed, the lab session starts where the selected students will be divided into interdisciplinary groups. Each group comprises of students from ECE, CSE, EEE with girls and boys combination. The size of each group is four members, which comprise of academically strong, average, and week

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students so that all students adequately engaged. After the grouping of the students, the mentor trains the students weekly twice, each session of 2 hours. Complete six months schedule shared with students before the commencement of training. In each session, the mentor explains on which modules students are going to work and teach the necessary code for 10 to 15 minutes, and remaining time students work on an assigned task. For example, if a mentor explains how the IR sensor works, then the task is assigned to students to design visitor counting using an IR sensor. By the end of each session, the interdisciplinary group is expected to complete the assigned task. So, this is the everyday routine at SSDC.

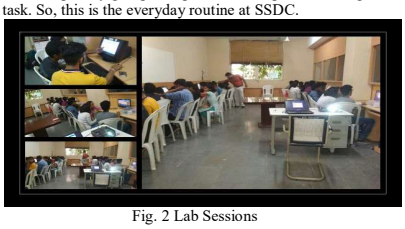

Fig. 2 Lab Sessions

STEP 4: WORKING DESIGN EXPO:
Once a semester, the mentor organizes a working model expo in the college. All SSDC students showcase their projects, and this gives them a more significant opportunity to demonstrate their project in front of students and staff.

Fig . 3 Design competition at HITAM

FLOW CHART:

III. INTERDISCIPLINARY LEARNING AT SSDC
Contextual analysis has been attempted at SSDC to observe and assess the results of PBL through interdisciplinary learning. It was chosen to incorporate students from various streams in every group, and the mentor assigns the task. In this approach, every student in the group will apply their core knowledge of their discipline to complete the project efficiently. For example, CSE students contributed to coding, EEE students participated in electrical connections, and the ECE student contributed to integrate hardware and software.

Fig.4 Introducing hardware to the students by the mentor.

Fig.5 Different streams students working together in one group.

IV. ROLE OF THE MENTOR: In SSDC, we have three trained mentors from different streams. All of them know all the three streams that are electronics, electrical, and computer science. Mentors design the task and assign it to the students. After the job is assigned, they will monitor the

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students whether they are going in the right way or not. Mentors are trained and experienced, and they are capable of helping the students to complete the task. Once in 6 months, the mentors conduct the design competition. One common project is assigned to the interdisciplinary group, and in three hours group should complete design, testing, and demonstrate a working model. Mentors follow rubrics, which is mentioned in the table below, to declare the winners.

Fig.6 Mentor clarifying the doubts of the student personally

V. RUBRICS FOLLOWED AT SSDC: Rubric followed in SSDC is mention below in table 1 [7].

Table 1

Criteria	Exceed Expectations (8-10)	Meets Expectations (4-7)	Couldn't meet the expectations. (1-3)	Score
TECHNICAL SKILLS (Hardware & Software)	Design and development of the project along with appropriate use of hardware and software.	Partially designed and development of the project along with appropriate use of hardware and software.	No design and development of the project and inappropriate use of hardware and software	
Establish A PLAN TO SOLVE THE PROBLEM	The student was able to devise and execute a concise plan completely in a very short span.	The student was able to devise a mediocre plan and accomplish it.	Students wasn't able to reach conclusions or devise any plan even after utilizing to the fullest.	
TEAMWORK	Always listens to shares with, and supports the endeavours of others. Attempts to keep individuals functioning admirably together.	The student tried to impose their opinions upon others without considering their perspective.	The student reluctantly agreed to be a passive member of the group.	
CREATIVE & INNOVATION	The student was able to propose unorthodox ideas with substantial evidences for the given problem statements.	The student was able to make some considerable changes in the pre-existing solutions of the given problem statement.	The student was not able to come up with any ideas even after thorough brain storming.	
SELF LEARNING	Applies strategies independently for self-learning, solving problems and looking for proper assistance if necessary.	Applies methodologies and understands the problem with periodic instructor/proper assistance.	Needs procedures to adapt, once in a while takes part in critical thinking or looking for assistance.	
PRESENTATION SKILLS	Present data, discoveries, contentions, and supporting proof briefly, and coherently; the audience can easily follow the line of thinking. Clearly and totally addresses elective or contradicting viewpoints.	Present data, discoveries, contentions, and supporting proof in a way that isn't in every case clear, succinct, and coherent; the line of thinking is now and then difficult to follow. Endeavours to address elective or contradicting points of view, but not clearly or totally.	Doesn't present data, contentions, thoughts, or discoveries, briefly and logically; contention need supporting proof; the audience cannot follow the lines of thinking. Couldn't be able to address alternative or opposing perspective.	

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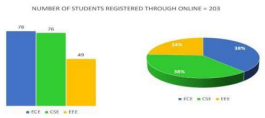
VI. DATA:

The data given below is the total number of students from different streams registered online.

The data furnished above shows that total 203 students has registered from different streams.78 students from ECE,76 students from CSE,49 students from EEE.



.Fig.7.Number of students registered online

Number of students showed up for online examination are 152

The data furnished above shows that 68 students from ECE, 58 students from CSE, 26 students from EEE wrote the online examination. From the above, we can see 51 students did not appear for the online exam. College authority decided to conduct classes from 4:00 PM to 6:00 PM that is after college working hours, and the transported facility was provided for limited areas due to which a few students who travel from a far distance didn't want to join the training. Online exam conducted those who are willing to stay on campus up to 6:00 PM. The online exam question paper consists of 20 basic c and electronics questions for 20 min. The students who secured above ten marks were eligible for the interview. Out of 152 students, 113 students secured above ten marks.

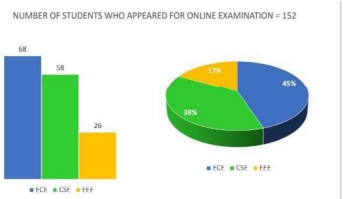


Fig.8.Number of Students showed up for online examination.

Number of students qualified exam and attended for interview are 113

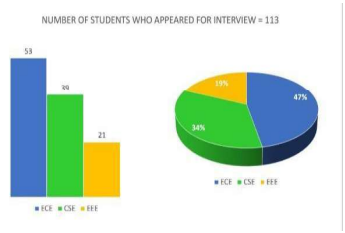


Fig.9.Number of students appeared for interview

The above-furnished data shows that 53 students from ECE,39 students from CSE, 21 students from EEE has appeared for the interview. The questions that were asked in the interview mainly focused on the interest and the commitment of the student. After the completion of the interview. A message was sent to the shortlisted students.

The number of students who were shortlisted for the training were 96.

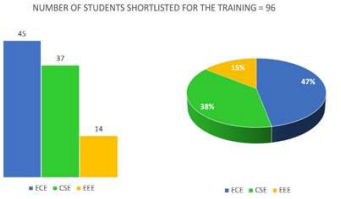


Fig.10 Number of students shortlisted for training.

The overall data of online registration, online examination, interview and the result are shown below in the form bar chart.

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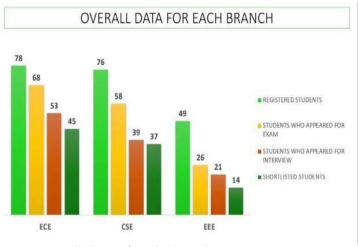

Fig.11 Overall data of each branch.

The above furnished data shows the whole procedure and how interdisciplinary learning is encouraged in SSDC.

II. SUCCESS STORIES OF SSDC STUDENTS:

1)Eighty seven students out of 96 were certified in the design competition held by Elegant Embedded Solutions (EES) Pvt Ltd.

Fig.12.Winners group of the design competition

2) SSDC students presented 7 research papers in national conference on recent challenges in engineering, science and technology (NCRCEST)2019 and successfully all the 7 papers were published in international journal of research in advent technology (IJRAT).

3**)** Students designed several interdisciplinary projects and bagged awards in design competition held at national level.

Fig.13.Projects designed by interdisciplinary group students.

4) SSDC students participated in innovation challenge and 3 ideas got accepted a national level.

5) Totally 25 students got internship opportunity in Elegant Embedded Pvt Ltd.

6) Successfully conducted several workshops on latest technologies like IOT, Raspberry Pi, Arduino, various sensors and actuators.

7) One of the interdisciplinary groups secured 3rd place Out of 603 students participated in design competition held in Pondicherry and received Rs 5,000 cash award.

Fig.14 Winners of design competition.

VIII SSDC VS NON-SSDC OBSERVATIONS:

A survey conducted on 60 students which comprises of SSDC and non SSDC students and observation of survey is showed below.

- SSDC students participated in workshops, and paper presentations, their skills like interpretation, project knowledge, stage fear, and presentation skills were better when compared to the students who did not opt for the training.
- The quality of the projects of SSDC students was excellent and completed the project on time compare to non-SSDC students.
- SSDC students work in teams; they have excellent team workability.
- The ability to adapt new technologies is more in SSDC students because they have experience of working on cutting edge technologies as part of the training.

IX EQUIPMENT AND MODULES USED AT SSDC

SSDC equipped with twenty-two sensors, seven actuators, four processing devices like Arduino, Raspberry Pi, 8051 controllers, Node MCU.

X RESULTS AND OBSERVATIONS:

Interdisciplinary learning at SSDC helped the students in gaining information about the interdisciplinary subjects. Students' coding skills, critical thinking, project design, teamwork, presentation skills are improved. Mentor and students' professional relationships developed.

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XI CONCLUSIONS:

The author would like to conclude to engage millennial at authors institute they introduced an innovative centre called SSDC. This centre opts PBL and interdisciplinary approach to engage students actively. In this paper, we have also discussed student's selection procedures and student's success stories.

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Inculcation Of Life Skills Through Project Based learning To Promote Sustainability

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Abstract: One needs to possess various life skills in order to prosper and promote sustainability in this progressive world. There are many such life skills, but the core life skills laid down by WHO may include problem-solving, critical thinking, decision and various other skills. One is not readily born with these qualities, but needs to imbibe them from various sources with the passage of time in order to increase personal sustainability in this walk of life. Merely teaching these life skills may not actually help a student to imbibe them. Hence, a methodology for efficient inculcation of life skills like, STUDENT SKILL DEVELOPMENT CENTRE (SSDC) with falls under PROJECT BASED LEARNING (PBL), needs to be adapted. With the usage of traditional pedagogy, it is possible to generate theoretical awareness but inculcation of life skills is a task in itself. Hence project based learning or outcome based learning comes into the picture. The change in teaching methodology which was introduced in order to record the inculcation of life skills was the origination of the Student Skill Development Centre (SSDC). In SSDC, student of various domains imbibe knowledge by generating self-taught solutions to realistic problems. As per the observations, the students working under SSDC or other project based learning (PBL) centres tend to inculcate enhanced decision making, critical thinking, team work and problem solving skills as compared to those being educated by traditional approach. These students find it easier to cope up with any problem they come across in their lives. Hence it can be concluded that inculcation of life skills is rapid in those students who work under skills development centres. Such students also tend to sustain and prosper in the long run.

Keywords: sustainability, life skills, PBL, SSDC.

I. INTRODUCTION:

The appellation "Life skills" cite to those skills required to extract the maximum out of one's existence. Whichever skill proves to be handy in our lives can be regarded as life skills. These skills help us cope constructively with the hardships of life. Few skills may prove to be appropriate for an individual based upon their current happenings, customs, ethics, geographical position, lifetime and so forth. Life skills theory is also entitled as "psychological competency", A life skill enables one to sustain in their surroundings and also aids them to emerge as an active and productive member of their community. Life skills play a key role in the promotion of sustainability which is defined as the potential to be nurtured at a precise amount or standard. Sustainability is the capability to subsist constantly. Also defined as the process of people adapting to the changes in a balanced environment and maintaining it, where the alignment of technological growth, the flow of investments, institutional advancements and the victimization of resources are all in harmony amongst each other and improve both present and future potential to meet human necessities and desires.

There are five pillars of sustainability namely:-

(i)***Human sustainability*** that aims at upgrading and supporting mortal wealth in the community. Few programs that fall under the umbrella of human sustainability are contributions in the field of education and health sector, availability of nutritious food, ingress of services, expertise and knowledge.

(ii)***Social sustainability*** that aims at safeguarding the social capital by financing and generating services that contribute to the framework of our mankind and it also houses a greater view of the world in terms of proliferation, communities and civilizations.

(iii)***Environmental sustainability*** which aims to refine prosperity via the conservation of crude stock like water, minerals, air.

(iv)***Economic sustainability*** which intents to preserve the wealth unimpaired. It focuses on refining the quality of livelihood.

(v)***Personal sustainability*** is defined as individual's capability to keep a level or pragmatic equilibrium of one's vigour even in the toughest phases of life. It is the core for individuals creating a change globally.

There are various life skills required by an individual through the course of life to promote the amalgamation of the aforementioned sustain abilities. However, in the year 1999, WHO or the World Health Organization has recognized the six essential domains of personal competency as *conveyance and relational abilities, innovatory and analytical intelligence , decisiveness and hindrance-resolving, psyche-consciousness and sensitivity (emotional*

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intelligence),confidence and equanimity(self-restraint), resilience and the potential to surmount with problem, teamwork. Mastering the inculcation of these life skills can make an individual predominant in the course of life and helps them promote sustainability. [1-3]

A .What is PBL?

PBL which is an acronym of Project based learning, also referred to as learning by doing scheme is a tutoring pedagogy wherein tutees acquire awareness and expertise by functioning for an elongated duration of hours in pursuit of exploring and reposting to an genuine, appealing, and composite query, issue , or hindrance. Through PBL tutees obtain sound understanding via agile research of absolute hindrances. It is a style of active query-oriented training that contradicts with parrot-fashioned knowledge retention, paper-based or tutor-guided direction that extends mainstream gospels or exhibits a resolved track to awareness by rather cross-examining obstacles and contexts.

Pedagogues have been making use of PBL or project based learning pedagogy for about 50 years today, but it has lately started to trend as the idea of student becoming "college and career ready "is prevailing. To flourish in this constantly evolving sphere, students are under the obligation to understand both the 4C's and 3R's (reading, writing, arithmetic, communication, creativity, critical thinking, collaboration) which fall under the umbrella of life skills.

Taking a closer look upon the *outcomes* of project based learning we find that the students following PBL pedagogy tend to *learn project management*, *grow more empathetic, become explorers and hindrance resolvers, tend to participate actively in the tutoring exercise and unabashedly different, engage in iterative thinking and are ready for the creative economy, think divergently, make deep connections between ideas , learn to take creative risks* which also fall within the framework of life skills. Hence we came to the conclusion that life skills are interlinked with the outcomes of project based learning and the PBL methodology has to be efficiently used for the welfare of the individuals and broadly the society and what better way to be using it to promote sustainability which not only aims at the welfare of the individuals but also the society in general.[4-5]

There exist seven key domains for Project-Based learning.

- A guiding query
- Cognizance
- 21st Centenary Adroitness
- Exploration and transformation
- Tutees' opinion and selection
- Critique and Emendation
- A communally conferred outcome

B. Differences between traditional and PBL Methods:

Criteria	Traditional method	PBL
Evaluation	Test scores	Students display of knowledge and performance
Syllabus	Content coverage is the prime most agenda	Complete understanding of the content is the prime agenda
Teaching Methodology	Chalk and talk	Activity and real time based Leaning
Role of the mentor	To spoon-feed the entire content to the students by preparing class notes and exercise sheets	To facilitate the students towards knowledge and to bridge the gap between the college and the career requirements.
Mode of Learning	Textbooks And class notes	Self-learning and inquiry
Type of learning	Individual learning	Peer-learning which promotes teamwork

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II. METHODOLOGY:

As we had figured out that the outcome of PBL and the life skills were intertwined and we wanted to utilize this to the maximum in order to promote sustainability, we devised a fool proof plan and started a Centre called the Student Skill Development Centre (SSDC) , wherein students can not only imbibe the essential life skills but also learn how to utilize them judiciously for the welfare of the community. To begin with the process of implementation of project based learning, students were asked to fill a form wherein they were inquired about their interests and the type of skill they would prefer to learn and the purpose of choosing that particular skill so that we would be on par with ideology and motive of the trainees. This would not only enable the pupil to have a drive but would also help the trainers to devise a smooth path for the implementation of the same. Hence both the Centre and trainees could meet their purposes.

So initially, as most of the students who displayed their interests in the project based learning pedagogy were from the ECE course and wanted to learn a domain oriented skill, so we went ahead with the same action plan. A 6 month action plan was devised to monitor and train the students without disrupting their methodical academics within the time frame of 4pm-6pm semi-weekly. In order to monitor the growth of the students closely not more than 30 students were placed in the cluster of each day. In the initial days, few students dropped out of the programs due to personals issues and transportation problems but later on re-joined the centre, which put the first tick on the checklist as we saw the motivation and drive in them to learn and create something new for providing community services.

Subsequently, when the training proceeded, the students were cross-examined at various stages by throwing real- time problems at them and they were readily accepting the challenges and were able to cope up with those problems. They were also asked to explore outside the college for a community partner who might either be a small scale farmer or a large scale industrialist, looking for solutions to their problems in exchange of money. By doing so the trainees ticked all the boxes like human, economic, personal, and social sustainability. These trained students were quite interactive as compared to the rest of the students being trained under only the traditional pedagogies and had good communication skills and displayed empathy towards others. The projects developed by the students working under the Centre were far ahead in terms of environment friendliness as compared to those students who were not trained under the centre. As the students contribute to massive number in the world's population and also are the roots for future generation, imbibing life skills to promote sustainability from the very beginning would take us towards a sustainable world.[6-7]

Fig 1. Working area

Fig 2. Technical interaction for industrial needs/critical thinking

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Fig 3. Environmental Sustainability (use of solar power)

Fig 4. Economic and social the investors)

Fig 5. Project based learning workshop to enhance teamwork

Fig 6. Rigorous presentations to inculcate communication and inter-personal skills

Fig 7. Peer learning for self-awareness and personal sustainability

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III.EVALUATION RUBRICS:

Criteria	Exceed Expectations (8-10)	Meet Presumptions (4-7)	Could not meet presumptions. (1-3)	Score
Communication skills, inter-personal skills and peer- learning	The student was able to put forward their ideas efficiently and to the point, to the best of the listener's understanding during presentations	The student was able to present their ideas but not to the fullest and had self-doubts	Were totally not able to put forward their ideas and had performance anxiety/stage fright considering the feedback from the listeners	
Decision making and problem-solving	The student was able to devise and execute a concise plan completely in a very short span of time with alternate backup strategies	The student was able to devise a mediocre plan and accomplish it	The student wasn't able to reach conclusions or devise any plan even after utilizing their time to the fullest	
Creative thinking and self-learning	The student was able to propose unorthodox/eccentric ideas with substantial evidences for the given problem statement	The student was make considerable changes in the pre-existing solutions of the given problem statement	The student was not able to come up with any ideas even after thorough brainstorming	
Empathy and teamwork	The student was quickly able gel up with any provided group of students and tried to understand everyone's perspective	The student tried to impose their opinions upon others without considering their perspective	The student reluctantly agreed to be a mere passive member of the group	
Resilience and personal sustainability	The student did not panic hurdling upon an obstacle during their course of work and were able to recover quickly	The student initially dreaded upon the thought of an obstacle but eventually was able to overcome it	The student tried but had given up towards the end	
Economic sustainability and technical skills	The student was able to develop an appropriately functioning mechanism along with additional features with the usage of minimal number of sensors and actuators incorporated within micro-controllers and micro-processors	The student was able to develop a moderately operating mechanism	The student wasn't able to develop any functioning mechanism with the usage of hardware and other components	
Social and environment -al sustainabilit y	The student tried to take up more issues concerning to the environment and society and accomplished the goal to solve them efficiently	The student tried to take up the issues concerning to the environment but wasn't able to find a solution	The student took up problems which had pre-existing solutions regardless of its concern with the society or environment	

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IV.RESULTS AND OBSERVATIONS:

The students trained under Student Skill Development Centre (SSDC) using the implementation the Project- Based Learning pedagogy were able to produce industrial standard projects that predominantly focused upon resolving the environmental affairs with the usage of minimal components that subsequently resulted in the promotion of sustainability of all sorts. Also the trainees of this centre displayed enhanced life skills as they have participated in/organized multiple workshops and presentations which require enhanced life skills.

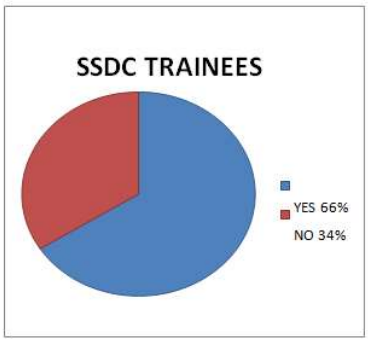

Fig 8. Percentage of trainees of SSDC and non-SSDC trainees

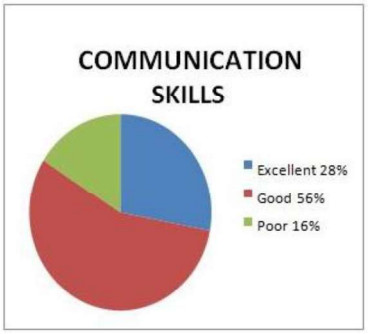

Fig 9. Students having sound communication skills

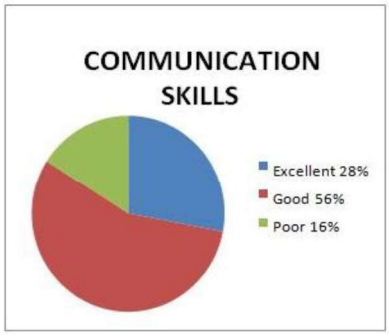

Fig 10. Students of SSDC with excellent communication skills

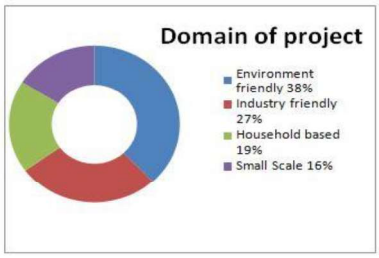

Fig 11. Project Domain

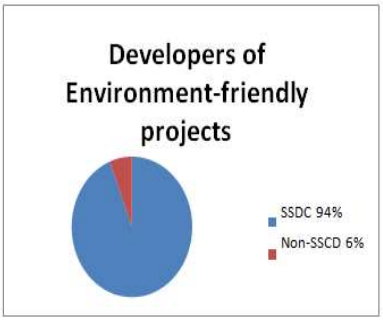

Fig 12. Environment friendly projects developed by SSDC trainees to promote sustainability

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V. CONCLUSIONS:

This course enables an individual to imbibe enhanced life skills and nurtures the students to solve multiple sustainability related concerns through rigorous practice of hands on learning, project/product building and presentations. It also bridges the gap between theoretical learning and real-time implementations. The project based learning pedagogy has directed students towards making projects and products to serve the purpose of community service. Alongside self-contentment, PBL also empowers students to prosper and sustain in the long run of life and helps promote sustainability.

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Experience of Engineering Exploration Course in Audit Mode for Second Year

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Abstract: Project based learning (PBL) is recommended to address the needs of millennial learners. It is a student-centred methodology that promotes development of the 4C - Critical thinking, Communication, Collaboration and Creativity. Engineering students need to develop these skills right from the first year. While designing the curriculum of FYBTech in our autonomous college the concept of active learning is introduced through 'Environmental studies' and 'Industrial Applications' with a focus on communication, collaboration and creativity.

During the curriculum design process, we came across the 'Engineering Exploration' course for First year developed by KLE Tech, Hubbali. Considering courses added in first year, it was thought that learning through activities and developing application based on need is best suited for Sem III students. Also it was decided to introduce the course in choice based audit format.

From July 2018 Engineering Exploration course was introduced with activity based learning and project development cycle. Our experience of offering such course in audit mode for second year students is narrated in this paper.

Since the duration of audit course was limited, students could demonstrate design and partial working of the project which we tried converting to internships. Students of first batch indicated that they appreciate activity based learning and understand the importance of development cycle of a project. Completion of this course motivated them to participate in project competitions like e-Yantra Robotic competition, Robocon etc.

Keywords: project based learning, freshman course

1. Introduction

The Fourth Industrial Revolution, Industry4.0, will put some challenges to the new engineers. It is envisioned that the way work will be organized in the future will enable the release of workers doing routine tasks, appealing to their skills for more creative and value-added activities. Additionally, they will be called to develop more complex products and systems and to manage them efficiently through new methods, tools and technologies.The skills to deal with the fast pace of change in businesses are beyond
the traditional "Three Rs" of reading, writing and arithmetic to a new set of skills, the "Four Cs": Critical thinking, Communication, Collaboration and Creativity, to enable workers to think critically, solve problems, innovate, collaborate and communicate more effectively[2]

Project based learning (PBL) is recommended to address the needs of millennial learners by many researchers. Important characteristics of PBL like (i) resolution of a problem (proposed by the students themselves preferably); (ii) initiative to solve the problem from the students (iii) integration of a range of educational activities; (iv) delivery of a final product, coherent with the initial problem; help students gain the Four C skill set.

In the implementation of PBL changing the role of the instructor from an authoritarian position to a consultant position is also required [3]

Hence a transformation in teaching and learning approaches is essential to prepare students to solve complex problems in a global world. In order for students to practice as engineers, they need to have exposure to a number of projects that offer real-world problems, along with the complexity and uncertainty of factors that influence such problems. Students need to learn how to frame a problem,identify stakeholders and their requirements, design and select concepts, test them, and so on.[5]

Colleges and universities are finding it challenging to fit projects into a curriculum along with ever changing technological advances in a timely manner.

This paper discusses the process and experience of introducing PBL course in the curriculum of an autonomous self-financed college affiliated to University of Mumbai. The designed course is implemented in audit mode for two batches of second year students. Section II discusses the motivation to add such a course in the curriculum. Section III describes the steps followed for Implementation of the same. Section IV presents the observations from the course, followed by students' responses and discussion and learnings in Section V.

2. Motivation

While designing the curriculum in our autonomous college the concept of active learning is introduced right in first year through courses named 'Environmental studies' and 'Industrial Applications'. While undergoing Environmental studies course, students work on projects focusing on environmental needs. In the course Industrial applications students are introduced to applications in different thrust

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areas of specific branch through interaction with industry experts and industrial visit.

A team of faculty members came across a course in KLE Tech University , Hubbali on Engineering Exploration.The faculty development programme on Engineering Exploration course gave an insight on implementation of project based learning. The features of the course developed for freshmen at KLE Tech are

- Identification of need and connecting it to technology
- Development of Project while learning new concepts.
- A dedicated well equipped laboratory for students to work on projects
- Course taught by four faculty from different branches (Special arrangement with Studio class room, four white board with LCD projector etc)

Though course is suggested to be introduced in the first year of engineering by KLE Tech , it is implemented for second year students in our college with following considerations.

- All students have learnt the same courses during their first year and are getting oriented to different branches from second year.
- Courses added in first year are preparing them for learning through activities and application areas for the branch. Hence developing application based on need is best suited for second year students.
- College administration decided to introduce such a course on a trial basis to understand students willingness in Metropolitan circumstances where a good number of students has an exposure to project based learning during their school days .
- Students should be willing to take up project and hence it was decided to introduce the course in choice based audit format.

3. Curriculum Design

Since the decision was to implement it as audit course, it was necessary to redesign the course in format of audit course of our college. Typically Audit courses are of 22 hours per semester (2 hours per week). However to implement project based learning it was decided to allot 3 hours per week

The course is designed with guidelines from KLE Tech with modifications with regards to number of contact hours per week, depth of coverage of various modules , nature of reviews of activities and project etc. Hence the outcomes of the course are defined as

CO1. Analyse a real world situation to convert it into engineering design statement

CO2. Adopt multidisciplinary approach in solving the design statement.

CO3. Use the engineering design process to build a product using simple mechanisms, controllers, sensors , actuators etc.

CO4. Execute the project ethically in the project management paradigm.

The modules are planned as follows

- Introduction to Engineering and Engineering Study - 2 hours
- Engineering Design - 7 hours
- Mechanisms - 7 hours
- Platform based Development and Sensors -10 hours
- Project Management and Engineering Ethics -7 hours

All the modules are planned along with hands on activities. The continuous assessment of students is planned based on project reviews at various stages as mentioned below.

Review 1 : Problem statement : Student's work on given need in a team to understand objectives , constraints and functions and detailed problem statement. (20 marks)

Review 2 : Concept generation and Product architecture : Team work on defined problem statement and design alternatives to choose the best one. Development of architecture based on the concept chosen (20 marks)

Review 3 : Prototype: Teamwork for developed prototype with its functionality tested and demonstration of the product (40 marks)

Report Writing (20 marks): Document submission in the form of report with all details.

4. Implementation

After preparations for activities and projects for a limited number of students,Engineering Exploration course was introduced as a choice based audit course, open to students of second year of all branches from July 2018. The course is one amongst approximately thirty other audit courses encompassing areas like accountancy, foreign languages, programming skills etc. to name a few. Audit courses are mandatory non credit courses. Since the nature of the course is different from other audit courses, an awareness note explaining its features was sent to all students prior to registration for the audit course.

The course was opted by 40 students (majorly from Mechanical, Electronics and Telecommunication Engineering).

All the sessions were co taught by four faculty members from different branches of engineering.

Each session was interspersed with small activities and reflection spots for students and students were encouraged for communication and critical thinking.

The content delivery was supported by activities such as catapult for understanding importance of engineering design process, card game for the importance of teamwork. Module of mechanism was majorly taught through activities based on gears, pulley, conveyer belt, and simulations using 'Linkage' software.Students explored arduino as a platform for controller with a variety of activities with the use of different sensors, zigbee modules, motors etc. Additionally demonstration and practice on pneumatic and hydraulic circuits was introduced with the intention of exposing them with real world large applications.

Interdisciplinary teams were formed with four students in each team for implementation of project. Following project need statements were given at the very beginning of the course.

1. A robot manufacturing industry is interested in making a self balancing two wheeled robot which can serve a cup of tea
2. Manual Gutter cleaning is a task which is very

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inhuman. Automatic cleaning of gutters/ drains is desired.

3. Manual cleaning of blackboard exposes teacher to chalk dust which is harmful. Automatic cleaner for blackboard / whiteboard is desired.
4. Automatic breaking and scrapping of coconuts is useful for large scale coconut product manufacturers. A machine is to be designed for this purpose.
5. Corn thresher which threshes seeds automatically is required.for reducing manual labour of farmers.

In addition ideas suggested by students were also discussed and the need statements were finalized for all teams.
Ideas such as portable floor vacuum cleaner , Coin sorter and counting machine were some ideas suggested and developed by students.
For manufacturing parts in the project, students were exposed to 3D modelling software and 3D printing. Progress of the project was reviewed for problem statement, design methodology and final demonstration.
Following figures are glimpses of activities and projects by students.

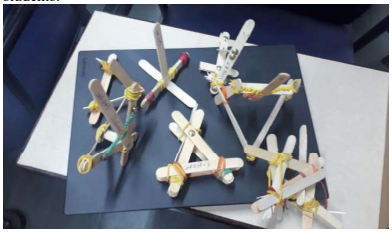

Fig1 Different catapult Designs

Fig 2 Students experimenting with pneumatic circuits

Fig 3 Students engaged in activity of conveyor belt

5. Observations

During the semester students were keen on the activities and were enjoying the new way of learning. During activities on mechanisms and platform based experimentation it was observed that the students are sharing knowledge and learning from peers.
In the review of Prototype developed (review 3) it was observed that many of the groups could just show the proof of concept or partial working of the project. They expressed the paucity of time and pressure of end semester examinations are the reasons for not completing the prototype. They also expressed their willingness to work on their projects during vacations, hence it was decided to allow them work in vacation as intern on their projects with faculty mentors.

