Blending ICT with Project based Learning for effective teaching and learning of Mechatronics

P.S.Jadhav¹, A.M. Mulla¹, P.M. Jadhav¹
¹²³ Mechanical Engg, Rajarambapu Institute of Technology, Sangli, Maharashtra
¹prashant.jadhav@ritindia.edu; ²abid.mulla@ritindia.edu; ³prakash.jadhav@ritindia.edu

Abstract: India is a rapidly growing country with its huge economy. As per the Vision 2020 India has a huge demand for product, services and automation. To fulfill this requirement, more number of engineers are required to build innovative solutions. It's a known fact that engineering graduates have a strategic and long-term impact on productivity, growth in industry and service sectors [8]. To produce sophisticated industrial products and services that are competitive in the global market and to realize the 'Make in India' dream, India needs a really high number of well trained and extremely qualified engineering graduates. Unfortunately the facts look a bit dismal. Institutions like the IITs, NITs and a few other public and private technical universities are admittedly performing well but the majority of institutes are affiliated to various universities and teach the curriculum developed by the affiliating university. As a result, they lack the incentive of continuous improvement of the quality of teaching and learning and are not geared to adapt to the changing qualification needs of the job market.

So, in order to bridge the quality gap in engineering education there is a need of a platform where ICT is effectively used by premier institutes of India to develop and train teachers and students of private and public sector engineering institution through a combined methodology of Project Based Learning which is completely online.

Keywords: ICT, Project Based Learning, Make in India, Vision 2020

1. Introduction:

IIT's have always tried to improve the quality of engineering education through distance learning, NPTEL videos, online courses, workshops and by providing continuous support to teachers and students of tier II & III type institutions. This had some limitations since engineering education needs hands on training/experience for theoretical aspects. When theory is combined with practical sessions or after theory when some work is assigned to students, depending on classroom teaching it gives the effective result. With this, Quality of education can be maintained and students will have a platform to think upon and showcase their capabilities. IIT Bombay team has provided the perfect solution to remove the gap of quality in education with their project- e-Yantra. e-Yantra (Engineering a better tomorrow) is a
project of Department of Computer Science and Engineering, IIT Bombay, sponsored by MHRD through National Mission on Education through ICT (NMEICT). Mission of e-Yantra is to Enable Embedded systems education in engineering colleges across India in a scalable and sustainable manner. The workflow of e-Yantra is outlined in following figure[1].

Phase 1) e-Yantra Lab Setup Initiative (eLSI)

This phase focussed on hands on training for teachers across various regions of the country in a scalable manner through Nodal Centres (NCs) as shown in figure 2.

Needs of this phase:

a) Colleges as a nodal centre

b) e-Yantra labs in Colleges

In order to make student projects successful, it requires trained teachers and infrastructure. Two days workshops were conducted at the nodal centres to train the teachers on a platform i.e. Fire Bird educational robot and e-Yantra which helped to set up robotic labs in colleges. Along with this, a competition and symposium for teachers was also organised to make a strong bonding between e-Yantra team and teachers from different regions of the country.

Phase 2) e-Yantra Robotics Competition (eYRC)

In the e-Yantra Robotics Competition, the course material covered in face-to-face two-day workshops was converted into video tutorials. These tutorials were given to student participants in eYRC to learn concepts at their own pace. Support was provided through an on-line discussion forum where students posted their queries. All teams participating in eYRC were given a FireBird-V Robot along with accessories required to implement the solution to a problem assigned to them [7]. Students did not incur any cost to participate in the competition. The interesting part of the competition was the model and methodology used to engage with students even from the rural area of the country. Robotic competition is an effective way to impart Project Based Learning (PBL). It is considered here that there are three different models of PBL:

a) PBL through a stand-alone competition,
b) PBL through a classroom course incorporating the competition as a course project

c) PBL through an online course.

e-Yantra team has taken all the positive aspects of these three models where a competition with a step by step methodology is provided to students completely online[1].

