Holistic Student Development Model for improving Employability of Engineering Graduates

Shiwani Gupta, Jesal Varoliya, Anupriya Babbar, Archana Nanade, R. R. Sedamkar

Abstract: The rapid expansion across sectors of global economy has changed the way we should educate and train our future engineering professionals. Upholding of the old standards by engineering institutions can not help much to improve the quality of engineers as well as impose difficulty in adapting to the rapidly changing global market. This paper addresses various holistic development models such as internships, self / online / blended / design-based learning through goal oriented activities, adopted worldwide and what we propose and implemented at TCET, the challenges we faced and the learning we developed. Embedding Diversity, Equity, and Excellence to the institute is critical. Further, stating future plans for the same which consists of self-efficacy beliefs, Intrinsic growth and Confidence in students. Major focus for over all development should be on work ethics, time management, team work and taking personal responsibility, conduct basic research, critical thinking skills and lack of interest in reading beyond curriculum. Through various tests and trials in order to develop engineering graduates on all front, it has been observed that beyond component learning cannot be imposed and different category of students are to be treated differentially to groom them. With that, positive feedback system helps student to understand his/her passion and identify the future scope in that domain. In all, online courses, project development and internships have shown acceptance by student community. The goal is to enhance personal, physical, emotional, and creative potential of students. They further appreciate hands on sessions and industry exposure through Industrial visits and Alumni Connect Programmes.

Index Terms: project based learning, technology based learning, holistic education, graduate attributes.

I. INTRODUCTION

There are thousands of engineering institutions in the country providing technical education and lakhs of students are graduating year on year [1]. The key purpose of engineering institutions is to advance the frontiers of knowledge, integrate new technologies from the laboratory to society, offer a rigorous education, and train students to become qualified engineers and society leaders. Engineering education has to rethink and develop teaching systems in relation to for example, learning objectives, choice of teaching and learning methods,

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assessment and organizational culture. The students must have the 3Cs (Curiosity and Creativity, Collaboration and Compassion) for a prospective future to be built. The University curriculum is lacking in industry alignment and there is less focus on life skills as mentioned by Industry experts and recruiters from time to time.Thus keeping in view, the requirements of NBA and NAAC, beyond curriculum learning, research and extension activities are to be undertaken by the department for holistic development of engineering graduates in order to make them globally acceptable. To develop above skills, the university system doesn't have a scheme which offers measurable outcomes. Out of 3700 public and private engineering institutions across India, more than 90% colleges are University affiliated and have to abide with university curriculum [2].

It is surprising that more than 60% of the eight lakh engineers graduating from technical institutions across the country every year remain unemployed, according to the AICTE. In the past, stakeholders particularly the recruiters have shown concern about the attitude and professionalism required for taking up client-side projects from day one at the industry. Only 18% Engineering Graduates are employable says [3]. In a world of rapid scientific and technological advancement, skill is rapidly becoming a commodity that can be bought from low-cost providers anywhere across the globe and even the half-life of an engineer's vocation-specific knowledge is steadily decreasing. To bridge this gap between curriculum and industry expectation, we introduce Technology based learning (TBL). The aim is to inculcate interpersonal and intrapersonal skills along with cognitive skills which require seamless learning.

In a survey conducted in [4], Students and teachers perceive internship that they call workplace learning as valuable as it connects theory with professional practice and contributes to students' professional personality development. In [5], authors have felt that the 'employability' of graduates depends on a combination of high technical knowledge, practical experience and soft skills. There are 55 million youth between age group of 18 and 23 in India and only 15% of them have the opportunity to pursue Engineering Education according to [6]. Though the focus is to provide access to many but equally important is to ensure quality of education. Engineering graduates today require not only adequate technological ability and problem-solving skills, but also must be equipped with soft skills, business skills, inter personnel and intercultural adaptability. The author has further laid down the importance of self learning and role of teacher as facilitator for projects, assignments and case studies. In [7], the author emphasizes collaborative learning through integration of teaching and research, holds students responsible for their own learning.

He further insists on permitting linking of university education with a system of professional certification, which opens better future opportunities for our graduates.

