# 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

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

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.
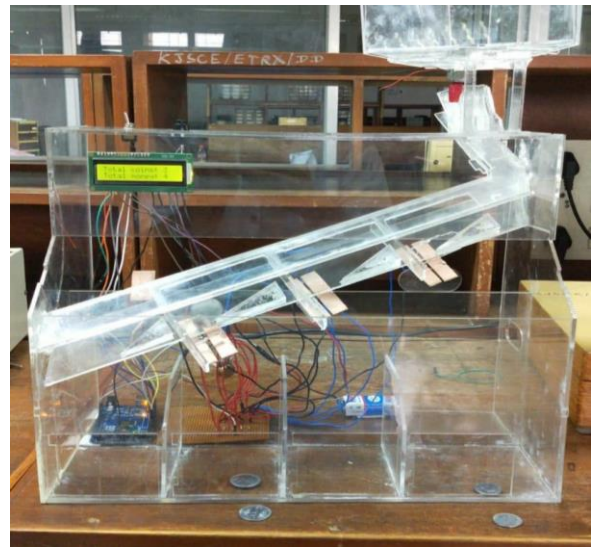

Fig 4 Coin Sorter and Counting Machine project

 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

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.
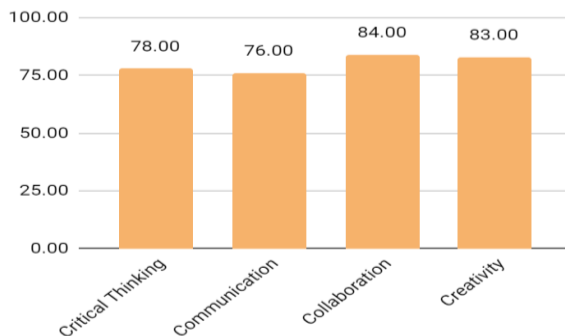


Fig 5 Feedback of Students

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.

## Acknowledgement

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