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A Structured Approach to Teaching and Learning Robotics

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Abstract: Students are not passionate enough about conventional teaching techniques because too often, we hear from students that conventional teaching is boring and that they cannot relate to or understand the course that is presented to them each day in class. Rather than feel disheartened, we need to understand that we have before us both a challenge and an opportunity. Project-based learning (PBL) experiences will help us figure out how to make learning come alive for our engineering students. Project-based learning goes beyond generating student interest. Due to these reasons twenty-first century students are moving towards modern learning approaches rather than conventional learning. This paper presents the conceptual analysis of learning approaches involving use of simulation software, robots and solving real-time problems. Learning can be made more fun and interesting through practical application of concepts. Learning by actual implementation of theoretical concepts, provides students good hands-on and makes them ready for the industry. Result analysis show that performance of the students has improved and also quality of course projects is increased. Thus, we can conclude that students are attracted towards the course and also found to improve their learning skills in the context of course project work.

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1. Introduction

In this modern era students are looking at innovative teaching techniques to involve themselves actively in to the course. Students are actively involved in project based learning approaches rather than the class room teaching technique. Students are looking at modern teaching techniques rather than the traditional learning approaches. Students are always enthusing to involve themselves insolving real-time problems/applications.

To implement new learning methodology or approaches to improve student's learning skills, teachers and institutions should take initiation to develop laboratories and collaboration with industries. To motivate students towards course, designing or modification of course should be initiated by the teachers or by the institutions.

Now adays,many institutions are developing Win-win philosophy with the industry to develop educational-institutional laboratories to establish practical implementation for the students.

Students are showing more interest on Project Based Learning (PBL) as compared to traditional teaching technique. Students are moving beyond the

traditional approach, due to this there is a challenge for the teachers and institutions to adopt new techniques or approaches to attract and motivate students towards the course.

The aim of all teaching activity is to motivate student learning in context of course project. Project based learning, is a teaching and learning model that uses projects to engage students and focus their learning. Projects are complex tasks that involve students in design, problem-solving, decision-making, team management and investigative activities. Students work autonomously over extended periods of time, and prepare realistic products or design/presentations (Arends, 1997; Diehl, Grobe, Lopez and Cabral, 1999; Thomas, 1998).

For teachers who use PBL, the task of classroom management is quite different from that faced by teachers employing the traditional instructional methods of teaching, discussion, and seatwork. With PBL, very little time is devoted to teacher-directed seatwork or whole-class discussions. Students spend the majority of their time working on their own or in groups. Teachers typically do not lead instructional activities, nor do they dispense resources, or present material to be learned. Students find their own sources, conduct their own research, and secure their own feedback. Experienced PBL teachers report that they spend very little time promoting student engagement. Teachers often spend their time participating in projects as peers rather than as classroom managers (Vinod Kumar V Meti, 2015).

Through the PBL approach, students can take leadership for their learning, structure and organize an action project and start communicating, thinking and involving in to the project. In other words, students become empowered and educated about new technology (Erica Baker et al., 2011).

In this paper, an attempt has been made to share some of the new techniques extracted from PBL approaches to make students and teachers to involve in to the course. Here the author discusses about course through the course project as well as associated laboratory. Student's feedback and their quality of course project motivate teachers and institutions to implement other courses as well.

2. LiteratureReview

Project-based learning is also called as problem-based learning refers to students designing, planning, and carrying out an extended project that produces a publicly-exhibited output such as a product, publication, or presentation(Alec Patton, Jeff Robin, 2012).

Introducing projects into the curriculum or project based learning approach is not a new or revolutionary idea in educational institution. During the past decade, however, the practice has evolved into a more formally defined teaching strategy. Project-based learning has gained a greater foothold in the classroom as researchers have documented what teachers have long understood: Students become more engaged in learning when they have a chance to dig into complex, challenging, and sometimes even messy problems that closely resemble real life.

Project-based learning motivates and develops student's interest towards the course. These learning approaches encourage students to develop problem solving techniques and higher order thinking skills through their projects (Thomas, 1998).

Brain research underscores the value of these learning activities. Students' abilities to acquire new understanding are enhanced when they are "connected to meaningful problem-solving activities, and when students are helped to understand why, when, and how those facts and skills are relevant".

