A Structured Approach to Teaching and Learning Hydraulics & Pneumatics

Vinod Kumar V Meti
Department of Automation & Robotics
B.V.Bhoomaraddi College of Engg & Tech.,
Hubli, Karnataka, India
vinod123meti@gmail.com

Arun C Giriyapur
Department of Automation & Robotics
B.V.Bhoomaraddi College of Engg & Tech.,
Hubli, Karnataka, India
aaron@bvb.edu

Abstract—***Students are more attracted towards and enthusiastic about modern teaching techniques. This paper provides a new concept in the design of a coursework thus enabling the teachers to enhance the teaching and learning process. The course work, laboratory and course projects are linked through proper planning. It is observed that there is an increase in the degree of involvement of the students in the course and they move from doing demonstrations to structured enquiry and also open ended enquiry. This new framework can also address some of the ABET criteria effectively. Results show positive response from the students towards this new technique.***

Keywords—techniques, demonstration, structured enquiry, framework.

I. INTRODUCTION

Nowadays engineering institutions moving beyond the traditional learning approaches to the modern learning approaches. Most of engineering colleges are updated towards the new teaching methods and adopted modern engineering tools to enhance the knowledge, concepts, design and to carry out innovative course projects. These institutions are attracting students towards the modern teaching world. The traditional norms in which teaching, methodology, tests and assessment of student's performance are to be changed towards the modern approaches [1]. Therefore teaching, learning and training students on the course content need not only class based but also can be carried out in lab, during the industrial visit and as well as during the course project [2].

To move beyond the traditional learning approach, outcome based education learning approach emerges to motivate and involve students in to the learning approach [1]. Outcome based education learning approach promotes the students and faculties to enhance innovative ideas and approaches towards the course [3].

Outcome based education emerges with new learning approach and methods to reform and renew the traditional learning approaches worldwide. Outcome based education approach has gained prominence recognition worldwide in relate to the modern engineering approaches [1].

Preparing students in to the course, work and life in the present modern world is complicated [4 Anna Alderson]. Teachers and educational institutions are referred to include present world skills, higher order thinking skills, complex thinking, communication skills, and team management skills to enhance the students to 21st century [5 Dr ACR Tavner]. So the course instructors and institution taken the initiation to adopt outcome based education learning approaches towards the engineering courses [6].

In this paper author explain the outcome based learning education learning approaches adopted in the Basic Hydraulic & Pneumatics control course to train the students under Train the Trainers concept. In this the instructor planned the content of the course and other activities at the beginning of the semester and delivers the principles, concepts and design analysis to the group of students during the theory sessions. Individual student from each group take the initiation to explain the principle, concepts and design analysis of course during the lab session, course project and during industrial visit.

II. LITERATURE REVIEW

There are a number of different approaches to designing the course. The design progress from instructor-led demonstrations, where all aspects of the laboratory are given by the instructor, to students-led projects in which all aspects of the design are open to the students [7].

Students to achieve a satisfactory understanding of engineering they will need to have significant exposure to hands on laboratory work and substantial individual project work and that the curriculum should include both design and research-led projects which are expected to develop independence of thought and the ability to work effectively in a team-a variety of approach is needed [8].

Students given experimental exercises throughout their degree programmes, where only the results are variable, may be ill-equipped to respond to challenges presented by independent project work. If creativity and innovations are to be fostered then students need to be involved in the design of experiments and to develop an understanding of the

uncertainties and inaccuracies of outcomes from the outset. This has implification for the design of laboratory and practical activities at programme level, as students need to be helped to make the transition from instructor-led to students-led approaches and to develop the skills necessary for independent learning through exposure to experimental design and project work at early stages in their degree [9].

Outcome-based education (sometimes called Performance-based Education, formerly called Mastery Learning) is a model of education that favors making students demonstrate that they know and are able to do whatever the required outcomes are. The outcomes are specified in terms of individual student learning. The model rejects the traditional focus on educational inputs and content and time allocation. Instead, OBE focuses on desired results. OBE emphasizes setting clear standards for observable, measurable outcomes through which student performance can be empirically measured [10].