In [8], a study carried out by the U.S. National Academy of Engineering (NAE) it was shown that, "The engineer of 2020 will be expected to foresee and prepare for potential catastrophes such as biological terrorism; water and food contamination; infrastructure damage to roads, bridges, buildings and the electricity grid; and communication; breakdown in the internet, telephony, radio and television. Engineers will be expected to provide solutions that lessen the risk of complete failure and at the same time prepare backup solutions that enable rapid recovery, reconstruction, and deployment".

AICTE chairman [9] states that "internship is mandatory for engineering graduates – this move will help students get jobs." Further according to [10] AICTE too feels the need to "cut down theory and focus on practice". Only 1% engineering students participate in internships. The poor quality of the graduates or low employability is due to the following reasons [11]:

1. Poor physical infrastructure
2. Lack of skilled faculty
3. Rigid and obsolete curriculum
4. Poor learner quality
5. Dearth of R & D activities
6. Poor quality of training
7. Ineffective linkage with industry
8. Poor gender ratio

II. RELATED WORK

The author interviewed different chemical engineering students and identified different weakness based on the qualitative analysis [12]. The self efficacy approach proposed by [13] states that the task should be approached with confidence and positive attitude and with a belief that one can succeed. Author here talks about the core competencies required to cope up the demands of life after school. The basic in competencies found in the students are:

- Lack of professional ethics
- Inability to manage time
- Unable to work independently and to take the responsibility of actions
- Inability to conduct basic research
- Underdeveloped critical thinking skills
- Lack of interest in reading beyond exam

Purpose of holistic student development is to maximise the employment opportunities and lifelong benefits to the society. Authors have focused on outcome and retention in course. A well-designed project based learning along with defined roles of teachers and mentors stating its strength and limitations [14]. Learning should be self-directed, activity based, interdisciplinary, analytical and in a team through collaboration, critical thinking, creativity, innovation and must have problem solving skill [15]. In [16] the author develops innovative, collaborative and creative designs for project development which in turn build confidence in students which is helpful for holistic student development (HSD). Student driven teaching is facilitated which raises self-esteem, self-confidence, problem solving ability, problem management and planning analysis, technical and inter disciplinary knowledge. According to [17], based on his/her teaching experience, teacher should be able to understand student metamorphoses and meet diverse learning needs of students. Curriculum design should be in a way which bridges the gap between academia and industry [18].

III. LITERATURE REVIEW

The author divided the technical competencies into two distinct areas – the science of engineering and the practice of engineering [12]. To bring all students at par, students having low academics and low self-esteem are enrolled. This approach is more effective to problem solving, manages time in a better way, sets more challenging goals for them and is able to deal with failures. 15 students per facilitator must be allocated and students to be asked to meet mentor twice a week. Portfolio development can be another approach of HSD [13]. Self-management skills are required for HSD and feedback for the same is obtained through questionnaire [19]. Goal oriented activities are proposed for HSD [20]. Various learning mechanisms as Online learning blended learning, and face to face learning are applied by practitioners. Technology, pedagogy and content are focussed by [14]. Design work is based on Accreditation Board for Engineering and Technology (ABET), European Accreditation of Engineering programmes (EUR-ACE), Technology enhanced student assessment (TESA), Australian Qualifications Framework (AQF) [15]. Design Based Learning deals with performing hands on, problem solving, collaborative, innovative and creative design, active learning encouraging both student and staff. The survey result showed that students were interested to learn by doing hands on projects and getting involved with practical application of engineering design [16]. Experimental learning model comprises of project based learning and internship is proposed by [17]. Through different surveys and industry visits, industry expectation is captured from students in terms of knowledge, skill and experience following ABET criteria 2000 [18].

IV. PROPOSED METHODOLOGY

The nature of training and skills that are being granted to understudies are not in a state of harmony with such epic desire. To bridge this gap between curriculum and industry expectation, we introduce Holistic Education Model.

