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Learning Outcomes of a National Level Project Contest

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Abstract: Today, industry needs highly skilled engineering graduates to combat real world challenges in an efficient manner. The mere knowledge of theoretical concepts would not help the students to solve the global challenges. As such, nurturing young minds to appreciate complex problems and to think of innovative solutions either to alleviate prevalent problems or to improve the quality of life become the responsibility of technical institutions. The project contests to showcase the talents would help the students to exhibit their skills and project their ideas with peers and also with the industry experts. In this paper, the learning outcomes of one such national level project contest "TELECOMBAT", held at the Department of Telecommunication Engineering, BMS College of Engineering, Bangalore has been presented. The contest aimed to bring together industry and academia experts to strengthen the industry-institution interaction and also to get the students' projects evaluated by the industry experts which would help the students to understand the need for implementing quality projects to excel in their professional career. The suggestions given by the experts have been incorporated for evaluating student's projects for the successive years. The rigorous evaluation of the projects involved three rounds with different rubrics for each round. This event provided a platform for institute and industry iteration and also helped students to get first hand feedback from experts and researchers.

Keywords: Learning Outcome, Project contest, PBL, OBE

1. Introduction

The research shows that the number of Engineers produced by the USA is around 1 lakh per year for a $ 16 Trillion Economy whereas India produces 15 lakhs Engineers for a $ 2 Trillion Economy [1]. Though India produces Engineers in such a large quantity, there is not much demand to absorb them. Unfortunately, that is not the case in India due to the lack of skills required for the industries. The manufacturing sector which was mass recruiting the engineers from core branches like Electrical, Civil, and Mechanical became stagnant at just 17% of the GDP made the placements for core branches very difficult. The new mass recruiter, the IT sector which employed millions of Engineers grew from scratch to almost 5% of the GDP in 25 years. Today, IT industry also has come to saturation and the demand for highly skilled engineers is in demand by the IT industry. Most of the sectors of the Indian economy do not need engineers. The Tourism department which contributes 10% to India's GDP, does not require engineers. Other sectors related to Trade, Finance, and

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Hospitality, etc. do not require engineers for their operations. The requirement of engineers in the Health, Education and Agriculture sector is also minimal. More than 50% of the India's GDP has no role for Engineers. Still, most of the students aspire to become Engineers though the demands in other sectors are more than that of engineers. [2].

The demand is for highly skilled Engineers while the supply of unskilled Engineers is growing. Except a few top Engineering institutions, the students who graduate from other institutions lack the employable skill set in the core field of their study. Most of the students are interested in scoring high CGPA and not interested in developing skill sets required for employability. Hence, many of the graduated Engineers are forced to take up jobs in different sectors, which are completely new to them. This results in a waste of resources and also reduces the chances of employability for the graduates who are meant for such jobs. Today, the cost of studying Engineering degree costs more than 10-15 lakhs on an average and would become a burden on the parents if their wards do not find suitable jobs. This paper explores the outcomes of the national level project contest financially supported by the Institute of Electrical and Electronics Engineers (IEEE) and organized in association with IEEE BMSCE student branch for the students of various Engineering colleges.

A very innovative approach was used to evaluate the projects. All project groups had to suppress their college information so that the judges will not have any bias regarding the institution from which the students are participating. Project contests like this bring out the application ability of the engineering students and help industries to understand and appreciate such knowledge. It also helps industry experts to understand the relevance of the curriculum offered in the institutions and provide feedback on areas where the institutions can further fine tune their course offerings. The feedback given by the industry experts would further explore the possibilities of doing joint research. The paper is organized as follows. Section 2 deals with Employability Skills required by Industry. Section 3 explains Project Based Learning (PBL). Section 4 deals with assessments of projects. Section 5 presents the outcomes of the project contest and the paper is concluded in section 6.