Educational process which is based on trying to achieve certain specified outcomes in terms of individual student learning. Thus, having decided what are the key things students should understand and be able to do or the qualities they should develop, both structures and curriculum are designed to achieve those capabilities or qualities. Educational structures and curriculum are regarded as means not ends [11].

An outcome is a culminating demonstration of learning; it is what the student should be able to do at the end of a course. Outcome-based education is an approach to education in which decisions about the curriculum are driven by the exit learning outcomes that the students should display at the end of the course. Outcome based education learning approach where teaching and learning activities are developed to support the learning outcomes and helped to design the assessment towards the course [12].

III. OBJECTIVES

- To encourage students towards the course more effectively.
- To engage students to involve in to the lab and project activity.
- To build a basic knowledge about the course.
- Effectively make utilize of modern lab facility available for the course.
- To motivate students to develop inter personal skills, communication skills and team management skills in the context of course project work.
- To enhance the higher skill development at course project work, future directions and engagement with challenging work during the lab and course project.
- To motivate students to Supporting the learning of others.
- Working in team: learning through co-operation and interaction.
- To explore practical knowledge to the students.
- To approach students to the industrial environment.

IV. METHODOLOGY

At the beginning of semester the instructor had planned the content, lab exercises in relate to industrial applications and other activities on the basis of outcome based education learning approach. The instructor divided the whole class strength in to teams, where in each team minimum 4 students are identified. First the instructor explain the learning approach adopted in the course and delivered the content of the course to students during the regular theory classes and experience the hands-on during the lab session on the basis of anatomy for laboratory. By simultaneous learning of theory and laboratory, students can perform well on their course project work. In lab students are using Automation Studio software and Hydraulics and Pneumatics hands-on kit for designing and simulating hydraulics & pneumatics circuit diagrams. Using software, students can design, simulate and analyze the hydraulics & pneumatics components and circuit diagrams. Later students setup the hard components and testing the circuit diagrams. In this the instructor delivers the laboratory on the basis of laboratory anatomy activity approach. Figure 1 shows concept of laboratory deliver plan towards course project.

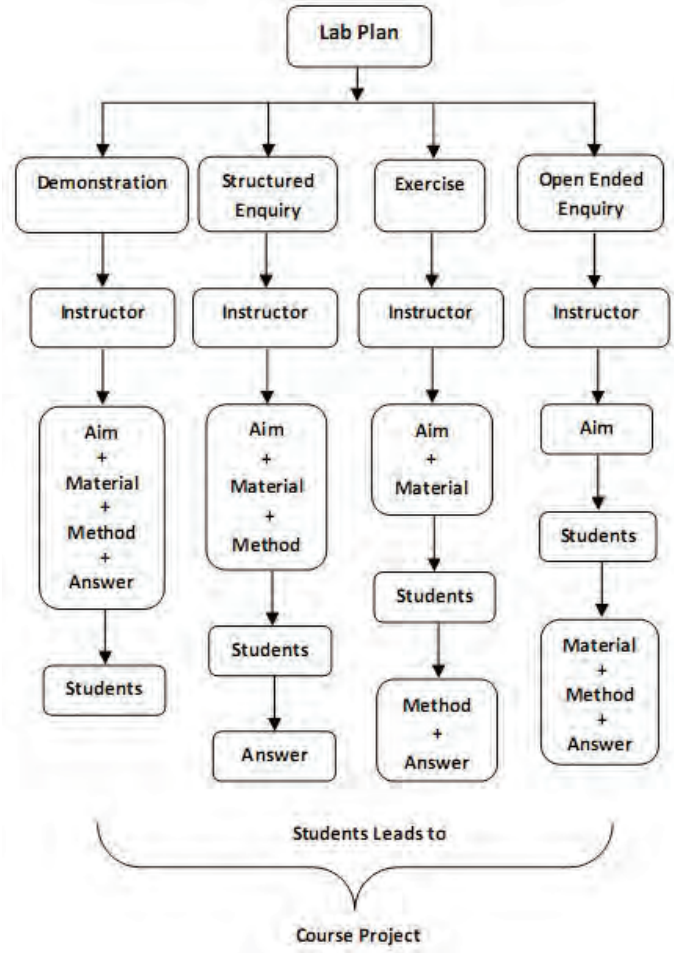

Fig. 1. Concept of laboratory activity towards course project.