When the students are connected to project based learning approach or problem solving technique, they become well engaged, understand the concepts better by discussing among teammates, help others to involve and develop inter personal skills (Bransford, Brown, and Conking, 2000).

Teachers and institutions are involving to develop project based learning approach or problem solving technique in to the curriculum to motivate students engagement. Project based learning approach not only develops students skills, improves institutional academic performance (George Lucas Educational Foundation, 2001, Vinod Kumar V Meti, 2016).

Benefits of PBL for students are as follows:

- Improved attitude and motivation towards teaching and learning(Thomas, 2000).
- Institutional academic gains better than the traditional approaches (Project based learning

takes greater responsibility towards new learning techniques rather than the traditional learning approaches) (Boaler, 1999; Sri, 2000).

- Opportunities to develop higher order thinking skill, team management skill, communication skills and inter personal skills (Sri, 2000).
- Opportunity to develop active based learning (motivates student's engagement more effectively) (Railsback, 2002).

PBL approach also benefits teachers to enhance their professional skills and creates opportunity to develop their research skills (Thomas, 2000). PBL approach always creates a new platform for the teachers and institutions to look new methodology rather than the traditional approach (Sri, 2000).

Also, this article covers research and research-related articles on "project-based learning," that conform to the criteria above.

3. Objectives

The Primary Objective is

- To motivate and encourage students inter personal skills in the context of course project and also build knowledge towards the course more effectively.
- Specific Objectives are
- Actual implementation of theoretical concepts, to provide students good hands-on and make them ready for the industry.
- To motivate and enthuse students to develop communication skills and team management skills in the context of course project work.
- To enhance the higher order thinking skills.

4. Methodology

To motivate and develop student's learning skills, institutions and teachers are trying to design and develop the courses to minimize the gap between educational institutions and the corporate sector.Learning by actual implementation of theoretical concepts, provide students good hands-on experience and makes them ready for the industry. To explore students learning skills, the teachers should take challenge to implement the new learning approaches. Win-win philosophy can be applied to bridge the gap between educational institutions and industry. In our institution management has taken initiation to develop labs in collaboration with the industry to meet their needs. Also institutional management listen to the industry demands in designing the course.

The laboratory sessions are planned in accordance with the theory concepts taught. In this course, the course instructor has designed the course in to two categories, theory and laboratory. In the regular theory class students undergo design, programming concepts and techniques. In laboratory, students have to performactivities/experiments based on concepts taught in class and at the end should carry out a course project involving all the concepts learnt. Here the course instructor allotted credits for the lab sessions to effectively carryout the experiments and course projects. List of experiments to be performed in laboratory is as shown in table 1.

In this course, the instructor formed teams; in each team max five students are working for the course project. Each team has to come up with an application based component/product, following the simple design process and concepts as explained in the course. At the end of the course the students have to submit the report along with the course project model. Marks/credits were allotted to each team according to their performance carried out throughout the course.

5. Analysis and Discussion

Table 1. List of experiments/jobs planned to meet the requirements of the course.

Category: Demonstration		***Total Weightage: 10***
No. of lab sessions: 4		
Learning Outcomes : *The students should be able to:* *1. Demonstrate the knowledge about the basic principles and laws of robot.* *2. Demonstrate the knowledge about the basic principle of operation, coordinates and parts of robot.* *3. Demonstrate the knowledge about Mat lab and Robot studio software based tools.*		
Expt.No	***Experiment/job Details***	***Marks***
1	Demonstration on working with Mat Lab software.	*10*
2	Demonstration of operations of ABB Robot.	*10*
3	Demonstration of controlling the robot using Flex pendant.	*10*
4	Demonstration on working with Robot Studio Software.	*10*

Category: Exercises	***Total Weightage: 20***
No. of lab sessions: 3	
Learning Outcomes: *The students should be able to:* *1. Demonstrate the robot programming methods.* *2. Demonstrate the operation of robot using robot controller.* *3. Simulate the robot using Mat lab and Robot studio software.*	
Expt.No.	***Experiment/job Details*** / ***Marks***
5	Write a program and simulate the robot using Mat Lab software. — *20*
6	Write a program and simulate the robot using flex/teach pendant. — *20*
7	Write a program and simulate the robot using robot studio software. Example: Path Tracing, Collision Detection. — *20*

