



Skill Development of Polytechnic College Students Through Project-based Learning (PBL), with Special Reference to the ‘Formula Maruti Car Project’ of Department of Automobile Engineering, Government Polytechnic College, Attingal, Kerala

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Abstract: Project-based Learning (PBL) is a teaching approach that motivates and inspires students to learn and helps them to become self-directed learners and constructors over time. This study examines whether newer skills could be developed and existing skills could be polished, among Polytechnic College students in a Project-based Learning atmosphere. Final Year Diploma Students of Department of Automobile Engineering, Government Polytechnic College, Attingal were assigned to create a racing car from scratch and the outcome is first of its kind created by a Polytechnic College in India! Other than key engineering skills like design and fabrication, all sort of life skills like problem-solving, creativity, collaboration, communication, time management, and responsibility showed an increase.

Keywords: PBL, Constructors, Skills, Creativity.

I. INTRODUCTION

Inventions and innovations are highly connected with the skills of individuals as commercialized innovations / inventions provide newer jobs as well as economic growth to the nation. India is all set to become the world's youngest country with 64 per cent of its population in the working age group by 2020. As on today, India has 605 million people below the age of 25, and 225 million in the age group 10-19, poised for higher education. Currently, India is a knowledge-based economy due to the abundance of capable, flexible and qualified human capital. India has the largest group of people below thirty-five years of age and the skill development of such working population is a high priority of Government of India. Though there are many industrial training institutes (ITIs), vocational schools, polytechnics and professional colleges, sector-specific skill development, training for self-employment and other forms of training, around 90% of employment in India is in the informal sector where employees are working in comparatively low productivity jobs. Polytechnic education contributes significantly to Indian economic development. Polytechnic colleges are the institutions which offer three-year diploma in engineering post tenth class. But, only 36% of the positions at the middle level in industry are occupied by diploma holders. It is quite embarrassing to note that 48% of the middle level positions are being held by persons, who have risen from the craftsmen level. Two significant reasons behind this are a) the education and training which are now being imparted at the polytechnics are not sufficiently industry or practice-oriented and b) the lack of collaboration between industry and the polytechnics. Moreover, there is another significant threat from engineering graduates, willing to work at lowered rate of remuneration. The present student intake in degree and diploma level technical institutions in India is 16.94 lakhs and 12.6 lakhs respectively. (Report of AICTE Review Committee, 2015) [4]. The ideal ratio of degree to diploma holders is 1:3. Unlimited privatization of engineering education is the real culprit, which resulted in a lowered employability of 7% of engineering graduates as per industry requirements. So, it's high time for Polytechnic teachers to introduce new pedagogy to improve educational quality of students.



Table 1: Growth of Intake of Technical institutions in India (Undergraduate)

Year	Engineering	Diploma
2011-12	1379149	882489
2012-13	1538767	951050
2013-14	1620958	1027567
2014-15	1693771	1259352

II. REVIEW OF LITERATURE

‘Currently it is estimated that only 2.3% of the workforce in India has undergone formal skill training as compared to 68% in the UK, 75% in Germany, 52% in USA, 80% in Japan and 96% in South Korea. Large sections of the educated workforce have little or no job skills, making them largely unemployable. Therefore, India must focus on scaling up skill training efforts to meet the demands of employers and drive economic growth’ – says INDIA SKILLS report 2016 [2], Powered by Wheebox is India’s leading online talent assessment Company Creating an Ecosystem for skills by NSDC

Traditional education practices all over the world often create students who are mostly dissatisfied and bored with their education. Unfortunately, they are forced to memorize a lot of information, most of which they feel irrelevant during their course of study! Studies have shown that in 90 days students forget 90% of everything they have been told [6]. It is high time to realize that the traditional educational practices will not help students to achieve 21st Century skills. As high rate of knowledge retention is the need of the hour, it can be achieved only through PBL.

Project Based Learning (PBL) is a teaching method in which the students gain knowledge and skills by working for an extended period of time to investigate and respond to an authentic, engaging and complex question, problem, or challenge. PBL helps the students to acquire deeper knowledge through active learning and inquiry based learning to solve a complex problem or challenge.