In this course the instructor divided the set of experiments in to demonstration, exercise, structured enquiry, open ended enquiry and open ended project. In demonstration part the instructor will demonstrate and conclude the experiments. In demonstration, aim, material/components, methodology and answer are given. In exercise part the instructor demonstrate & conduct experiments but answer kept open for students to conclude. In exercise, aim, material/components, and methodology will be given and answer is kept open for students to conclude themselves by understanding the exercise. In structured enquiry the instructor give aim & material/components but method & answer are kept open for students to proceed further. In open ended enquiry the instructor give only aim and rest (material, method & answer) are kept open for students to perform further. Here the instructor had selected the exercises for demonstration, exercise, structured enquiry and open ended enquiry on the basis of industrial applications. The lists of exercises are listed in the table 1.

List of experiments/jobs planned to meet the requirements of the syllabus (Demonstration only)

Expt./Job No.	*Brief description about the experiment/job*	*No. of Lab. Slots per batch (estimate)*
1	Single-rod cylinder/ Using 4/2 DCV (Meter-in and Meter-out circuits)	*1*
2	Study of Hydraulic Motor with 4/3 DCV	*1*
3	Indirect control of Double Acting Cylinder	*1*
4	Position Dependent Control of a Double Acting Cylinder with Mechanical Limit Switches	*1*

List of experiments/jobs planned to meet the requirements of the syllabus (Exercise)

Expt./Job No.	*Brief description about the experiment/job*	*No. of Lab. Slots per batch (estimate)*
5	Single-rod cylinder/pressure intensification	*1*
6	Application of 4/3 directional valve (Tandem and closed centre)	*1*
7	i. Speed Control of Single Acting Cylinder– Slow Speed Extension and Rapid Retraction. ii. Stop control, double-acting cylinder with 5/3 directional control valve, tensile load	*1*
8	This exercise conveys the understanding for the logical "AND and OR function" in relay technology.	*1*

List of additional experiments/jobs planned (Structured Enquiry)

Expt./Job No.	*Brief description about the experiment/job*	*No. of Lab. Slots per batch (estimate)*
1	The sequential control with two pneumatic drives. The signal overlapping occurring during this exercise is constructively solved by use of rollers with idle return. Practice is obtained in developing sequential diagrams and pneumatic circuit diagrams.	*1*
2	Aim is to Stop control of a double-acting cylinder with a 5/3 directional control valve in closed mid-position in pneumatics.	*1*

List of open ended experiments planned (if any)

Expt./Job No.	*Brief description about the experiment/job*	*No. of Lab. Slots per batch (estimate)*
1	A double-acting cylinder is used to press together glued components. Upon pressing a push-button, the clamping cylinder is to extend and trip the roller valve. Once the fully extended position of the cylinder has been reached and sufficient clamping force has been developed, the cylinder is to retract to the initial position. Develop a control circuit using a pressure sequence valve.	*2*

Table 2. Lists of experiments for Hydraulics and Pneumatics laboratory.

For the project students have to choose industrial application oriented problem definition and has to present during the semester end exam. The assessment criterion for lab is also well established and is as shown in table 2 [9]. Here the continuous assessment is done based on their performance during the laboratory. Through this assessment continuous monitoring and continuous internal evaluation of students can be done easily.

Type of Evaluation	Types of laboratory work	Given or Open				
		Aim	Material	Method	Answer	Marks
CIE	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	Project	Open	Open	Open	Open	20
					Total	100

Table 2. Autonomy for laboratory activity.