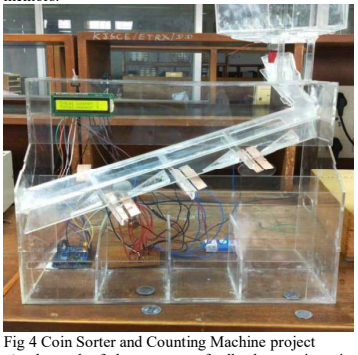

Fig 4 Coin Sorter and Counting Machine project

At the end of the course a feedback questionnaire was circulated in the form of Google form. Student's perspective of the course was gathered through the responses.
The questions included points such as

- Usefulness of course for self learning skills and critical thinking
- Importance of communication skills (oral and written)
- Working in team
- Innovation / creativity in prototype building

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The chart in figure 6 shows the opinion of students on these aspects. Also around 76% of students felt that this course facilitated integration and participation in outside competitions like e-Yantra Robotic competition, Robocon etc.

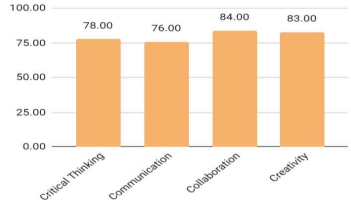

Fig 5 Feedback of Students

Sample expressions by the students about the course are as

- The subjects in our education system are only theoretical, practical things are not high, so students and teachers have to focus only on marks not their technical skills because marks give better degrees and can be a better job but not creativity. But if colleges, schools and universities make this type of more courses (EE) compulsory and give marks on the basis of these subjects then most of the students can be creative and innovative.
- Provide some extra credits on completion of project that will boost them to put in more effort. Provide additional help to carry that project forward after course as well.
- Good course for understanding the life cycle of a project.
- It was a wonderful course to start off with to form a foundation in robotics. More such audit courses and activities should be organised and encouraged.
- The in class project discussions with group members and faculty were very helpful for development of ideas and concepts for the project; and this aspect must be retained in future semesters of this course as well. In my view, it would be beneficial to introduce this course as a full 3 credit course at the Semester 3 level, so that all students can obtain the experience this course provides. It will also improve the dedication of students towards this course, which can lead to better outcomes and results.

6. Discussion and Future Scope

Based on our experience in teaching this course in year 2018-19, we observed that

- Participation of students from computer engineering and Information Technology branch is negligibly small. These students apparently prefer software development courses than developing projects which are electromechanical in nature. Some needs with a focus on development of Mobile App or Computer Application may attract these students.
- If the need statement is initiated by students, their enthusiasm for completion of the project is more. Hence they should be motivated to choose project on their own.
- Students find it very difficult to spend more time on non credit course especially when they have to devote time for development of prototype towards the end of the semester.Interested students could devote their time during vacations on these projects. Students can earn internship credits by completing the project.
- The experience of co-teaching was introduced first time and teachers feel that more interactions among faculty members of various disciplines can enhance this type of course delivery. Faculty members have realised the impact of activity based learning and co-teaching due to this course. Training for PBL based courses will help in improving the project reviews.

From this experience we feel that such a course should be offered as choice based credit course in second year, which will motivate students for Project Based Learning.

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Energetic Teaching Activity Role Play and Round Quiz: A Case Study

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Abstract: Teaching Learning process involves different activities. Every lecture has an outcome. However, if the lecture is forenoon, there is a need to energize the students with learning outcomes. Role-play and round quiz are energetic learning activities. Role-play activity increase numerous abilities in the students such as team building, leadership quality, demonstration, thinking, working, playing, creativity, etc. Round quiz is a game applied for the fuzzy logic course. Round quiz clears the tiniest of their doubts and prods them to answer it themselves. Students become energetic for these activities. The paper demonstrates learning with joy.

Keywords: Role-play, Round quiz, Energetic activity, assessment, outcome.

1. Introduction

Now a day, knowledge and information is available on the internet, hence teacher's role is to facilitate the students' instead of one-way teaching. The teacher must facilitate students in the right way with the right material and clear visualization of imaginary things. Active and collaborative teaching methods help a teacher to facilitate the students. Role-play and round quiz are active and collaborative teaching, learning tools that help students in fun learning. The role-play activity and round quiz designed for final year students of electronics and telecommunication engineering, for the fuzzy logic course. For post lectures the role-play round quiz supports teacher to keep students' active. Students' master all skills required for engineering. These techniques help all types of students' i.e. shy student, active students, silent students and clever students. The students' relationship will develop with teachers and colleagues. These tools empower the students. Social skills of students increase. These collaborative activities maintain the learner interest in the course.

2. Literature review

Adolfo Cobo et al. [1] adopted role-play as a teaching methodology in engineering education. Researchers practiced the role-play for trouble shooting or doing maintenance of industrial scenarios of mechanical, electrical, chemical or electronics industry. They implemented role-play in communication networks to trouble shoot the layers of TCP/IP networks. They analyzed the study based on rubrics developed, including knowledge, relevance, and selection of instrumentation. This was the innovative teaching tool for theory courses.

Aidan O'Dwer [2] conducted open book, multiple-choice questions for postgraduate as well as undergraduate students. He presented the systematic study with quizzes. The author had given the choice for students to choose the book. He also led the quizzes of papers presented. The quizzes directed individual and team that supports to create different types of quizzes such as formal and informal quiz, paper based quiz, open book quiz, social quiz, etc.

Genevieve Marie Johnson and Julia Ann Johnson [3] evaluated the learning styles of students in study groups and online quizzes. Researchers surveyed 48 college students and analyzed the students' learning style and preference of online study.

Maria Asuncion Rojas and Jhonny Villafuerte [4] had presented that role-play is task based, communicative and cooperative learning tool. They believe that role-play is science. Role-play develops the healthy relationship between students' and teacher. It helps to strengthen the students' confidence in speaking, as well as active exploration of course knowledge.

Mohad Firdaus Mohd Ab Halim et al. [5] proposed innovative quiz that bridges the gap between theory and practical. The authors explained the detail procedure and testing the quiz required for electrical and electronics engineering student. They suggested that this quiz clears the fundamentals of electrical circuits.

Shawna Shapiro and Lisa Leopold [6] accessed the role-play and critical role. For role-play active involvement and critical thinking is required. For completing the role-play, the students' must have cognitive and linguistic skills with deep knowledge of course content.

Stephan Krusche et al. [7] applied interactive learning techniques for software engineering course. In teaching, they used case studies, quizzes and icebreakers. The results evaluated based on the students' feedback and performance in that course.

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Suzanne E. Weinstein and Shao-Wei Wu [8] suggested difference between frequent quizzes verses regular assessment quizzes. Researchers evaluated 51 college students and proved that frequent quizzes enhance the students' learning. They recommended the frequent quizzes avoid students to cheat and make them ready for any time.

Tim W. Lowe [9] analyzed the summative and formative online quizzes based on the number of attempts made and scores achieved. In this quiz, the attempts are unlimited. Authors proved that summative assessments promote students to attempt the quizzes many times and helps to clear the concept of mathematics.

Zina Adil Chaqmaqchee [10] compared the students' perspective for two different University higher education students. The researcher found the different university students have a different perspective for quizzes and discussion. They predicted that more study is required for quizzes in different context.

3. Problem identified:

- The success of teaching activities is not measured by individual faculty
- Pedagogical effectiveness of teaching activity implemented by faculty is not analyzed.

Three factors affect the effectiveness of teaching activities:

i) Teacher variables: Dedication, Experience and motivation.
ii) Student variables: Entry behavior and motivation
iii) Institution variable: Facilities, motivation

If all the above factors exist, the success is measured by The following formula:

Success=Teachers interest+ student involvement + Outcome of the activity.

3.1. **Objectives**:

- Prove role-play and round quiz are Energetic Teaching Activity
- Promote evaluation of learning by using rubrics method
- Analyze clarity in fundamentals of respective course.

4. **Research Methodology:**

The case study was conducted at Rajarambapu Institute of Technology affiliated to Shivaji University, Kolhapur. To overcome the problems identified in the energetic activities, role–play and round quiz are finalized through literature review. It is decided to apply for an undergraduate elective course (fuzzy logic) of the final year of Electronics and Telecommunication Engineering department. Total 53 students have participated in the case study. Students test was conducted at the beginning of the course, in the middle of the course and after role-play as well as round quiz activity i.e. at the end of the course. Three prominent variables, namely clarity in fundaments, recommendation for role-play or round quiz and active involvement of students were selected for statistical analysis. The students' three tests were used for ANOVA analysis, Correlation analysis and ROC analysis for energetic activity. Students were circulated with questionnaire to get feedback about the activity. The data collected from questionnaire was used for feedback analysis.

One way repeated measures ANOVA was used for testing because it is helpful for one group i.e. final year B. Tech. of ETC department. The ANOVA testing helps to analyze the energy of students in role-play activity and round quiz. Correlation analysis is applied to test the impact of variables. Correlation also shows the relation of variable with each other i.e. positive or negative relation. ROC (Receiver operating characteristics) curve used to test the decision of faculty objective with positive and negative energetic activity. The impact of the results and outcome are discussed.

5. Role-Play:

Role-Play is a speaking and acting activity. Students dip their toes in functional languages for multiple scenarios through role-play. Students explore realistic situations.

5.1. **Role-Play activity**:

Any role-play activity has seven steps. The Role-play steps are as follows:

i. Step1: Group the students
ii. Step2: Start the process, encourage open discussion
iii. Step 3: Introduce the problem
iv. Step 4: Details added
v. Step 5: Assign Roles
vi. Step 6: Act out the functional scenario
vii. Step 7: Discussing what students have learned.

5.2 Types of role-play activities:

Mainly four types of role-play activities practiced.

The types of role-play described below:

i. Functional Role-play: Used for functional language or to increase the proficiency of any language. This role-play used for describing the functions of block diagram. This is good for block diagram presentation.
ii. Interview Role-play: This activity practiced in the business world. In this role-play, students play-act out scenario of interview. In this, students can ask different questions for a course, which are not found in books.
iii. Real world visualization of imaginary scenarios: Present the real world scenario for imaginary concepts. This helps all students to think in a particular situation for imaginary scenarios.
iv. Role-play Game: Different technical games will be played to clear the concepts. This is useful for mathematics, e.g. fuzzy mathematics. Fantastic games can be formed for a suitable course.

Role-play is an educational tool useful for engineering education. Role-play have fun learning. Role-play does not have disadvantages if a teacher follows the course boundaries and try to fit in a course or topic goals. From this teacher will also learn many things.

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5.3 Picture of Role-Play:
Picture of Role-play shown in fig.1. Role-play help every student to take part actively. In role–play, students become energetic.

Fig. 1.0 Role-play of Lambda cut in fuzzy logic

5. 4 Advantages of Role-play:

- Students think out of the box
- Breaks the barriers of classroom
- Builds confidence, creativity and good language communication
- Students take part in decision making, work as a leader or team member
- Apply the course contents in a relevant real world context.

6. **Round Quiz:**
Round quiz is useful for summative assessment. This is the interactive quiz. In the round, quiz students sit in the round immediately. The late sitter will take the first question. Round quiz played as we play in school level the game is "Mother's Letter Lost". The rules of the round quiz are followers:

1. Step 1: Form the round in one minute
2. Step 2: The late sitter will ask the first question
3. Step 3: More than a hundred questions should be asked and given to the students or no. of students multiplies by four/three.
4. Step 4: No repetition of questions and to be limited in the course contents.
5. Step 5: Asking the question in 10 seconds
6. Step 6: Answers should be given within 10 seconds.
7. Step 7: The next student will ask the question and students must answer that question. If the answer is wrong, the question is forwarded, and the teacher will take a decision.
8. Every student must take part in the quiz.
9. No time wastage but fun in learning.
10. Conduct in the last lecture of day or last lecture of topic/course.

Round Quiz helps to clear the fundamentals of fuzzy mathematics. This quiz will help to clear all doubts in the teaching-learning process.

6.1 Image of Round-Quiz:
Image of Round Quiz shown in fig.2. This quiz helps every student to take part. The first and frequent quiz will be asked by standing student and question given by faculty.

Fig.2.0 Round quiz in classroom in one minute

7. Data Collection:
Data is collected by the primary Questionnaire method. The Questionnaire is designed to analyze the role-play and round quiz. The questions are given below:

Table1: Questionnaire for students

Questions	Strongly Agree (5)	Moderately Agree(4)	Agree (3)	Neutral (2)	Disagree (1)
Could you get the clarity in fundamentals?	[ ]	[ ]	[ ]	[ ]	[ ]
Would you recommend the Role-play to a friend or colleague?	[ ]	[ ]	[ ]	[ ]	[ ]
Would you recommend the Round quiz to a friend or colleague?	[ ]	[ ]	[ ]	[ ]	[ ]
Were you actively involved in activities?	[ ]	[ ]	[ ]	[ ]	[ ]
Did you enjoyed the activities?	[ ]	[ ]	[ ]	[ ]	[ ]

8. Stastical Analysis:
The role-play and round quiz are analyzed stastically using stastical tools, ANOVA testing, Correlation testing and ROC testing.

8.1 ANOVA Testing:
ANOVA testing used is one way repeated measures ANOVA. Same test is assed for final year B. Tech. class at beginning of the course, middle of the course, after role-play and round quiz activity i.e. at the end of the course. This analysis provides to find the students energy changed from beginning of the course to the end of the course. For testing the ANOVA the SPSS software is used.
Table2: ANOVA testing for Role Play

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Test Result Variable(s)		Sum of Squares	df	Mean Square	F	Sig.
Clarity in fundamentals	Between Groups	.353	2	.176	.722	.491
	Within Groups	12.462	51	.244		
	Total	12.815	53			
Recommend Role-play	Between Groups	.364	2	.182	2.606	.084
	Within Groups	3.562	51	.070		
	Total	3.926	53			
Involved actively in role-play	Between Groups	.497	2	.249	2.336	.107
	Within Groups	5.429	51	.106		
	Total	5.926	53			

The significance value of ANOVA is greater than 0.05, therefore there is no significant difference in variables. The table shows that the role-play is suitable between groups, within groups and proved statistically i.e. role-play is suitable for engineering study.

Table3: ANOVA testing for Round Quiz:

Test Result Variable(s)		Sum of Squares	df	Mean Square	F	Sig.
Clarity in fundamentals	Between Groups	.059	2	.029	.149	.862
	Within Groups	10.034	51	.197		
	Total	10.093	53			
Recommend Role-play	Between Groups	.003	2	.001	.072	.931
	Within Groups	.979	51	.019		
	Total	.981	53			
Involved actively in round quiz	Between Groups	.177	2	.088	.356	.702
	Within Groups	12.638	51	.248		
	Total	12.815	53			

The significance value of ANOVA is greater than 0.05, therefore there is no significant difference in variables of round quiz. The table shows that the round quiz is suitable between groups, within groups and suitable for study, proved statistically.

8.2 Correlation Testing:

The correlation tool generally used to describe the degree to which one variable is related to another. It finds the relationships among variables. The correlation analysis describes the comparative changes occurred in role-play and round quiz test variables and their cause effect relationship examined using SPSS software.

Table 4.0: Correlations for Role Play

Test Result Variable(s)		Clarity in fundamentals	Recommend role play	Involved Actively in role-play and round quiz
Clears Basic fundamentals	Pearson Correlation	1	.099	-.034
	Sig. (2-tailed)		.475	.807
	N	54	54	54
Promotes role_play	Pearson Correlation	.099	1	.192
	Sig. (2-tailed)	.475		.164
	N	54	54	54
Actively Participated	Pearson Correlation	-.034	.192	1
	Sig. (2-tailed)	.807	.164	
	N	54	54	54

Table 4.0 indicates positive correlation with for clears basic_ fundamentals with clears fundamentals and promotes role-play. Positive correlation with fundamentals, promotes role-play and active participation. Negative correlation with active participation promotes role-play fundamentals because few students are directed by teacher to take part in role-play. Table indicates positive correlation. Here the majority is positive correlation that if one variable increases, the other also increases. The table shows the variable itself had positive correlation. The total table specifies the role-play is significant proved statistically. From the above tables it is proved that the students become energetic after role-play and round quiz.

Table 5.0: Correlations for Round Quiz

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Test Result Variable(s)		Clears_basic_fundamentals	Energetic	Promotes_role_play	Actively_Participated
Clarity in fundamentals	Pearson Correlation	1	.074	-.041	-.355**
	Sig. (2-tailed)		.597	.767	.008
	N	54	54	54	54
Energetic	Pearson Correlation	.074	1	-.021	-.047
	Sig. (2-tailed)	.597		.878	.733
	N	54	54	54	54
Recommend Role-play	Pearson Correlation	-.041	-.021	1	-.042
	Sig. (2-tailed)	.767	.878		.764
	N	54	54	54	54
Actively_Participated	Pearson Correlation	-.355**	-.047	-.042	1
	Sig. (2-tailed)	.008	.733	.764	
	N	54	54	54	54

In the table 5.0 the variables energetic have 1 Pearson correlation value, that means the variable energetic, itself proves that it is stastically significant. In table 5.0 the Pearson value for the variable-clarity in fundamental and energetic have a positive correlation with each other. The value for this correlation is 0.074 that means if we increase; the variable-clarity in fundamental then the variable-energetic value also increases. The variable-clarity in fundamentals with variable-actively participated is negative i.e. -0.355. This means that if we increase the variable-clarity in fundaments will decrease the variable-active involvement of students. The table 5.0 defines that there is positive correlation with energetic activity and hence the round quiz activity is significant proved statistically.

8.3ROC for Role Play and Round Quiz:

ROC curves used first time to test the linking with positive and negative energetic objective. The ROC curve is used for testing the decision. The curve intersects with factors involved or not? If the curve intersects, the meaning is that the all factors are linked with each other. With this curve, it is tested that the factors are positively linked or negatively linked. This is very useful tool used in machine learning to take decision. This tool is used for testing whether the energetic activity affects positively or negatively for learning of students and their involvement in these activities.

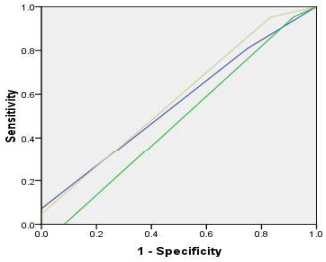

Fig.3.0 : ROC for Role Play

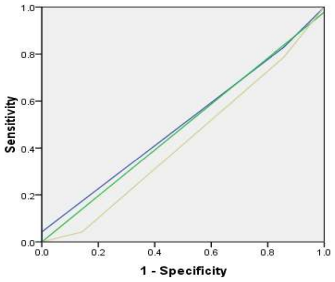

Fig.4: ROC for Round Quiz

In fig. 3 and fig.4, the true positive rate with the variable energetic is sensitivity. The middle line will give the energetic variable with proper cut off. The specificity means difference between the variable-clears fundamental with the variable-energetic. The result of positive test is defined as sensitivity/1-specificity, and the negative result value is defined as 1-sensitivity /specificity. The confidence level for this used is 95%. The case processing summary for Role-play is positive energetic is 42 and negative energetic is 12. The case processing summary for Round Quiz is positive energetic is 47 and negative energetic is 7. Larger values of the test result variable(s) indicate stronger evidence for a positive actual state. The positive actual state is 2.00. The test result variable(s): Clears fundamentals, Recommend role-play; Active Involvement has at least one intersection between the positive actual state group and the negative actual state group. The variables intersect with a point positively as well as negatively. The fig. 3 and 4 shows, that the sensitivity and specificity are balanced with energetic variable. Therefore, role-play and round quiz has been proved statistically **energetic.**

9. Results and discussion:

The analysis of energetic teaching activities role-play and round quiz have adopted the learning cycle of teaching activity.

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The learning cycle of teaching activity is accepted based on four questions,

First question: Why-Need of activity, contextualize, Newness

Second question: What- Conceptualize, justify

Third question: How- Implement, Test

Fourth question: What Next- Analyze, Review

The analysis of the activities done using rubrics.

Table2: Rubrics for Role–play Evaluation.

Factors	Student Performance Indicators			
Knowledge	Poor	Fair	Good	Excellent
Speaking Skill	Poor	Fair	Good	Excellent
Presentation Skill	Poor	Fair	Good	Excellent
Quality of Scenario	Poor	Fair	Good	Excellent
Quality of Contents	Poor	Fair	Good	Excellent

Table3: Rubrics for Round-Quiz Evaluation.

Factors	Student Performance Indicators			
	1	2	3	4
Involvement	Poor	Fair	Good	Excellent
Respond Questions	Poor	Fair	Good	Excellent
Correct Answer	Poor	Fair	Good	Excellent
Quality of Answer	Poor	Fair	Good	Excellent

In classroom, the course teacher completed the evaluation of activity. From this activity teacher can identify the low performer students and students' participation in activity. In the final year class, the four students are identified and separate guidance is provided to these students.

The round quiz feedback analysis of students represented in fig. 5.0

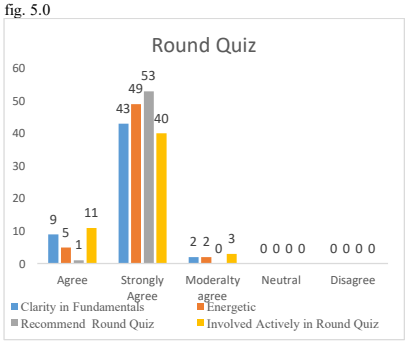

Fig.5.0: Feedback analysis of Round Quiz

The Role-play feedback analysis of students represented in fig. 6.

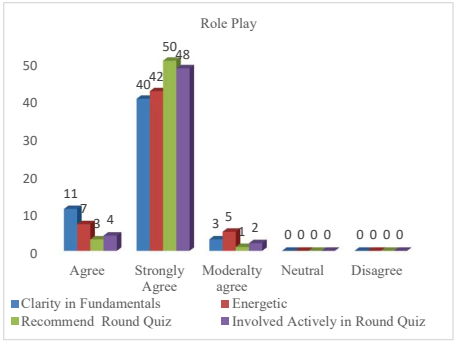

Fig. 6.0: Role-Play feedback analysis

Students' feedback is collected. 53 Students' have given the feedback. The analysis of these feedback is that the students become energetic when they are involved in the role-play and round quiz. They get the clarity in fundamentals, they also became creative. The ANOVA analysis, Correlation Analysis and ROC curve stastically verified that role-play and round quiz are energetic activities moving towards positive direction.

10.**Outcomes:**

The outcome of the students' activity is that 63 students developed the application on real life problems with the concept of fuzzy logic, few applications are listed below.

- Fuzzy Rule based diagnostic system for inspecting the effect of video games on the eyes.
- Analysis of water quality in fishery using a fuzzy logic controller
- Milk Quality analysis using the fuzzy Logic system
- Hotel rating using the Fuzzy interface system
- Fuzzy inference system for sugarcane yield prediction, etc.

All applications of students were uploaded on Moodle activities. The link of Moodle activity is: http://210.212.171.173/moodle/mod/assign/view.php?id=53310&action=grading

The outcome of these activities are students gained skills to apply fuzzy tools in real time problems and enjoyed learning concept.

11. Conclusion:

Role-play and round quiz are energetic teaching activities proved through feedback of students and statistical analysis. Fuzzy mathematics fundamentals were clear to students by implementing role-play activity. Round Quiz, activity helps students to answer all the short questions. The case study

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supports the faculties to engage students with full energy. Role-play and round quiz teaching activities can use for any course. These activities help the classroom with full of learning enjoyment.

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Teacher's perception towards their role in Course Level Project-Based Learning environment

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Abstract: This research article focuses on survey of teachers of Vishwaniketan Institute of Management, Entrepreneurship and Engineering Technology (ViMEET), affiliated to Mumbai University, India who are implementing Course Level Project-Based Learning (CLPBL). ViMEET has to follow the curriculum given by Mumbai University, India. To make students industry ready with more practical knowledge, management of ViMEET introduces CLPBL in every semester for specific subjects along with the curriculum defined by Mumbai University, India. As there is no scope of CLPBL in Mumbai University curriculum therefore teachers of ViMEET have to deliver different roles while curriculum delivery along with CLPBL implementation. Therefore, this survey was carried out to understand teacher's role clearly while implementing CLPBL to make CLPBL successful. In the present survey, quantitative research design method was used to understand teacher's role in CLPBL. The survey was conducted to find out what teachers know about their role while implementing CLPBL and how they are implementing PBL at course level in Vishwaniketan iMEET, India. A total of 16 teachers of Vishwaniketan iMEET, India have implemented CLPBL in the even semester of academic year 2018-19 and participated in question based survey. Quantitative data were collected by sending emails to the teachers. About 54% participants agreed that CLPBL supervisor should have leadership skill. 45% participants believes that CLPBL implementer should have passion to do mentorship, whereas 50% participants felt that CLPBL implementer should use different approach to deal with students of different skill set. 48% of participants believes that the purpose of CLPBL was to make students compulsory to do any project. Frequency analysis of participant responses shows that teachers are not aware about their roles in CLPBL. Almost half of the participants in present study stated that the main motive of CLPBL was to make students compulsory to do any project, which does not match with the definition of PBL. Also, respondents agreed that more training is required to teachers to understand their roles clearly while implementing CLPBL.

Keywords: Project-based Learning (PBL), Course Level Project-based Learning (CLPBL), Leadership, Technical Skill.

1. Introduction

Since many years, teaching methodology of engineering courses is same. The lecture-based approach is adopted to control the learning practices (Akao, 2012). Now-a-days, engineering students should have questioning and critical thinking skills to solve complex practical problems (Alves et al., 2016). Also, engineering students should have good communication skill as well as ability to work in team (Bacarin et al., 2014). In recent years, industry requirements from engineering graduates have been changed. Industry requires graduate engineers with practical knowledge. Therefore, it is need of time to improve teaching-learning process. Teaching-learning process can become more effective by implementing CLPBL in curriculum (Baytiyeh and Naja 2016).

Research and new trends in engineering education clearly emphasize the importance of practical application of theory, creativity and innovation as key skills required for problem solving (Carpenter et al., 2016). The world has changed rapidly in the last decade and major changes such as globalization, technological advances, inter-connectedness, and accessibility to information influence the way current and future generations of students learn. Educators are finding it challenging to fit in new material into a full curriculum in a timely manner (Chau, 2015). For a long time the focus in engineering education was mainly on disciplinary knowledge only, but recently there has been a significant shift in focus to include more design thinking and professional practice elements, as highlighted by professional industry bodies (Chau, 2014). Interaction with industry professionals indicates that they require engineering graduates to be able to think critically, analyse problems, create innovative solutions and communicate effectively (Chau et al., 2014). Therefore, it has been found that there is a need of PBL in engineering courses.

PBL is a technique which motivates students to study the concepts in detail which may or may not be given in curriculum. PBL needs considerable understanding of technical subjects, team work and determination on the part of the students and CLPBL implementer (Cooper, 2013). Implementer of CLPBL plays an important role in guiding students from idea generation to project completion.

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It has been found that in PBL teacher's role changes from instructor to project guide. Instructor transmits information and organizes activities for practice. To understand the learner's interest is the need of PBL. The teacher should act as a good listener when the learner is eager during solving the issue and start asking the questions. PBL implementer requires to enable the skill in the group of learners for moving in single direction by choosing own ideas of solutions without any hesitation. (Daun et al., 2016). The teachers should have some liberality for obscurity. This research article gives an overview about the different PBL models used in Vishwaniketan Campus and expected role of teachers in all PBL models.

1.1 PBL Models in Vishwaniketan Campus

Over and above the 'University of Mumbai' curriculum; Vishwaniketan employs Project-Based Learning approach to transform students into design engineers, industry-ready professionals and entrepreneurs for successful career. Vishwaniketan uses four different PBL models i.e. VA-PBL, CLPBL, i-PBL, UG Fellowship in their campus (refer fig. 1). The major outcomes of this PBL models being start-ups, scholarship for MS program and international mentorship for the students.

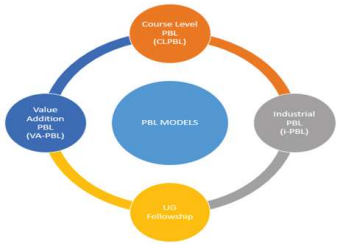

Fig. 1: PBL Models in Vishwaniketan Campus

1.1.1 Course Level PBL (CLPBL)

Course Level PBL (CLPBL) models are implemented at the course level and focuses on student's deeper content learning and skill development. Every semester, each department practices CLPBL.

1.1.2 Value Addition PBL (VA-PBL)

Value Addition Project Based Learning (VA-PBL) starts in the second semester, and focuses on students technical skill development in which students are trained by the industry on the future technologies of his/her choice. Every semester students work on one project till sixth semester. This way he learns five technologies and completes five projects.

1.1.3 Industrial PBL (i-PBL)

Industrial Problem Based Learning (i-PBL), is aligned to design new products as per the customer requirements and technology useful for industry. In this model, students work on industrial problems. Vishwaniketan have four industrial labs sponsored by the industries in automobile, wireless robotics, automation and product design. Aim is to get acquainted with industrial, tools, techniques and practices. Goal is to produce future products.

1.1.4 Undergraduate (UG) Fellowship

Vishwaniketan firmly believe that education has no boundaries. The best possible global exposure and learning through Vishwaniketan's UG-Fellowship programme, helps students to transform themselves into ideal global professionals. Project Based International Research Summer Internship gives students international exposure. Vishwaniketan have networked with CTIF and 16 international universities, which offer fellowships in which students work with university professors on research projects. Typically, students spend six weeks in that university and takes university support to complete the project.

1.2 PBL Teacher's Qualities and Skills

By changing traditional "teacher and students" model, PBL can be made effective and successful. In PBL environment teachers have to possess different skills and roles. Teachers must:

a. Be able to provide encouragement, empathy and motivation.
b. Enable and accelerate brain storming, development and involvement through group activities.
c. Generate classroom activities based on understanding of students.
d. Should be innovative for performing experiments and flexible to be available after working hours in case of need.

PBL should include advancement is in traditional teaching pattern and adaptable for opting learner's choices and views. Currently system encourages compliance and demonstration-based learning and bell schedules. In a PBL scenario the instructor's orthodox role changes and it may need some time to change. The instructor should act as a guide or coach in the classroom (Du et al., 2013). The instructor should not assume skilled problem solving attitude from the students. To learn rational issue solving technique is the main aim of PBL, students might need guidance and assistance during this process (Dym et al., 2015). To create and solve questionnaire along with the students, the instructor can put a good teaching model in front of the students. The teacher may change his/her involvement as per improvement of the students in problem solving. However, the teacher should be able to distinguish between guidance and extra engagement (Edström and Kolmos, 2014). The teacher should use multidirectional techniques of finding the solution for a problem to enhance the good thinking skill of the students. Also, if the teacher always give complete solution for the problem then students will not take ownership for finding out the solution (Fernandes et al., 2012). The teacher should develop the skill of observing the things and ask questions for it in various manner.

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1.3 Factors Affecting PBL Implementation

1.3.1 Factor 1: Organizational

In order to implement PBL successfully the engineering institute's internal dynamics should be flexible and agile. Otherwise, implementation of PBL is almost impossible or risky.