Thomas Markham [3] describes project-based learning (PBL) thus: "PBL integrates knowing and doing. Students learn knowledge and elements of the core curriculum, but also apply what they know to solve authentic problems and produce results that matter. PBL students take advantage of digital tools to produce high quality, collaborative products. PBL refocuses education on the student, not the curriculum—a shift mandated by the global world, which rewards intangible assets such as drive, passion, creativity, empathy and resiliency. These cannot be taught out of a textbook, but must be activated through experience."

III. OBJECTIVES OF THE PRESENT STUDY

Polytechnic education in India began with a mandate to provide skilled workforce to a nation. But unfortunately, obsolete equipment, poor funding, and lack of autonomy to introduce new industry-sponsored programmes have denied the polytechnics their great relevance in employment generation. Main Problems of Polytechnic Education in India over the years, the diploma programmes have deteriorated losing the skill components, which has resulted in their being just a diluted version of degree education. Polytechnics in India have to provide skill based education, so that their outcome can directly merge with the need of the industry. Since none of the industries would prefer to train the fresh diploma holders on basic skills, it becomes the key objective of polytechnic college teachers to ensure the same.

The ability to apply the concepts learnt to constantly develop innovative things and find solutions to complex problems are main factors working behind the employability of an engineer. The traditional education sector in India has not evolved at the same pace as the industry. One of the major problems facing the fresh graduates is their insufficient understanding of basic concepts. The lack of in-depth understanding of technical information, lack of client-handling skills and insufficient knowledge across domains are the major skill gaps in the area. The above said problems be rectified with the aid of PBL, is the main objective of the current study.

Some of the key areas where an Automobile Engineering diploma student must possess proficiency as per industry requirements are They require basic knowledge in body, chassis and engine systems, electrical and electronic instrumentation and control systems, thermodynamics, aerodynamics and fluid mechanics fuel technology and emissions, design – turning ideas into blueprints for development and testing, taking into account safety, cost-effectiveness, environmental impact and look development – building and testing prototypes using computer simulations and physical models to assess components' strengths, weaknesses, performance and safety production – planning the production run, including redesigning machine tools, equipment and processes to make new parts, monitoring costs and production schedules, and overseeing quality control

Other skills and competencies that employers look for are Strong analytical and problem solving skills, Knowledge of machine design, manufacturing processes and mechanical systems, Understanding of electrical and electromechanical



systems, Knowledge of digital circuits and interfacing with mechanical/electromechanical system, The ability to analyze and interpret data, Good communication and presentation skills and the ability to prioritize and plan effectively

IV. METHODOLOGY

Currently, *Project work* is a mandatory part of Polytechnic Diploma course across India and it begins with the commencement of fifth semester. Six periods are allotted for project work generally. Many unhealthy practices are still going on in India, like various agencies supply readymade projects for students for a specific fee. It is quite unfortunate to notice that many teachers would also support such heinous activities. Many private /Self-financing institutions convert project work as a shortcut to improve their infrastructure by forcing the students to do irrelevant projects. The current project work scenario is not at all encouraging.

Since PBL needs a project for execution, the project guide/ department head can select a project in such a way that it includes almost all relevant information the students had learned so far/ will be currently learning. The project is focused on student learning goals, including standards-based content and skills such as critical thinking/problem solving, collaboration, and self-management.

The students of fifth semester Automobile Engineering were chosen for the current study during the first week of June 2016 and they were asked to find a suitable project in such a way that it would cover their entire syllabus. Again, the project must be quite challenging and not done earlier by any of the polytechnic colleges in India. The students engaged in finding resources, various levels of group discussions, lot of search through internet and finally emerged with a project, ie, creating a Formula car from scrap materials. Since the project was quite authentic and challenging, it was readily approved by the project guide, the author himself.

Since project guide has the role of key facilitator, he/she must be aware of the major problems being faced by the polytechnic education system, including inadequate infrastructure facilities and obsolete equipment, lack of flexibility and autonomy to the institutions, inadequate industry institute participation, antiquated Curricula, poor funding options and how to overcome all.