V. RESULT AND DISCUSSION

At the end of course, feedback was collected from each student towards the learning approach. Individual students have given feedback for the questions prepared to know the learning approach adopted in the course. List of questions and feedback given by students is listed in below table 3.

Questions	Excellent	Good	Satisfactory	Not Satisfactory
1. How do you rate the content of the course?	22	18	0	0
2. How do you rate the way course was delivered?	27	13	0	0
3. How do you rate the associated practices/support given by the instructor during teaching the course?	18	20	0	0
4. How do you rate your involvement/interest/engagement with the course?	16	19	5	0
5. How do you rate the learning happened during the lab session in associated with the theory?	17	22	1	0
6. How do you rate the modern lab facility available in the institution?	28	12	0	0
7. How do you rate the lab practices (Train the Trainer Concept) will help you to work in group and communicate effectively?	20	20	0	0
8. How do you rate the learning happened during the course project work in associated with theory & lab?	20	18	2	0
9. How do you rate the learning happened in theory & lab will help you to motivate towards course project?	18	20	2	0
10. How do you rate the industrial visit will help you to motivate towards course?	18	18	4	0
11. How do you rate the way of assessment criteria adopted throughout the course?	14	24	2	0
12. How do you rate that this course will help you in your academic or professional career?	20	18	2	0
13. How do you rate the learning happened in this course as compared to the traditional learning.	25	15	0	0

Table 3. Feedback obtained from students for the questions set for the course.

Figure 2 shows the graph obtained as, no. of student's verses questions as a function of attributes. From the graph we conclude that students have given good response for the learning approach adopted in the course. Result shows students are involved in the course actively and improved their higher and communication skills effectively. Student's positive response towards the learning approach adopted in this course motivates the instructors/faculties to improve or adopt these kinds of learning approaches in other courses also. To motivate students towards the course and to make them to involve in to every activity of the course new learning methodology has to be adopted. This new framework adopted in this course can also address some of the ABET criteria effectively.

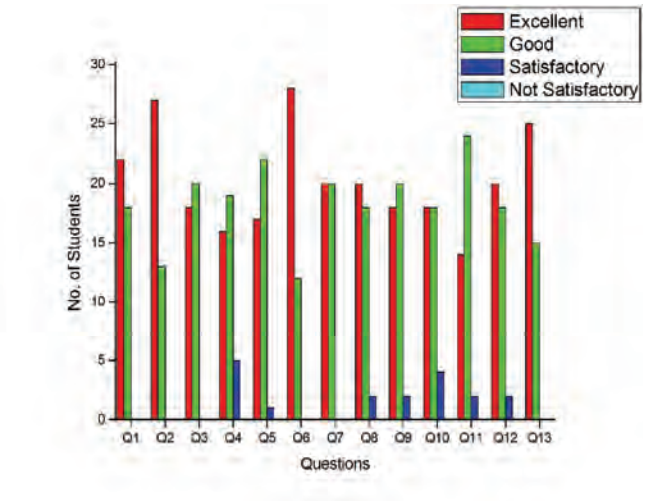

Fig. 2. Students feedback

During the course project students had selected industrial application oriented problem definition and performed well in designing and developing. Figure 3 shows the sample of student's course project. In this project students had automated industrial material handling system. From the figure we can easily conclude about student's active involvement towards the course and development of higher skills by adopting outcome based education learning approach towards the course.