- University Based Learning
- Activity Based Learning
- Technology Based Learning
- Project Based Learning and Program Specific Research
- Technical/ Research Paper Writing
- Self/Collaborative Learning through online courses

Fig I. MODES OF LEARNING OFFERED AT TCET

a) **ABL:** The institute offers learning through various Activity Based Learning (ABL) activities such as to enhance research ability, team work, communication, leadership and time management, moral and ethical development, etc. Through ABL, we try to provide multiple platforms to students in form of Domain Activities, Quizzes, Debates, Hackathons, Seminars and Workshops related to building life skills etc. to make them industry ready.

b) **TBL:** To bridge the gap between curriculum and Industry expectation, we have introduced Technology Based Learning (TBL) in form of Basic bridge course (BBC), Industry bridge course (IBC) and Research Bridge Course (RBC) for second, third and final year respectively. This provides a scope for self and lifelong learning. Students are encouraged towards self learning platforms to learn at their own pace in their area of interest. Anyone anywhere can learn from TCET-NPTEL local chapter, which provides certifications from IITs and IISCs. One can learn from experts at one's own pace to strengthen the foundation and improve employability. The students are undertaking a lot of courses online on Coursera, Udemy, Udacity and NPTEL. Students who are unable to learn through these mechanisms, their learning beyond is enhanced through direct bridge courses conducted by faculty.

c) **PBL:** Project Based Learning (PBL) integrates knowing and doing where in students not only learn knowledge and elements of the core curriculum, but also apply what they know to solve authentic problems and produce results that matter. Through PBL students take advantage of advanced computing tools to produce high quality, collaborative products.

d) **Internships:** Students of SE, TE and BE are encouraged to take up internships in various domains during term break. Senior students who have taken internship share their experiences so that peer to peer interaction is there.

The model has been proposed keeping in view NBA graduate attributes. During the process of mapping and attainment of these GAs, it was found that university curriculum is unable to cater to GAs as: The Engineer and Society, Environment and sustainability, Ethics, Individual and Team work, Communication, Life long Learning and Project Management and Finance. The activities were framed keeping in mind the attainment of above GAs.

The outcome of these TBL paradigms is evaluated in form of Project Based Learning PBL through mini/minor/major modes. Many of these projects are carried to the next level in next year or a different group of students. Students and faculty perceive to undertake projects solving industry problems, societal issues and Government of India laid problems. Similarly Activity Based Learning ABL is conducted every Friday 3:30-5:30 wherein activities are conducted under Research and Development, Co curricular, Extra curricular, Industry Institute Linkage heads at Institute Level.

Further the institute has a strong Training and Placement cell (TnP), Higher Studies and Online certification cell (HOC), Entrepreneurship Development cell (EDC), Incubation centre, Innovation cell, Intellectual Property Rights (IPR) cell etc. each of which work cohesively to nurture and groom student for his holistic development. TCET's strong mentoring system and regular counselling motivates students to assess their strengths and weaknesses and accordingly groom themselves towards their area of interest.

For any Academic Institution, stakeholders play a major role in providing Inputs for the betterment of its customers i.e. students. Thus, we consider valuable Inputs from following stakeholders at different platforms: Students, Industry, Parents, Faculty and Alumni. Similarly, the parents and alumni realize that the youth of the age group 18-25 need grooming in the form of personal and professional development to compete in the market.

V. IMPLEMENTATION

To bring effectiveness in implementation of proposed model, various teaching learning modes have been adopted for TBL, PBL, ABL and subject specific prerequisite and advanced bridge courses in the form of Self/E-learning and Collaborative/Blended Learning. With suggestions from students, such modes of learning are executed before and after college hours. To implement above mentioned best practices, the provision is created in Academic Calendar at institute level and incorporated in department specific time table.
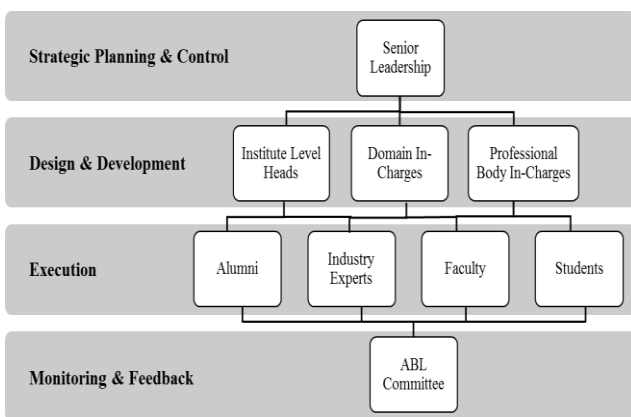