1.3.2 Factor 2: Quality of Teachers

Engineering institutes are facing problems because existing faculties are not accepting PBL willingly. Faculties feel insecure about their jobs and responsibilities. This barrier could be outshined if the management educates their faculties for PBL. It has been found that PBL requires students to work in a group therefore number of teachers working in an institute also matters. Otherwise, teachers need to guide multiple projects. From fig. 2 it has been found that successful implementation of PBL in engineering education depends upon two factors i.e. organizational and man power. Therefore, this research article is devoted to understand the different roles of teachers in PBL.

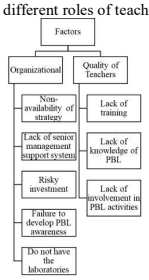

Fig.2: Factors Affecting PBL Implementation (Source: Authors own research)

2. Methodology and Methods

Fig. 3 shows the research methodology flow diagram for research work. The literature review is completed by searching some keywords along with their combinations such as – Challenges and difficulties in PBL; Project Based Learning in Engineering; Course Level Project Based Learning in Engineering; Role of Supervisor in PBL; PBL Implementation; Role of Supervisor in PBL and Challenges. For searching these Scopus, keywords and Google Scholar were explored.

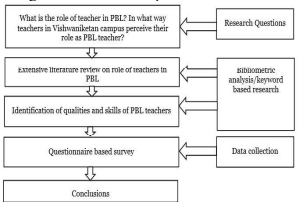

Fig. 3: Research Methodology Flow Diagram

The articles related to these keywords were examined. In addition to this, collected articles are evaluated using some criteria, given as - (i) the articles written in English only were considered; (ii) the articles belong to peer-reviewed publications and published reports were only considered; (iii) the articles published in between year 2012 to 2019. In this way, the literature review was performed in this research.

From literature survey it has been found that teachers should possess various qualities (such as leadership skill, time management skill, creative thinking skill, and must be passionate to do mentorship) while implementing PBL. Also, teachers must use different approach to deal with students of different skill set and must have capability to experiment with different ideas. Fig. 4 shows different roles of teachers in PBL.

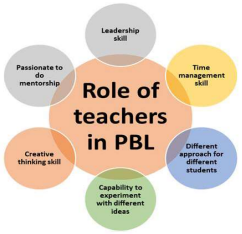

Fig. 4: Role of Teachers in PBL

2.1 Questionnaire based Survey

Questionnaire based survey among Vishwaniketan's iMEET (ViMEET) faculties are carried out to understand their experiences during PBL implementation. The questionnaire was sent to 16 faculties of ViMEET by an e-mail and received response of all participants i.e. response rate was 100%. In this research article, questionnaires were prepared for CLPBL model with the aim to understand faculty's perception towards their role in CLPBL. Assessment of questionnaire were carried out on 5 point scale. Questions are as follows:

a. CLPBL implementer should have "leadership" skill. (code: Q1)
b. CLPBL implementer should be "passionate" to do mentorship. (code: Q2)
c. CLPBL implementer should "use different approach to deal with students of different skill set"? (code: Q3)
d. CLPBL implementer make students compulsory "to do any project"? (code: Q4)
e. CLPBL implementer should have "time management" skill? (code: Q5)
f. CLPBL implementer should be "free to experiment"? (code: Q6)
g. CLPBL implementer should "provide empathy and inspiration to students"? (code: Q7)
h. CLPBL implementer should have "creative thinking" skill? (code: Q8)

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3. Results and Discussions

From fig. 5, it has been found that about 54% participants agreed that CLPBL supervisor should have leadership skill. 45% participants believes that CLPBL implementer should have passion to do mentorship, whereas 50% participants felt that CLPBL implementer should use different approach to deal with students of different skill set. 48% of participants believes that CLPBL implementer should make students compulsory to do any project. 75% participants agreed that CLPBL implementer should have time management skill. 87.5% participants believes that CLPBL implementer should be free to do experimentation with innovative ideas, whereas 56.25% participants felt that CLPBL implementer should provide empathy and inspiration to students. 50% participants agreed that CLPBL implementer should have creative thinking skill.

It is observed that teachers are not aware of their roles while implementing PBL. If teachers are not aware of their role then effective and useful outcome of PBL cannot be achieved. To implement PBL effectively faculties must attend PBL trainings. PBL training is conducted in three different levels. Level one of PBL training deals with why PBL is important? How teachers can implement PBL? Level two deals with teacher's role in PBL and research in PBL. Level three deals with the outcome of PBL.

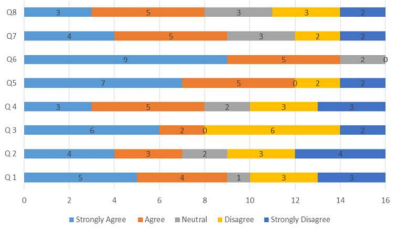

Fig. 5: Questionnaire based survey results

4. Conclusions

It is concluded that PBL teachers must have higher level skills such as leadership skills, ability to think differently, time management skills, and passion towards attaining goal.

From the survey it is observed that majority teachers are unaware about their roles in CLPBL. Almost 50% participants in the present study indicated that the main purpose of CLPBL was to make students compulsory to do any project, which is contradicting with the definition of PBL. It is concluded that more training is required to teachers to understand their roles clearly while implementing CLPBL. In future work this research work can be extended to evaluate sustainability of PBL models.

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Development of ecosystem and learning spaces in effective implementation of PBL in Vishwaniketan Campus

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Abstract: Vishwaniketan iMEET is an engineering institute where Project Based Learning philosophy has been accepted and different PBL models are designed for various learning objectives. Institute has developed its unique framework for supporting PBL practice, which is named as PBL Ecosystem. This paper shortly describes each PBL practice followed at the institute with more emphasis on describing the "Frame work of a PBL Eco-System" developed for effective implementation of the Project Based Learning approach. This Eco-system is in place since the last one year and an institute's management was interested to know the effectiveness of this PBL-Eco system to influence student's learning. Thus, this paper also discuss in brief outcome of survey conducted to check effectiveness of Eco-system for one of the important PBL practice Value Addition PBL (VAPBL). Faculty experience and student's survey outcomes suggested that for effective implementation of the VAPBL, PBL-ecosystem has played crucial role. Result suggested that continuous support and collaboration with industry trainers helped to students for successful implementation of technology for which ecosystem supports. The survey also suggested that there is a need of improvement in lab infrastructure and faculty supervision..

Keywords: Project Base Learning (PBL), Eco-system, Value Addition Project Based Learning (VAPBL), Industry Project Based Learning (IPBL), International Project-Based Research Internship (IPBRI)

1. Introduction

Engineering education is a field of learning through hands in training and implementation of gained knowledge in actual practice. Professional courses run in engineering education, require technical skill competence as well as to pursue human values. To enhance technical skills and to nurture the values of social responsibilities, new approach in learning and teaching is very essential. To satisfy the complex demands of industry and society which are interlinked, education system need to be transformed. As a result there has been growing demand in recent years to introduce Project Based Learning.

The PBL originally started in the field of medical education and was originally introduced in the medical school at Mcmaster University in Canada in the late 1960s [1]. It is now essential and common curriculum component in medical and health science schools around the world consistently. Very similar to medical as a professional course, engineering is also refereed to be a professional course. Due to technological advancements and certain weak political decisions in terms of policies, engineering graduates always deals with uncertainty in Indian scenario. Professional skills demanded in industry and actual engineering graduates coming out from different institutes find very difficult to cope up with the situation. Despite these challenges, engineering education system in India remains same as that practiced in 1950's as "Chalk and Talk" with large classes and single discipline, lecture based delivery the norm particularly in early graduation years of study[2].

The PBL is a learning process towards the understanding the solution of a problem and the problem is the first encounter in the process [3]. PBL is an educational approach whereby the problem is the starting point of the learning process. It is crucial that the problem serves as the basis for the learning process. Hence Problem Based Learning has been reported by several authors although it is not fully implemented in all courses. Don Woods in chemical engineering program at McMaster University, adopted Problem Based Learning approach for certain applications[4][5]. At Monash University, Australia, Problem Based Learning has been introduced to several courses of Civil engineering through initiative of Roger Handcraft [6]. But engineering profession and academics are more familiar with the concepts of Projects in their practice than concepts of Problem Based Learning. It therefore seems that Project Based Learning (PBL) is likely to be more suitable in engineering education [7]. Annette Kolmos a faculty member at Aalborg university argues that the "idea of problem based learning and project work support each other and emphasize different aspect of learning. In the contrast to traditional lecturing method, the Problem Based Learning encourages the students search for information literacy skills and thereby increase the use of library [8].

Although, PBL has been widely accepted approach and different PBL practices have been followed; we believe that there is a need to put together a complete system which can sustain its implementation. Thus, an objective of this paper is to discuss on the "framework of PBL ecosystem" developed for effective implementation of PBL for engineering students in Vishwaniketan, India. This Ecosystem is in place since the last one year and an institute's management was interested to know the effectiveness of this PBL-Eco system to influence student's learning. Thus, this paper also discuss in brief outcome of survey conducted to check effectiveness of Eco-system for one of the important PBL practice Value Addition PBL (VAPBL).This paper is organised as follows. Section II discuss about the theoretical Framework of PBL ecosystem.

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In Section III actual methodology that required to support the framework is described. Section IV contain the results and discussion.

2. Theoretical Framework:

2.1 Different PBL Approaches:

Vishwaniketan institute has organised many PBL workshops in the recent past. So, faculty has been trained on PBL principles, philosophy and practice. Through this workshops and deliberation, its faculty has developed different PBL models. All PBL models uses following PBL principles (Kolmos et al 2004); Cognitive principle which state that problem is driver for the learning process and students are expected to solve it during entire semester. Content principle depicts exemplary practice adapted to achieve learning objectives and puts problem in the contextualised setting. Social principle puts an emphasis on learning in team setting where cooperative and collaborative learning is principles used for learning. These principles are effectively used to develop four models listed below.

A. Value Addition PBL (VAPBL):

In VAPBL model a training is given a students to a 6070 hours on a future technology which is not included in curriculum and the trainer is a person from an industry. After training students are divided into groups and topic for a project is given throughout the semester. After completion of that project is exhibited by the industry person.

B. Course level PBL (CLPBL):

This model is implemented in our institute in the Second Year and the Third Year students. Every semester one subject and a staff members were involved in PBL practice. Faculty allocate projects to the students project topics were selected in such a way that course content also learned with real life problems solutions which is need of engineering education.

C. Industrial PBL (IPBL):

Depending upon the student's interest some of the groups are allotted the real industrial problems and this model provides industrial problem solving experience to students.

D. International Project-Based Research Internship (IPBRI):

Every year the students are send to the foreign universities which has been collaborated with our institute. Due to which the students gets an opportunity to explore the foreign universities courses and also gets to learn innovative things. The aim of this model is to help students to get exposure in international universities. We believe only modal design will not make PBL effective so, we need to develop PBL eco-system. Different components of PBL Ecosystem are discussed in following section in detail.

2.2 PBL Eco-system Components:

The different components involved in PBL Eco-system can be represented as given in following figure 1.

Fig. 1: PBL Eco-System Components

In this section, each component of this system discussed in the brief.

1. Management Vision/ Institute Vision:

Our management vision is to employ Project based Learning approach (PBL) and life skill activities to transform students into design Engineers, industry ready professionals and entrepreneurs for a successful career based on strong moral and ethical foundation. Without their support it is rather impossible for any institute to practice PBL. To our experience, we found that institute management including principal and Vice-president are supportive for PBL practice.

2. Quality of Undergraduates:

Student Admitted for engineering courses in the institute are mix of higher percentage to lower percentages. To succeed in PBL environment, considerable time has to be invested to promote and motivate students for PBL activities. This is usually done by PBL core committee which motivates students for doing projects. Regular counselling sessions are conducted to inform incentive of PBL to the students. As a result, PBL practice is been rooted deeply into institute culture.

3. Quality of VAP Training:

As selection of recent technology that helps the students, to narrower the gap between industry and academics selection of VAP Training along with Trainer is very crucial in the PBL. While helping students for the projects he is expected to guide students with several reviews taken during semester. For VAPBL training is arranged from the industry people who have expertise in that technology. Content of training is scheduled as per requirement of updated knowledge in that field. In general, it is understood that quality of the trainers and teachers involvement will have impact on the outcomes of the model.

4. Infrastructure Facilities:

Library: As compared to traditional lecturing method the PBL model encourage the students to search information in research papers, books, e-content, thereby increase the use of library. As per requirement of problem statement they have to search particular information so the library is a very effective resource. So we designed a network in such a way that student can access the library around the globe. Apart from remote access, all reference books, hands books, ebooks, project black diaries are made available in the library for reference.

Laboratory: PBL model demands for well-equipped laboratories to get acquainted with various technological

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advancement in current technologies. In Vishwaniketan every department has well equipped labs to support regular academic activities. Some of students select interdisciplinary projects, for them, other department labs are made available for the use as per their project requirement.

Class-rooms: Systematic arrangement of benches in class room also help students to work in team and improve their professional and ethical skills. In Vishwaniketan arrangement of Class room in steps really help them to develop inter personal skills.

5. Systematic Time Approach:

To build bonding between student and mentor for their project, teacher should have more contact hours with student groups. So, time table is customised by providing two hours in which student and staff will work for the project. Activity hours is also provided for project reviews, group discussion and presentation.

6. Finance:

To fulfil the vision, management always supports to the students in form of sponsoring projects as well as for encouragement of students prizes are given to the winner of the Innovative projects. We believe that prizes at right platform motivate students towards PBL practice. Every year institute keep budget for the projects.

7. Learning Elbows:

Along with the infrastructure facilities another approach of learning elbows is essential component of PBL. It contain PBL Huts and Self Learning Session (SLS) type rooms.

PBL Huts: To support PBL approach PBL huts help students to discuss project related stuffs with open and healthy atmosphere. In Vishwaniketan PBL huts are built in garden areas where students with different streams can discuss on project related issues.

SLS Rooms: Specially designed SLS rooms where students can work together with systematic planning and completed tasks and tasks coming ahead on the walls of room really help them to complete the targets within stipulated time periods.

8. Industrial Exposure:

Some of students select interdisciplinary projects, for them, other department labs are made available for the use as per their project requirement. Along with conventional labs, there are four industrial labs which support the PBL activities in Vishwaniketan.

Table 1 Components of PBL eco-system and their influence on success of PBL

Model	Vision of Institute	Quality of Undergrads	Quality of Training	Infrastructure Facilities	Systematic Time Approach	Finance	Learning Elbows	Industrial Exposure
	1	2	3	4	5	6	7	8
CLPBL	High	Medium	High	Medium	Low	Medium	Low	Low
VAPBL	High	Medium	High	High	Med.	High	Low	Medium
IPBL	High	High	Medium	High	High	Low	Not Required	High
IPBRI	High	High	High	High	High	High	Not Required	High

3. Methodology

The goal of any PBL model to implement successfully is, to develop PBL eco-system framework and proper specific implementation method to adopt. Following flow chart steps give the glimpse of any PBL practice to embrace.

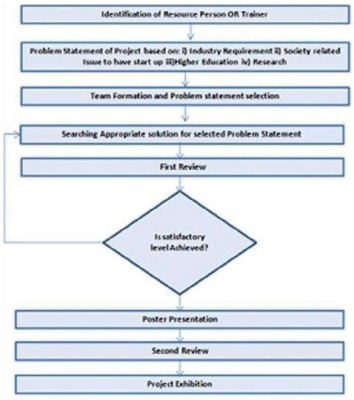

Fig. 2 Flow Chart of adopting PBL Model with Predefined Framework

In Vishwaniketan, implementation of VAPBL follows the above methodology. To support all specified steps suggested in above chart require the all framework components to act together. Identification of technology and to train the undergraduates on selected technology, selection of trainer is very vital. To manage the gap between actual industry requirement and academics along with the vision of management or Institute, value added training plays a very crucial role. Before to start with actual training problem statements refereed to different mindsets of undergraduates, trainer should manifest. Selection of problem statement in terms of mindset of student and his carrier proves to be significant. Any student adopting for engineering education have following primary objectives

i) Good placement after graduation ii) Any innovative idea to resolve issue of society in terms of small start-up iii) Higher education after completing graduation and iv) Enter in research field to have his or her own patent. In initial phase of learning, student should be properly guided hence eco-system should contain this as major component. Financial condition of student to work on industry related problem also matters a lot. Any sponsoring mechanism really inspire student to accept the challenge. Intellectual level of student to work in team and successful completion of project is also critical.

Once the title of project got selected, working in team and to search for the solution of selected problem statement, the infrastructure facilities like library, e-library, research articles, literature required etc is very much necessary. While acquiring the knowledge of newer technology getting failure is obvious but taking continue review and helping them to complete the tasks within specified time frame decides the triumph of PBL. Activities like poster presentation, power point presentation, and participation in technical competitions really help every individual to extend their technical skills, communication skills and moral values.

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While participating in all other activities beyond the class room walls facilities like PBL huts, Self Learning Classrooms really boost the confidence level of every individual.

To work on real time project, traditional laboratories will really face the limitation but industry sponsored laboratories help students to achieve their objective. Project Exhibition participation proves to be added feather to PBL approach since various industry expert with their valuable suggestions may offer them good opportunity based on selected technology.

The student's survey was conducted to check the effectiveness of the ecosystem which has been developed for the students. How the students take the advantage of this and how it supports the PBL activities was the purpose. The pilot survey has been conducted with the students. Questions are prepared by considering VAPBL and all aspects of ecosystem. For pilot purpose, 30 students from Mechanical Engineering branch, 36 students from Electrical branch, 40 students from Civil Engineering branch and 17 students from Electronics and
Telecommunication branch, who have done
VAPBL are selected. The questions are framed and divided into two parts 1) resources related questions 2) Infrastructures facilities related questions.
The questions were designed to access commonly known as attributes for resources person and learning facilities available and the rating are given by students on the scale of 'a' to 'd' where 'a' is strongly agree and d is disagree.

4. Results And Discussion

As stated above, review of students from different streams of engineering in Vishwaniketan is taken. Graphical representation of Electrical Engineering branch shown in figure 3, Civil Engineering branch shown in figure 4, Mechanical Engineering branch shown in figure 5 and Electronics and Telecommunication Engineering branch shown in figure 6 reflects that for to implement Project Based Learning model effectively in engineering education continuous monitoring of different components of PBL Eco-system is essential.

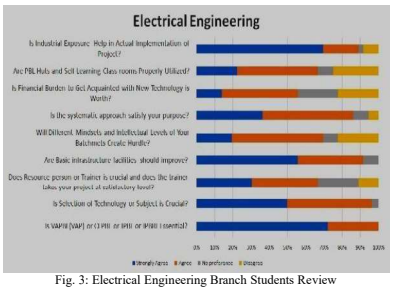

Fig. 3: Electrical Engineering Branch Students Review

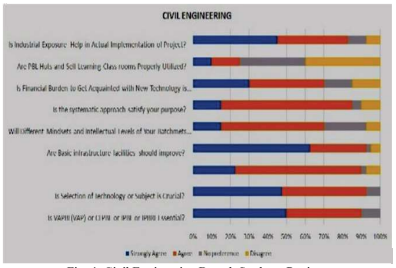

Fig. 4: Civil Engineering Branch Students Review

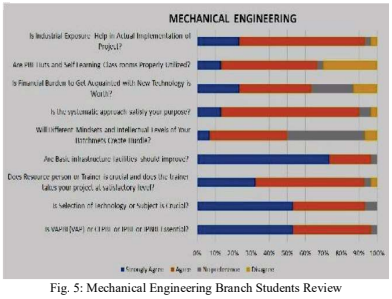

Fig. 5: Mechanical Engineering Branch Students Review

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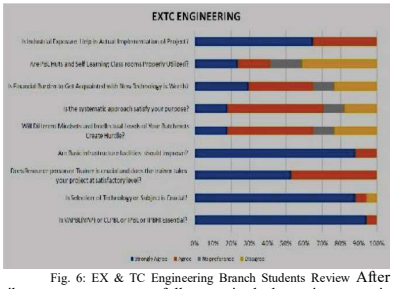

Fig. 6: EX & TC Engineering Branch Students Review After pilot survey was successfully exercised, the main survey is carried out. Total 45 students which are involved in VAPBL projects are given paper questionnaire, 33 students participated in the survey. Response rate is 73.33 percentages. As shown in fig. 7, the percentage of students who strongly agree or agree for the attributes related to the VAP quality, trainer and staff co-ordinator involvement in the project work. Due to PBL model implemented the overall approach of students in projects is improved as compared to last two years.

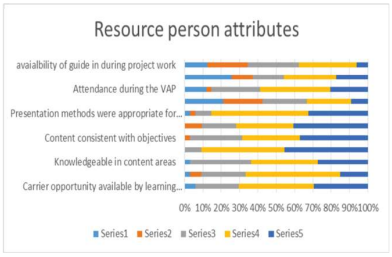

Fig. 7 Role of Resource Person Attributes.

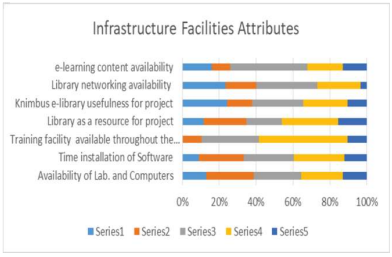

Fig. 8 Role of Infrastructure Facilities

From figure 3, 4, 5, 6, 7 and 8 it is following points are to be noted very precisely

1. Traditional teaching approach of teaching and learning should be transformed to any PBL based model.
2. Selection of current technology and the resource person always decide the success ratio of PBL implementation.
3. Continuous support of resource person while implementing the project is crucial.
4. Infrastructure facilities to implement PBL are must to create interest in teaching and learning.
5. Intellectual levels of team mates while working in team find it difficult.
6. Systematic approach in terms of time management found to be mixed opinions due to difficulty level of project.
7. Scope of improvement in other facilities of elbow rooms is always there.
8. Industrial exposure like technical conferences, workshops, technical fairs, project competitions and project exhibitions is a demand from students to execute project smoothly.
9. Selection of current technology and resources person impact on the project quality.
10. Students are strongly agree that after completion of VAPBL training they have good opportunities in career

5. Conclusion

This paper takes a holistic view on complete ecosystem of PBL and its effectiveness to insure framework and effectiveness of eco-system. Institute has developed its unique framework for supporting PBL practices which is names as PBL ecosystem. All the models developed which follows the PBL principles. Only one model which was developed for implementation of PBL that is VAPBL taken into consideration for analysis purpose. A pilot survey has been conducted for all departmental students who had been involved in VAPBL and then main survey was carried out under the two headings as resource person attributes and infrastructure facilities In future other models such as IPBL, CLPBL and IPBRI could be possible for detail study. If you want to imbibe PBL in campus then teachers training on PBL is very essential component with special focus on teachers who are going to implement it. Student involvement and counselling to change towards PBL approach is critical because students are prone to followed traditional practice. Cleary augment PBL infrastructure with financially assistant helps to create conducive environment for promotion of PBL in campus.

6. Acknowledgment

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Course Level PBL: an Excellent Teaching Method for Increasing Skill Levels and Learning Motivation in First Year of Engineering Students

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Abstract: The recent survey done by various agencies on employability of engineering students indicates that an Indian graduate engineers lacks crucial employability skills such as critical thinking, problem solving, team work and communication. Problem and Project based learning can be the best alternative to solve the employability issues of an Indian engineering graduate. In first year of engineering failure percentage, drop out and learning problems are generally high. Success of engineering profession largely depends on the knowledge gained and skills acquired by student during four years of engineering graduate programme. In this paper, to improve skills and learning motivation of students, an attempt is made to implement course level PBL model for one of the important technical course of first year as Basic Mechanical Engineering. The outcomes to be assessed were problem solving ability, team work and communication. Course Basic Mechanical Engineering was designed and developed to learn it in PBL environment. Course PBL assessment and evaluation strategies were communicated with students before starting the course. Implementation was carefully done for entire academic semester of the course and observations were noted. Implementation results were found very promising and satisfactory. Students were found extremely happy in learning PBL environment. They also stated that course level PBL was very much helpful for them to improve critical skills such as problem solving ability, team work, communication and self directed learning.

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Keywords: course level PBL, problem solving, team work, learning motivation, self directed learning.

1. Introduction

Engineers are technically skilled professionals. They are responsible for solving the problems faced by society and nation. Technological development of any nation is duty of engineers and technocrats. Thus, engineers are the backbone of nation building. To perform these duties effectively, engineers requires different sets of skills such as professional, soft and personal skills. To fulfil the requirements of society and nation, large demand of engineering graduates results into establishment of number of engineering institutes in our country. As per the numbers of survey performed by various agencies, the quality and competency of most of the engineering graduates coming from these institutes is questionable. To improve the quality of engineering graduates in India, government and engineering institutes have introduced number of skills enhancement programmes. I think, problem and project based learning could be one of best alternative to solve process skills and quality related problem of Indian engineering graduate student. If we able to implement problem and project based learning in scientific way, then we can improve the quality of engineering education.

2. Problem Statement:

In India, undergraduate engineering program is of four years. First year of engineering is very important for every engineering graduate. Because at first year failure percentage, drop out and learning problems such low learning motivation, change management are generally high. This is because the way by which students prepare for

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10+2 pattern is not suitable to learn various engineering courses. In engineering it is expected that students should apply the knowledge of science to solve the problems. Basically, engineering is applied science wherein we have to apply knowledge of science to create something called product or to solve societal, industrial or engineering problems. Success of engineering profession largely depends on the knowledge gained and skills acquired by student during four years of engineering graduate programme. Therefore, to increase the levels of important process skills such as problem solving, critical thinking, communication, team work, self directed learning and to improve the learning motivation, to make students as active learners we have to think on non-traditional, innovative teaching-learning method. In this research paper problem and course level project based learning method is adopted for one of the engineering course of first year of engineering as Basic Mechanical Engineering to overcome above mentioned learning and motivation problems with students.

3. Objectives of the Research

In order to achieve desirable outcomes of the research, following objectives were formulated;

- To develop PBL curriculum for the course Basic Mechanical Engineering. PBL curriculum includes the details such as problem statement, activities of project with timeline, assessment and evaluation strategies for the desirable outcomes of the project work.
- To improve the important process skills such as problem solving, critical thinking, team work, communication and self directed learning of the students.
- To improve learning motivation in students to make them active learners.

This research work is motivated by requirements of critical process competencies in an Indian graduate engineer to make it employable in all over the world.

4. Methodology:

The research work mentioned in this paper is experimental. To achieve the desirable outcomes, following methodology is adopted.

- Development of course PBL curriculum and assessment-evaluation strategies for achieving desirable outcomes.
- Identification of activities of the work with their timelines.
- Actual implementation of the PBL course in entire academic semester.
- Taking students responses for PBL
- Review of students' responses and attainment of outcomes.

5. Experimentation:

5.1 Introduction to PBL:

PBL can be defined as educational strategies in which the learning of knowledge skills and competence is organized around contextual, well-structured and authentic problems. In such a learning environment, students take responsibility for their own learning and work collaboratively with each other to achieve meaningful solutions of posed problems. In this way, PBL encourages students to learn about aspects of collaboration, problem solving, co-operation and teamwork. This is called as learner centric and participant directed approach in which students own their projects and make decisions to get desired outcome. PBL way of learning is based upon is based on three principles of learning such as cognitive learning, content and social learning. In a typical PBL way of learning, the learning is problem centered and problem acts as motivation of learning. PBL starts with identification of authentic problem for study. Once, problem statement is declared then the students are advised to prepare the teams. Generally team size is 4 to 5 members in each team. Team members undergo brainstorming and discussions to find the number of solutions for the problem. Out of all alternative solutions, team selects one solution as initial feasible solution. During the process of development of solution, the problem solving and critical thinking abilities of the students gets nurtured. Collaborative and cooperative learning motivates the students for self learning and learning in team. Preparation of project reports and presentation helps the students to improve verbal and non-verbal communication skills.

Benefits and features of PBL way of learning are:

- **i.** It helps to nurture critical thinking and problem solving abilities in students.
- **ii.** It helps to improve learning motivation in students.
- **iii.** It improves self learning and team working abilities in students.
- **iv.** It encourages students for entrepreneurship and product development.

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5.2 Details of course selected for PBL:

In this research paper, course level PBL model developed by Dr. Vikas Shinde of Vishwaniketan, Khalapur India is adopted for one of the engineering course of first of Bachelor of Technology as Basic Mechanical Engineering at Kolhapur Institute of Technology's, College of Engineering (Autonomous), Kolhapur, India. This course is common for students of all programs at F Y B Tech. The course Basic Mechanical Engineering deals with understanding of construction, working and applications of various work producing devices, work absorbing devices, energy conversion devices, power plants, energy sources, mechanical power transmission devices and manufacturing processes. In credit system, this course has three credits for theory and one credit for laboratory. The course consists of three one hour lectures and one two hours of practical per week

Table 1: Course credit details

CLPBL Course	Credits	
	Theory	Laboratory
Basic Mechanical Engineering	3	1

5.2 Development of course curriculum in PBL:

Before implementation of CLPBL, the course curriculum was developed in PBL. The details of course level PBL are as follows.

Problem Statement:

Create working model/prototype of your innovative product or idea which can be very much useful to mankind and society by applying knowledge and skills of mechanical engineering.

Problem description:

Most commonly observed mechanical systems in our day to day life and industries are; work producing devices, work absorbing devices, energy sources and power plant, energy conversion devices, actuators, power transmission devices, mechanisms, manufacturing processes and machine tools, robots and automatic systems. By applying knowledge of mechanical engineering, is it possible to create innovative product or develop solution for problems faced by mankind and society in agriculture, industrial, power generation, automotive, renewable energy sources, fuels, kitchen and household appliances or any suitable sector.

Project activities with timeline:

Following schedule shown in table 2 was adopted for carrying out various activities of the CLPBL.

Assessment of project was completed in three steps;

i. Project Synopsis presentation

ii. Project Progress Presentation with Model/prototype

iii. Final evaluation of the PBL Project and Projects competition

All these assessments were supported by rubrics to make assessment more fair and unbiased. Sketch of the proposed model/prototype, project plan, number of references used, individual contribution and presentations were the rubric parameters used to evaluation of synopsis presentation. For project progress presentation percentage completion of work according to project plan, individual contribution and presentation were considered as rubrics parameters.

For assessing final presentation of project, use of eco-friendly materials, project cost, operational accuracy, individual contribution and presentation were considered as evaluation rubric parameters.

Table 2: Project activities with timeline

Sr. No.	Activity	Timelin
1	PBL awareness in class	1st week
2	Discussion of problem for PBL and its evaluation rubrics	2nd week
3	Team formation	3rd week
4	Project Synopsis presentation	5th week
5	Completion of corrections/improvements in	6th week
6	Project Progress Presentation with	10th
7	Completion of correction/improvements in previous evaluation	11th week
8	Final evaluation of the PBL	13th

Students Presentation

PBL projects competition

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5. Experimentation Results and Discussions

Out of total 319 students involved in PBL activities of the course, 279 students submitted their responses to various questions as shown in Table 3 below.