V. FORMULA MARUTI CAR

Formula Maruti is a single-seater, open-wheel class in motorsport made and raced in India. Many of the top teams in Indian motorsports have run in the series, including Team Lakshmi Mills Superspeeds, Team JK, Team MRF, Gabriel Racing, WSRF Racing, McDowell Racing, and Team Valvoline. Top Indian drivers have started their career racing in Formula Maruti, most notably Narain Kartikeyan. The car was a brainchild of S Karivardhan who wanted an affordable single-seater that can be highly economical to run/own, as well as being a stepping stone to several new drivers. It made its debut in 1988 at the Sholavaram races in Chennai. Young drivers in India often begin their competitive careers in Formula Maruti, or after a few years in Karting. Formula Maruti provides drivers with their first insights of a racecar, their first racecar experience, and this is where they cut their teeth in racecar set-up. The engine and gearbox are from Maruti 800 car, which is an 800 cc 3-cylinder engine. The chassis is a space-frame mono-coque with FRP body panels. (Wikipedia).

VI. M-LEARNING NETWORK USING SOCIAL NETWORKING APP CALLED TELEGRAM

A PBL project requires high level of *student-student*, *student-teacher* collaboration. Smartphones have become a basic necessity today and smartphone based information sharing is an essential mode for modern educational practices. '*Telegram Messenger*' is the best suitable app for setting up of an *M-learning network*. This network enabled the students of sharing various information picked up from internet as well as in conducting online discussions in free-time. Beyond all, they are always in touch with their project guide and other teachers. All sort of learning materials in digital format could also be easily distributed.

VI.1 PRELIMINARY SCREENING OF CANDIDATES

Students confirmed their project, including how they work and what they create by the second week of June 2016 itself. In this critical juncture, it was the duty of the project guide to assess the basic skills of 57 students. A questionnaire was prepared for the identification of their basic skills. Immediately after the preliminary selection of candidates, detailed discussions were conducted to finalize the *project flow chart*. As per fabrication flow chart, 6 different students groups were formulated based on their skill and expertise. Each group contains a group leader, at least two students with sound



academic performance and skilled persons. The time required for each stage of project completion was estimated and decided to stick on the stipulated time schedule.

Table 2: Skill analysis of students

Basic Skills	No of students	Capability Rating / teacher's inference
Knowledge level / information literacy / technology literacy	13 (Results - All clear)	Very good
Leadership/ Communication skills/ Initiative	10	Very good
Engine overhauling / Service	2 with ITI certificate	Very good
Welding / fitting	2	Very good
Metal cutting / grinding	3	Very good
Electrical system maintenance	2	Good
Design software	1 (Solid works)	Very good
AutoCad	10	Good
Problem Solving capability	5	Good
Flexible and collaborative	45	Good

Table 3: Project flow chart

Formula Maruti Project flow chart					
Engine	Chassis	Drive train	Suspension	Brakes	Miscellaneous
Get suitable engine and recondition the same	Finalize design, buy material and hardware, suspension tabs, weld frame	Replace clutch plates assembly and check the gear box.	Redesigning front and rear hub assembly	Finalize suitable master cylinder. Fix up pedal assembly, finalize proportionate valve.	Steering: New steering wheel, Rack extenders, finalize rack location, new tie-rod ends, steering column extender
Finalize intake & exhaust position	Finalize engine mounts, weld it. Reassemble engine and fix it in the rear portion of chassis.	Fix new half axle shafts	Procure additional ball joints and rod ends	Front: Finalize calipers and brake pads	Finalize seat design, construct and mount it.
Electrical wiring, ignition circuits, battery enclosure, reroute wiring	Fixing transmission lines, Clutch pedal, brakes and accelerator	Fix the gear shifting mechanism inside the driver's cabin, reverse its direction.	Design upper and lower wishbone assembly using Cromoly tubes	Rear: Finalize calipers and brake pads	Construct fuel tank, connect fuel lines.
Throttle	Finalize safety considerations	Fixing various meters inside driver console	Finalize shock absorbers and anti-roll bar	Finalize brake lines and connect the same to master cylinder assembly	Fix new alloy wheels and tyres
Shifter	Strengthening of welds Nose cone design, front and rear wings	Fixing seat belt	Finalize design and adjust steering geometry	Finalize parking Brakes	Wheel alignment
Engine tune up	Fix up diffuser design				Fixing fire wall
Fuel	Body design and painting				Test run