Fig. II. Model for Holistic Development of Students [21]

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Fig III: Inclusion of Beyond Learning Components in Time Table[2

Activity Based Learning can be adopted by students in form of Programme specific research (PSR) that helps channelize the energy and enthusiasm of students into conceptual-based education, thereby igniting their minds to explore with curiosity the world around them. Secondly, Proponents of Professional Personality development (PPD) under Professional Body Chapter (CSI) cite numerous benefits in the form of understanding of concepts, broader knowledge base, improved verbal and written communication, interpersonal/social skills and enhanced leadership skills.

Technology Based Learning is promoted through Higher Education and Online Certification Cell (HOC) by identifying NPTEL courses and associated faculty mentor at department level. The mentor motivates students for online learning and peer discussions.

Project Based Learning is inculcated from second year level students itself in the form of Mini Projects in core courses, which can be further taken to next level in their third year through Minor Projects which are mostly application based and finally their Major projects which are mostly research based. Students are also encouraged to take up industry projects (outhouse) which aids them to adapt to new technologies and learn professional etiquettes.

Lastly, for providing industry exposure to students, we motivate them for grabbing internships in industry to build Learning by Doing. The internships are provided at three levels through: a) personal contact b) Training & placement cell c) department.

We have fruitfully deployed the above practices w.e.f. 11th July 2017, with different strategies for different category of students. The categorization of students is done at Department through validation process by segmenting students into High (H), Medium (M), Low (L). The Low-profile students' performance improvement is expected through Tutorials and Practice sessions (TPS) along with Remedial Assignment and Compliance (RAC). Medium profile students' Professional and Personality Development (PPD) is expected through Professional Body Activities at Department Level and Institute level Activities (ILA) to further build upon their skills. The high-profile students are directed towards Programme Specific Research (PSR) in the area of their interest.

Table I. SCHEME FOR LEARNING BEYOND CURRICULUM

Sr. No.	Year / Semester	Subject / Course / Activity	Mode of Teaching / Learning		
			Traditional (Faculty Contact Hrs)	Self / E-Learning	Collaborative / Blended Learning
1.	S.E	TBL (Basic Bridge Course)	01	01	-
		PBL (Mini Project / Technology Workshop)	01	01	-
		ABL Institute Level (4 Parallel Activities) / Department Level (9 Parallel Activities)	01	-	01
		Prerequisite / Advanced Bridge Course	-	01	01
		Sub Total	**03**	**03**	**02**
2.	T.E	TBL (Industry Bridge Course)	01	01	-
		PBL (Minor Project / Technology Seminar)	01	01	-
		ABL Institute Level (4 Parallel Activities) / Department Level (9 Parallel Activities)	01	-	01
		Prerequisite / Advanced Bridge Course	-	01	01
		Sub Total	**03**	**03**	**02**
3.	B.E	TBL (Research Bridge Course)	01	01	-
		PBL (Case Study / Paper Writing)	01	01	-
		A ABL Institute Level (4 Parallel Activities) / Department Level (9 Parallel Activities)	01	-	01
		Prerequisite / Advanced Bridge Course	-	01	01
		Sub Total	**03**	**03**	**02**
		Total	**09**	**09**	**06**

The Training and Placement cell organises various programmes as Student Development Programme (SDP) for Second Year (S.E) and Third Year students (T.E.) to create awareness of latest updates and hands on experience on technology. Further to make graduates successful professionals and responsible citizens, Pre Placement Training (PPT) a 3 week programme is conducted for Final Year (TE) students. They are trained to attain need based skills and life - long learning ensuring global employability with sound engineering knowledge of modern tools. The basic training is on aptitude and soft skills. Other programme conducted are Infosys Campus Connect Programme (ICCP) to cater to all category of students to enhance their technical knowledge, Employability Skills Development by Zensar Technology helps them experience corporate needs and how to meet them through team effort and out of the box thinking.