Table 3: Students responses towards achievements of process skills and learning outcomes (Shinde 2014)

Question No.	Question	Students Response (%)		
		Agree	Neutral/no opinion	Disagree
1	My course PBL project helped me to take responsibility for my own learning and motivated me for self learning	85.30	11.11	3.59
2	I learned to become a more independent and self-directed learner	84.58	10.03	5.37
3	My learning through projects was better than classroom learning	94.95	4.65	0.4
4	I feel, project work motivated me to become self learner.	84.94	10.75	4.30
5	I feel project work improved my interest in learning and learning motivation	86.37	12.54	1.07
6	I learned to think deeply	81.36	14.33	3.58
7	I feel, my problem solving ability is improved	80.64	15.05	4.30
8	I feel, my presentation skills are improved due to project work	86.37	13.63	-
9	Working on a projects was a good experience	95.34	4.65	-
10	The project engaged my learning and thinking skills throughout the semester	95.69	4.30	-
11	I feel, due to projects I learned project management principles	96.05	3.94	-
12	Working in a team was a nice experience	91.39	4.30	4.30
13	The team member‘s roles was crucial for project outcome	90.68	9.32	-
14	PBL helped me to improve my ability to work in a team	91.75	6.45	1.79
15	My teammates helped me to complete my part of project and also helped in understanding the technical concepts involved in project.	92.83	6.09	1.07
16	I feel, working models competition helped me to learn number of new technical things.	94.98	5.02	-

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The effectiveness of project in motivating students for self learning was evaluated on the basis of students' responses to question numbers 1, 2, 4 and 5 as shown in Table 3.From these responses is seems that 85.30 % students felt that due to project work their self learning ability and learning motivation get improved which is very closely related to National Board of Accreditation (NBA) programme outcomes PO12: Lifelong learning. This improved learning motivation results into development of interest and enthusiasm of students in learning process.

The effectiveness of project in nurturing problem solving ability of students was evaluated on the basis of students' responses to questions 6 and 7 of Table 3. From these responses, it seems that 81.36 % students agreed that CLPBL work helped students to nurture their problem solving abilities which is very closely related to attainment of NBA programme outcomes PO2 and PO3.

The effectiveness of project work in improving communication and soft skills of students was evaluated on the basis of students' responses to question 8 of Table 3. From these responses it seems that 86.37 % of students realized that due to PBL approach their communication and soft skills improved much which is very closed related to NBA programme outcome PO10 (communication). As per assessment plan of CLPBL activities, each project group has to give three presentations of their project work in entire semester. These presentations helped students to improve their communication and soft skills.

The effectiveness of PBL approach in improving team work of students was evaluated on the basis of students' responses questions 12 to 15 of Table 3.From these responses it seems that 91.66 % students felt that due to PBL approach their team work is improved which is very closely related to NBA programme outcome PO9 (team work). Students learn to work in collaboration and co-operation while working in teams. Students also learn and understand various technical concepts involved in project through their teammates

6. Conclusions

In this research paper, an attempt is made to implement course level PBL model for one of the technical course of first year of engineering. Results of implementation are very much promising. From students' responses to PBL approach as shown in Table 3, it can be concluded that PBL approach helped students to nurture the important process skills such as; problem solving, critical thinking, learning motivation, team work and communication. It was found that students actively participated in all activities of the project work. Students interest in learning and enthusiasm were improved which was very useful to convert them into active learners. Total 319 students participated in PBL projects competition in 71 projects. Evaluators of this competition remarked that out of 71 projects, six projects were ready as a product to launch in market. Course teachers were very much actively participated in all activities of the PBL project. Students and teachers also recommended that PBL approach should also be used for teaching other courses of first year of engineering.

Acknowledgement:

The authors wish to thank Dr. Vikas V. Shinde of Vishwaniketan Khalapur and head of departments of Mechanical Engineering and Basic Sciences and Humanities of KIT's College of Engineering, Kolhapur for supporting us in implementing CLPBL model. We also wish to thank all the students who have participated in various activities of project work and have given their valuable responses.

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Collaboration of UG-PG Learners for Enhancement of Digital Design Verification Aptitude Using PBL Methodology

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Abstract: The courses like system Verilog, VLSI Design Verification & Testing and Digital Signal Processing are considered for this activity. Delivery of these courses is centralized upon development of verification environment to identify and fix the bugs in DUT (Design Under Test). This is achieved by generating test vectors through programming. The proposed work binds three levels of leaners namely UG, PG and course owner by attaining proficiency in verification of digital design. The methodology is implemented in three major phases namely design of modules, preparation of verification plan and development of verification environment and coverage analysis. Project based learning (PBL) is used to implement the proposed methodology. PBL improved student's attainment by 15% as compared to previous year in VLSI Verification course. The average marks attained by both UG-PG is 79%.This also helped students to grab placement opportunities in VLSI verification domain. Also students experienced the industry culture of various teams working on single project.

Keywords: PBL, Verification plan, Attainment, VLSI verification, Collaboration, UG-PG , DSP

1. Introduction

In traditional teaching learning method there is one way communication from teacher to students but, student's teacher communication has become very rare except students show some interest. In traditional method delivery of knowledge to students does not guarantee that all will be received by students. The effective learning happens only when two way communication takes place between students and teacher. To enhance participation of students in learning and gain knowledge, many active learning techniques comes into existence. The PBL is one among various active learning techniques works on the mantra called "Learning by Doing".

Especially in academic, effective learning takes place when discussion happens at same age group or small age difference group as compared to the group of members where age difference is significant among teammates. The PBL provides a platform where same age or less age difference groups comes together to express their views on the topic.

(Intel tech 2012) Described concept of PBL inquiry in learning, benefits of PBL, Transformation of traditional classroom using PBL and various challenges faced by students and teachers in traditional teaching learning method and activity based teaching learning method. Also described challenges in implementation of PBL. (Shaban , 2018)Described PBL implementation and challenges faced by primary school pre service teachers. However, most of these aspects applicable to engineering graduates and teachers also. The challenges related to teachers, students, curriculum, schools, parents are described.(Barbara et al.,2017) In current education research profession these competencies are usually called as "21st century skills", "deeper learning," or "college and career readiness skills." The NRC committee clarified these concepts by defining "21st century learning competencies" as the "transferable knowledge" and "skills" that are produced through deeper learning processes. The aspects of learning for transfer, novices and experts has been detailed. Along with these research details, The PBL implementation describes the way how context contributes, investigate the effectiveness of implementation of various models for professional development of PBL, focus on the use of technology, deliverable, instructional strategies, study the link between

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teacher's beliefs and implementation, develop reliable measures of intra and interpersonal competencies.

PBL effects on math and literacy skills, and also focus on underserved student populations.(Nizwardi et al.,2017)Discussed seven steps of PBL model to improve student's competencies and learning activity, formulation, designing projects to solve real time problems and team work.(Douglas,2000) given detailed steps and 6A's for effective execution of PBL. (Margaret ,2011) This article provides a review of research happened on effective implementation and productive outcome of PBL from 2000-2011 at preschool level. This includes academic improvement in education, learning ability of students and teachers. This paper initially provides information on PBL and their historical context. Next, the reviewer combined various aspects emergent in the literature including attitudes of student and teacher, growth in academic, overall development of students and teachers and finally recent trends in project-based learning with specific student subgroups.(Arwizet K,2018) This paper provides collaborative learning models using PBL. This gives the comparison study of students learning related to energy conversion machine course and thermodynamics using PBL technique and conventional technique.(Joseph S,Book) Provides an idea of better design and implementation of PBL in consideration with many aspects of teaching learning methodologies and student and teacher centric challenges. (Zancul et al.,2017) Demonstrated the product development of undergraduate course based on a project-based learning (PBL) perspective. The PBL has been elaborated as effective teaching learning method in engineering education. Also discussed some fit falls of PBL implementation and shown improvement in students learning in terms of academic, body language and personality development. This paper demonstrated the collaboration of different interdisciplinary teams to provide complete solution.(Mohd Shafie et al.,2005) Defined the implementation of PBL for computer programming course and also discussed problems faced during implementation of PBL. At the end suggested some points for the improvement of PBL. (Hetty and Wendy, 2011) Identified and described various guiding instructions to design and implementation of problem based learning, evaluation & monitoring strategy in the context of pre and in service teaching profession.(Utku Köse 2010)Improved students learning in Web design and programming course with PBL. The web system is designed under PBL activity. The PBL also inculcates diversity of characters in a team from various academic levels to experience the industry culture during academic. This makes students to aware of industry working culture and takes little effort to get adjust to industry environment after their graduation. But the fact that PBL alone cannot serve the purpose unless proper guidance, monitoring and controlling the PBL activity for effective outcomes. There comes the role of teacher for effective planning, implementation and monitoring of PBL activity. In this process teacher has to facilitate students technically and motivate them to reach their goal.

The proposed work explores the new aspects of PBL by collaborating undergraduate and post graduate students to share knowledge and develop industry culture in academic. The PBL technique is applied for undergraduate courses such as System Verilog, Digital Signal Processing and post graduate course VLSI Design, Verification and Testing, Advanced Digital Signal Processing. The respective courses from UG and PG were selected due to close match between course content of these courses. Though there is close match between course contents, the depth of delivery of course is different for UG and PG. This factor motivates to the idea of collaboration of both UG PG students through PBL. Organisation of this paper is as follows: section 2 deals with methodology, Section 3 describes the results and discussion and section 4 gives the conclusion and challenges faced during implementation of PBL.

2. Methodology

There are three levels of learners are associated with proposed methodology. UG, PG and course owner. The main role of course owner is to act like a facilitator for effective implementation of PBL. The conceptual methodology of proposed PBL is shown in figure 1. Since mentioned courses in section 1 have emphasis on verification of designed system rather than formulation and designing of system based on problem statement. Hence more stress is given on verification hence, designed & buggy digital systems are given as problem statement to students groups. These systems are formulated and designed by course owner and some bugs are added deliberately at deep modular level. This requires skilled engineer to identify the bug and fix it before forward the design for fabrication.

The methodology flow of proposed PBL is shown in figure 2. UG and PG students are divided into groups separately. Each heterogeneous group has all levels of learners like slow, medium and fast learners with different band of earlier CPI. This kind of group formation helps slow and medium learner to actively participate in PBL since everyone is representing part of the work individually.

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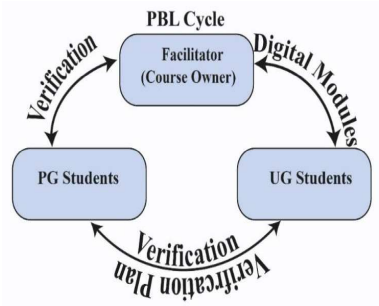

Figure 1: Conceptual methodology of proposed PBL

The main functions included in PBL are as follows

Table 1. Methodology of proposed PBL activity

Sr. No	Particular	Task	Responsible person
1	Problem Statement	Design of Systems Redesign of Systems based on feedback from verification plan team/ validation team Demonstration of systems	Facilitator (Course Owner) Target Audience: UG PG students
2	Preparation of Verification Plan	Understanding of Problem Statement Modularization of system Detailed input output information of each module Identification of test vector for each module and system as a whole Set of test cases to be generated Corner case test vectors Golden Values Presentation	UG Students Target Audience: Associated PG students and facilitator
3	Writing Verification code	Selection of coding style Reusable Test bench Physical generation of various test vectors Test vector to verify functionality of critical block Proper timing signal generation Comparison of results with golden values	PG Students
4	Validation of Design	Code coverage Analysis Function Coverage Analysis Modification in test bench Reapplication and analysis Coverage report	PG Students

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		preparation Discussion with facilitator & UG students Feedback to change verification plan to UG students Repeat the steps 3 & 4	
		Feedback to change design	
5	Tap-out	Manufacturing of chip	Physical design

The table 1 supports to understand the complete methodology flow of proposed PBL. The table 1 consists of functions of each level of learner at each phase in PBL. Table 1 also depicts micro level tasks at each phase along with the team which is going to perform the task. The formulation of problem statement and design is done by course owner and only pseudo information of designed module is given to UG and PG students. Both UG PG students associated to the particular project brought together and discussed on given module. UG students prepared a verification plan. During preparation of verification plan many aspects have been considered and are listed in 2 phase of table 1.The functions of PG students is to write verification test bench based on verification plan and verify the design with all aspects by analysing code coverage and functional coverage. The code coverage is quantitative analysis of execution of each line of code written in DUT & verification model to assure that DUT will function satisfactory in all scenario. If % code coverage not attained, PG students have to modify the test bench. After modification, if code coverage is attained but functional coverage not, then discussed results with UG students and instructed to modify the plan. The functional coverage provides quantitative analysis of verification of all features implemented in DUT. This gives information about the feature which is/are not considered in verification and may have bug in the design. If functional coverage is not attained then the coverage results are discussed with whole team and facilitator to change the design.

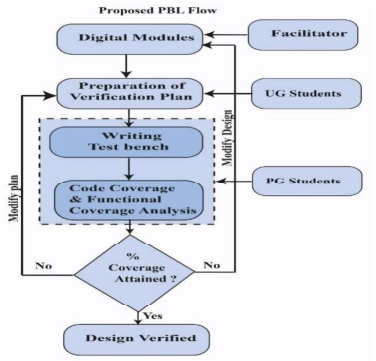

Figure 2: Flow of implementation of PBL

3. Results and discussion

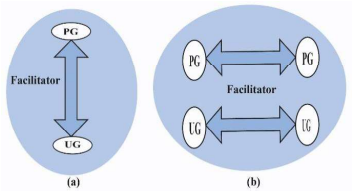

Figure 3: Vertical and horizontal flow of knowledge

Figure 3 shows bilateral/trilateral participation and knowledge flow in this activity. A team of UG –PG has same project and is been divided into two major parts. As mentioned in table 1 verification plan is prepared by UG team and verification function is done by PG team. UG team discuss among themselves and also with facilitator if required and prepare a verification plan. During this process the knowledge shared between members of same team(Horizontal) is shown in figure 3b. Figure 3a shows, once verification plan is prepared, is shared to PG team for verification process as per the plan(Vertical flow of knowledge). PG team write verification code as per the plan provided by UG team in consultation with all members of their team as shown in figure 3b(Horizontal). If 100% verification of DUT is not achieved, then PG team communicates with UG and discuss with facilitator

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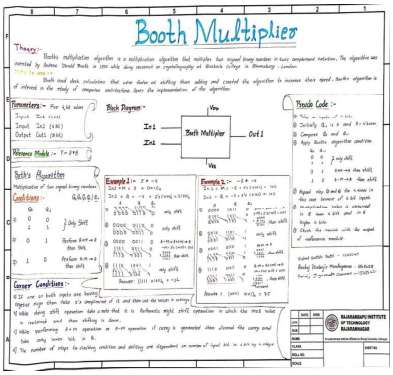
to take necessary action to achieve complete verification of DUT as depicted in figure 3a. The role of facilitator is to assist both teams to complete their task effectively.

The figure 4 shows sample of verification plan prepared by UG groups on Booth Multiplier and First in First out (FIFO) respectively. Figure 5 shows coverage analysis after verification of modules by PG groups. This shows the values generated for verification of design and verification status. If design functions properly the tool generates the status as *success: match,* else gives failure message.

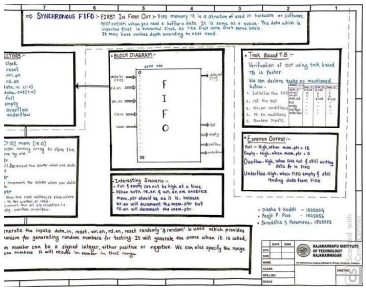
This activity has contributed significantly in students learning and attainment of course outcomes of UG as compared to previous year. Also PG students CO attainment is observed as remarkable.

Figure 6a depicts COs attainment of last two years of UG students . This shows improvement in attainment of COs of the courses. The average marks obtained by UG students in 2017-18 is 74% and in 2018-19 average marks is 79.2%. Figure 6b shows the COs attainment of PG students of 2018-19. The average marks obtained by PG students is 79.1%. This course is introduced for PG in 2018-19 curriculum hence no prior data is available for the comparison.

The attainment is calculated based on equation 1
Attainment % = (x/y) * 100 --------(1)
x = Count of Students >= to Threshold %
y = Total number of Students Attempted .
Threshold set for UG and PG attainment calculation is 60%.



(a)



(b)

Figure 4: Sample Verification plans

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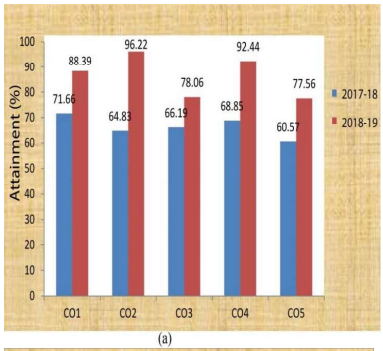
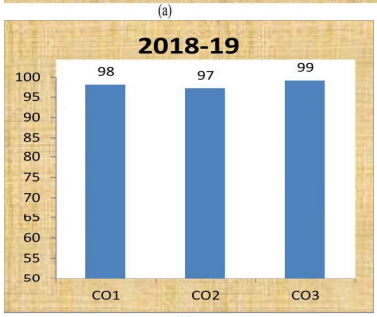
```
**********_____**********
Successfully generated values on X, Y
Generated Value of X=0001,   Y=3
DRIVER sent values to SCOREBOARD as input X=  1, Y=  3
DRIVER sent values to DUT as input via INTERFACE X=  1, Y=  3
Output of DUT sent to MONITOR is          X=  1,  Y=  3,  Z=  3
Values sent from MONITOR  to SCOREBOARD  is X=  1,  Y=  3,  Z=  3
SUCCESS: Match
145 value pkt1.X=  1, value  pkt2.X=  1, value pkt1.Y =  3, value pkt2.Y= 3,
value pkt1.Z=  3, value pkt2.Z=  3
**********                **********
```

Figure 5: Verification results

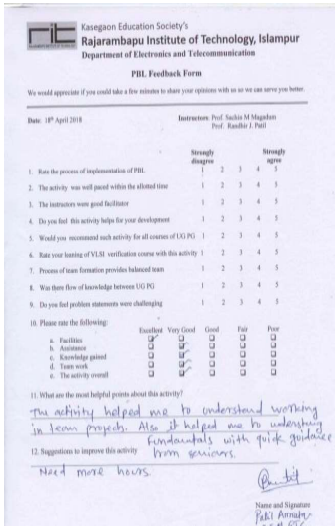


(a)



(b)

Figure 6 (a).Comparison of attainment of two academic years of UG (b). One academic year of PG



Kasegaon Education Society's
Rajarambapu Institute of Technology, Islampur
Department of Electronics and Telecommunication

PBL Feedback Form

We would appreciate if you could take a few minutes to share your opinions with us so we can serve you better.

Date: 18th April 2018 Instructors: Prof. Sachin M Magadum, Prof. Randhir J. Patil

	Strongly disagree				Strongly agree
1. Rate the process of implementation of PBL	1	2	3	4	5
2. The activity was well paced within the allotted time	1	2	3	4	5
3. The instructors were good facilitator	1	2	3	4	5
4. Do you feel this activity helps for your development	1	2	3	4	5
5. Would you recommend such activity for all courses of UG/PG	1	2	3	4	5
6. Rate your learning of VLSI verification course with this activity	1	2	3	4	5
7. Process of team formation provides balanced team	1	2	3	4	5
8. Was there flow of knowledge between UG/PG	1	2	3	4	5
9. Do you feel problem statements were challenging	1	2	3	4	5

10. Please rate the following:

	Excellent	Very Good	Good	Fair	Poor
a. Facilities	☐	☐	☐	☐	☐
b. Assistance	☐	☐	☐	☐	☐
c. Knowledge gained	☐	☐	☐	☐	☐
d. Team work	☐	☐	☐	☐	☐
e. The activity overall	☐	☐	☐	☐	☐

11. What are the most helpful points about this activity?
The activity helped me to understand working in team projects. Also it helped me to understand fundamentals with quick guidance from seniours.

12. Suggestions to improve this activity
Need more hours.

Name and Signature
Pabl Amruta

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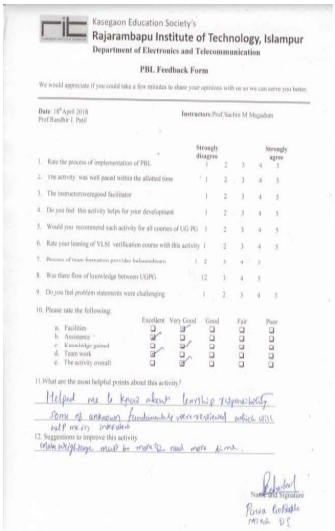
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Department of Electronics and Telecommunication
PBL Feedback Form

Figure 7: Sample feedback forms of UG and PG students

Rate	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6	Q 7	Q 8	Q 9
1	0	1	0	0	1	0	0	0	0
2	0	6	1	2	2	3	0	2	0
3	8	15	12	10	11	14	3	9	2
4	8	19	17	24	22	28	26	26	17
5	40	15	26	20	20	11	27	19	37
Total Responses	56	56	56	56	56	56	56	56	56

Table 2: Students responses about activity Q1-Q9

The figure 7 shows the sample feedback from by students of UG and PG. Table 2 & 3 shows the overall students responses as per their level of satisfaction about the activity in terms of rating. This is the formal assessment of activity. For the assessment of UG students rating taken by team member of PG students of same project and PG students rating is done by facilitator.

Q10	Facilities	Assistance	Knowledge Gained	Team Work	Overall Activity
Excellent	19	18	21	25	22
Very good	21	22	24	22	19
Good	13	15	8	3	11
Fair	2	1		2	3
Poor	1	0	1	1	1
Responses	56	56	56	53	56

Table 3: Students responses about activity Q10

4. Conclusions

The proposed PBL methodology significantly contributed to change in course outcomes attainment and results discussed in section 3. The free flow of knowledge in vertical and horizontal direction is observed. This also helped students to grab internship and placement opportunities. Placement, Internship and higher studies opportunities grabbed by students in VLSI verification domain of UG PG students is as shown in figure 8.

Some PG students got selected for internship in Linked Loops Pvt. Ltd. Pune which is working on embedded and VLSI domain. The feedback which we got from this industry was as follows i. Students are well-versed with HDL language ii. Familiar with verification methodology iii. No need to train students in this area.

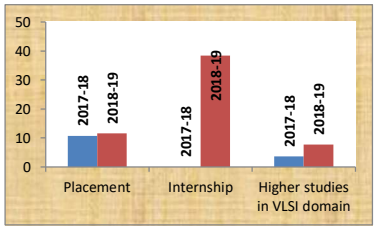

Figure 8: Placement, internship and Higher studies in VLSI domain.

The proposed methodology has showed qualitative improvements in student's skills such as team synchronization, interpersonal skills and knowledge sharing. Apart from many positive aspects, there are some

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challenges also to be addressed during implementation of this methodology. Some of them are as follows. i. Identification of suitable problem statement ii. Expertise in design of module iii. Placement of bugs in designs iv. Curriculum time constraint v. Initial synchronization of UG-PG students. vi. Monitoring of projects. vii. Motivation of students. Overall this improves students learning ability hence can be extended to various courses of UG-PG to inculcate industry work culture during their education.

Acknowledgement
We would like to appreciate UG and PG students for this experiments. We are very much thankful to the Department of E&TC Engineering, RIT for providing necessary resources for implementation of PBL activity.

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Project Based Learning and Publishing Refereed Papers through Course Projects

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Abstract: Publishing quality papers in both International conferences and Journals is one of the great challenges faced by Engineering Institutions. To publish quality papers with scopus index based on the experience of Course Projects which are explored through Project Based Learning. This was considered in third semester MTech. Since the time is too short and is only 12 weeks, we have come up with many ideas and used new innovative process to publish papers in International Conference with Scopus Index. The main purpose is to train the MTech students to publish quality papers in International Conferences / Journals with scopus index through course projects. To publish quality papers with scopus index, based on the experience of course projects require lot of in-depth knowledge, choosing tools and making use of the latest technology. Imparting this knowledge is challenging and is achieved through project based learning. Choosing the latest area was the first challenge. Internet of Things (IoT) was a course in third semester MTech and was selected as the theme for Course Projects and it was compulsory. The students were given a chance to choose a project in the area of their interest under IoT. After selecting a project, optimal and feasible solution has to be selected with innovation. The students as a team have to learn and give a solution to the problem and it should be such that the work carried out should be able to publish the paper in an International Conference / Journals. There were nineteen students in the class and five teams were made out of nineteen students. The target of each team is to publish one scopus indexed paper in International Conference / Journal. All the five teams are able to achieve the goal set and is discussed in the results below. All the five teams formed are able to submit the papers to IEEE International Conference on Advances in Information Technology 2019 (**ICAIT2019**) and all the papers have been accepted and presented, three will be published in IEEE Explore and two will be published in UGC Referred INTERNATIONAL JOURNAL OF RESEARCH IN ELECTRONICS AND COMPUTER ENGINEERING (IJRECE) and all are scopus indexed. It has been a practice to teach a course with emphasis on theory. In this approach a course project was insisted by selecting a problem and giving an IoT solution to the problem. The five teams formed are able to publish five scopus indexed papers one per team and are able to get in-depth knowledge about the course taught. Without this kind of approach, the students would not have published such papers and would not have got in-depth knowledge.

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Keywords: Internet of Things, Project Based Learning, Course Project

1. INTRODUCTION

Many students who join MTech are interested to join teaching / industry and interested to publish refereed papers in International Conference / Journal. Also publishing quality papers in both International conferences and Journals is one of the great challenges faced by Engineering Institutions. To publish quality papers with scopus index based on the experience of Course Projects which are explored through Project Based Learning. This was considered in third semester MTech. Since the time is too short and is only 12 weeks, we have come up with many ideas and used new innovative process to publish papers in International Conference with Scopus Index. We need time to publish the work done. We continue to work for three hours per week along with the project work of fourth semester. Fourth semester is completely dedicated for project work and is of eight months. The students spend only small amount of time on the course project of third semester in fourth semester so that they are able to publish the quality papers. This experiment is made first time in KLE Technological University, Hubballi. We are happy to say that the efforts and the ideas put together have yielded fruitful results. By the time the students complete the fourth semester they are able to publish papers with the help of the TEQIP facility of the University.

61.Regional Research Symposium on PBL

2.PURPOSE, CHALLENGES AND INNOVATION

The main purpose is to train the MTech students to publish quality papers in International Conferences / Journals with scopus index through course projects. To publish quality papers with scopus index, based on the experience of course projects require lot of in-depth knowledge, choosing tools and making use of the latest technology. Imparting this knowledge is challenging and is achieved through project based learning. Also it is seen that by doing the projects students are able to understand the subject better and are able to do better in both In Semester Assessment (ISA) and End Semester Assessment (ESA).

2.1 CHALLENGES FACED

1. Internet of Things was selected as the Theme for the Course Project and it was Mandatory. The students were given a chance to choose the project based on their interest.

2. The second challenge was to impart in-depth knowledge This was achieved by conducting special labs. Also a resource person from EBSCO/IEEE conducted a three hours training on literature survey and publishing papers.

3. The third challenge was; most of the students are from Computer Science and Engineering background are having less experience on hardware, writing device drivers, interfacing machine, lack of knowledge on sensors and working with high voltage devises. This was overcome by the support given by our Institute to purchase the IoT kits under TEQIP. The students were given the IoT kits and trained. The students were able to adopt themselves to the kits and the Technology

2.3 INNOVATION

The following points are integrated to achieve the goal of publishing the papers:

1. Five teams were formed; each group consists of 4 students
2. Impart the in-depth knowledge
3. Choose problem of interest
4. Provide hands-on experience
5. Conduct Special Labs
6. Conduct workshop for writing skill
7. Continue to work on course project in forth semester also.

3APPROACH

Choosing the latest area was the first challenge. **Internet of Things (IoT)** was a course in third semester MTech and was selected as the theme for **Course Projects** and it was compulsory. The students were given a chance to choose a **problem** in the area of their interest under **IoT**. After selecting a problem, optimal and feasible solution has to be selected with innovation. The students as a team have to learn and give a solution to the problem and it should be such that the work carried out should be able to publish the paper in an International Conference / Journals. There were **nineteen** students in the class and **five teams** were made out of nineteen students. The target of each team is to publish one scopus indexed paper in International Conference / Journal. All the five teams are able to achieve the goal set and is discussed in the results section.

The time allocated for third semester is hardly 11 weeks from mid August to beginning of the month of November. Thus it is very difficult to publish the work in 11 weeks. In Semester Examination and End Semester Examinations are conducted as per the Calendar of Events, however the students are asked to continue the Course Project by spending 3 hours per week and are given additional 16 weeks to complete the project in all respects and to write a paper. By the end of March the students start sending the papers to IEEE International Conference / Journals or any other scopus indexed Conference / Journal. Then the review and acceptance and presentation are completed by the end of the July month. The following figure shows the details:

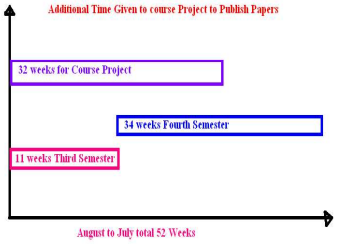

Fig. 1.0 Time allocation for Course Projects

Since the time allocated for third semester is too short, we made the students to work three hours per week towards the Course Project. The students were happy to work and publish the papers.

Mapping of Course Outcomes with Program Outcomes are shown in Table 1.0. In addition to the proposed Outcomes we could also achieve POs 8 and 9.

3.1 POs AS PER LESSON PLAN

Program Outcome 1: Scholarship of Knowledge: Ability to acquire in-depth knowledge of Computer Science and Engineering discipline with an ability to discriminate,

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evaluate, analyze and synthesize existing and new knowledge.

Program Outcome 2: Critical Thinking: Ability to analyze complex Computer Science and Engineering problems critically, with application of independent judgment for synthesizing information to make intellectual and/or creative contribution to the enhancement of knowledge.

Program Outcome 3: Problem Solving: Ability to think independently, conceptualize and solve Computer Science and Engineering problems by evaluating a wide range of potential solutions for problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors involved.

Program Outcome 4: Research Skill: Ability to explore unfamiliar problems through literature survey, apply appropriate research methodologies, techniques and use tools to design, simulate, analyze and interpret data for the development of knowledge in the area of Computer Science and Engineering.

Program Outcome 5: Usage of modern tools: Ability to create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction, simulation, measurement and modelling, to complex Computer Science and Engineering problems with an understanding

Table1.0 Mapping of Course Outcomes with Program Outcomes.

Course Outcomes (COs) / Program Outcomes (POs)	01	02	03	04	05
Describe the characteristics of Internet of Things	M				
Choose IoT Enabling Technologies for developing applications				M	
Acquire domain specific knowledge to build IoT systems	M				
Select system parameters and components to design IoT applications			M		
Develop IoT solutions using Python, Raspberry Pi and Cloud		H			M
Illustrate use IoT for home automation and smart cities.			M		

3.2 EXTRA POs ACHIEVED

Program Outcome 8: Communication: Ability to communicate effectively with engineering community and society at large, regarding complex engineering activities in oral, written and presentation forms.

Program Outcome 9: Life-long Learning: Ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

4. RESULTS

All the five teams formed are able to present the papers in **IEEE International Conference on Advances in Information Technology 2019 (ICAIT2019)** and all the papers have been accepted, three will be published in IEEE Explore and two will be published in UGC Referred INTERNATIONAL JOURNAL OF RESEARCH IN ELECTRONICS AND COMPUTER ENGINEERING (IJRECE) and all are scopus indexed. The details of the papers are as shown below in Table 1.0

Table2.0 List of Papers Presented at IEEE International Conference on Advances in Information Technology 2019 (ICAIT2019), Chickmagalur, Karnataka

S.No.	Authors	Title
1	Unnati Koppikar, Shobha Hiremath, Akshata Shiralkar Akshata Rajoor Vishwanath P Baligar	IoT based Smart Attendance Monitoring System using RFID
2	Pooja B L, Annapurna Kattimani Raksha Nidavani, Harshita Kanamadi , Vishwanath P Baligar	Smart Security System for Invasion Detection
3	Asfia Khan, Bhagyashree Hanamshetti, Meghadarshini Hiremath, Keerti Akkur and Vishwanath Baligar	IoT based Wireless Electronic Notice Board
4	Akshaya Kulkarni, Amit Potdar, Suresh Hegde and Vishwanath Baligar	RADAR based Object Detector using Ultrasonic Sensor
5	Amulya D, Deepa Malimath, Keerthi Lotlekar Namita Kanthi, and Vishwanath Baligar	SMART DOOR USING IOT

Feedback by the students was collected and compared with the feedback of the previous year and there was a slight improvement as shown in Fig. 2.0.