2. Employability Skills required by Industry

Global problems of today need to have global solutions being developed in a distributed manner worldwide. The global problems have so deeply rooted in terms of its criticality, imminence, and rate of growth that nominal solutions are unable to provide sustainable solutions. Coincidently, ample infrastructure for realizing innovative solutions is affordable through governmental agencies, institutional support, R&D establishments, and corporate CSR with no significant effort and cost. However, amidst such a congenial ecosystem, innovative minds and their nurturing are scarce and manifests as a show stopper in the process of realization of solutions. Solutions devised, specifically, to address prevalent solutions are specially treated as projects for community services. Innovations under technology banner hover, to a great extent, on electronics, telecommunications, networking, computer science, and information technologies.

Today, the employer in every sector needs highly skilled Engineering graduates who can face the day to day challenges in the industry. In addition, they look for graduates with individual abilities such as working in a team, integrity, attitude, effective communication and the enthusiasm to adapt to new technologies. Many times, Engineering graduates with good academic records fail to perform in industries due to lack of other skills such as teamwork, critical thinking, etc. To create industry ready graduates is a challenging task for the institutions. All the institutions must aim for the overall development of the students to make them industry ready. The co-curricular activities such as project contest, hackathon, codethon etc. must be encouraged to develop critical thinking in students which would enable them to think out of the box. Today industry needs skilled engineers and not the grades obtained in their BE/B.Tech degrees. Though minimum CGPA is required to get an entry into an industry, the skills acquired by a graduate matter a lot during employability. This is one of the approaches to enhance the skills of the students as the students' assessment is based on analytical skills, presentation, professional ethics, etc.

The following factors decide whether an Engineering graduate could be employable [3]:

- The ability to apply the theoretical concepts learnt to solve societal problems and to develop innovative solutions.
- The ability to work effectively in multidisciplinary

projects as an individual and as a team member.

- The ability to present their ideas without ambiguity with employers, peers etc.

- The ability to apply ethical principles and commit to professional ethics

According to Stanford University and World Bank, which surveyed approximately 5000 first year and third year Engineering students from 200 randomly selected Engineering institutions across the country, overall higher order thinking skills are "substantially lower" than the Chinese and Russians [4]. The survey did not include IITs. The results of the survey also showed that Indian Engineering students make decent progress in Mathematics and critical thinking in the first two years. These issues need to be addressed at the root level to make our students highly skilled and industry ready once they graduate from institutions.

The institutions need to provide platforms to exhibit their talents by organizing project contests under professional bodies and also group discussions and technical paper presentation which would improve their critical and design thinking and communication skills. Project contests would motivate them to provide solutions for societal challenges.

The various challenges in the engineering fields are different and vary in their complexities. To cater to the various societal problems, some may ask for sustainable solutions through new designs, a redesign, smart electronics, or with the use of existing technologies to improve the performance. Hence it becomes even more important to allow academia to freely study the ecosystem around it and find solutions through open innovation. "Telecombat", the national level project contest is an outcome of such ideology that aims to refine and recognize creativity. The self-sustaining platform not only aims to motivate the new ideas but also provides a channel for students to connect directly with industry experts to discover better alternatives and help them fine-tune their ideas according to the industry or societal needs.

This event is also extremely beneficial for industry experts and helps them identify new technologies to adopt and make their businesses more efficient. It also provides them an opportunity to understand the thought processes of the future workforce and align and upgrade their training methodology for fresh recruits accordingly. Such contests would help the students to develop critical design thinking. This would also help juniors to explore the possibilities of extending the project work which could lead to publications in reputed journals, conferences, patents, etc.

3. Project Based Learning (PBL)

PBL is one of the ways to address various skills such as communication to convey the intended information, teamwork to develop a sense of belongingness for productive work, lifelong learning to think out of the box etc. [5]. Out of the 12 Graduate Attributes (GA) defined by the NBA, the first four attributes emphasize the application of basic science and engineering concepts to solve, design, analyze core engineering systems and subsystems. The fifth attribute deals with the ability to select appropriate modern engineering and IT tools to solve complex engineering problems [6]. The 6th and 7th attributes deal with the ability to apply contextual knowledge to solve societal, health, safety, legal, and cultural issues and to analyze the impact of engineering solutions needed for sustainable development. The GA 8 defines the ability to commit to sustainable and high ethical principles in personal as well as professional life. GA9 is the ability to work effectively as an individual or as a team in a multidisciplinary project. This would help the students to develop skills in diversified fields and also excel in their professional careers. GA10 is the ability to communicate effectively with the engineering community and with society at large, to write effective reports, and make an effective presentation using ICT tools. GA11 measures the ability of a student to understand and apply the project management principles to one's own project while planning and implementing a project with emphasis on the financial aspects. GA12 attempts to measure the ability to engage in independent learning and the need to continuously upgrade the knowledge to cope up with the advancements in the technologies [7].