To inculcate Research culture among Undergraduate students, the institute is holding conferences since 2010, with continual improvements in form of multiple conferences, workshops, journal affiliations and paper presentations. Students are promoted for various grants under government schemes. HOC Cell of the institute initiated Portfolio building activity for students in 2015 initially in hard copy form and later online,

in order to help them introspect their participation in co/extra curricular activities and thus plan participation in coming semesters w.r.t. socio, techno and industry requirement thereby authenticating the Letter of

Recommendation (LOR) issued by the institute for higher education [22]. The portal also provides students opportunity for improvement (OFI) thereby helping them in enhancing their resume for placement opportunities as well.

Table II. SAMPLE IMPROVEMENT IN HOLISTIC THROUGH PORTFOLIO

Class-Div-Roll no	ABL participation	Academic	Co-curricular	Extra curricular	ABL participation	Academic	Co-curricular	Extra curricular	MNC/ HS university name
	Previous semester (Attainment / participation)				Current semester (Attainment / Participation)				
BE-IT-A-71	1	5	1	1	6	5	4	3	L&T InfoTech
BE-CMPN-A-58	1	5	2	2	5	5	2	3	Oracle
BE-CMPN-A-57	2	5	1	1	4	5	2	2	Infosys
BE-IT-A-14	2	4	1	2	5	4	2	3	GRE- 325
BE-ETRX-33	9	5	4	5	12	5	5	5	Accenture

VI. EXPERIMENTED RESULTS

Execution of ABL is carried weekly on Fridays, taking consent from students based on their interest, calibre and learning ability. Teacher's role in the process is of a mentor and facilitator. PBL is carried out throughout the year under guidance of faculty, who guides and evaluates their performance at regular intervals. Technology Based Learning is conducted in two modes: Contact with faculty as trainer and Non contact with faculty as mentor. In the first mode, faculty evaluates student learning at the end of course whereas in second mode, students attempt certification exam and online assignments as per course schedule. Students undergoing internship are provided survey/feedback form, through which assessment of their learning is obtained. It is found that if students are motivated and provided platforms for their growth, they excel and become professionals in true sense which is supported by the achievements of the department in previous semester. Efforts have been tested and sample outcome is shown in the following graph:
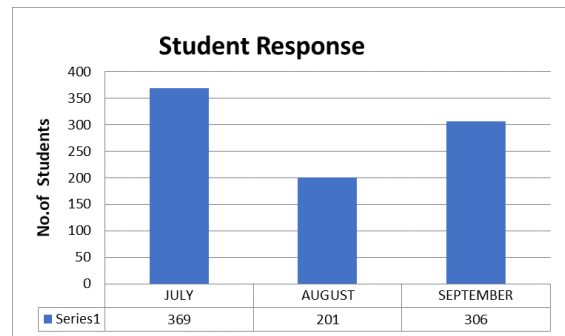

Fig iv: No. of student participation in ABL

Fig v: Average Student Attendance in ABL

The students participated in different activities and Score is given as mentioned in TABLE II. Below is a sample of Score achieved by 20 students in their Second year, Third year and Final year which majorly shows increasing trend.The student whose score is not ther for TE and BE got a drop in SE.
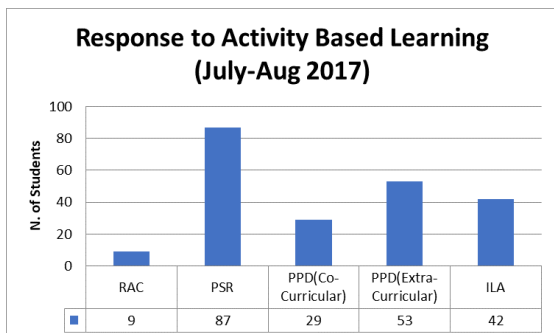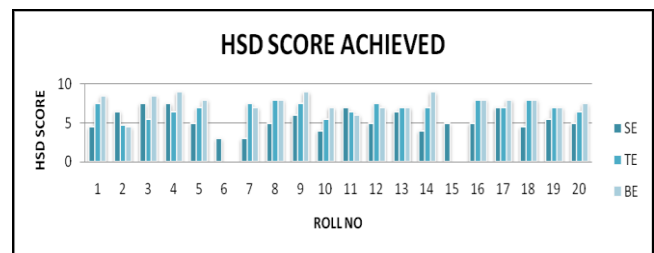

Fig vi: HSD Score Sample of 20 students

Below image (Fig. vii) shows total student falling in High, Medium and Low category for Sem 5, sem 6, sem7, and sem8.The trend is increasing for High category as student prepare for Placement or Higher studies and attend activities accordingly in their final year.