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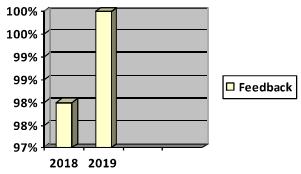

Fig. 2.0 comparison of Feedbacks before and after the proposed methodology.

The feedback has 14 questions and each question carries 8 marks and is are shown below:

1. How punctual is the teacher to the classes?
2. Discussion about the lesson plan in the classes?
3. Is the teacher is always well prepared for the classes?
4. How does the teacher explain the subject?
5. Opportunity for question and discussion
6. Continuity from class to class
7. Motivation to think about the subject
8. Syllabus completion and exam pattern
9. Language of the teacher
10. Utilization time for teaching the subject in the class
11. Control on the class
12. Help outside the class room about the subject
13. Attitude of the teacher towards the students.
14. Favoritism to the students.

Analysis of Outcome Based Education:

Internet of Things 2017-19 batch

Q	PI	BL	CO	Marks	Attainment
1	1.1	L2	1	5	72.63%
2	4.1	L2	2	5	76.67%
3	2.1	L2	3	5	70.53%
4	2.1	L2	4	5	75.79%
5	2.1	L2	5	5	72.04%
6	2.1	L2	5	5	
7	5.2	L3	5	10	
8	5.2	L3	5	10	
9	2.1	L3	5	10	
10	2.1	L3	5	10	
11	3.1	L3	6	10	76.82%
12	2.1	L4	6	20	
13	2.1	L4	6	20	

Comparison with 2016-18 batch:

CO	CO Attainment	
	2016-18 Batch	**2017-19 Batch**
1	85.88%	72.63%
2	80.59%	76.67%
3	82.35%	70.53%
4	80.59%	75.79%
5	63.77%	72.04%
6	----	76.82%

Average Marks Scored by 2016-18 batch is:

5 *(0.8588 + 0.8059 + 0.8235 + 0.8059) + 80*0.6377

= 16.35 + 50.4 = **66.75** out of 100 marks.

Average Marks Scored by 2017-19 batch is:

5 *(0.7263 + 0.7667 + 0.7053 + 0.7579) + 50*0.6377 + 30 * 0.7682

= 14.65 + 31.5 + 22.8 = **68.95** out of 100 marks.

When compared with the previous batch, CO1, CO2, CO3 and CO4 performance of the previous batch was better as shown in the Table above. However CO5 achieved is better than the previous year. Also additional CO6 is added for the current 2017-19 batch.

5.Conclusions

It has been a practice to teach a course with emphasis on theory. In this approach a course project was insisted by selecting a problem and giving an IoT solution to the problem. The five teams formed are able to publish five scopus indexed papers one per team and are able to get in-depth knowledge about the course taught. Without this kind of approach, the students would not have published such papers and would not have got in-depth knowledge.

6. Acknowledgement

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One-Day Many-Problems: A Problem Based Learning Approach

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Abstract: Problem Based Learning not only improves problem-solving abilities but also promotes the development of critical thinking skills, involvement in the team, communication skills, comprehending the reflections, and all of the mentioned along with understanding and applying the course content. A considerable number of universities have experimented with variants of problem-based learning on a variety of course content delivery. The methodology has its challenges of crafting a good ill-structured problem, delivery techniques, evaluation parameters, scaffolding, etc. The problem-based learning sessions usually require lengthier time due to inherent nature, while most universities have class hour sessions of one to two hours. Also, the problem-based sessions are generally effective in smaller classrooms of strength up to thirty. This paper presents the One-Day Many-Problems approach, a teaching-learning model, which helps to craft questions, facilitate discussions, trigger motivation, provide reflections, and comprehend using scaffolding activities. The sessions are planned to engage the classes in intervals where a chain of sessions sum up to inclusive conclusions — the approach aids in the attainment of expected course learning outcomes with systematic and meticulous planning and execution. The paper further presents a case study of the model applied to an eight-semester course – Model Thinking. The paper discusses the results and ponders over the achievement of course learning outcomes along with general guidelines and learnings. One-Day Many-Problems approach proves to be a beneficial delivery model for a shorter session and larger strength classrooms.

Keywords: Course Learning Outcomes, Model, One-Day Many-Problems, Problem Based Learning.

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1. Introduction

The academic environment is largely driven by industry requirements, research, and state-of-art societal challenges. The academic environment, so why has seen radical changes with respect to curriculum design, delivery, and assessment over time-lapse to meet the demands of ever-changing essentials. New pedagogies have been timely introduced to meet the necessities. We are no more a simple to-do plan of action society. We are instead in a complex evolutionary adaptive environment. With digitization, collaboration, globalization, etc. phenomenon, the complexity inevitably becomes constituent and nature of the problem. Considering the various roles which come into the picture, one crucial aspect commonly worked towards is problem-solving skills. Companies are looking for graduates well equipped with problem-solving skills. Universities are designing course delivery through problem-based learning. Students are working towards honing their problem-solving skills, realizing its importance. From competitive programming to solving real-world problems, the skill set is most looked for.

As simple as the definition sounds, problem-solving is a process of working towards a solution for the problem at hand, be it using an ad-hoc approach or a systematic methodology. The multi-faceted domain has created interests in several research groups to find effective means and measures of achieving it.

However, from the academic perspective of the problem domain, the inquiry is how effectively can we use problem based learning as a teaching pedagogy. There is no one way, but there is certainly a way out. This is where we aptly come into defining a Problem Based Learning (PBL). PBL is a student-centered pedagogy. It tactics the learning experience through student groups solving an ill-structured open-ended problem. The trigger materials provided usually do not come with a single pre-defined solution. Along with problem solving, students also are benefitted from developing effective communication and collaboration skills.

(Wood, 2003) defines problem-based learning as a process that uses identified issues within a scenario to increase knowledge and understanding. He lists fourteen principles of the method where one of it mentions that it enhances

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teamwork, communication, problem-solving, and encourages independent responsibility for shared learning - all essential skills for future practice. PBL can be used to improve content knowledge while simultaneously fostering the development of communication, problem-solving, critical thinking, collaboration, and self-directed learning skills. PBL may position students to optimally function using real-world experiences (Barret and Terry, 2010), (Wells et al., 2009).

PBL methodology has seen its advantages and challenges from various perspectives. The method has its proven benefits and as well as challenges to be adapted into different teaching environments.

The paper is further divided into the following sections. Section 2 presents the literature survey. Section 3 presents the One-Day Many-Problems (ODMP) design goals and the model. Section 4 presents a case study, results and discussion. Section 5 concludes the paper along with the future scope.

2. Literature Survey

There is no one predefined meaning for problem based learning. It has a historical origin from medicine. There have been books published on how it can be used for medical education (Barrows and Tamblyn, 1980). Not only medical, but it has also been an inspiration in and to many fields. The method can morph its forms based on the course and course teacher (Barrows, 1986). It's an experience-based education where students learn with thinking strategies (Hmelo-Silver, 2004).

PBL has been explored in many areas. It's experimented in a constructivist learning environment (Savery and Duffy, 1995). A meta-analysis has been carried out on the method (Dochy et al., 2003). The benefits of the technique have been psychologically analyzed and reviewed (Norman and Schmidt, 1992). PBL's methods have been effectively employed in entrepreneurship education. (San and Ng, 2006). Not only in entrepreneurship, but PBL's methods have also been studied and explored in schools as well (Achilles and Hoover, 1996). PBL has been studied with instructional methodologies for administrators and to prepare them for the future (Bridges, 1992).

PBL has been explored in various dimensions and depths. Engineering teaching methodologies have been questioned over PBL methods (Mills and Treagust, 2003). The characteristics of the method have been studied (De Graaf and Kolmos, 2003). The effectiveness of the method has been reviewed and concluded to improve the knowledge base (Colliver, 2000). 'What works in PBL and Why' has been studied as well. (Schmidt et al., 2011).

Not only the advantages, but PBL disadvantages and demerits have also been researched and analyzed as well. PBL can be stressful and can get unrealistically costly (Berkson, 1993). However, the study is domain restricted. The theories and underlying principles have been questioned.

PBL has been introduced for an entire curriculum where one problem is being addressed each day (O'Grady et al., 2012). PBL has also been studied through postholes, where the teacher can occasionally introduce without driving the entire curriculum PBL way (Stepien and Gallagher, 1993). As well, the PBL method has been compared and correlated with other learning methodologies (Savery, 2006).

This paper unifies the theories and principles from two schools of thought – one day one problem and postholes and presents a cohesive approach. Considering the nature of courses that are usually offered in universities and the class strength, the model proposes a workable and potentially effective solution.

3. One-Day Many-Problems

This section discusses the design goals, the model – One-Day Many-Problems, and its characteristics.

A. Design Goals

The design goals of ODMP are the basis to achieve an effective PBL delivery. The model has three design goals. The first one concerns on planning sessions for larger classrooms with shorter durations. The second one is about crafting problems. The third one concerns to assessments.

The first of design goals answer the questions: How can we have PBL sessions to larger classrooms? How can we engage an effective PBL for shorter class sessions of one to two hours? The facilitator might not be able to monitor all the present teams. In the concern, how can the facilitator make sure that every team in a larger classroom is working towards the assigned goal? We need a mechanism where one or two teams lead, and other teams follow-up with thoughts. One team presents, another argues, and yet another concludes. The PBL activity can be split across the sessions. The facilitator needs to plan the sessions to make it logical connected.

The second design goal is about crafting the problems. Crafting a good problem is one of the significant challenges in a PBL session delivery. For a shorter session, the problem can have its pre-defined objectives. The problem can be designed to deliver a principle to aid a concept or to explain an entire concept as a whole.

The third design goal is PBL assessments. Not all PBL sessions need to have an assessment. An assessment can be planned after a set of sessions. Or the assessment can be a reflection activity. The assessment can also happen during the internal exams of the course. The facilitator can plan an appropriate mechanism depending on the PBL sessions structure and management.

B. The Model

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The ODMP model is shown in Fig.1, which segregates the engagements based on the involved actors in the process. Here the actors are facilitators and students. With a thin line of orientation, we divide the ODMP model into a four-phase process.

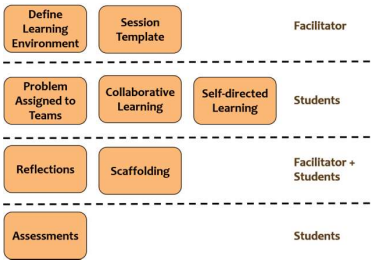

Fig. 1 ODMP Model

1) *Phase I – Definition:* The facilitator here defines the learning environment. The definition is the crucial step of ODMP. The facilitator might decide the entire concept to be covered using PBL, or a basic principle which supports the idea of using PBL or a related application using PBL. This phase includes understanding the syllabus, preparing notes on the connectivity of course contents, identifying the social connection with the concept coverage, abstracting the concepts, and identifying the related real-time scenarios. Then the facilitator prepares a session template. The objective of the template is to monitor and manage the outcome of the session. Each session template may vary depending on the coverage and depth required. The session template here corresponds to the planning of all the four phases of ODMP.

Crafting a problem is equally challenging. The facilitator can create a related scenario, use an existing scenario if it already relates to the concept, borrow a scenario from another domain, create a scenario using real-time events, etc. The facilitator has to decide based on the plan and template of the concept delivery.

2) *Phase II – Learning:* The facilitator here supports the learning environment. The class is divided into teams and assigned problems. The problem can be given as handouts. The student teams brainstorm, discuss the possible solutions, and carry out the activity. This phase may go from thirty minutes to two hours. At the end of the session, the facilitator may provide pointer on concepts to be read as homework activity before attending the next lecture.

3) *Phase III – Reflections:* Depending on the problem type, this can happen on the same day as the case study is given or in the next lecture session. One or two teams present and discuss the solutions, and other teams ponder on the thoughts and conclusion. The facilitator here makes sure that the view is in-lined towards the desired objective. The facilitator must make sure that students are working in the right direction. This phase can go from thirty minutes to two hours. Even scaffolding activities can be planned to reach up to the desired conclusion.

4) *Phase IV – Assessments:* The assessments can take several forms. It can be a non-graded activity. Or it can be an activity that can stand as a foundation for the next graded assignment. The assessment can happen later during minor exams too. The evaluation can also be yet another PBL session.

A facilitator needs to carefully plan out the four phases of a PBL session. The model is decidedly dependent on the problem crafted for the session. For the challenges it throws, can be mastered with experience and course expertise.

4. Results and Discussion

This section presents the case study of ODMP applied to eight-semester elective: Model Thinking. A part of the course discusses various models as an alternative to address the data science challenges and another on model checking, which verifies the formal properties of the models. The course had 43 registered students from the School of Computer Science and Engineering. The Course Learning Outcomes (CLO) of the course are listed in Table 1.

Table 1. CLO's for the Course

CLO id	CLO
CLO1	Explain the need, advantages, disadvantages, implications, and applications of modeling
CLO2	Infer and explain the model characteristics
CLO3	Use model checking and model system's and concurrent system's behavior
CLO4	Discuss linear time and regular properties through the process of model checking
CLO5	Identify a real-world application and produce a model using Game of Life

Each of the above CLO's is mapped to program learning outcomes, and a threshold is set for each CLO indicating the target attainment. There are two numbers – threshold and target. Target is the percentage of students, and it is a common number set across all. Threshold is set per CLO. Table 2 presents the target, threshold, and methodology used.

Table 2. CLO Threshold, Target, and Methodology

CLO	Threshold	Target	Methodology
CLO1	65%	75%	PBL is used
CLO2	60%	75%	PBL is used
CLO3	70%	75%	PBL not used
CLO4	65%	75%	PBL not used
CLO5	80%	75%	Course project

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As an example, the numbers are interpreted as 75% of students must score 65% or more marks allotted for CLO1. For CLO1and CLO2, PBL was used as indicated in Table 2. This does not mean the entire course syllabus was designed using PBL. Around 10 case studies were designed for the course material. For CLO3 and CLO4, traditional teaching methodology was used. CLO5 is addressed by the course project which does not involve any PBL activity. CLO1 and CLO2 cover 24 hours of the course syllabus and CLO3 and CLO4 cover 16 hours of the syllabus.

Table 3 presents the assessment statistics for the mentioned CLO's. The assessments covered in the Table only indicate the minor and semester-end exams. Course project, mapping to CLO5 was evaluated for 20 marks.

Table 3. Assessment Stats

CLO	Minor 1	Minor 2	Semester End
CLO1 and 2	60 marks	30 marks	90 marks
CLO3 and 4	0 marks	30 marks	70 marks

The table above shows the total marks where students have options to attempt selected questions. The assessment is scored on the following basis: if the set target is achieved as per table 2, a number of 3 is scored. If it is 10% less than the set, a number of 2 is scored. If 55% of students score the set threshold, then a number 1 is scored. Anything lesser is scored 0.

For the considered course, below is the ODMP presented for two sets of PBL session plans. Table 4 presents the session template for activity 1. The table presents sufficient details to understand the process followed.

Table 4. PBL 1 Session Template

Phase	Activity	Time
I: Definition	Pick the concepts to be covered from the syllabus. They can be from different chapters but needs to be interrelated. Concepts Selected: Rational Thinking, Nash Equilibrium, and Lyapunav functions. Craft PBL problems for each concept.	The facilitator needs to spend at least 3 days. One day per concept to frame the PBL statement.
II: Learning	Make teams and handhold the sessions.	Each PBL session is of 30 minutes.
III: Reflections	Discussion session after all the three sessions	1 hour. One team for each problem present their solutions.
IV: Assessment	A question to be set during the minor exam. Question is another PBL problem which questions if lyapunav function can be written for Zeno's paradox which tests all the three concepts understanding.	Minor exam period.

As seen in Table 4, a session was planned and conducted with three PBL problems and assessment question set during the minor exam. Table 5 presents the result statistics of assessment.

Table 5. PBL 1 Assessment Results

Type	Students Number
Total students registered for the course	43
Students who attempted the question	40
Students who scored 4/4	5
Students who scored 0/4	6
Class average	2.025

Most students who had analyzed the problem partially correct had failed to conclude it appropriately for the given case study. The question mapped to CLO2. Table 6 presents the session template for another PBL session.

Table 6. PBL 2 Session Template

Phase	Activity	Time
I: Definition	Craft a PBL problem on Game of Life concept.	The facilitator needs to spend at least 3 days to craft the problem
II: Learning	Make teams and handhold the sessions.	2 hours
III: Reflections	Discussion session in the next class. Discuss the rule formations and applications.	2 hours
IV: Assessments	A question to be set during the minor exam. Question is another PBL problem.	Minor exam period.

During the same time period, India had witnessed two fire events within 24 hours. One during the air show where around 500 cars had caught fire in Bangalore city and another Bandipur forest fire which then went on for weeks (Both events in state Karnataka, India). The question was framed on - what appropriate model can be used to explain and prevent the fire. Table 7 presents the statistics for the question.

Table 7. PBL 2 Assessment Results

Type	Students Number
Total students registered for the course	43
Students who attempted the question	8
Students who scored 6/6	1
Students who scored 0/6	0
Class average	3.25

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The question mapped to CLO1. The majority of students opted out not to answer this question. The overall attainment of all CLO's for the course with various PBL sessions can be seen in Table 8 presented below.

Table 8. Course CLO Attainment

CLO	Attainment Score
CLO1	3
CLO2	2
CLO3	1
CLO4	3
CLO5 – Course Project	3

The scores are calculated as explained at the beginning of the section after Table 3. We can see that CLO's, which were achieved using the PBL session (CLO1 and CLO2) has average attainment of 2.5 and CLO's where PBL was not used (CLO3 and CLO4) has average attainment of 2. PBL sessions have benefitted students to understand the concepts better, enhancing the learning processing and applicability of the studied concepts. CLO5 is not detailed as it was for the course project.

Fig 2 and 3 captures PBL sessions in progress. The students have been actively engaged in the activity.

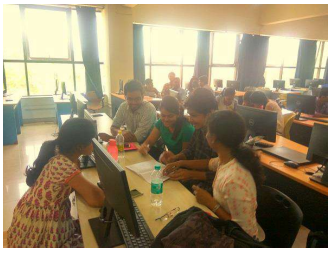

Fig. 2 PBL Session Picture 1

Fig. 3 PBL Session Picture 2

A feedback form was circulated to measure the effectiveness of the PBL sessions conducted during the course tenure. 32 students submitted the responses through an online feedback form. For each of the questions, 1 indicates the least score, and 5 indicates the highest score measuring the effectiveness. Three questions and their ratings are discussed further.

Question 1: The Model thinking part of the course had several case studies and activities. Did it help in learning the concepts better?

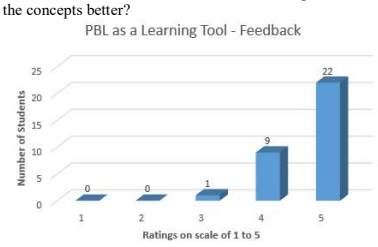

Fig. 4 PBL as Learning Tool Feedback

Fig 4 presents the feedback analysis. 69% of students found it to be highly effective, and 0% of students expressed unhappiness.

Question 2: Did the case studies and problem-based learning help you to connect with the real world better?

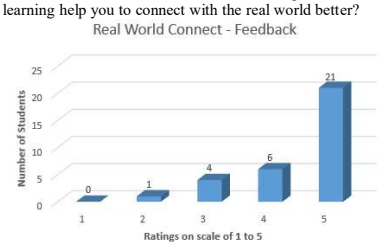

Fig. 5 PBL Real World Connect Feedback

Fig 5 presents the feedback analysis for question 2. 65% of students found this to be highly effective – positively a progressive number.

Question 3: Minor question paper had scenarios based on the concepts learned in the class. Rate on the effectiveness of minor papers in improving learning and problem solving abilities.

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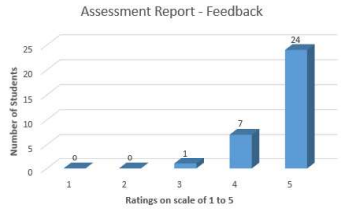

Fig. 6 PBL Assessment Feedback

Fig 6 presents the feedback analysis for question 3. 75% of students found this to be highly effective.

5. Conclusion

ODMP is found to be an effective methodology to deliver PBL sessions of shorter duration and to larger classes. A problem can be divided into smaller sub-problems for PBL sessions. Each sub-problem can be a PBL session. The sub-problems can span across the syllabus. The PBL sessions are usually short, can be as short as thirty minutes. PBL sessions include discussing key insights. Take home study can involve reading about applications of PBL discussed. The assessment can be yet another PBL session. With the results and feedback collected, the employed methods show positive implications.

As a future scope, a formal template can be designed for the session template. A structured template can help and guide the facilitators to plan and implement the PBL sessions meaningfully and effectively. Regardless to mention, also a template to craft a PBL session problem.

While this paper gives an overview of the ODMP model, each of the phases can be a detailed paper compelling its effective form for course delivery. The author's future efforts will be on the same lines.

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Enhancing the Student Learning Outcomes in Electric Drives and Control by Integrating the Core Courses Through PBL Approach.

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Abstract: In recent years Power Electronics and Drives has gained much importance in the Electrical Engineering domain, owing to the growing need for industrial applications, such as Motor Drives, Switched Mode Power Supplies (SMPS) and Electric Vehicle. Electric Drives and Control course is delivered for Electrical and Electronics Engineering junior year students at K.L.E Technological University, India. The course derives the knowledge from the core courses of the program like Electrical Machines, Power Electronics and Control Systems. It is challenging to facilitate the integrated learning experience to students at the junior year with conventional teaching pedagogy. Problem Based Learning (PBL) approach is known to be a fascinating, problem-centered teaching/learning process, that helps the student for a more in-depth understanding of the concepts and to strengthen the application of the knowledge gained by students in theory classes. This paper presents the experience of faculty team adopting a PBL in delivering Electric Drives and Control course for junior year level at K.L.E Technological University. An open-ended problem in Electric drives and Control laboratory was floated as a PBL activity to integrate the learnt concepts of three courses (Electrical Machines, Power Electronics and Control Systems). Through this approach we are able to increase learning outcome of a student such as applying fundamental knowledge of electrical science, theoretical and practical understanding of a subject, use of modern engineering tool to solve complex problem and to validate the simulation and practical results.

Keywords: Electric Drives and Control, PBL.

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1. Introduction

Electrification process is opening up more opportunities for Power Electronics and Drives in the field of power train for the electric vehicle, DC- charging stations, motor drives, and its control, etc. It's a challenge for any academia to equip students to current industry requirements in the area of Electric Drives. The traditional "*chalk and board pedagogy"* in delivering Electric Drives and Control course are trailing in reaching out industry demands. The pre-requisite knowledge for Electric Drive and Control course is core courses of the program like Power Electronics, Electrical Machines, and Control Systems. It is a challenging task to facilitate integrated experience to students in the junior year with current teaching practices. This paper presents how the Problem Based Learning approach has helped in the eradication of traditional pedagogy barriers in Electric Drives and Control course. The Centre for Innovative in Teaching and Learning (CITL), Illinois describes, that problem based learning or teaching is motivating that can improve the quality of engineering education and helps the students in long term retention of knowledge, reinforcement in the subject matter.

Recently the Technical University of Denmark has adopted delivering Power Electronics course with PBL approach [1], which emphasizes peer evaluation and peer learning, which reflects the quality of work done by the students. The paper includes assessment method, course teaching plan, and student feedback. Fernando Martinez-Rodrigo discus, in his article how PBL approach is used to improve educational outcomes in power electronics course by addressing topics on choppers, controlled rectifiers, etc. [2]. The outcome was measured by comparing the previous year results. The results have shown an improvement in educational outcomes and student satisfaction.

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This paper presents the experience of faculty team adopting PBL method in Electric drives and Control course. An open-ended problem in Electric Drives and Control course is floated as a PBL approach to integrate the concepts of three core courses viz. Electrical Machines and Control systems and power electronics course.

This paper describes the structure of the course in brief, pedagogy followed in delivering the course. Rubrics framed for student assessment, followed by attainment of program outcomes and comparison of results with and without PBL approach is also discussed.

This paper is organized as follows — Section-1 introduction. The process for course delivery is discussed in Section-2. PBL methodology followed in Electric Drives and Control course will be discussed in Section-3. Results are discussed in section-4. Finally paper wraps up with the conclusion.

2. Course delivery process

Course contents is organized in three units, where Unit I is dedicated to DC Drives and its control, Unit II comprises of AC Drives and its control and Unit III consists of Special machine drives like Switched Reluctance Motor, Permanent Magnet Synchronous Motor and Brushless DC Motor.

The structure of the course is L-T-P: 2-0-1 which means two lecture hours per week followed by two hours laboratory session.

Laboratory experiments were planned to run concurrently with the topics covered in theory course. As discussed in the introduction section, to get a complete understanding and operation of electrical drive, one should have the knowledge of courses Electrical Machines, Control System and Power Electronics which were thought in fourth and fifth semester respectively. Experiments were designed according to the block diagram referred in Fig.1 [5]. Source for the power modulator may be AC or DC supply. Based on the type of load, power modulator block modulates the flow of power, selects the mode of operation of the motor and limit the current well within safer limits. Control signals for power modulator are generated from control unit. Sensing of motor parameters like current and speed are required for closed loop operations is done by Sensing Unit.

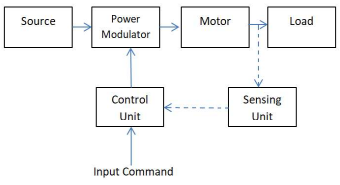

Fig.1 Electrical Drive Components

As we know, any electrical system nowadays is controlled through embedded systems. Keeping this concern in mind as one of the opportunities, the first few laboratory sessions were dedicated for hands-on training on usage of sT-Embed tool provided by Altair, which is considered as one of industry-standard modern engineering tool for developing embedded systems. This tool facilitates Frequency Domain Analysis and Linearization, generalized reduced gradient method of parameter optimization, model-based development, etc. In recent days model-based development is gaining importance in design of complex control systems, hence we faculty have designed all laboratory experiments using model-based development approach.

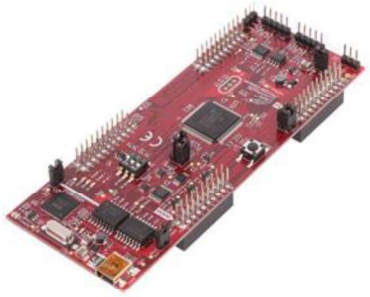

Fig.2 DSP Processor (TMS320F28069)

Control signals are generated through sT-Embed tool using TMS320F28069 DSP processor as shown in Fig.2 the strength of these control signals are not sufficient to trigger the switches of the power modulator circuit. So these signals are amplified to required voltage level through level shifter circuitry using 7417 IC as shown in Fig.3.

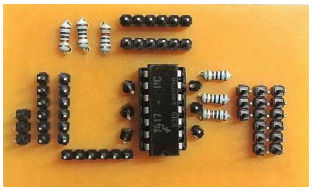

Fig.3 Level Shifter Circuit Using 7417 IC

Once the control unit block is ready, then the student is given the task of realizing the power converter module, knowledge of which was acquired from power electronics course. Control unit and power modulator block (Refer Fig.4) prepared in hand, the next exercise is given to the

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student is to verify the drive operation. For this exercise, prior knowledge of electrical machines is necessary.

Fig.4 Power modulator block

3. PBL approach in Electric Drives and Control Course

As discussed in the Course delivery process, after completing all the experiments, students were given with open ended problem statement as a part of lab assessment, for which students have to arrive at the solution as per understanding of course. *Open Ended Problem* statement floated among students is given below:

The state-space model of a separately excited DC shunt motor with name plate specification: 220 V, 3kW, 1500 rpm are given in equations (1) and (2).

$$\frac{di_a}{dt} = -\frac{R_a}{L_a} i_a - \frac{K_{bt}}{L_a}\omega_a + \frac{V}{L_a} \qquad (1)$$

$$\frac{d\omega_a}{dt} = -\frac{B}{J_m}\omega_a + \frac{K_{bt}}{J_m} i_a - \frac{T_L}{J_m} \qquad (2)$$

where,

V : Voltage applied to armature in Volts
i_a : Armature current in Ampere
R_a : Armature resistance in Ohm
L_a : Inductance of the armature in Henry
T_L : Load torque in N-m
ω_a : Mechanical speed of the motor in rad/sec
B : Damping coefficient
J_m : Moment of inertia of the motor
K_{bt} : Machine coefficient

Design a closed loop speed control of DC motor given for 50% of the loading conditions.
Data: Damping coefficient=0.023Nm-s, Moment of inertia=0.08735 kg-m^2, Machine coefficient=1.1607V-s/rad

After floating this open ended problem statement, students were asked to identify the challenges they may face during implementation.

Methodology followed by students to solve the above problem

1. Identify and determine required data experimentally.
2. Mathematically model separately excited DC shunt motor using state space equations given in equation (1) and (2), simulate the same using MATLAB/Simulink.
3. Experimentally validate the results.
   a. Develop a model for control signals in sT-Embed and export the developed model on to DSP launch pad TMS320F28069M.
   b. Control signal tapped from DSP launch pad are of 3.3V in magnitude.
   c. The power circuit in power modulator module requires control signal of magnitude 15V, which is not provided by DSP launch pad TMS320F28069M alone.
   d. An additional circuitry is required to boost the amplitude of the control signal to 15V from 3.3V, which is achieved by level shifter.
   e. The output of Level shifter is given to switches of power modulator, which supplies controlled input to the motor.
   f. Closed loop control system is designed with PI controller as per block diagram shown in Fig.5

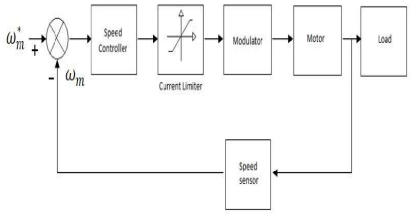

Fig.5 Closed loop control system

g. Integrate all individual blocks as per Fig.1 and its verification carried out experimentally as shown in Fig.6

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Fig.6 Experimental set-up

A. Student Assessment:

In a semester, students are assessed for four internal events which include two In Semester Assessments (ISA) through mode of theory examination and one with laboratory and last activity through assignment or quiz through *Moodle*. Evaluation scheme is as shown in Table.1

Table-1 Evaluation Scheme

Assessment	Weightage in Marks
In Semester Assessment-1	15
In Semester Assessment-2	15
Electric drives and control laboratory	15
Assignment/Quiz	05
Total	**50**

PBL approach was followed majorly in Electric Drives and Control laboratory and its assessment rubrics are discussed in Table.2

Table-2 Evaluation Rubrics for EDC lab

Assessment Parameters	Excellent	Good	Poor
Evaluating unknown parameters	* Student is able to clearly identify the data which is required solve a given problem and evaluate them. * Student is able to recognize unknown which need to be derived either through calculations by applying basic engineering knowledge or through any experimentation (2 Marks)	* Student is not clear about which all data need to be considered to solve a given problem * Student has identified the unknown data which is required to solve the given problem, but lack in knowledge how to acquire at those data.(1 Mark)	* Student has no knowledge in identifying data in problem statement. * Student is not able to identify there is data missing in problem statement which is required in the process of solving the problem. (0 Mark)
Design or development of solutions	Student is able to apply the prior knowledge in the process of developing the solution and implement the same. (3 Marks)	Student is able to arrive at solutions after faculty intervention (2-1 Marks)	Student is not able to arrive at solution even after faculty intervention. (0 Mark)
Mathematical modelling	After obtaining all the data which is required to solve problem student is able to demonstrate its mathematical model of a system or subsystem and validate the results through simulation and experimentation. (4 -3 Marks)	After obtaining all the data which is required to solve problem student is able to demonstrate its mathematical model of system or subsystem with faculty intervention and but lack in validating the results through simulation experimentation. (2-1 Marks)	Student is not able to model at least any of the subsystem (0 Mark)

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Modern tool usage	Student is able to choose appropriate modern engineering tool to demonstrate the possible results virtually and draw conclusion from the all the results obtained. (6-5 marks)	Student is able to choose appropriate modern engineering tool to demonstrate the possible results virtually but lack in drawing conclusion from all the results obtained. (4-2 Marks)	Student is able to choose appropriate modern engineering tool with the help of faculty intervention but lack in demonstrating the usage of it for solving the given problem. (1 Mark)

B. Students Learning Outcome during various stages of problem solving:

Assessment rubrics were designed in such way that each student should be able to gain few competencies or skills. This section describes how aimed competencies were achieved through various reviews.