These attributes are usually addressed by various theory and laboratory courses of the curriculum. But a single course when implemented through PBL addresses most of the 12 GA's more effectively [8]. The PBL needs the application of skills and the thorough knowledge of the subjects to apply the same during the implementation of projects. The students start to analyze the given problem and try to solve the real-world problems using the knowledge and skills from multidisciplinary domains [9]. PBL encourages

students to learn and apply knowledge and skills through an engaging experience. The teacher becomes a facilitator rather than a teacher. The students start the project with an inquiry which leads to deep learning. The projects that meet PBL criteria differ from projects that have been traditional in classrooms [10].

The main focus of the OBE is to empirically measure student's performance which is evaluated based on communication skills, analytical skills, professional ethics, etc. [11]. The objective of OBE is to ensure that the students have the ability to understand the outcomes defined by the facilitator [12]. Students learn the concepts more deeply when they apply the concepts studied in theory courses to solve real-world problems. Working in a team would help the students of different states, cultures, language, etc., to understand the societal problems of different states across the country to work collaboratively to provide effective solutions. Active-learning practices have a more significant impact on student's academic and overall performance than any other achievement.

In any industry, there are 5 phases of project implementation. They are 1. Feature finalization. 2. Design procedures 3. Implementing the project. 4. Positive, negative, and boundary condition testing cases. 5. Documentation or user manual for the product developed. In most of the courses, phases 1 and 2 are covered. Phases 3 to 5 are covered under project work in the final semester of the degree. Most importantly the project contests will focus on achieving all the 12 GAs through these 5 phases of the project evaluation. Section 4 covers the evaluation methodology implemented in the national level project contest "Telecombat" based on the above 5 phases of project implementation.

4. Assessment of Projects

A panel of twelve judges was framed from various industries with subject expertise in the field of embedded systems, deep learning, internet of things, unmanned aerial vehicle, renewable energy systems, signal processing and, robotics, Internet of Things (IoT), etc. These twelve judges were regrouped into six teams with two judges in every team. Each team was given the task of evaluating about 15 projects randomly. It was a blind review process without mentioning the department and institute name of each and every batch of project students. We called this evaluation as Round 1 during the event. Round 1 took about half a day to complete the evaluation by all teams of judges successfully. Total 90 batches of projects were evaluated during Round 1 by 6 teams of judges. The sample evaluation sheet used in the event is as shown in Table 1. The first round of evaluation is shown in Figure 1.

Each project was evaluated based on the rubrics mentioned in Table 1. Three best projects were selected by each of the six panels of judges. So totally 18 projects were selected for round 2 of evaluation out

Fig. 1: Evaluation process-First round

Table 1: Sample evaluation sheet used in the event for project assessment

PID (Project ID):			
Project Title:			
Rubrics	**Total Marks-50**		
	High-10	**Medium-7**	**Low-5**
Innovation			
Research			
Societal concern			
Presentation			
Questions & Answers			

of 90 projects. The second round of evaluation focused more on the product development and publication of the work done and the rubrics were designed to suit the industry trends. These rubrics were carefully designed in consultation with industry experts. The evaluation rubrics for the second round are given in Table 2. Round 2 of the evaluation is done as follows.