3. Levels of e-YRC:

Level 1: At this level, students were encouraged to form a multidisciplinary team to take part in competition and register online through e-Yantra website. Plenty of students registered for the competition e-YRC 2012. the number of students registered was over 4000. Then an online test was conducted to check the basic knowledge of students in robotics and programming which is a need to participate and solve the problem allotted to them. The test conducted comprised of multiple choice questions related to basic electronics and C language for programming. Out of 4000 students, 500 were selected on the basis of online test.

Level 2: a robotic kit - a Firebird-V robot along with accessories, video tutorials, detailed hardware and software manuals, instruction sheets, and necessary software - was given to each team. e-Yantra proposed four themes: Pothole filler, Pick and placer, Line follower, and Room cleaner. One out of these four was assigned to each team. The span for competition was 3 months; during this, every team had to perform different tasks within stipulated time [1].

Level 3: Each task was evaluated and the total score of the team was used to select the finalists. Five teams from each theme were selected as finalists. Evaluation consists of a set of tasks designed to impart PBL, along with awareness of basic concepts in embedded systems and micro-controller programming. Several other skills that are honed through PBL were also evaluated on-line. This skill includes hardware design, algorithm design, report writing and code documentation, in addition to soft skills such as presentation skills and video recording skills. 20 finalist teams - 5 teams from each of the 4 themes - travelled to IIT Bombay to participate in the grand finals.

Different tasks are enlisted below and detailed in Table 1:

i) Task 0: Flex Printing

ii) Task 1: Theme Analysis

iii) Task 2: Implementation Analysis

iv) Task 3: Video demo

v) Task 4: Report and Code Documentation

<table>
<thead>
<tr>
<th>Table 1: Detailed Task</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Task</strong></td>
</tr>
<tr>
<td>Task 0: Flex Printing</td>
</tr>
<tr>
<td>Task 1: Theme Analysis</td>
</tr>
<tr>
<td>Task 2: Implementation Analysis</td>
</tr>
<tr>
<td>Task 3: Video Demonstration</td>
</tr>
<tr>
<td>Task 4: Report and Code Documentation</td>
</tr>
</tbody>
</table>

4. Analysis of PBL through e-YRC:

a) Total number of teams participated = 131

b) Number of teams submitted at least one task = 127 (i.e. 97% of a)

c) Number of teams submitted all the tasks = 79 (i.e. 62% of b)

d) Number of teams completed all the tasks = 41 (i.e. 52% of c)
c) Number of teams selected as finalists = 20
   (i.e. 49% of d)

This event provided the Level-3 evaluation which authenticates the project implemented by the students in

(i) Design quality
(ii) Generality/optimality of the algorithm implemented
(iii) Modularity of the code written and
(iv) Validating authorship of the project.

Teams were asked to demonstrate their solution in an arena that was slightly modified to ensure the originality of the work done and generality of the algorithm used. Expert judges conducted an oral questioning during the demonstration, to evaluate the contribution from each of the team members and their understanding of the solution provided. Design aspects of the solution provided were also given due consideration.

Above statistics show, according to b, 97% of teams acquired at least basic knowledge. From c, 62% of these teams were exposed to all the tasks through the PBL mode. From d, 52% of students were trained to implement a project independently. From e, 49% of these teams not only successfully completed all the tasks but also have shown the potential to be innovators.