VI.2 FUNDING, PROCUREMENT & PHYSICAL INFRASTRUCTURE

Usually, PEL projects in engineering are quite expensive and funding for the same is the main bottleneck to overcome. Since Govt Polytechnic College, Attingal, is not quite a known institution like high profile engineering colleges, it is impossible to attract funds from private industries/people. And as a result, all the 57 students decided to share the expenses, with an assurance from the Principal that a part of the expenses would be borne by PTA. A Maruti 800 car was purchased from scrap, dismantled it completely, suitable components were collected. In-order to complete the project in time, a temporary fab-lab was set up. Brand new set of welding machine, portable cutting/grinding machine, portable drilling machine, cut-off machine and major tools kit were procured. Basic level of skill training to almost all students, who showed genuine interest, were given.

VI.3 PROBLEM-BASED LEARNING THROUGH VARIOUS STAGES OF PROJECT

Fabrication of a Formula Car involves a lot of research, software analysis, fabrication of new components and fund management etc. Immediately after the commencement of project, students had to face immense difficulties and the learning activity shifts to Problem-based learning. Because of the shoestring budget, students are forced to modify almost all components rather than constructing a new one. Such reverse engineering practice helps the students to deepen their knowledge level at that particular area of the project. Again almost every details, including photographs, videos etc were kept as a part of record keeping

Immediately after the completion of each stage, review meetings were regularly conducted to assess the progress of the project. As a result, the students could do the test run in the third week of Dec 2016, though it was proposed to be done at the third week of January 2017



Fig. 1 - Trial run during Dec 2016



Fig. 2 - Finished Formula Car



Skill development of the project participants were regularly monitored and recorded accordingly.

Table 4: Skill development of students after partial completion of project

Basic Skills	No of students	Capability Rating / teacher's inference
Knowledge level / information literacy / technology literacy	16 (Results - All clear) 4 (Single arrear) 10 (2 to 4 arrears)	Very good Critical enhancement of exam results were noticed after the completion of fifth semester
Leadership / Communication skills / Initiative	20	Almost doubled
Engine overhauling / Service	10	Excellent
Welding / fitting	22	Excellent
Metal cutting / grinding	32	Excellent
Electrical system maintenance	10	Very good
Design software	8 (Solid works)	Very good
AutoCad	21	Very good
Problem Solving capability	25	Excellent
Flexible and collaborative	57	Great achievement
Knowledge retention	35	Almost permanent!

Placement Linked:- Since many dailies, web magazines, social media like facebook and whatsapp spread out the achievements of S6 Automobile Engineering students, many reputed automobile engineering firms (mainly service industry) approached to conduct their first campus interview of the year 2017 at GPTC Attingal.

Increased effectiveness of teachers and students:- In-order to solve the various problems associated with the Formula Maruti Project, teachers were forced to update themselves to co-operate with the students.

Student and teacher relationship:- There is a drastic change in the basic approach of students towards their teachers and lab instructors. Students are more disciplined and they keep high regard towards their teachers. It was also noted that frequent rivalry between students were reduced/ nullified after starting the current project.

Training for junior students:- As a part of regenerative teaching, senior students have started training junior graders in acquiring various skills like welding, fitting, etc. The project has great influence among junior students of Automobile Engineering as well as students from other branches.

Training Partners:- M/S Cadd Centre, Attingal, a software training firm, has offered to train the Automobile Engineering students at half the rate of their course fee. They have offered placements as well.

Funding by seniors:- Alumni of GPTC Attingal showed their comradeship to the institution as well as their juniors by partially funding of the project.

Scope for external funding / CSR:- In future, students are hopeful of getting CSR funds from various industrial giants across India.

Achievements:- Formula Car Project of GTC Attingal took part in FAN 3 International Seminar at Mill Hall, Kochi Biennale (Held on 18/1/17 to 19/1/2017). CEO of Kerala Startup Mission has offered funding for new projects of students of GPTC Attingal.

Esteem for institution and inspiration for further projects:- Project based learning will help the parent institution to achieve grade points during NBA Accreditation process.

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