Table 2: Rubrics for second round of evaluation

Sl no	Performance Indicator	Excellent (10)	Good (8)	Average (6)	Acceptable (4)	Unacceptable (2)
1	Impact on society, engineering community	Extensive	Very satisfactory	Moderate	Limited	Minimal
2	Applications and Future scope	Future extensions in the project are very well specified	Future extensions in the project are specified	Future extensions in the project are moderately specified	Future extensions in the project are limited	Future extensions in the project are not specified
3	Involvement of an individual in the team	Extensive knowledge related to the project and very regular, consistent in work	Good knowledge related to the project and regular, consistent in work	Average knowledge related to the project and regular, non-consistent in work	Fair knowledge related to the project and irregular, consistent in work	Lacks Sufficient knowledge and irregular, non-consistent in work
4	Publication of the work	Unpaid Scopus index journal	Paid Scopus index journal	Peer reviewed journal	IEEE conference	National conference

All twelve judges evaluated 18 projects individually and assessed based on the rubrics given in Table 2. Six projects were selected for the third round, based on the rubrics set for the second round. The rubrics for the third round were focused on business plans, marketing and start-up ideas as shown in Table 3. These rubrics were designed with the help of MBA faculty, founders of startup companies, and marketing professionals. The group of judges for the final round consisted of a marketing manager, founder of a startup company and, an MBA faculty.

Table 3: 3rd round of evaluation

Performance Indicator	Very high (10)	High (5)	Moderate (5)
Marketing Opportunity			
Possibility of starting a startup			
Business plan			

The rubrics set for evaluation of projects covered a wide range of evaluation parameters starting from simple to complex, encouraging the students for planning a startup. This round of evaluation gave few participants to have a discussion with startup founders, marketing experts, and MBA faculty to convert their project ideas to start up.

All scores were consolidated for each project and the top 3 projects were rewarded with a certificate of appreciation and prize. Certificate of participation was issued to all the students who participated in round 1 and round 2 of evaluation to support their efforts put in to complete the projects and their participation in the contest.

5. Outcomes of the Project Contest

The outcomes of the project contest are discussed here with respect to graduate outcomes defined by the NBA (National Board of Accreditation). Figure 2 shows a broad area of themes covered under the project contest and also shows that most of the subjects or topics are covered in the project contest and gives an overall idea of present research and happenings to the younger community of students from lower semesters (non-participants of the project contest) during project exhibition.

The rubrics mentioned in Table 1 address most of the GAs defined by the NBA as shown in Table 4. Figure 3 shows the comparison between the maximum score set during project contest and

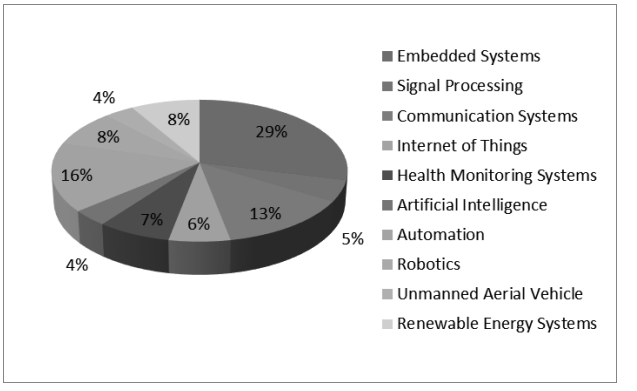

Fig.2:Broad areas/themes covered under project contest

achieved score by students with respect to rubrics mentioned in Table 1. It shows a consolidated outcomes from all 90 projects consisting of around 350 students from various institutes and specializations. Figure 4 shows the percentage outcome of GAs according to the rubrics mapping given in Table 4. This mapping involved a first round of evaluation with all the participants. The outcomes achieved by participants of the project contest are satisfactory which is evident from Figure 3 and 4.