Category: Structured Enquiry	***Total Weightage: 20***
No. of lab sessions: 4	
Learning Outcomes : *The students should be able to:* *1. Demonstrate the knowledge of solid modeling software tools.* *2. Demonstrate the knowledge of industrial applications of robot.* *3. Demonstrate the knowledge about the mapping of sensors and end effectors with the robot.*	
Expt.No.	***Experiment/job Details*** / ***Marks***
8	Write a program and simulate the robot using robot studio software by inserting the CAD model objects/workstations designed using solid works tool. — *20*
9	Design of end effector for a particular application using Robot Studio and Solid worksoftware. — *20*

Category: Open Ended	***Total Weightage: 20***
No. of lab session: 2	
Learning Outcomes : *The students should be able to:* *1. Demonstrate the knowledge about the commands used in simulating the robot.* *2. Demonstrate the knowledge about work stations and conveyors.*	
Expt.No.	***Experiment/job Details*** / ***Marks***
10	Design a complete process for welding, assembly, drilling, gluing or sorting using Robot Studio and Solid worksoftware's. — *20*

Table 2. Autonomy for laboratory activity (Students Assessment through CIE (80%) + SEE (20%))(Vinod Kumar V Meti, 2015)

Type of Evaluation	Types of laboratory work	Given or Open				
		Aim	Material	Method	Answer	Marks
CIE (Continuous Internal Evaluation)	Demonstration	Given	Given	Given	Given	10
	Exercise	Given	Given	Given	Open	20
	Structured Enquiry	Given	Given	Open	Open	20
	Open Ended Enquiry	Given	Open	Open	Open	20
	Quiz (Viva)	-	Given	-	Open	10
SEE (Semester End Exam)	Project	Open	Open	Open	Open	20
					Total	100

To design the courses and also attract students towards the course in this modern engineering world is a challenging task. Every day there is a new challenge for the instructor to attract students towards the course. In this challenging scenario, further improvement and development of the course is necessary. Keeping these things in mind, the instructor collected student's feedback. Students have responded positively towards the design and development of the course. Table 3 show the feedback

Table 3. Feedback obtained from students for the questions raised towards the course.

Questions	Excellent	Good	Satisfactory	Not Satisfactory
1. Design of the course in accordance with industry needs.	20	15	0	0
2. Involvement/interest /engagement with the course/course project/activity.	27	8	0	0
3. Time Management to implement the activity.	7	18	9	1
4. Assessment of the course.	19	14	2	0
5. Help you to implement the theoretical concepts.	24	9	2	0
6. Help you to improve your team management skills, communication skills and higher order thinking skills.	29	6	0	0

received from the students towards the course.

Figure 1 show the graph generated from the students feedback. With this graph we can conclude that student's response towards the design and development of the course was very good. With this methodology students are able to be attracted and motivated towards the course more effectively. This activity/methodology helps students to improve their project management skills, communication skills, complex thinking skills, higher order thinking skills and present world skills. But student's feedback also says further improvement is required to implement this course more effectively

To ensure design and development, the activity/methodology adopted in this courseis shown