1. During review 1: It was expected from the students that to identify any data missing which is required in the process of solving the problem.
   a. It is observed from the problem statement that it is essential to have the data regarding armature resistance R_a and inductance L_a.
   b. Students conducted a laboratory experiment to determine the unknown data with the prior knowledge of Electrical Machines which students studied in 4th semester.

   Learning outcome gained by the student through this activity was **applying fundamental knowledge of electrical science.** .

2. After gathering all required data students modelled the electric motor mathematically with the given specification and they were expected to verify the results through simulation. With the aid of this activity students were able to **draw conclusions** from the various results obtained in MATLAB/Simulink competency gained through this activity was the **usage of the modern engineering tool.**

3. To control the motor for given application through power modulator, next task for students was to design an appropriate controller for power modulator unit which was available in laboratory.

4. Designing of closed loop controller was implemented using PI controller. With the course Linear Control System learnt in 4th semester students designed PI controller, arriving at appropriate values of proportionality constant and integral constant. In the process of designing particular controller students gained the competency of **applying discipline specific knowledge**

5. During review 2 expected work to be done from the students was to integrate the designed controller, power modulator unit and electrical motor. Competency gained through this activity was **theoretical and practical understanding of a subject, by integrating the skills acquired through fundamental courses.**

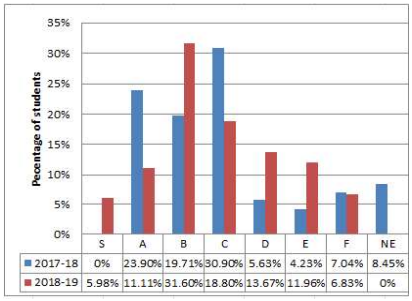
4. Results and Discussions:

To conquer 21st-century grand engineering challenges, any engineering student should possess specific graduate attributes given by Washington Accord. Here in our department, the faculty team tried making students attain a few significant Program Outcomes (PO) through various assessment events. Comparison of PO attainment for the academic year 2017-18 with chalk and board pedagogy, 2018-19 with PBL approach as shown in Table.3

Table-3 Comparison of PO attainment

Program Outcomes (POs)	Academic year 2017-18	Academic year 2018-19
PO1	✓	✓
PO2	✓	✓
PO3		✓
PO4		✓
PO5	✓	✓
PO9		✓
PO10	✓	

Besides enhancing the student learning outcomes, there is a significant improvement in the performance of the students in End Semester results. The bar graph shown in Fig.7 is a comparison of End Semester Assessment results for two consecutive academic years 2017-18 and 2018-19. It can be observed from the graph that there is an improvement in the percentage of students obtaining 'S' grade. Also, there is an improvement in the cluster of students shifting from 'C' grade to 'B' grade through the PBL approach.



	S	A	B	C	D	E	F	NE
2017-18	0%	23.90%	19.71%	30.90%	5.63%	4.23%	7.04%	8.45%
2018-19	5.98%	11.11%	31.60%	18.80%	13.67%	11.96%	6.83%	0%

Fig.7 Comparison of Grades Obtained

5. Conclusion

The paper presented here is an attempt made by authors to enhance the learning of students in Electric drives and controls course through problem based learning approach. As discussed in the paper it was witnessed that through PBL approach, authors could make the students to enhance their learning outcomes and competencies by integrating the courses.

Acknowledgment

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Development of ICT Based PBL Platform

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Abstract: Since Vishwaniketan's Institute of Management Entrepreneurship and Engineering Technology (ViMEET) is affiliated to Mumbai University, it has to follow the traditional teaching learning methodology. Daily routine of typical classroom teaching and feeling of unworthiness for few courses makes learning process boring and irritating for students. But following PBL practices along with traditional teaching learning methodology can add spice to the professional life of teachers and students. Though, PBL is innovative tool for teaching and learning process, but following the practices of traditional teaching learning methodology along with PBL approach increases workload on teachers and students. Maintaining the details of all PBL activities manually can be a cumbersome process for teachers. In such case integration of ICT to PBL can be a great help. So far participation of ICT in PBL is in online learning, online feedback, for assignment submission etc. This paper proposes the architecture of web based tool which automates PBL activities and makes it paperless. This tool is first of its kind in the institution and in whole Mumbai University.

Keywords: PBL, ICT

1. Introduction

In traditional classroom teaching, students are completely dependent on teachers in every study related matter. Due to this spoon feeding students hinder creativity in them and become handicapped in critical thinking. In traditional education system it is impossible to maintain work life balance and it make students jack-of-all and master of none. Sometimes routine activities makes learning process very boring and frustrating, due to which students lose their interest in education and their passion about work and career. Project Based Learning (PBL) is the answer to every limitation of typical classroom teaching.

Project Based Learning (PBL) is very powerful and innovative teaching learning tool. Project Based Learning (PBL) assists to improve the quality of education, employability of students and give more practical approach to teaching and learning method. It is a influential teaching learning tool with many benefits, like it prepare students for critical thinking, problem solving, project management, collaboration. It also improves interpersonal skills in students, increases their creativity, determines actual depth of knowledge in students and teachers, technology inclusion and many more. Looking towards its inestimable benefits of Project Based Learning (PBL), Vishwaniketan's Institute of Management Entrepreneurship and Engineering Technology (ViMEET) is following PBL approach along with traditional teaching learning methodology. Selecting PBL approach means changing the culture of traditional teaching learning approach.

In Project Based Learning, teaching and learning is through project. Students select projects either from the list provided by faculties or of their choice and form their project groups. Formation of project groups and project selection is always a chaotic process. Faculties has to keep track whether all students has enroll for PBL or not. Faculty also has to monitor whether same project is not been selected by multiple project groups. Many times students keep changing projects and their project groups depending upon their relations with other friends in their own group or sometimes in other group. Situation become worsen when students don't follow the deadline of project selection and project group formation. It becomes time consuming and hectic process to run behind the students who are lagging in submitting their project name and project group information.

Faculties find it very difficult to maintain students' information and their project details manually. Every time they have to check their papers to know whether all students have got project or not. It is very wearisome and tiresome process to analyse the repetition of project titles, to identify number of students who failed to submit their project details and to keep track of project completion status physically. The proposed web based tool ViPBL can definitely answer all above problems which teachers are facing.

ViPBL facilitate students to provide information about project group members, their names, project title, etc online. With the help of the data supplied by students various inferences can be drawn out. Teachers can easily identify how many students has enroll for PBL, How many project groups are created, which group is working on which project, how many project groups are working on same project, how many students have not yet formed group and many more. As ViPBL is web based tool, this information is available 24X7 and teachers can access it anytime and from any corner of the world. Teachers' don't need to contact students personally and ask about project. Teachers can monitor students' performance online and can

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motivate them to complete their work on time. This reduces his/her pressure of taking follow up of students' projects in working hours. Design Components are shown in Fig. 1. Few activities mentioned in Deign Components are course specific and few activities are project specific. As faculties are maintaining this information manually for each project group, they have specified this information again and again. This repetitive task consumes their valuable time which makes them annoying and develops dislike about PBL process. To avoid this hassle and to increase the acceptance for PBL, ViPBL has served certain modules where teachers enter this information only once. More explanation is given in Section IV. ViPBL will save the valuable time of teachers which they were wasting in writing same data repeatedly. The technology inclusion in ViPBL will make PBL activities smart and paperless. This will allow teachers to spend quality time with students where students can discuss their project related queries and this will lead to build good student teacher relationship. Students can complete their projects on time and can maintain the quality of projects under the surveillance of their teachers. This will eventually make PBL interesting and lead to huge success of PBL.

The rest of the paper is organized in following manner:

Section II is a CLPBL: Philosophy and Practice, Section III is Related which describes use of ICT in PBL. Architecture of web based tool is explained in section IV. Section V is Future Development and Section VI is Advantages of system and VII is References.

2. CLPBL : Philosophy and Practice

CLPBL is an abbreviation of Course Level Project Based Learning. The main objective of CLPBL is content learning. CLPBL can help to merge PBL activities in traditional teaching learning methodology. Mumbai University is running various under graduate, post graduate and PhD programs. All these programs comprises of many courses/subjects. Syllabus/curriculum and examination structure for all these courses is predefined by the University. All colleges who are affiliated to Mumbai University ought to follow this predefined structure for programs which they are running. Course Learning Objectives (CLOs) are associated with every course, which are predesigned by University. A course learning objective (CLOs) specifies a behaviour, skill or action, the students can demonstrate, if they have achieved mastery of the objective for that particular course. The achievement of these CLOs is to ensure that students have learnt the subject at par. The confirmation for the same can be done with the help of CO-PO attainment matrix which is mapping of course objective with program objectives. The automation of CO-PO matrix is future development of ViPBL.

Students enroll themselves for some program and later realize that learning of some of the courses in the program is total waste of time. These courses have no real time applications. Concepts taught in this subject have no further use. This feeling of unworthiness withdraws their interest in that subject. This later reduces their attendance in the class room, which eventually increases the difficulty level of that subject. This leads to poor performance in examination and less grades.

To change this scenario, to make students realize the importance of subject, Course level PBL (CLPBL) is designed. The faculties who are conducting CLPBL designs real life problem statement, which can be further solved by students with the help of concepts mentioned in the syllabus of that course. Problem statements design by the faculty has peculiar characteristics like, problem statement should be vague, challenging, should not be elaborative and should cover few topics from the syllabus. The purpose of CLPBL is shown in Fig. 1.

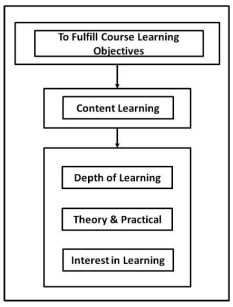

Fig.1 Objective of CLPBL

In ViMEET, to implement CLPBL, one course is selected from each semester for a particular program. Rubrics are designed by the faculty for assessment and evaluation of CLPBL project. The main intention of CLPBL is to fulfil Course Learning Objective (CLO). CLOs can be fulfilled only, if there is a content learning. Content learning is achieved if problem statements designed by faculty satisfy Course Learning Objectives, if not all, but at least few of them. Once the Content Learning is achieved, the depth of learning and knowledge of the students will automatically increase. Thus the knowledge earned by the students can be implemented practically by them. As it is a proven fact that the practically implemented knowledge can be memorized for a longer time, so, this will help students to smoothly prepare & appear for the written exams and improves their grades. This will immensely develop their interest in the subject and will help to improve the attendance in the classroom. Fig. 2 elaborates the step-by-step conduction of CLPBL in ViMEET.

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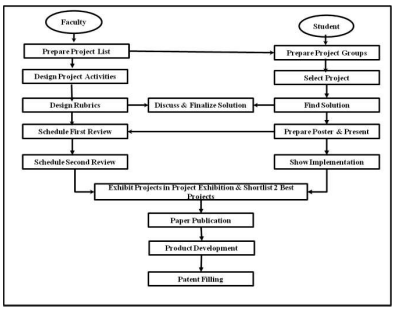

Fig.2 CLPBL: Step-by-Step

There must be some proof that will help to access the effectiveness of CLPBL conduction, quality of the problem statement, students learning out of that project, important topics covered through that project etc. In ViMEET, faculties, who implement CLPBL, answers these questions through CANVAS. The CANVAS is nothing but a document which is maintain by faculties for every CLPBL project group, whose template is shown in Fig. 3(a) and Fig. 3(b).

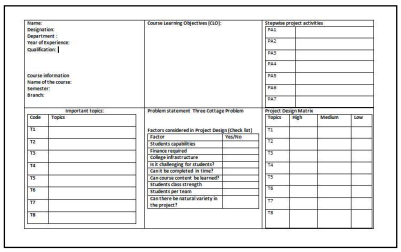

Fig. 3(a) Template of CANVAS

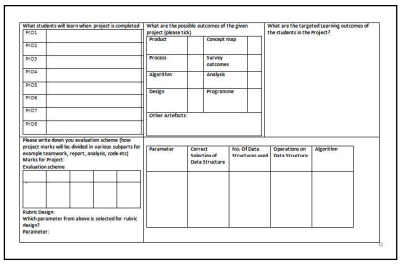

Fig. 3(b) Template of CANVAS

CLOs, evaluation scheme and Rubric design shown in CANVAS template is common for all CLPBL projects. Whereas, stepwise project activities, important topics, project design matrix, possible project outcomes, targeted learning outcomes and students learning from project when it is completed varies from one project to another. All these factors mentioned in fig.4 are considered while designing ViPBL.

The Course Learning Objectives (CLO), evaluation scheme and Rubrics are designed only once at the start of the course and applicable to all the projects of that particular CLPBL. As all projects are developed under that particular course to learn the course content, CLOs are applicable to all projects of CLPBL and so, need to design only once. Rubrics designed are used to assess and evaluate all the projects of CLPBL. As canvas is filled manually, faculties have to mention CLOs and Rubrics on each canvas of project. This repetitive task consumes quality time of faculties which they can use in some productive work. For an individual project, faculty has to specify important topics covered in implementation of CLPBL project, stepwise project activities, project outcomes, what students has learned after the completion of project and the targeted learning outcomes of the students in the project. But when multiple groups selects same project, faculty has to specify all these details in each group's canvas. Though PBL is a very innovative teaching learning tool, it also increases workload of faculty. In addition to this, the repetitive task not only increases the fatigue of faculty but also reduces their faith on PBL.

ViPBL removes the bottleneck in manual system by avoiding repetitive data entry in the CANVAS. ViPBL tool not only relieves faculty from this iterative job but also helps in making these PBL activities interesting and smart. Because of this smart tool, faculty is required to feed the CLOs, evaluation scheme and Rubrics design only once,. Also, the common parameters as explained above for each project are required to be entered by the faculty, only once for each individual project. Along with this, other benefits of ViPBL as explained in Section IV make it a very intelligent and efficient tool to conduct CLPBL.

3. Related work

To conduct PBL activities more efficiently and powerfully ICT plays vital role. PBLAssess uses various modules that provide problems statement, online collaboration, problem solving steps and assessment of project. But tool does not provide the provision for feedback and its analysis module, Rubric design module, project completion status etc.[4] The main purpose of this study is to enhance critical thinking and communication through real time problem solving. ICT tools are used for understanding of course 'Microcontroller Based System Design' using PBL approach. KEIL and CAMU software are used for programming and for assignment submissions. It is observed that ICT based teaching of the course has increased the satisfactory index by considerable margin. [1]

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Code Puzzle Android Game is developed with the help of Action Script 2.0, Adobe Flash CS6 to make learning of Programming language interesting for budding programmers using PBL approach. Study reveals that Code Puzzle plays an important role to motivate the beginners to learn programming skills. [2] ICT can be the integral part in learning activities and learning environment to solve real-life problem using PBL approach.[3] This paper studies the effect of ICT assisted PBL practices on ICT integration skills of the 'to be' class room teachers. Here the mixed approach of quantitative and qualitative dimensions has been used for evaluation of the effect. ICT-SEPS and ICT attitude scale used as quantitative data, while interview form was used for qualitative data. Results obtained in the pre and post data collection revealed that ICT assisted PBL practices have positive effects on ICT integration levels for the pre-service teachers.[7] The study through this paper says that PBL with ICT gives better result to improve communication skill over PBL with traditional approach. [10]

Many researchers have used ICT competently to implement PBL practices. Use of various softwares for problem solving, assignment submission, game designing, online collaboration, assessment, to improve communication etc. has made learning process interesting. But it is times need to have all these facilities under one roof where students can also give their feedback about PBL conduction and it should get reviewed. Faculties should able monitor students' performance from any corner of world and any time. This research gap has gave birth to the web based tool ViPBL.

4. Architecture of Proposed System Web Based Tool ViPBL

In ViMEET, the last stage of CLPBL project completion is canvas generation. Canvas is generated for each CLPBL project. Fig. 3 depicts various activities that need to be completed to fill the canvas.

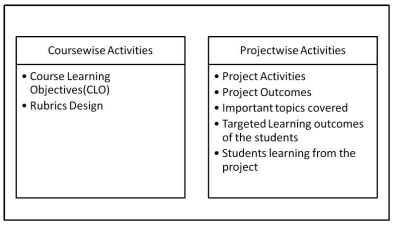

Fig.4 CLPBL Design Components

The proposed architecture of web based tool automates the process of project selection and project group formation, project report submission and evaluation, feedback and the list goes on. This architecture is fortified with various modules which go in line with the canvas. Fig. 5 shows the architecture of web based tool ViPBL.

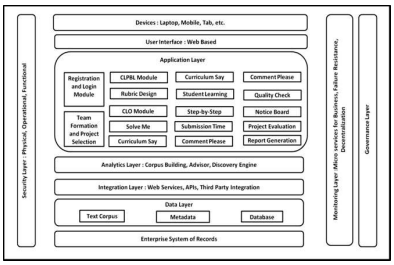

Fig. 5 Logical Architecture of ViPBL (Component View)

The application layer of ViPBL is equipped with various modules that enable faculties to conduct CLPBL more efficiently and with more concentration.

1) *Registration and Login Module*
   Registration and login module allows faculties and students to register themselves for CLPBL. Here, the authentication of students' is verified by sending OTP on their mobile phone.
2) *Team Formation and Project Selection*
   Students who have registered themselves in *Registration and Login Module* are authorized to provide the details of their project group and the project on which they want work through this module. This module is open to students only when faculties upload their problem statements.
3) *CLPBL Module*
   In *CLPBL* module faculty can supply information about his/her CLPBL i.e. course name, year of engineering (e.g SE or TE), semester in which that course is taught, academic year, faculty name etc.
4) *Rubric Design*
   Project once is completed, it need to be evaluated. *Rubric Design* module helps faculties to specify various parameters on which projects can be evaluated. Each parameter will be given weightage depending its importance in the evaluation. Faculties can also give the detail bifurcation of weightages of each parameter. This will help students to know on which basis or parameters their work will be evaluated. This will act as guideline for students to produce good quality work.
5) *CLO Module*
   Course Learning Objectives of a particular CLPBL are to be mentioned in this module. CLOs, once designed can be later used by all canvases per project group of CLPBL.
6) *Solve Me*

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Solve Me is the heart of the CLPBL. It allows faculties to upload the real time problems that can be solved by the students with the help of the concepts they are learning in that specific course.

The information in modules from 1-6 is entered once in the semester and can be used by all canvases. Whereas information in modules from 7-9 is for each individual project. These modules reduce the faculty's time wasted in entering same data in the multiple canvases when same project is selected by multiple groups.

7) *Curriculum Say*

Curriculum Say gives the list of important topics from the curriculum that can be covered for the implementation of the specific project.

8) *Student Learning*

Student Learning module holds the information about what students will learn after the completion of that particular project. E.g. report writing, algorithms, any particular technique or method, communication skill, critical thinking etc.

9) *Step-by-Step*

For efficient project development every project must get divided into various modules, task, sub tasks or activities and all these activities need to be completed into specific sequence. This break down of project is mention in *Step-by-Step* module. Students can take help of this break down and can march towards the successful completion of project in a very organized and planned way. The system is designed in such a way that they have to follow the sequence and deadline otherwise group may get blocked and further process will not be allowed unless otherwise faculty allows them using his/her rights.

10) *Submission Time*

Students not only should complete their work but also should submit it on time. Submission Time provides platform to the students to upload their project status every after 15 days. They can take help project activities mention in *Step-by-Step* module to update on which activity they are working on and how much percentage they have completed. Students can prepare and upload poster before their first review of project. *Submission Time* also enables students to upload their project report after the successful completion of project. This immensely helps faculties to keep track of all the project activities of all the projects and can also monitor the status of project completion. Faculties can check the project status and can motivate the students if they are lagging in ensuing the deadline that too from anywhere and anytime. This reduces her pressure of taking follow up of students' projects in working hours.

11) *Comment Please*

Comment Please gives liberty to the students to express their views about CLPBL, about the quality of problems statement given to them, about the overall conduction of CLPBL, faculty's technical competence, faculty's cooperation, their satisfaction and many more.

12) *Quality Check*

Quality Check is an analytical module. The feedback received from students in 'Comment Please' module is analysed to measure the quality of CLPBL conducted by the faculty.

13) *Notice Board*

Notice Board is used by faculties who are involved in conduction of CLPBL to broad cast the notice, message or submission dates.

14) *Project Evaluation*

Project Evaluation module allows faculties to award marks to students' projects on the basis of Rubrics specified in *Rubric Design* Module.

15) *Report Generation*

A Report Generation module engenders many reports with the help of the data entered all above modules. Feedback report is generated with the help of feedback submitted by students in *Comment Please* module. Project status report can be created on the basis of information mentioned in *Submission Time* module, Faculty will get list of enrolled students from the data entered in *Registration and Login Module*, individual student's grade report and Statement of marks of all enrolled students can be created with help of data feeded by faculty in *Project Evaluation* module. CANVAS is the consolidated report generated for each project group with the help of data entered in each module.

5. Future Development

A. Library Module

In typical classroom teaching, teachers and books are only the resources available to students for learning. Through *Library Module*, web link, e-book, articles, videos, pdfs can be made available for the students through ViPBL.

B. Chat Room

In a city like Mumbai, due to long distance, students cannot find suitable time and location for face to face discussion with their peer teams and mentors. This bottleneck can be solved using *Chat Room*. In *Chat Room*, student can communicate with their team members and mentors. They can share their ideas, discuss queries, seek guidance and can co-operate each other.

C. CO-PO attainment Matrix

To analyse the quality of student learning, *CO-PO attainment Matrix* is used. This Matrix is a mathematical model which supports innovation, helps in continuous evaluation, NBA Accreditation and self assessment report generation.

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6. Advantages of System

There are many advantages of ViPBL. Due to ViPBL, student information, along with their project title and project group is available online. Teachers can have 24X7-surveillance on students' project completion activities. Teachers can control and monitor the allocation of same project to multiple groups. Students have platform to give their feedback on CLPBL which will help to understand the quality of CLPBL. It provides provision for online assessment and evaluation of Projects. Students can submit project report, posters and project completion progress in every 15 days. ViPBL make system paperless and saves teachers' valuable time wasted due repetitive data entry.

The architecture of ViPBL has been tested and verified by exerts. The web tool is under development and will get completed soon. It is first of its kind in the institution and in whole Mumbai University. This dedicated web based tool will help in increasing the effectiveness of PBL. It will help teachers to control project activities. Students will experience the automation in PBL with latest technology. It eventually softens the process of PBL and reduces the workload of teachers.

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Project Based Learning-An Innovative approach to enhance higher order skills

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Abstract: Project based learning (PBL) is an approach of active learning in which students search real-world challenges and problems and work on it in small collaborative groups to get solution. Group of students work together to achieve common goal. During this process certain skills are developed viz. research and inquiry skills, organization and time management skills, communication and presentation skills, group participation and leadership skills, self-assessment and reflection skills and critical thinking. In implementation heterogeneous groups are formed. Through discussion and brain storming, problem statements are finalised. From circuit simulation, results are observed and checked those results using breadboard implementation. Printed circuit boards are created and all components are soldered. Circuits are tested to check results. Report is documented and uploaded on MOODLE. This is considered as one of the In-Semester Evaluation (ISE) components. The assessment is carried out using rubrics. In addition, students' feedbacks are taken**.** It has been observed that there is improvement in ISE performance. Students enjoyed learning by doing. Learners have learned applying theoretical knowledge to solve practical problems. Students learnt to use simulation tools, circuit mounting and testing, troubleshooting the circuits.

Keywords: Project based active learning; higher order skills, Hardware implementation

1. Introduction

Learning is long process to develop students with number of skills. Traditional teaching is mostly reading, listening and viewing images/videos. This is not effective in changing future as students are from different environments and their learning styles are different. In outcome based education outcomes are defined first and accordingly teaching learning methodologies are decided and implemented. In this active learning is alternate option to traditional teaching learning methodology. Research claims that students learn more through active learning in comparison with traditional teaching techniques. It is applicable to any subject. Also students enjoy the class more and able to retain the information for long duration. The researchers also claimed that active learning allows students to learn in the classroom with the help of instructor, rather than learning on their own [1]. Cone of Learning shows that students learn more if they do things themselves i.e. Learning by doing [2].To achieve active learning number of techniques are available and day by day new techniques are experimented and tested. One of such active learning is project based learning (PBL) in which students work in group to complete certain project.

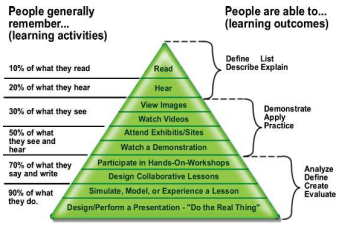

Fig.1 Cone of learning

Bloom's Taxonomy is a framework that starts with remember and understand levels of thinking as important bases for pushing our brains to higher order levels of thinking—helping us move beyond remembering and recalling information and move deeper into application, analysis, evaluation, and creation [3].

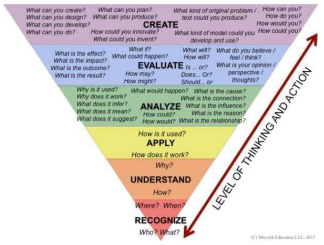

Fig.2 High level thinking approach

2. Why PBL

Research shows in learning process if hands on performance are present, learning takes place in better manner and long lasting. Learning by doing can be done by different ways such as Jigsaw, Flipped classroom; Problem based learning and many more. Project based learning (PBL) is the active learning technique which concentrates

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on simulation, modelling, collaborative learning, designing and performing presentation with documentation [4]. With this students can learn and remember concepts for long time. PBL addresses upper four skills of Blooms taxonomy. Higher-order thinking involves the learning of complex judgmental skills such as critical thinking and problem solving[5]. Higher-order thinking is not easy to learn or teach but more important as these skills are more usable in various engineering problem solving situations. Through PBL higher order skills can be developed which eventually reflects in program outcomes and graduate attributes[6-9].

3. Methodology of implementation

PBL has been implemented for Linear Integrated Circuits course of second year B. Tech. Electronics and Telecommunication engineering branch. Total students were 72. Following are the phases of implementation.

a. Group formation
   Groups are formed considering two heterogeneous students per group which. Details are uploaded on Moodle.
   http://210.212.171.173/moodle/course/view.php?id=3202
b. Project title selection and discussion
   From the curriculum 36 separate project statements are found out through discussion with each group. E.g. Instrumentation amplifier, Temperature controlled fan using 741, etc.
c. Simulation
   Circuits are designed and simulated using softwares:- Proteus, MultiSim, TINA and DipTrace. Simulation results are uploaded on Moodle.
   http://210.212.171.173/moodle/mod/assign/view.php?id=56506
   http://210.212.171.173/moodle/mod/assign/view.php?id=55180
d. Breadboard implementation
   Components are selected and mounted on breadboard and circuits are tested.
e. PCB layout and fabrication
   PCB artwork has been generated using softwares and then PCB is fabricated in PCB lab.

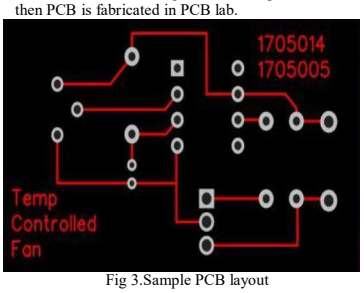

Fig 3.Sample PCB layout

   As per circuit PCB layout fabricated and drilled.
f. Component mounting creation and testing of circuit
   Components are soldered and circuits are tested. Some connectivity and dry soldering issues were found out and troubleshooted.
g. Documentation and presentation.

Reports are prepared, uploaded on Moodle and presentation is done in front of the S.Y. B. Tech Electronics and Telecommunication Engineering class. http://210.212.171.173/moodle/mod/assign/view.php?id=53770

4. Assessment

Project based learning is considered as In Semester Evaluation (ISE) component. For grading rubrics are defined. For grading four dimensions were defined with three levels of grades as excellent (4-5), good (2-3) and average (0-1) as Problem definition & literature survey (5M), Methodology and Simulation (5M), Results and Implementation (5M) and Report (5M).

Table 1. Rubrics sheet

Dimensions	Grade Points			Roll No.	
	Excellent (5-4)	Good (3-2)	Average (1-0)		
Problem definition & literature survey (5M)	Excellent knowledge of problem and relevant material	Good knowledge of problem and relevant material	Basic knowledge of problem but lack of details and lack of relevant study		
Methodology and Simulation (5M)	Accurate circuit simulation with PCB artwork	Accurate circuit simulation with no PCB artwork	Partially working circuit simulation with no PCB design file		
Results and Implementation (5M)	Accurate results with glass epoxy PCB implementation	Moderate results with general purpose zero PCB implementation	Poor results on zero PCB or breadboard implementation		

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Report (5M)	Report with proper component specification & accurate result	Report with proper component specification & moderate results	Report with proper component specification & poor results		
			Marks out of 20		

5. Simulation

The designed circuits are simulated to test their performance using simulation softwares before actual implementation. Some of sample simulation circuits have been depicted in figures 4 and 5. Also students got knowledge of using different simulation tools.

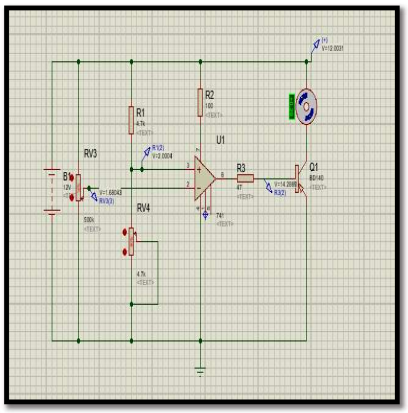

Fig 5.Sample simulation circuit 1

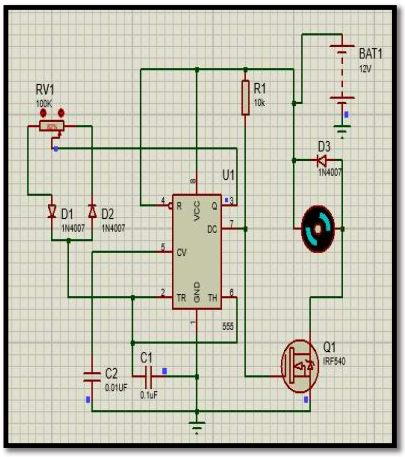

Fig 5.Sample simulation circuit 2

6. Hardware implementation

The simulated circuits are actually implemented on PCBs. Their performance is tested for respective applications. Some of the sample projects have been shown in figures 6 and 7.