Table 2: Level description of task

<table>
<thead>
<tr>
<th>Cognitive Level</th>
<th>Level Description</th>
<th>Task</th>
<th>Task Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>Route a policy. Quiz questions know the safety rules, define a term.</td>
<td>Task-2: Flex Printing</td>
<td>Registration, downloading files, putting it with given dimensions, uploading photos</td>
</tr>
<tr>
<td>Comprehension</td>
<td>Understand the meaning, translation, interpretation, and interpretation of instructions and problem. State a problem in your own words.</td>
<td>Task-1: Theme Analysis</td>
<td>Critically examining the problem; answering questions based on the material learnt</td>
</tr>
<tr>
<td>Application</td>
<td>Use a concept in a new situation or unspoken role of an abstract concept. Use what was taught in the classroom into novel situations in the test phase.</td>
<td>Task-2: Implementation Analysis</td>
<td>Considering different options for solving the problem, testing the pros and cons of each option, justifying the selection of a particular algorithm</td>
</tr>
<tr>
<td>Analysis</td>
<td>Separate material or concepts into component parts so that the organization of structure may be understood. Distinguish between facts and inferences.</td>
<td>Task-3: Video Demo</td>
<td>Making a working prototype; evaluating the prototype to make the solution more efficient</td>
</tr>
<tr>
<td>Synthesis</td>
<td>Build a structure or pattern from diverse elements. Put parts together to form a whole, with emphasis on creating a new meaning or structure.</td>
<td>Task-4: Report and Code Documentation</td>
<td>Specifying implementation idea, design constraints, challenges faced; coming up with a desk design and an efficient algorithm</td>
</tr>
</tbody>
</table>

i. No Knowledge Gained: Students who did not complete even one task. These students did not learn anything from the e-Yantra Robotics Competition.

ii. Basic Knowledge Gained: Students who submitted at least one task but could not solve the assigned problem and dropped out of the competition. These students learnt the basic concepts related to robots through video tutorials and completed the first or second task.

iii. Application of Knowledge: Students who tried to solve the assigned theme but could not complete the theme as desired. These students were able to make the robot perform part of the solution but could not integrate all modules required to solve the theme completely.

iv. Incorporated Critical Analysis: Students who successfully completed all the tasks and solved the problem as specified. These teams learnt the basic concepts and applied those to design the robot by understanding and analysing the problem statements.

v. Showcased Creativity: These students were the members of the top five teams from each theme. These students not only demonstrated a working solution but also showcased their creativity in designing an efficient [7]. Attainment of program outcomes with task involved is mapped in the following table:

<table>
<thead>
<tr>
<th>Program Outcome</th>
<th>Task</th>
<th>Task Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>a, d, e</td>
<td>Task-C: Flex Printing</td>
<td>Registration, downloading file, putting it with given dimensions, uploading photos</td>
</tr>
<tr>
<td>c, d</td>
<td>Task-1: Theme Analysis</td>
<td>Critically examining the problem; answering questions based on the material learnt</td>
</tr>
<tr>
<td>d, e</td>
<td>Task-2: Implementation Analysis</td>
<td>Considering different options for solving the problem, testing the pros and cons of each option, justifying the selection of a particular algorithm</td>
</tr>
<tr>
<td>d, k</td>
<td>Task-3: Video Demo</td>
<td>Making a working prototype; evaluating the prototype to make the solution more efficient</td>
</tr>
<tr>
<td>e, g</td>
<td>Task-4: Report and Code Documentation</td>
<td>Specifying implementation idea, design constraints, challenges faced; coming up with a desk design and an efficient algorithm</td>
</tr>
</tbody>
</table>

*List of program outcomes for Mechanical engineering, RIT, Sakharale, taken from [12]

5. Conclusion:

E-Yantra was initiated with the aim of reducing the gap in engineering education in India. Two days face to face workshop for teachers was very effective in terms of making them self sufficient to mentor student projects with the e-LSI. EYRTC is launched soon after the workshop to train the teachers to implement a solution in the PBL mode. E-Yantra Symposium brought together colleges which have established E-Yantra labs through eLSI for discussions and seminars on how to turn these labs into innovation hubs. Then e-YRC provided students a platform to showcase their abilities and ideas. In all projects, e-Yantra used as a very effective way to reduce the gap in education
quality and opportunities offered to students. e-Yantra team has taken all the positive aspects of three models of PBL where a competition with a step by step methodology is provided to students completely online. eLSI adds value to teachers in preparing them to mentor students in embedded systems and robotics and also gives a path for colleges to set up an embedded systems facility along with the training to sustain it.

References:


[12] List of Program Educational Objectives (PEO) for Mechanical Engineering in Rajarambapu Institute of Technology, Sakharale, Maharashtra, (India).