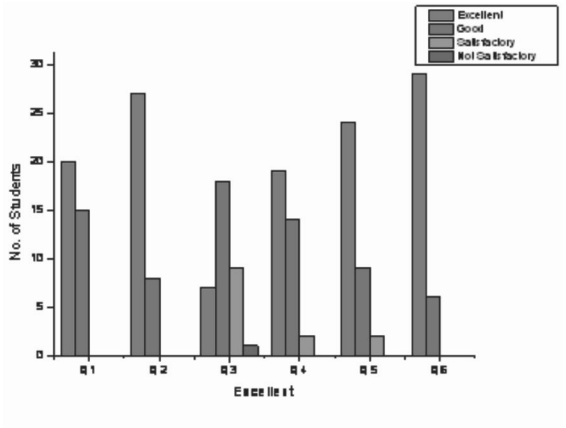
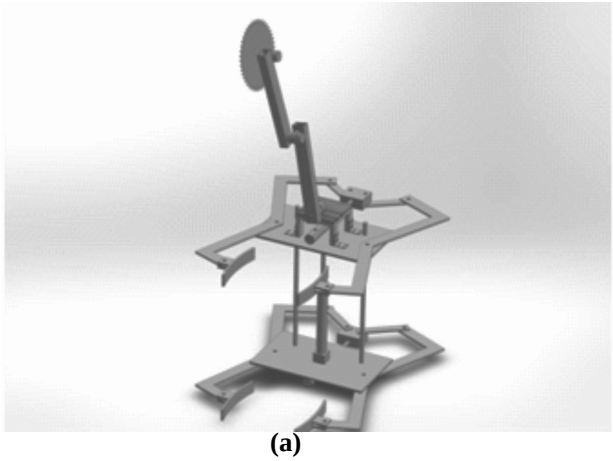
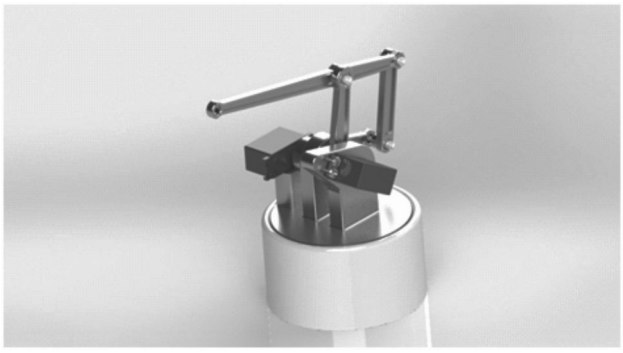


Fig. 1.Students feedback.

with the help of the course projects handled by each of the team. Each team successfully designed the machine or machine components using the facility available in the department (Solid Works-Modeling and Simulation Software). Figure 2 showsstudent's



(a)



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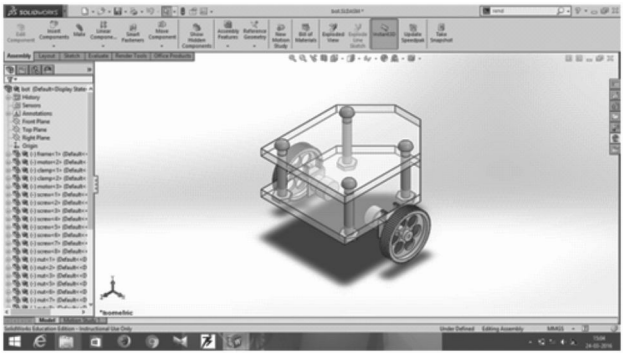

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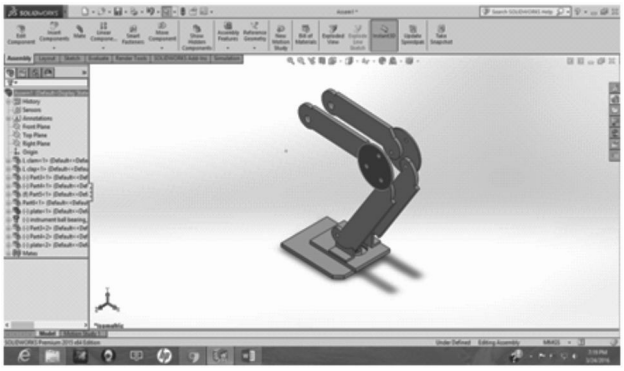

(d)

Fig. 1.Samples of students course project carried out during the course: (a)(b)(c)(d) shows the different types of robots.

performance in the course project. These samples of course project enumerate the development of student's complex and higher order thinking skills.

6. Conclusions and Recommendations

Course and laboratory activity have been successfully planned and categorized based on demonstration, exercise, structured enquiry and open ended enquiry. Student's feedback helps to design other course to develop the course projects. Student's feedback also helps teachers and institution to develop

laboratories in collaboration with the industry towards the development of students learning skills.

By this we can conclude that students are more attracted towards the course and this helps to improve their inter-personal skills, communication skills and team management skills in the context of course project work. This also supports students to enhance higher order thinking and complex thinking skills.

An inclusion of more of structured enquiry and open ended exercises is recommended. Communication with industry to introduce the realtime examples in the course is a future scope.

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