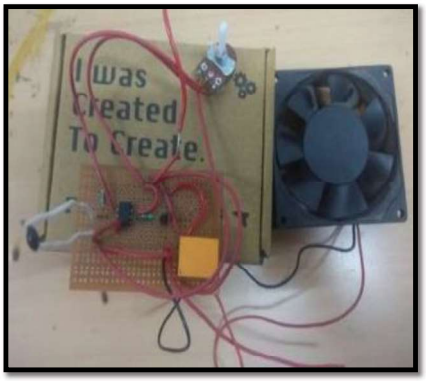

Fig 6.Sample Project 1(Temperature controlled Fan)

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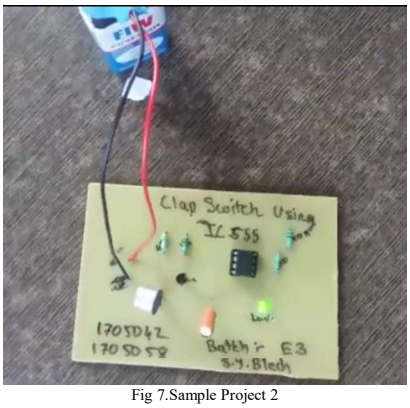

Fig 7.Sample Project 2

7. Results

Results are compared on the basis of Course Outcomes (CO) attainment of the course Linear Integrated Circuits (LIC). Figure 8 shows ISE attainment after implementation of PBL. Figure 9 shows survey representation of higher order skill viz. time management, critical thinking, self-assessment, communication skills and team work that students has achieved. Details are as follows.

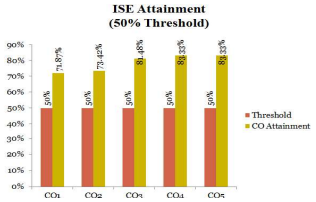

Fig 8.ISE attainment after PBL implementation

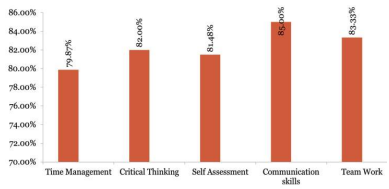

Fig 9.Analysis of higher order skills feedback

Also student feedbacks were taken by using MOODLE on following basis and shown in figure 10.Deatil are uploaded on MOODLE http://210.212.171.173/moodle/mod/feedback/analysis.php?id=56363&courseid

a. Up to what extent students liked this activity
b. Ability to analyze the linear integrated circuits
c. Ability to test and design linear integrated circuit
d. Ability to simulate circuit using simulation tools.
e. Ability to work in team with joy and enthusiasm

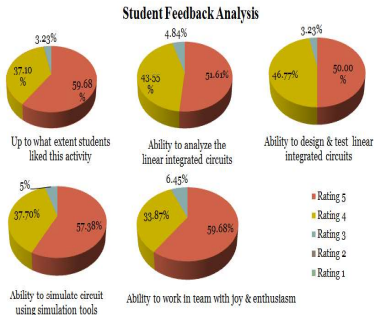

Fig 10.Analysis of feedback

Figures 11 and 12 shows feedback of course and feedback given for PBL by students.

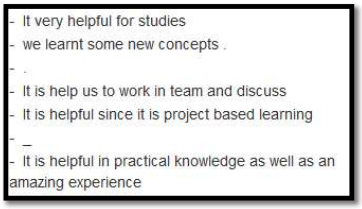

Fig 11.Analysis of feedback

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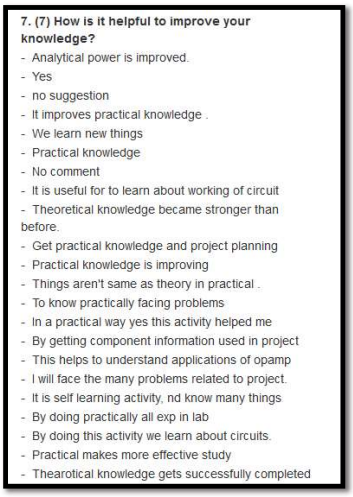

Fig 12.Analysis of feedback

Figure 13 shows the actual presentation of PBL in classroom.

Fig 13.Classroom presentation

Figure 14 shows demonstration of the project.

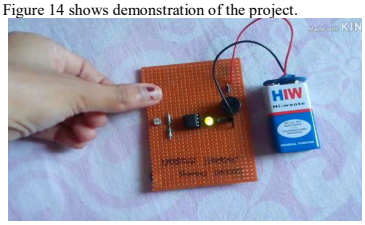

Fig 14.Demonstration of the project

8. Conclusions

PBL active learning technique has been implemented. After implementation it is observed through feedback and interactive communication that students have improved in terms of knowledge, problem solving skills, interpersonal skills, self-directed learning and motivation to work in team. This is experiential learning techniques where students are learning through experience. Students enjoyed learning by doing. They have learnt to apply theoretical knowledge to solve practical real life problems. The performance in ISE has been improved.

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Curriculum Design and Implementation of Project-Based Learning for Electronics Engineering Graduates

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Abstract: Design, development and analysis are the integral part of electronics Industry. Majority of Electronics Engineering graduates are working in embedded, VLSI, Automation, and Software Industries. To design industry ready curriculum is a major focus of this paper. To cope with industry requirements theoretical approach of Electronics subjects will not provide required skills and unable to build confidence while working in industry. In this paper we discussed autonomous curriculum which is based on project-based learning implemented from year 2016-17. First year curriculum focuses on to development of social awareness to observe social, environmental and industry needs. Second year has been focused on analog and digital components, sensors, market survey and to develop the small circuitry with PCB design. Main focus on third year is given on controlling parameters, Integrated circuits, controllers design and programming like Python, Raspberry Pi etc. Final year has been planned to make students expertise in domains of Embedded, VLSI and Automation to build social and environmentally sustainable projects. Overall 40 percent credit evaluation is based on project-based learning. In this paper comparison of non-autonomous curriculum and present curriculum of autonomous which is project-based learning with soft and technical outcomes measured through rubrics are presented. During last three years it has been observed that project-based learning approach is developing the technical skills like problem analysis, design and development, problem investigations etc. It also improves soft skills like team working ability, leadership quality, marketing skills etc.

Keywords: Autonomous Curriculum; Industry ready curriculum; Skill development.

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1. Introduction

Modern electronics engineering practice has to deal with projects in which complex and initially unclear requirements have to be met in stipulated time. The professional engineer has to communicate with clients to transform ambiguous verbal instructions to demanding specifications by following a system engineering process [1]. He has to organize his work in collaboration with other specialists to comply with objectives and deadlines. It is not unusual for an engineer to work on a product or solution for a client and, at the same time, control the work subcontracted to providers. Engineering education should prepare students for this scenario. Important ingredients of Project Based Learning method are: to provide the students incomplete information and encourage them to complete the requirements and specifications, to promote self-discipline and self-regulation by allowing the students to define their objectives and commitments, and to promote team work, specialization and inter disciplinary collaboration [2,3]. Project Based Learning (PBL) is a teaching methodology focused on students in which the instructor acts as advisor and facilitator. Students are encouraged to think the need of the society and industry. In the first step they start defining problem statement with requirements and specifications. In second step students in a team share their innovative ideas about solutions and find out optimized and creative solutions. In the third step they start design and development parts with modern tools and technologies. Despite the wide variation in PBL models [4], there still exists some common pedagogical principles to all variations, as follows:

- **Problem-based**: Students have to define the problem statement considering real problem addressing to need of society and industry. So, as this can be more motivating to the students than an artificial problem.
- **Self-directed**: Student are able to design and develop solution for given problem statements freely.
- **Experiential learning:** Through experience and interests' students are able to modify their previous work.
- **Activity-based**: Students are actively engaged in literature review, research, decision-making, writing papers, developing products and applying for patents.

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• **Interdisciplinary:** Students should provide solution to the problem typically from different engineering disciplines.
• **Group-based:** Due to industry needs students should work in team to facilitate and encourage and improve communication and teamwork skills.

A. Objective of Curriculum Design and Implementation of Project-Based Learning

The design of the curriculum has accounted for the following pedagogical objectives:

- To develop higher level learning skills like design, apply and analyse.
- To inculcate soft-skills like team building, communication, usage of modern tools, project management & finance, technologies and ethical values.
- Ability to develop interpersonal skills to work in inter disciplinary environment.
- To train the students to think, imagine and create.

The paper is organized as follows: Section II details the curriculum structure and its implementation. Section III describes the evaluation methods of PBL. Finally, Section IV discusses the results and conclusions of the paper.

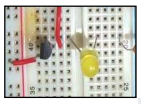
2. Curriculum structure and implementation

The paper discusses the curriculum of Department of Electronic Engineering in the DKTE'S Textile & Engineering Institute, Ichalkaranji. The professors and instructors in the department teach both undergraduate and postgraduate courses in electronics, ranging from electronic circuit design (both digital and analog) to its applications with advanced technology.

The autonomous curriculum with project-based learning has been implemented from year 2016-17. Project based learning begins with First year. It has been planned to develop social awareness to observe social, environmental and industry issues and needs. From the first year itself they start thinking about the problems related to society. Student visit various places like hospitals, railway stations, bus stations, market, government offices, economical backward areas, farmers, rivers etc. They then discuss these problems and solutions with the instructors which helps to identify technical issues, devolve thinking, collaboration, creative and communication skills. Overall it builds creative energy among the first-year students. They understand social responsibility and develop thought process to provide engineering solutions in societal and environmental contest which is essential for sustainable growth. Student has to implement projects related to social issues in this year. Second year has been focused on analog and digital components along with design and development of small circuitry on breadboard and general-purpose PCB. This is used to develop a strong fundamental electronics engineering knowledge and creates interest in the field of electronics engineering. Main focus on third year is given on microcontroller board design, system design and programming like Python, Raspberry Pi, PLC, and Arduino etc. So as to develop ideas to design innovative projects. Final year has been planned to make students expertise in the fields of Embedded, VLSI and Automation to build social and environmentally sustainable projects with product development. Semester wise detail curriculum of F. Y (B.Tech) and S.Y. (B. Tech) is as shown in Table 1.

Table 1. First year courses and Second year syllabus structure

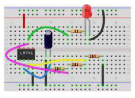
First year course	
GEP132	Social Innovation
Second Year- Semester-1	
Course Code	**Name of the Course**
ELL201	Engineering Mathematics III
ELL202	**Electronics Devices and Circuits**
ELL203	Linear Circuits
ELL204	Analog Communication
ELL205	**Structured Programming**
ELP206	**Electronics devices and circuits**
ELP207	Analog Communication lab
ELP208	**Structured Programming lab**
ELP209	Circuit Simulation Lab
ELD210	**Mini Project I Lab**
ELL211	Environmental Studies (Mandatory Audit)
Second Year- Semester-2	
ELL212	**Digital System Design**
ELL213	Control System Engineering
ELL214	Linear Integrated Circuits
ELL215	Data Structure and Algorithms
ELL216	**Object Oriented Programming**
ELP217	**Digital System Design Lab**
ELP218	Control System Engineering Lab
ELP219	Linear Integrated Circuits Lab
ELP220	**Object Oriented Programming Lab**
ELD221	**Mini Project II Lab**



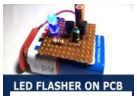
Discrete Component Based Project

Digital IC Based Project

Mini Project -II



OP-AMP Based Project



Mini Project - I

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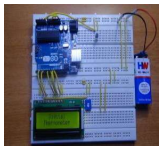
Fig. 1 Projects implemented by second year students.

In second year, first and second semester Electronics Devices and Circuits (EDC) Digital System Design (DSD) and Linear Integrated Circuits (LIC) deals with fundamentals of discrete devices, analog and digital circuits. These are the core electronics subject and its tutorial and lab sessions are purely designed under the concept of project-based learning. In the courses like EDC, DSD and LIC students develop discrete component-based projects on breadboard and general-purpose PCB. Teacher guide students in understanding various terminologies included in the data sheets so that students get acquainted with using sheets properly. This helps them to compare specifications and cost of various components. Students can take help of internet to do market survey for component selection with such curriculum many electronic applications are developed. In mini-project-I students implement discrete component-based projects like water level indicator, security alarms, power supplies etc. In mini-project-II the focus is given to IC based projects. It includes timer, different wave generators, regulators etc. Structured programming and object-oriented programming courses assist in developing programming skills to develop small software-based projects in group. These skills required to fulfil need of today's IT based companies. In these two-semester out of 50 credits, 20 credits (40%) courses teaching learning and evaluation is based on PBL component. Fig. 1 shows implemented projects by second year students.

Table 2. Third year syllabus structure

Third Year- Semester-1		
Course Code	**Name of the Course**	
ELL301	**Microcontroller**	
ELL302	Signals & System	
ELL303	Electromagnetic Engineering	
ELL304	**VLSI Design**	
ELL305	Digital Communication	
ELP306	**Microcontrollers Lab**	
ELP307	**VLSI Design Lab**	
ELP308	Digital Communication Lab	
ELD309	**Mini Project III Lab**	
ELI310	Renewable Energy Sources (Mandatory Audit)	
Third Year- Semester-2		
ELL311	Digital Signal Processing	
ELL312	Audio/Video Engineering	
ELL313	Power Electronics	
ELL314	**Electronic System Design**	
OE	**Open Elective**	Hybrid & Electric vehicle
		PLC & SCADA
ELP315	Digital Signal Processing Lab	
ELP316	Audio/Video Engineering Lab	
ELP317	Power Electronics lab	
ELP318	Electronic System Design (Lab)	
ELD319	**Mini Project IV Lab**	

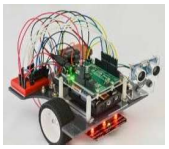
In third year, first and second semester project-based courses are highlighted as shown in Table 2. It includes Microcontroller, VLSI design and Electronic system design with major focus on mini project III and mini project IV. These subjects deal with hardware and software component. In microcontroller study student develop their own microcontroller board and learn microcontroller (8051) hardware and its interfacing with display and key board. They perform various projects on this board with embedded C software. In VLSI design student simulated pipeline multiplier, data path design for algorithm, frequency generator etc. In ESD course student build electronic system-based projects like frequency synthesizer, SMPS, DVM, frequency counter etc. In mini-project-III students implement Aurdino based projects. In mini-project-IV focus is given on Raspberry-pi based projects. Open elective subjects like Hybrid & Electric vehicle and PLC & SCADA fulfils the industrial needs. Industry 4.0 plays very important role now a days. So, to fulfil that requirement PLC & SCADA subjects are introduced. In semester V and VI two subjects out of five covers PBL concept. Fig. 2 shows project implemented by third year students.



Arduino based projects

VLSI based projects

Microcontroller based projects



Raspberry-pi based projects

Fig. 2 Projects implemented by third year students.

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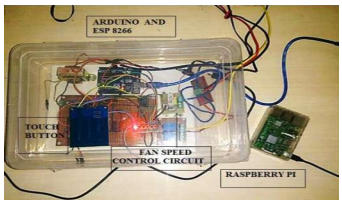

Fig. 3. IoT based automation using Raspberry Pi

IoT based automation using raspberry pi as shown in fig. 3 was implemented by one of the groups from third year. This project won number of prizes in different competitions held at state and national level. Also, this project is converted to commercial product with the help of JANGS Technology, Kabnoor.

Table 3. Final year syllabus structure

Final Year- Semester-1		
Course Code	**Name of the Course**	
ELL401	**Embedded System**	
ELL402	Power Electronics & Drives	
ELL403	Computer Network	
ELLEL1	**Elective I**	
ELP407	**Embedded system Lab**	
ELP408	Power Electronics & Drives lab	
ELP409	Computer Network Lab	
ELPEL1	**Elective I Lab**	
ELD413	**Project Phase I**	
Final Year- Semester-2		
ELL414	Image Processing	
ELLEL2	**Elective II**	
ELLEL3	**Elective III**	Consumer Electronics
		Digital Marketing
ELP423	Image Processing Lab	
ELPEL2	**Elective II Lab**	
ELPEL3	**Elective III Lab**	
ELD432	**Project Phase II**	

In final year project-based learning courses are increased up to 60% as shown in Table 3. It has been observed that during last five years maximum students get placement in the domain of Embedded system, VLSI and Automation. Electronic industry is rapidly growing in these areas. To make students expertise in these fields elective subjects are streamlined. Elective I and II are horizontally linked to each other as shown in Table 4. Project-I implementation steps are survey, problem definition, block schematic, viability of project, finalization of problem statement through presentation and discussion. It has been also evaluated and modified by external industry expert's opinion. Project-II has been allotted more credits (8) compared to project-I (4 credits). In this they carry out project with the steps circuit finalisation, PCB design & fabrication, soldering and software programming simultaneously in a group. Finally testing and troubleshooting of project is done. This process is supported by arranging regular workshops and events. Every year department conduct Multisim workshop, PCB designing workshop, Aurdino workshop, Raspberry-pi workshop and Project Extravaganza to provide hands on experience. The students take participation in various state and national level project competition and build their confidence in various technical and soft skills.

Table 4. Elective linkage

Elective I	Elective II
Automation & PLC Programming	PLC based industrial applications
Internet of Thing (IOT)	Embedded based applications
Digital CMOS Design	Advanced VLSI design

B. Percentage of project component

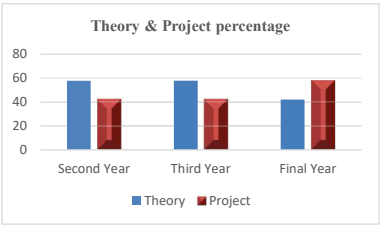

Fig.4. Class wise theory and project percentage

In second and third-year learning through PBL component is around 40%. In final year, it is increased to 60% by increasing project component in more subjects. Fig. 4 shows comparison of theory and project percentage in curriculum.

3. Evaluation of PBL

Course outcomes (CO) are statements that describe what learners are able to do by the end of course (subject). As shown in Table 5 Program outcomes (PO) are short term outcomes describing what students are expected to know and able to perform at the point of graduation. Attainment is measured as value of skills they have learned in alignment with COs. CO attainment is calculated through various evaluation methods and these COs are aligned with POs at different levels level 1: Slight (low), Level 2: Moderate (Medium) and level 3: Substantial (High).

Table 5. Program Outcomes

PO no.	Program Outcomes
PO1	Engineering Knowledge
PO2	Problem Analysis
PO3	Design and Development of solutions
PO4	Conduct investigation of complex problems
PO5	Modern tool usage
PO6	The Engineer and Society

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PO7	Environment and Sustainability
PO8	Ethics
PO9	Individual and Team Work
PO10	Communication
PO11	Project Management and Finance
PO12	Life Long Learning

A. Sample Rubrics and PO Attainment

Some sample rubrics are presented here for mini project which is filled by students. The mini project evaluation which is part of curriculum can be evaluated using rubrics. Table 6 shows the rubrics designed for mini project evaluation wherein attributes like teamwork, presentation skill, time management and lifelong learning are measured. The attainment of these soft POs is presented in Table 7. Number of students considered are 64 for filling rubrics in the scale of 0 to 5. At the end average of each PO is taken and converted it to percentage. Appropriate percentage is converted to attainment level according to levels decided initially by course co-ordinator. e.g. Initially one can decide the range as follows: 40% to 50% is considered as level 1. 51% to 60% considered as level 2. 61 % and above is considered as level 3.

Table 7. Attainment of Program Outcomes through Mini Project Activity (Number of students considered = 64)

Program Outcomes evaluated →	**PO2, PO3**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Average marks	4.16	3.69	3.95	3.98	3.91	4.02
Average attainment percentage (%)	78.48	85.90	72.26	55.62	69.48	76.68
Attainment Level	3	3	3	2	3	3

B. Mega Project evaluation methodology by faculty:

Mega projects are evaluated through following steps:

1. Formation of course (project) outcome.
2. Mapping of course outcome with POs.
3. Decide assessment parameters for project evaluation.

For example, one of the course outcome is "*A team of students will decide a Project topic and define problem statement" Similar* kind of methodology is followed for remaining COs of project. These COs are mapped to respective POs. Deciding assessment parameters and project evaluation is carried out with four attributes (R1, R2, R3, R4) as shown in Table 8.

Table 8. Assessment parameters for project evaluation.

Attributes	**Assessment Parameter & PO Mapping**
R1: Project synopsis approval	Identification of Problem Domain and Detailed Analysis (PO1)
	Study of the Existing Systems and feasibility of Project Proposal (PO2)
	Objectives and Methodology of the Proposed Work (PO2)
	Presentation (PO10)
R2: Midterm Project Evaluation-I	Formulating the Methodology (PO2)
	Building and Testing of Hardware & Software Modules (PO3)
	Planning of Project work (PO11)
	Project Demonstration (PO10)
R3: Mid Term evaluation-II	Project Execution (PO3)
	Integration of Hardware & Software Modules (PO3)
	Result Interpretation (PO4)
	Project Demonstration (PO10)
R4: Final Project Evaluation	Project Execution (PO3)
	Modern tool usage (PO5)
	The engineer and society (PO6)
	Sentimental Aspects (PO7)
	Ethics (PO8)
	Teamwork (PO9)
	Oral Communication (PO10)
	Project Report Evaluation (PO10)
	Project Management (PO11)
	Evidence of Learning PO12)

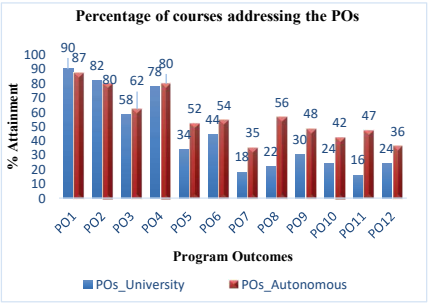

Fig. 5 Comparison of university and autonomous PO attainment.

Fig. 5 shows curriculum program outcome (PO) attainment of non-autonomous structure (University curriculum) and Autonomous curriculum for the year 2015-16 and 2018-19 respectively. Percentage of design and development is only 58% through various subjects. Percentage as shown in fig. 5 for non-autonomous are below 50%. Few of them are below 25%. Theoretical subjects are not supportive to improve these POs. Major areas where these POs get improved is only through projects. So, after autonomy decision has been taken to implement PBL in curriculum design. The program outcome statements are as per NBA norms [5].

PBL implementation in autonomous curriculum for the year 2018-19 has been improved. Percentage of attainment of PO4, PO5, PO8, PO9, PO10, PO11 and PO12 shows significant improvement. For example, PO8 of non-

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autonomous was 22% it is increased to 56% in PBL autonomous curriculum. Ethics can be assessed very easily through projects.

4. Conclusion

Students are benefited significantly through project based learning curriculum of Electronics Engineering. It also builds confidence to serve electronics industry by improvement in fundamental knowledge and communication skills. They also start developing their idea through innovative thinking. In autonomous curriculum it has been observed that there is significant improvement in various PO attainment as compared to university curriculum. Modern tool usage (PO5) has improved by 50%. PO6 deals with engineering and society which shows rise by 22%. PO7 improved by 50%, PO8 increased by 150%, PO9 improved by 60%. PO10 improved by 75%, PO11 improved by 200% and PO12 improved by 50%. PO8 signifies professional ethics which is improved due to various PBL component in each semester. PO11 relates with project management and finance which is improved significantly because a greater number of group projects done by students in each semester. PO10 relates with communication which also shows improvement because students have to work in group and present their work number of times in each semester. From above results we can conclude that PBL based curriculum is better than another curriculum structure.

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Table 6. Rubrics for evaluation of Mini Project

Rubrics for Evaluation of Mini-Project					
Sr. no.	**Assessment Parameter**	**Excellent (5-4)**	**Good (3)**	**Average (2)**	**Below Average (1-0)**
1	**Basic Knowledge regarding design and analysis of basic electronics circuits (PO2, PO3)**	Demonstrated extensive knowledge about the project work undertaken.	Demonstrated good knowledge about the project work undertaken.	Demonstrated basic knowledge about the project work undertaken.	Lacks basic knowledge about the project work undertaken
2	**Ethics (PO8)**	Student is always on the task, never needs remainders to do the work and encourages other group members to do the work.	Student is usually on the task, seldom needs remainders to do the work	Student is sometimes on the task, seldom needs remainders to do the work	Student is never on the task, constantly has to be remained to do the work
3	**Working in a group (PO9)**	Executed the assigned task completely & contributed significantly to the group.	Partially executed the assigned task & moderately contributed to the group.	Merely executed the assigned task & some-what contributed to the group.	No responsibility towards assigned group task & hardly contributed to the group.
4	**Presentation skill (PO10)**	Prepared excellent presentation and also presented it well. Answered all questions with proper explanation very fluently	Prepared good presentation but moderately presented it. Fails to elaborate entire project fluently.	Poor preparation of project presentation. Lacks presentation skill reflected through the inability towards expressing and answering questions.	No efforts at all towards preparation of Project Presentation. Completely lacks presentation skill
5	**Time Management (PO11)**	All modules/parts of the project and project report completed in time.	Most of the modules/parts of the project and project report completed in time.	Some of the modules/parts of the project and project report completed in time.	No modules/parts of the project and project report completed in time.
6	**Lifelong learning (PO12)**	Excellent responsibility for learning & personal development through complete involvement in PCB design and project report formation.	Somewhat good responsibility for learning & personal development through complete involvement in PCB design and project report formation.	Poor responsibility for learning & personal development through complete involvement in PCB design and project report formation.	Very poor responsibility for learning & personal development through complete involvement in PCB design and project report formation.

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Problem-solving in Integrated Laboratory using Hackathon Approach

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Abstract:
There is a need to introduce new pedagogy practices to improve the problem-solving skills and critical thinking capabilities of students helping them to execute multidisciplinary projects, thus striving to meet one of the important objectives of the Automation and Robotics program. This proposed paper describes such an activity initiated by an instructional team of 3 faculty members that made students practice the engineering design process using an integrated approach for the selected real-time case study problems during their 6th semester. This integrated approach methodology resulted in the application of the knowledge gained in three different laboratory courses, namely Real-Time Embedded Systems, Object-Oriented Programming languages, and Database Management System practice. The activity was initiated at the commencement of the semester, along with the regular laboratory activities. With a planned schedule, students were made to solve problems, namely, Machine Health Monitoring, Electric power monitoring system, and Sleep Health Monitoring, shortlisted by the faculty team based on the survey done for the latest research topics in the automation area. The time allotted for the activity was two days on an individual basis and was evaluated as a part of their final lab End Semester Assessment scheme. Evaluation of students was done based on well-defined rubrics to test their individual and team-wise skills related to each of the three labs integrated. Here, we present the summarized results of the Integrated activity using Hackathon Approach in the form of the grades achieved and the feedback analysis for the entire class of fifty-five, number of students.

Keywords: multidisciplinary projects, Real-Time Embedded Systems, Object-Oriented Programming, Database Management System, Integrated approach, Hackathon

1. Introduction

In the era of rapid technology advancement, explosive growth in the innovation of technology has a tremendous impact on society. The main objective of the Automation and Robotics program is to make students develop the best competencies in the different fields of engineering so that they are industry-ready. In the department, students study subjects related to Mechanical Engg., Electronics, and Communication, Electrical Engg. and Computer Science Engg. The activity of the integrated approach has accomplished the process of combining various fields of Engineering to solve real-time problems and propose solutions starting from a systematic literature survey using the engineering design methodology for VI sem students of Automation and Robotics program.

The integrated approach used for problem-solving has combined the three different laboratory courses, namely, Real-Time Embedded Systems, Object Oriented Programming languages (OOP's), and Database Management System (DBMS) practices respectively to solve the given multi-disciplinary problem. The students are exposed to the integration technologies required to combine sub-systems belonging to all three disciplines. In the last few decades, the complexity of systems has risen dramatically, leading to the necessity of acquiring the knowledge required to design, implement, and maintain. This paper provides "best practice" paradigms of how these challenges are addressed in "Problem-solving Activity using an integrated approach. This activity has incorporated active learning approaches, using group and team-based approaches. This activity has provided better insights for subjects offered and taught in the curriculum. The integrated programs have a good deal of benefits in terms of project execution skills and developing an in-depth knowledge of a specified problem area and the proposed solution[1,2,3,4]

2. Problem Statements Selected Based On Literature Survey

The generic problem statements, namely, Machine Health Monitoring, Electric Energy Monitoring, and Sleep Health Monitoring, were given to students based on the survey done by the faculty team among the latest research topics. [5]. The detailed problem statements given to students are listed below:

I. The first problem is the machine maintenance problem. Machines are continuously-operated for many hours. Once they break down, it takes a substantial cost to repair them. Detecting symptoms of machine trouble requires a considerable amount of time and technology. Hence it is

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difficult to implement. Repairing a machine takes much time; it significantly affects the machine activity rate. Therefore, machines, especially large ones, are required to be free of downtime and capable of planned operation without interruption. To secure such machines, it is necessary to early detect any symptoms of machine trouble by physical examination and analysis of parameters like temperature, vibration, torque, speed, etc. gathered from the machine by installing appropriate sensor modules. There is a need for a data logging facility for each of the parameter and storing on to the database. The further, the algorithm has to be designed for analyzing the data records and make decisions making to give input to the maintenance personnel to take suitable measures to upkeep the machine. The proposed system should ensure predictive maintenance to avoid break down maintenance.

II. The second problem is the detection of a sleep disorder. Sleep disorder caused during night time is one of the very concerning health problems of modern society. It is many times caused by breathing disorders leading to an insufficient supply of oxygen to the heart, causing many heart-related ailments like hypertension, stroke, and atrial fibrillation. Preliminary detection of breathing disorders can save people from such heart diseases. The gold-standard test, being used for sleep disorder detection, is Polysomnography (PSG), which is a very sophisticated and costly technique. Also, the patient needs to be in the sleep lab setup continuously for a minimum of 8 hours during the night. One way of detecting the disorder is through the study of physiological parameters like Electrocardiogram (ECG), EEG, EMG, EOG, blood pressure, pulse rate, temperature for about 8 hours of sleep. The values of these parameters lie in the specified ranges for a normal person. For a patient affected with the sleep disorder, the parameter values are going to change from the normal ranges based on its severity level. There is a need to decide on the optimized set of parameters that can be studied to detect sleep disorders. Hence the need is to develop a data acquisition system for gathering the necessary physiological parameters for the entire night that can be stored on to the database. Further, an algorithm can be developed for processing data records in offline mode.

III. The third problem discusses the issue of management of water supply across the KLE Tech campus, which has many bore-wells, generators used for 13 academic blocks, and four hostel buildings. There is a problem of power shut down; power fluctuation and interruption of power supply. There is a need to monitor the electric power consumption campus-wide. The proposed system needs to have a data logging facility whenever there is an interruption in the power supply using the database. Further, an algorithm can be developed to analyze the recorded data and estimate the power consumption building-wise and analyze the problems of power shut down, power fluctuation, and interrupted power supply that occurs thought the day.