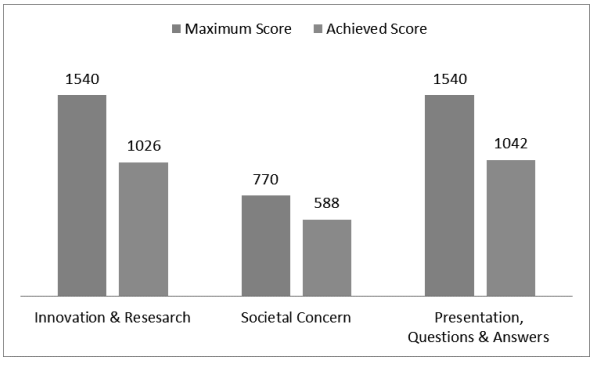

Fig. 3: Comparison of maximum score and achieved score with respect to rubrics

From Figure 3, it can be seen that 67% of the projects are based on innovation and research and 76% of the projects are oriented towards solving the societal problems. It can also be seen that the score for

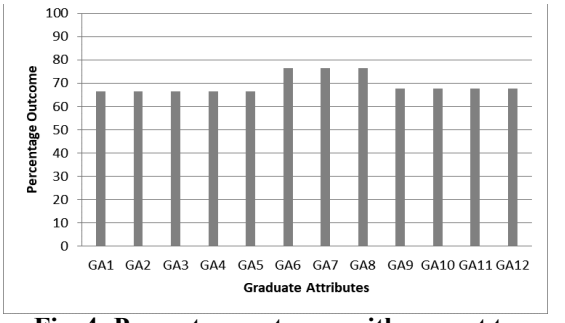

Fig. 4: Percentage outcome with respect to Graduate Attributes

the presentation skills was 68% which shows that the presentation skills of an individual participant are highly appreciable.

A few takeaways were, firstly it gave students a chance to interact and learn from industry experts of their project domain. Secondly, it helped the lower semester students of the hosting institution to identify their domain of interest to develop the projects as part of their curriculum. Table 4 gives the comparison of outcomes with and without PBL.

Table 4: Comparison of outcomes with and without PBL

Sl. No	Graduate Attributes (GAs)defined by NBA	Rubrics used in Evaluation of Projects	GAs addressed with PBL*	GAs addressed without PBL*
1	Engineering Knowledge	Innovation & Research	✓	✓
2	Problem Analysis		✓	✓
3	Design/Development		✓	✓
4	Conduct Investigations		✓	
5	Modern Tool Usage		✓	
6	The Engineer & Society	Societal Concern	✓	
7	Environmental Issues		✓	
8	Ethics		✓	✓
9	Team Work	Presentation , Questions & Answers	✓	
10	Communication		✓	✓
11	Project Management		✓	
12	Life Long Learning		✓	

It was found that 67% of the projects were oriented towards innovation and research and 33% towards societal concern and product development. It shows that most of the students were likely to go for higher education and to start a startup. The exhibition of projects was based on modern simulation tools, embedded systems, IoT, Robotics, Signal processing, image processing and Artificial Intelligence. This kind of contest would help in bridging the gap between institute and industry, where participants got the reviews of industrial experts on their projects and thus they got to know where they stand with respect to the industrial standards. Secondly, Telecombat gave the participants a chance to improve their communication and presentation skills and the way to tackle questions fired at them.

Thirdly, peer learning was enhanced as around 100 teams participated in the contest, which means each team got to learn about 99 other ideas and implementation methods. Thus, the project contest was a great overall learning process for the participants as well as the students of the organizing team who learned a lot about managerial and effective communication skills. Also, the managing team consisted mostly of third year students. So, they got a hold of interesting project ideas as well as multiple implementation methodologies which may prove useful for them.

6. Conclusion

In this paper, the learning outcomes of a National level Project Contest have been discussed. The project contest would help the students to learn from peers, develop communication skills, and to work in a team. Most of the GAs defined by the NBA are addressed by such contests when all the students participate in the contest. Students must be encouraged to participate in such contests which would help them to develop confidence and also help them know where they stand when their projects are evaluated by industry experts. The participation of all students of the Host department (Telecommunication Engineering) helped the department to incorporate changes in the rubrics of project evaluation set by the department to evaluate 7th and 8th semester projects and also to improve the quality of projects to be taken up by the students of successive batches. It was found that all the GAs can be addressed with PBL (90-100%), based on the type of projects taken up by the students. whereas without PBL only 42% of GAs can be addressed. The project contest, which is a first of its kind in the department, where more than ten industry experts in different fields collaborated, helped the department to introduce new courses on product design and Value Engineering.

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