The portfolio attainment tool when deployed by HOC cell in ODD sem 2017-18 in SOP week on students of the institute shows that Engineering students are more participative in academic but less in Co-curricular and Extra Curricular activities.

Weightage is given as 60% to academic, 10% to in house co-curricular, 10% to outhouse co-curricular and 20% for extra curricular. Cutoff was kept as 60% for academic, 50% for extra/co curricular. The graph shows level-1 (score <=40%) as low and level-5 (score>=75%) high.
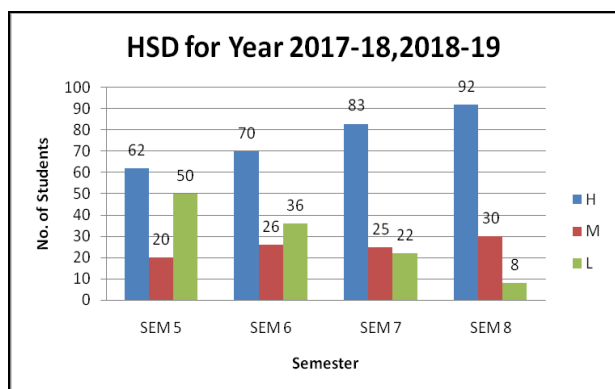

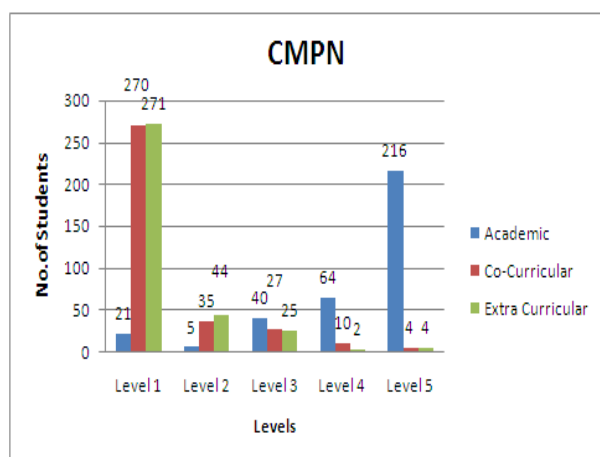**Fig vii: HSD score for last four semester of Batch 2019**

Fig viii. Participation captured through Portfolio Attainment

There has been considerable participation in Hackathons, ACM ICPC, competitive programming, coding competitions, etc. The same is measured with Holistic Development sheet by every mentor. Further to know the impact of activities conducted, survey was conducted for one branch on sample basis. Total 142 responses were received. Following questions were asked:

1. Are you aware about the various holistic development initiatives taken by TCET?
2. In which such activities have you participated actively?
3. Do you think Initiatives taken by TCET are helpful for holistic development.
4. The activities conducted under ABL/PBL/TBL are well designed as per needs of students.
5. Due to participation in any such activity the academic performance of an individual has positive impact.
6. The holistic development activities help to comply Engineering Graduate Attributes in today's scenario
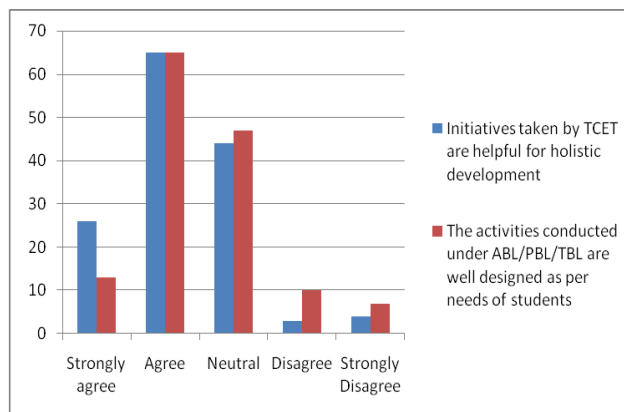7. Suggestions for improving response of students.