3. Design and Implementation

The activity was initiated at the commencement of the semester, along with the regular laboratory courses. The activity is conducted according to a planned schedule, based on which introduction to the activity, the guidelines, the scope, and expectations were discussed as the first stage. The basic concepts related to the three laboratory courses were taught during the regular lab sessions for 8-weeks involving demonstration, exercises, and structured queries, which was a prerequisite for the planned activity. The class strength of 55 students was divided into teams of 6 students, and each team was assigned a specific problem statement. Thus the integrated approach aimed at proposing solutions for real-time case studies by the student teams of Automation and Robotics program during their 6th semester[8]. The activity was conducted team-wise from the literature survey up to review of progress on the analysis of the problem as per the schedule planned for 4 hours per week. Later, students were asked to work on an individual basis to propose a unique solution for the selected problem. Further, the proposed solution was implemented by students in the Hackathon event on an individual basis. As the first part of the activity was conducted in teams, the collaborated efforts within the team helped them in analyzing the problem with enthusiasm.

The hackathon event was planned and conducted for two working days for 7-8 hours at a continuous stretch. During the event, the students were asked to build their proposed solutions on an individual basis from scratch. The activity aimed at guiding the students to solve the given problem starting from data acquisition using sensors, use of real-time hardware for processing of the input data, data logging on to a SQL database, and finally an intelligent decision making with algorithms developed using object-oriented programming language.

The Engineering design process was followed in the activity to analyze the problem thoroughly and arrive at an efficient solution. Under the first stage of the activity, students were made to analyze the chosen problem with a set of collected requirements gathered from the state of art literature survey[9], The specification obtained after the requirement analysis resulted in predefined behavioral assumptions which were verified before the actual implementation using system modeling language (SysML). The use of software tools for help in presenting the critical analysis of the problem[10], which is highly convincing and enabled better understanding. The complexity of the problem is resolved using System Modeling Language (SysML) with the help of standard models such as the USE-CASE diagram, Requirement Diagram, Activity Diagram, Sequence chart, and statecharts diagrams respectively[10]. The proposed techniques can be easily realized using the software tools that prove to be very beneficial in analyzing the problem as well as the solution

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in every detail. The techniques help to understand the intricate details of each of the steps in problem-solving, before developing the final algorithm. The advantage is that the approach can be adopted for solving any real-world problem from scratch, which is an important ability of a budding engineer.

The sample diagrams such as USE-CASE, Requirements Diagram, and Sequence Diagram are shown in Figure 1, Figure 2, and Figure 3, respectively, for the problem on Sleep Health Monitoring.

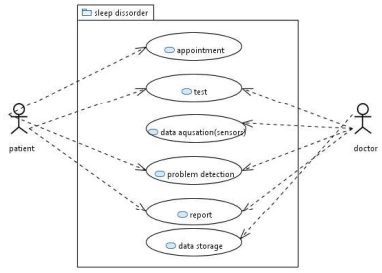

Figure 1. Sample SysML diagrams- USE-CASE

The requirement diagram deals with the requirement analysis of the problem in-depth and also the performance of the proposed solution, and further, the built system can be rated against the required specifications. The pictorial representation of the requirement analysis is quite convincing for the students.

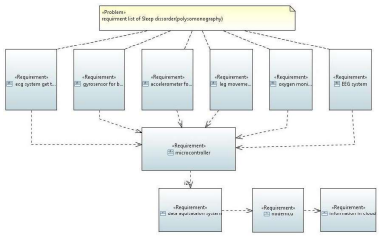

Figure 2 Sample Requirement diagram

The sample sequence diagram shown in Figure 3 provides the stepwise approach to solving the problem, which helps in ensuring the smoother development of the algorithmic code. The approach proved to be very useful and easy for students to analyze and present the solution using specialized software tools discussed above. This was an important step to refine their programming and analytical skills using the extensive use of software tools for the purpose[5,6].

Peer learning ensured simplification of the learning for every member of the team while studying the survey papers and analyzing the selected problem. Students were able to build a morphological chart explaining the means of implementation of each of the subsystems for the proposed solution.

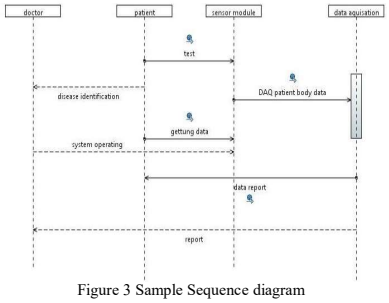

Figure 3 Sample Sequence diagram

As per the objectives of the Real-Time Embedded System course, students need to acquire knowledge in the areas. Namely, the capturing of real-time data, deciding on the selection criteria for sensors, mounting of sensors, power-management strategies, and interfacing of real-time target hardware. The student needs to understand the requirements of programming and storing the captured data on to a storage device for future usage in offline processing and online gathering of parameters from sensors through a real-time target. To address these requirements and build the solution, the students had the choice for materials and methods under each category, for sensing, signal conditioning, processing, storing, and lastly, interfacing with computers for access to high-end tools for intelligent decision making and database management.

The relational database used in the proposed solution provides support for efficient data logging. The information collected through requirement analysis and the data-acquisition from sensors was used by the student to check the dependencies between the identified entities by the E-R diagrams.SQL engine is used to create the table and to write queries. The students have been experimenting the object-oriented programming techniques, namely, C++, Java, and python successfully. The front end GUI design that enabled the user's interaction and the intelligent decision making for the data captured in the database system was implemented using object-oriented programming language[7-11]. Thus the extensive use of tools enables every student in a team to understand the

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stages of the design process, analyze the problem as well solution.

The generic block diagram of an example inter-disciplinary system is as shown in Figure 4.The prototype models having the essential blocks built by student teams, as shown in Figure 4, that are developed under each of the problems. Hence the representation of the proposed solution is taken to be a control system programmed for monitoring and control problems.

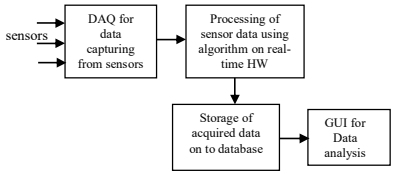

Figure 4. A generic system block diagram for the solution of selected problem statements

The multi-methodology approach based on the "pick and mix" method was followed by students, in which the most appropriate methods for data acquisition, data logging, and decision making were chosen to fit the problem rather than following a single methodology. The prototypes developed at the end of the hackathon event were interesting. In one of the solutions developed on machine health monitoring, the physical model of sensor network was built using temperature and vibration sensors installed at required places on a shop-floor machine and the sensor data was processed in real-time using the TIVA C series microcontroller and analysis graphs were presented using the graphical user interface. For the second problem on sleep health monitoring, students had gathered sensor data using a pulse oximeter, motion sensor, and heartbeat sensor installed on the body for a set of adults during sleep. The analysis of sensor data was done in off-line mode on a desktop computer to provide a decision based on number of sleep apnea events that occurred during sleep and infer whether the person is a normal being or the one affected with apnea. The solution provided the analysis of graphs of physiological parameters tapped from the body.The real challenge for students was to satisfy the objectives of each of the integrated laboratories in a justifying manner.The activity involved team-based efforts and thus promoted peer learning. The weaker students were motivated to perform the tasks assigned to them efficiently [11].

4.0 Assessment

During the review process, the challenge was to measure the attainment of objectives of each of the laboratories, namely, Real-Time Embedded System, OOPS, and Database Management Lab. Students were tested on the integration technologies used under the project solution. This was achieved by following the well-defined rubrics developed for each phase of the evaluation process. The time slots planned for review could accommodate interactions of faculty mentors with students regularly up to the time of the start of Hackathon event. There were four review meetings along with intermediate evaluation, conducted for follow up of progress done by student teams. Intermediate grading was also done for 30% of the allotted marks. Time allotted for implementation of the finalized solution was two days through the Hackathon event, i.e. a total of 14 hours on an individual basis and was evaluated as a part of their final lab End Semester Assessment (ESA) grading procedures. Evaluation of students was based on well-defined rubrics used for testing their individual and team-wise skills related to each of the laboratory for the remaining 70% of the allotted marks in the respective laboratories[8-11].

5.0 RESULTS AND FEEDBACK

Students presented the analysis of the problem and the solution, in detail satisfactorily, and could address every issue using the survey data. Analysis of the results achieved by students was quite encouraging, as 75% of students completed the development of the solutions within the stipulated time satisfactorily, whereas 15% of them ended with partial results as shown in Figure 3. Grading of students was done using the rubrics on the survey of the literature, algorithm design, execution time, and analytical ability. The oral feedback and the enthusiastic participation of students in the hackathon event were encouraging. The knowledge gained by students on the integration technologies was quite satisfactory, as evident from the grades scored.The student's feedback on the activity was captured through a questionnaire, and it revealed that the activity helped them in enhancing their skills related to problem-solving ability in a real-time scenario along with other skills, namely, time management, programming, debugging and troubleshooting as shown in Table 1.

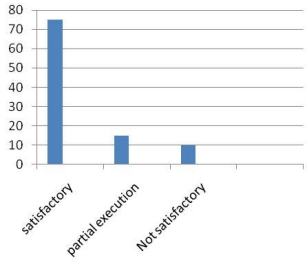

Figure3 Analysis of Student feedback

Table 1.0: Summary Feedback collected through Questionnaire

Factors measured based on Feedback and performance	Attributes			
	Strongly agree	Agree	Disagree	Strongly disagree
Team work	52	30	14	4
Problem solving skills	45	52	3	0
Extent of achievement activity	55	25	15	5
Time duration of activity	60	30	5	5
Skill development	50	35	10	0
Communication skills	60	35	5	0
Autonomous learning	50	20	15	5

The feedback received and the results attained by students was quite motivating for the involved faculty members to refine the activity. The evaluation conducted by the faculty team in a collaborated manner helped the analysis of students' performance critically as well to give them the feedback for improvement, which proved very crucial, while students solved real-time case studies. Hence the outcomes of the proposed activity addressed the important requirements under the majority of the graduate attributes

6. Conclusion

The analysis of feedback and the performance of students could boost the morale of the faculty members involved in conducting the activity. Students understood the intricacies of integration technologies involving hardware and software elements while building the solution for the stated problem, which is essential for the students of the interdisciplinary branch. The experience gained by students through the proposed problem-solving approach will surely help them in executing the projects in higher semesters. Students experienced the advantage of peer- learning in the team as well as test their solutions through Hackathon event. It was a unique and challenging experience for the faculty members to guide the students to solve problems mimicking real-time case studies.The faculty members involved got motivated through students' volunteered participation and demonstration skills. The activity could address the majority of the engineering graduate attributes. The need for refining the activity in terms of changes to be made in team size and allotment of extra time slots was felt for the smooth conduction of the activity, which will be taken up as an improved measure.

Acknowledgment

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Project-Based Learning Approach in Undergraduate Engineering Course of Cryptography and Security in Computer Science

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Abstract

The core idea of project-based learning (PBL) is to focus on the real-world problems that capture students' interest and develop critical thinking and problem-solving skills in students. We present in this paper how project-based learning help students to learn factors in project design and how technology can support students when they work on the projects. It presents the difference between traditional learning and project-based learning and also presents the execution of a project-based approach used in the work of the course conducted for sixth-semester students of the University of Mumbai that is Cryptography and System Security. Cryptography is a technique to convert the data from plain text to encrypted text and Vice a Versa. Security provides protection to any information from theft or damage from hardware or software. In our institute, Cryptography and System Security course are chosen for designing the PBL approach from Couse Level Project-Based Learning (CLPBL) because of its difficulty is higher level and importance in Industry. In the CLPBL process the teacher gives the key concept of projects to students and students will find out an appropriate solution for a given problem by using different security techniques, algorithms and authentication methods, etc. After completion of projects, students submit implementation, as well as documentation and the teacher, will evaluate them by using different assessment tools. Resulting from this is the students built enough confidence to implement not only what they learned in the class but also practically they can implement these concepts.

Keywords
Project-base learning, CLPBL, Security, Cryptography

Introduction

In traditional teaching, we begin by conveying the information, usually in descriptive class, and then presenting the problem to be solved, assuming that the contents previously conveyed will allow the students to understand and solve the problem.
In PBL the order changes. It begins by presenting the problem and the students try to obtain the information necessary to understand and solve the problem. The teacher changes their role, no longer delivering the information, but does help the student to get it and understand it. Project-based learning (**PBL**) is a practical approach in which small groups of students engage in tasks and learn as they attempt to solve relevant problems. Students ask and rewrite the questions, debate ideas, generate predictions, experiments, collect data, draw conclusions, communicate and detecting ideas, clarify the approaches, and create products.

Vishwaniketan Institute of Management Entrepreneurship and Engineering Technology (**ViMEET**) affiliated to University of Mumbai, is following the traditional as well as a project-based learning system. In ViMEET, the Course Level Project Based Learning (**CLPBL**) is being conducted for second and third-year students.
In this paper, we present a learning system that is built upon project-based learning. This learning system is capable of generating different issues from Cryptography and Security domain, that developing appropriate solutions, evaluating students' solutions and referring them to acceptable learning materials.
Course level project-based learning(CLPBL) is for higher education, the student attainment goes beyond content knowledge, to prepare and challenge the student to direct their own learning, solve problems of academic significance and to move beyond controlled information containment. Project-Based Learning in the Classroom ideas must be explored, developed, integrated, and resolved within the context of a particular assignment as knowledge construction at advanced levels take on new meaning. Rather than being the source of content expertise, teachers are challenged to be the coordinator of knowledge and motivators of action learning. Unlike assignments of traditional learning, the PBL approach recognizes and values unpredictable outcomes. Higher-level thinking and an extended thought process are to be expected from the students for real-world problems and life-skill expertise. PBL can be a leading factor in making

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students successful and capable. At this level, students experience responsibility for academics that guide them into the essentials of lifelong learning and are validated through their decisions and actions. For this responsible instructional outcome, classes with large enrollments become easier to manage because learning is student-centered.

Computer Science and Engineering department of ViMEET is chosen Cryptography and System Security course of sixth-semester for the Course level project-based learning approach because of importance in Industry and difficulty in higher level. In this CLPBL process the teacher who has been assigned for the CLPBL course, he/she designs the problem statement of projects, but only project ideas or concepts are given to students. Students have to do a lot of brainstorming to identify the correct solutions. After completion of the projects students submit their report of projects to the teacher. Teachers are evaluating the projects throughout the semester by observing student activities.

PBL in Cryptography and Security

Cryptography is a widely known process of encrypting and decrypting messages. It can use anything from numbers to letters. We can pass messages without knowing others what the message is with the use of protocols, algorithms, and strategies. Cryptography is based on the sender and recipient having keys. When the sender wants to send a message, the sender encrypts the technology, and then sends the message. If the message is hacked the hacker will not understand the message. After the message reaches the recipient the message can be decrypted and read by the recipient.
Security needs against attackers and hackers. Security provides confidentiality, integrity, and availability from data hardware, software, and firmware of a computer system. Security protects the information from unauthorized access and loss.

The Cryptography and Security approach in project-based learning will show how cryptography and Security work in a real-world problem. Humans love to be secure. If anyone proved that something is secure and useful, humans will accept it. This will allow humans to feel safe enough to try to change old inefficient aspects of life with the new method given to them. In this approach, we are providing the method which uses cryptography for better securing information and data. It will allow using smarter and more secure methods. During these small transitions can observe many changes. Changing to a cryptography system is beneficial in the end as well as during the process. Society will be insecure due to some attackers. It will make small changes first. It will also have to be an attractive change. Using safe security of cryptography must attract the person by attractiveness as well as efficiency. The change will be slow in cryptography taking over other aspects of life that are not online, but certainly can be done. This change will have a major impact while and after it is being introduced into the everyday life of humans. The major impact can come from studying and learning science while this change is taking place. It will also reduce the vulnerability of paper documents. Translating languages isn't hard, but translating cryptography without a key is very difficult. Due to this, the work in this approach will be beneficial for society.

The principle behind this to prove that Cryptography can be effective and useful anytime and anywhere if used properly. Currently, cryptography is being used all over the globe, even by unsuspecting people. It is being used online. Everything that is secured or even slightly protected online is using cryptography. This little-known star of our lives protects and safeguards are valuable online information. Seeing that cryptography work is well, other forms of data storage and information safekeeping may be updated to use cryptography. For safety reasons, even written documents can be made into cryptography.

When we used cryptography and security concepts in our day-today life then every student needs to know how these concepts used in our life. So with the traditional system, it's not possible too much because in the traditional learning system theoretical part of the concepts expressed widely not actual implementation. So students cannot implement any concept that much effective in real-life. Due to this reason student needs to know what are the real-world problems and how to solve those problems with the help of those concepts learn previously, how to implement all these concepts and in day-to-day life by using project-based approach.

To enhance these concepts, In our institute, Cryptography and System Security course are chosen for designing the PBL approach from Couse Level Project-Based Learning (CLPBL) because of its difficulty is higher level and importance in Industry.

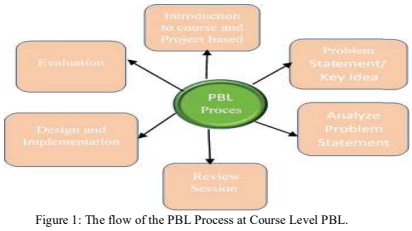

Figure 1: The flow of the PBL Process at Course Level PBL.

Figure 1 describes the flow of the PBL process when it considered at the Course Level. It describes after selection of course for CLPBL, the teacher who has been assigned for CLPBL, he/she designs the problem statement, but only project ideas or concepts are given to students. The teacher becomes a guide to this learning

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process, and every student is the leading player of this learning. In this approach, the job of a teacher is to guide the student to find the best solution to the problem. Students also assume a new role and move from a generally static attitude, in which they expect to receive the knowledge, to be active subjects of their own learning. It is difficult for them to make this change but the teacher must get them involved, instead of listening; that they speak and communicate, instead of receiving explanations; analyze, obtain information, make decisions and do, rather than waiting for knowledge. Students have to do a lot of brainstorming to identify correct cryptographic techniques, cryptographic components, algebraic structures, hashing algorithms, and authentication techniques. For this process, students refer to some books and they also discuss with their teachers and friends and find out effective encryption algorithms, hashing techniques, etc. for the real-world problems given as projects. It develops a student's ability to work with other students, building teamwork and group skills. The teacher represents the learning outcomes of the course as well as he/she clears the explanation of basic concepts used in the course by giving some examples. He/ she has highlighted the concepts covered in the lecture and students are mapped these concepts with the learning outcomes as well as the concepts of projects covered. Simultaneously teacher designs the stepwise activities that involve in each project. Then he/she find out which topics are covered by each and every project from the syllabus. After this he/she designed the factors considered in project design such as student capabilities, Finance required for any project, College infrastructure, Is it challenging for students?, Can it be completed in time, Can course content be learned to fulfill? Etc.

Considering these factors he/she gives the rating to project design like high, medium and low. On the other side, a teacher takes a follow-up of students' progress by scheduling review sessions and gives any suggestions or changes to students. According to that, the students give their reviews on the project and also they report the completion of the project. Students are engaged with their activity to involve in a project means they are trying to finding out the solution for the project in various ways, by different-different concepts used in cryptography and security. Teachers find out the program outcomes that students will learn when the project is completed. Suggestions and changes will be checked in the next review and give remarks to them. After completion of the project students submits survey reports of projects and teachers evaluate them.

In the evaluation scheme, he/she defines some criterion that is the rubrics. A rubric is a grading tool that represents the performance, expectations for project work. A rubric provides clear descriptions of the characteristics of the work-related to each component, at every level. Rubrics give grades by finding patterns in student achievement or student error, it also provides analyzed information about student strengths and weaknesses of technical knowledge. It gives the score for individual parts of the product or performance of the student. It helps a student how to improve their performance regarding what is expected for each criterion. We use different parameters to evaluate the projects with the help of rubrics like security objectives, mechanisms, choosing appropriate algorithms from the cryptography and security concepts.

We sum up the PBL process with the help of one case study which is implemented by our students. When we start this process at that time we state the learning outcomes of the PBL process like:

CLO1. Apply the knowledge of symmetric cryptography to implement simple ciphers.
CLO2. Able to analyze and implement public key algorithms like RSA and El Gamal, hashing algorithms.
CLO3. To explore the different network tools to gather information about networks like sniffers, port scanners and other related tools for analyzing packets in a network.
CLO4. Able to set up firewalls and intrusion detection systems using open source technologies and to explore email security, web security and attacks on it.

After stating the course learning outcome we gave the key idea of a project to a student that is how to overcome the issue of manual bus pass checking system and some students travel without paying fees. Then our students started their brainstorming task such as finding the actual problem it is mean that they analyzed the problem and search for an appropriate solution with the help of a security concept. After this, they represented their analyzed work in the form poster at the time of the review session. At the time of the review session, students explained why they select the Triple-DES algorithm and how the project flow is. On another side, the teacher assessed their activities and has given some suggestions for implementing techniques in the project.

For this process, students referred to some books and they also discussed with their teachers and friends and did a lot of brainstorming to identify correct cryptographic techniques, cryptographic components, algebraic structures, hashing algorithms, and authentication techniques to find out the effective solution for the real-world problems given in their project. After finding all these things they gained actual concepts used in the project then they try to implement this. In a described case study, the students used the Triple-DES algorithm for encrypted as well as decrypted information and overcome the real-world problem. The Triple-DES algorithm used the concept of the Data Encryption Standard (DES)/ Data Encryption Algorithm (DEA). In the Triple-DES algorithm, we can use three different configurations of keys. In the first configuration, keys are used three independent keys and this is the most secure. In the second configuration, the first and third keys are

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the same and the third configuration uses three identical keys. When identical keys are used, it works the same as DES. When we used the first type of key configuration – the 16 sub-keys are derived from key one with Initial permutation that includes the block is split into left and right halves. The right half is sent through the F function, Expansion permutation, XOR with the sub-key for the round, Substitution, Permutation, XOR the result of the F function with the left side and swap the right side the new left side, and the result is the new right side. Repeat the above steps 14 times. The right half is sent through the F function, Expansion, permutation, XOR with the sub-key for the 16th round, Substitution, Permutation, XOR the result of the F function with the left side and combine the left and right sides of the block together and complete with final permutation.

With all these methods, students have implemented the code for the given problem statement in Figures 3, 4, 5 and 6.

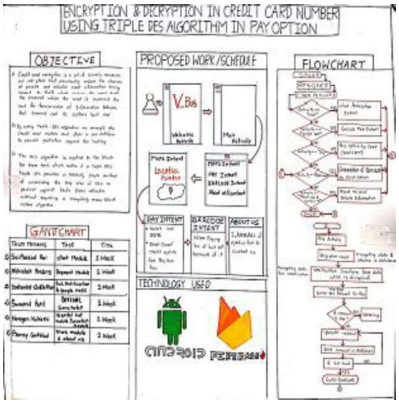

figure 2: Poster presented at the review session

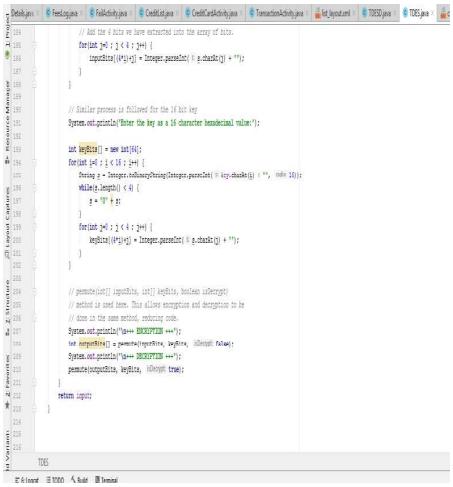

figure 3: Encryption Part

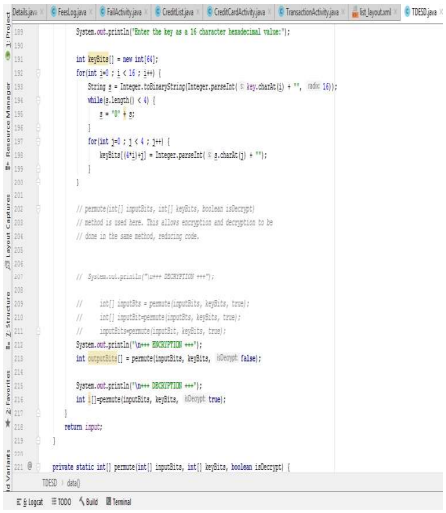

figure 4: Decryption part

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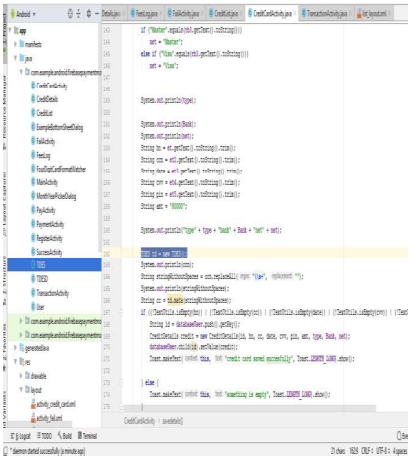

figure 5: Implementation in Activity

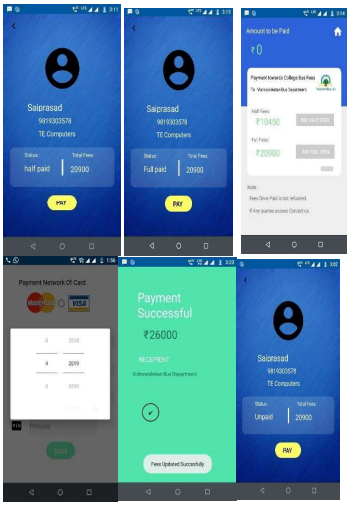

figure 6: GUI Interface

The actual output of the code given in figure 6.

By using this Triple–DES algorithm, students encrypt the credit card no. and store it into a database to provide protection against hacking. The DES algorithm is applied to the block cipher three times which makes it a Triple-DES. Triple-DES provides a relatively simple method of increasing the key size of DES to protect against brute force attacks without requiring a completely new block cipher algorithm.

After completion of this implementation of an android application based on security, students presented the outputs with live demo to the teachers and the teacher evaluated them by using rubric parameters considered for the PBL process and the grades are given to them.

The rubric parameters considered for evaluation as shown in figure 7.

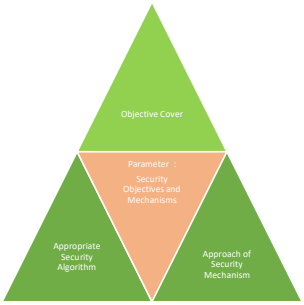

figure 7: Rubrics Design

According to this, the teacher evaluates student's projects and grades have given to them.

Results

An objective of the course is students can be able to analyze the given problem. They have to do a lot of brainstorming to identify correct cryptographic techniques, cryptographic components, algebraic structures, hashing algorithms, and authentication techniques and find out an appropriate solution for the problem. The main goal is to involve the students' in a PBL approach actively engaging students during the learning process, solving problems and different difficulties faced in project activities. To evaluate this goal during the course and after completion of the course, we interacted with students and took the responses about a PBL approach.

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The class consists of 70 students, 80% of the students were interested to learn the course by using this approach and they were motivated not only to learn the course in-depth but also learn the effective algorithms from the course. Apart from the course, they have learned a fundamental skill (like reading, writing), mathematical skills along with problem-solving, teamwork, information collecting, time management, and handling high technological tools from a project-based learning approach. When students referred to different books at that time they developed the quality of reading as well as writing. When they wrote the End Semester Exam at that time they showed these skills as well as mathematical skills along with problem-solving, time management very effectively. In the exam, they improved their paper writing quality as compared to the last exam.

Following are students reactions with respect to course level project-based learning:

" We implemented the Triple-DES security algorithm for increasing security while storing the data in firebase. We learned and applied something new that was not in our syllabus. It also increased our knowledge regarding the course Cryptography and System Security. The PBL implementation was on credit card number which was encrypted and stored in firebase and while retrieving would be decrypted and showed in the interface of the app, since the credit card is an information value."

"The project-based learning process is quite unique in its own way. It makes us learn things by ourselves and Project-Based Learning is something in which we learn or understand the concepts taught in class by the means of building projects. So, this semester PBL was on the Cryptography and System Security course in which we implemented the concepts of data encryption, decryption and authentication concepts in our projects. To see their real-time working which proved to be very helpful, in terms of understanding which gave us enough confidence to implement not only what we learned in the class but outside the class also. "

Conclusion

Monotonous concepts of the course do not understand when students learn the course by a traditional learning process. due to this reason, for a greater understanding of that concept, the course will select for the project-based learning process. So it concluding that greater student interests ruling to better performance and deeper learning. In the traditional learning process, those concepts are very tedious, uninteresting, boring, etc. that the PBL process makes it very simple, understandable, interesting as well as challenging also. We concluded that, after the use of the PBL approach, the students improved knowledge of the respective subject which is used for the semester exam.

The project-based learning is not only useful for the students but teachers also. Teachers use the project-based approach at that time they learned multi leading, teamwork, professional development, new multiple technologies from the PBL approach.

We have concluded that the project-based learning process is useful for students as well as teachers also. When students gave presentations in review session they build up the presentation skill as well as teamwork. When teachers use PBL at that time they also learn how to evaluate the real-world problem according to course parameters.

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Dr. Anand K. Bewoor is currently working as an Associate Dean Academics and Professor, in Mechanical engineering, Cummins College of Engineering for Women, Pune. He holds bachelor's degree in Mechanical, master's degree in Production, from WCE, Sangli and PhD in Mechanical Engineering. He has also worked as Vendor Development and Quality Control Engineer in the industry. He earns 20+ years of experience. He has published 13+ books in the field of Metrology & Measurements, Quality Control, Production Planning and Control, Industrial Engineering and Management etc. He has presented 50+ technical/research papers at national and international conferences and published papers in journals of national and international repute and 4 patents. Total 3 research scholars received an award of PhD under his supervision and 4 are on-going.

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Dr. Suhas P. Deshmukh is currently working as an Associate Professor, in Mechanical engineering, Government College of Engineering, Karad. He holds bachelor's degree in Mechanical, master's degree in Mechanical Design Engineering, from WCE, Sangli and PhD in Mechanical from IIT Bombay. He serves as a Certified Energy Auditor & Manager, Bureau of Energy Efficiency. He earns total 19 years of experience. He has presented 90+ technical/research papers at national and international conferences and published papers in journals of national and international repute and 9 patents. He holds Young Scientist award, for Fast Track Research Project, DST, Govt of India. He served as principal investigator for "Sensor-less XY Flexural Mechanism for Precision Application" by DST and received funding of 14 Lakhs and "Design and Development of Sensor-less Linear Compressor", for ISRO-UoP Cell, received funding of 15 Lakhs.

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Vidya Srikanth B. Arch, MTP (Ph.D.) is Professor, School of Architecture REVA University. She has over 17 years of combined experience in academics and practice. She is widely travelled and brings with her rich experiences of living and working in Europe and North America. She is closely associated with the Curriculum design of the B. Arch program and is member coordinator of the Board of Studies for the School. She is passionate about Vernacular Architecture and is involved with documenting and researching the Vernacular architecture in Karnataka across different Climatic zones. Her interest in innovative pedagogical methods has led her to pursue her doctoral research at REVA University. Her broad area of research is Project Based Learning in the domain of Architecture education. Vidya has an interest in Hindu temple architecture and teaches courses on History of Architecture. She initiates and practices several innovations in course delivery and evaluation methods and her publications are rooted in the themes of Pedagogy and Temple architecture.

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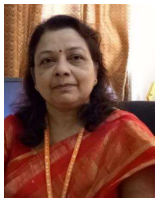

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