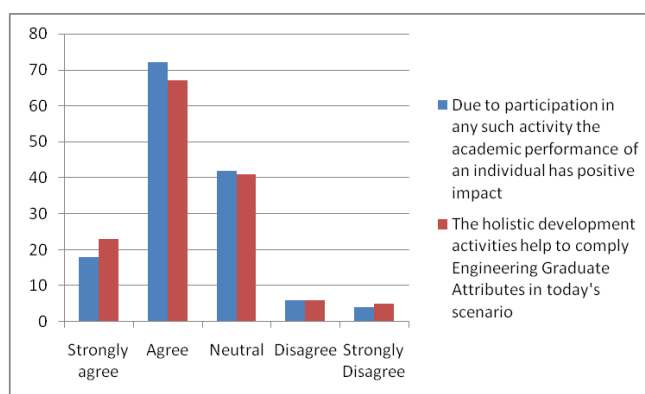**Fig ix. Survey response for Holistic Development**

Fig x. Survey response for Holistic Development

It is observed that 81.8% students are aware about activities. The participation of students in various activities is as: ABL:63%, PBL:44%, TBL:39% and other:8%. From above graphs it is evident that more than 60% of the students agree to the initiatives taken by TCET are helpful in holistic development .

Table II. TEACHER GUARDIAN EVALUATION SHEET FOR HOLISTIC STUDENT DVELOPMENT

Roll No	Name of the student	SGPA (Previous Sem)	Activity Distribution with weightage(10 point Scale)																	
			Industry Skill Based/Blended Learning (4)			Activity Based Learning/Research Based Learning(4)								Self Learning /Collaborative Learning(2)						Measurement/ Outcome: Total(10)
			PO1-PO5, PO12			PO6-PO9								PO10-PO11						
			To Become Technocrats			Socially sensitive citizen						Responsible citizen		Professional Carrier			Higher Studies & Placement			Attendance(5)/ Attainment(5)
			TBL	PBL	EL	CC	EC	IL	V.E	R&D	ET	PSR	PPD	RAC	TPS	IN (I/E)	CF (I/E)	IIP	HS	EP	PT

TBL: Technology Based Learning	R&D: Research & Development	EL: E-Learning
PBL: Project Based Learning	ET: Education Technology	CF(I/E): Certification(Internal/External)
CC: Co-Curricular	PSR: programme Specific Research	IN(I/E): internship(Internal/External)
EC: Extra Curricular	PPD: Professional/Personality Development	HS: Higher Studies
IL: Industry Linkage	RAC: Remedial activity & compliance	EP:Entrepreneurship
VE: Value Education	TPS:Tutorial & Practise Session	IIP: Inter Institute Participation
PT: Placement & Training		

VII. CHALLENGES

The foremost challenge faced is time management by students and faculty at par. Further challenge lies in introspecting the ability of students. There was lack of motivation in students' due to no direct credit and stretching of college hours to accommodate the activities at initial phase of implementation but motivation enhanced considerably viewing the achievements of holistically developed students in form of higher pay packages, admission in foreign universities etc. Students have exhibited certain traits like being responsible citizen, time management, effective communication skill (technical & non technical), leadership skill and lifelong learning. The deployment requires further strengthening and support from stakeholders.

VIII. CONCLUSION AND FUTURE SCOPE

The above stated practices have impacted few students to become ambassadors for promoting the same activities in future. These practices have helped students in overall development of their skills and also acted as a medium of strengthening their individuality. This style of education imparted through aforesaid activities not only focuses on mere learning but also on implementation of outcomes of learning. It is observed that the impact of conducting such activities for student holistic development have brought accolades to the institute at colleges in vicinity, state, national and international level. There has been an observation of enhancement of self motivation among students for beyond learning and holistic development.

AUTHOR CONTRIBUTIONS

The first author has deployed the model in Computer Engineering Department with help of other 3 authors. The last author has envisioned the entire model.

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