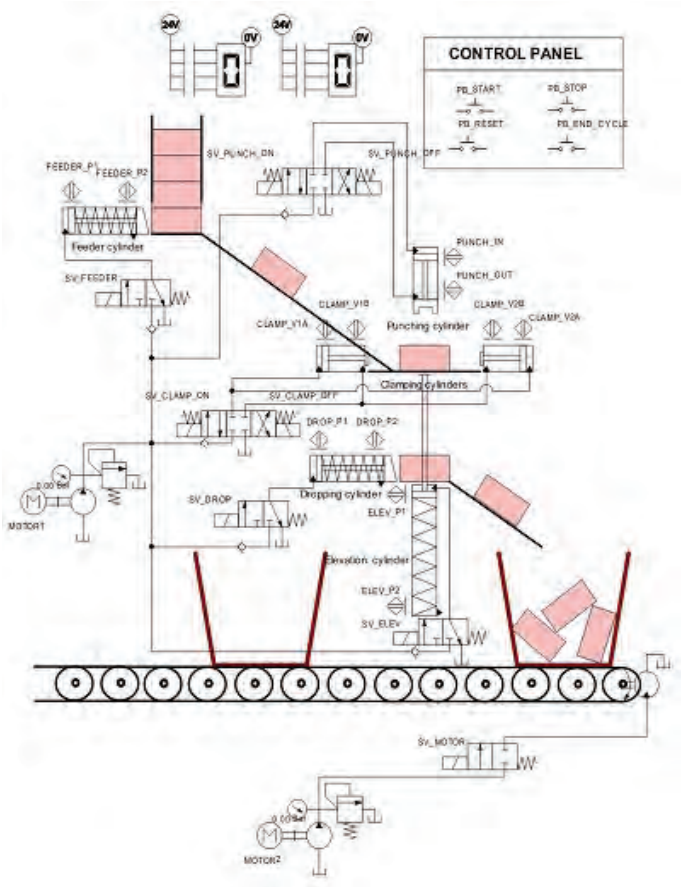

Fig. 3. Sample of students course project carried out during the course.

VI. Conclusion

The positive response obtained from the student's feedback analysis motivates the instructor/faculties to improve or adopt these kinds of learning approaches for other courses also. As a conclusion, outcome based education learning approach support and encouraged students in all respect of learning levels and skills in accordance with the 21st century skills. In this we can conclude that students are more attractive towards new teaching/learning methods/approaches as compared to traditional teaching methods/approaches. So the faculties/institutions have to go beyond the traditional learning methods. The new framework adopted in this course can also address some of the ABET criteria effectively.

Acknowledgment

The authors would like to acknowledge B.V.Bhoomaraddi College of engineering & Technology, Hubli and Bosch-Rexroth India Ltd for developing the full fledged lab facility.

References

[1] Oriah Akir, Tang Howe Eng, Senian Malie, "Teaching and learning enhancement through outcome-based education structure and technology e-learning support", 1877-0428 © 2012 Published by Elsevier Ltd, Procedia - Social and Behavioral Sciences 62 (2012) 87 – 92.

[2] Kristina Edström, Stefan Hallström, and Jakob Kuttenkeuler, "Mini Workshop – Designing Project-Based Courses for Learning and Cost-Effective Teaching", 41st ASEE/IEEE Frontiers in Education Conference, 978-1-61284-469-5/11 ©2011.

[3] R. M. Harden, J. R. Crosby & M. H. Davis, "AMEE Guide No. 14: Outcome-based education: Part 1Ð An introduction to outcome-based education", *Medical Teacher, Vol. 21, No. 1, 1999.*

[4] Anna Alderson and Made Martin, "Outcomes Based Education: Where has it come from and where is it going?," *Issues in Educational Research,* 17(2), *2007.*

[5] Dr ACR Tavner, "Outcomes-Based Education in a University Setting", ISSN 1324-5821, AJEE 2005-02.

[6] Richard M. Felder, Rebecca Brent "Designing and Teaching Courses to Satisfy the ABET Engineering Criteria" *Journal of Engineering Education, 92* (1), 7-25 (2003).

[7] Clara Davies, "Learning & Teaching in Laboratories", an engineering subject centre guide, ISBN 978 -1-904804-826, 2008.

[8] Farooq Asif, "Philosophizing The Concepts "Teacher Training" And "Teacher Education", International Journal of Multidisciplinary Academic Research, Vol. 1, Issue 1, May 2013.

[9] SPT Malan, "The 'new paradigm' of outcomes-based education in perspective" ISSN 0378-5254 Tydskrif vir Gesinsekologie en Verbruikerswetenskappe, Vol 28, 2000.

[10] Gladie Lui, Connie Shum, "Outcome-based education and student learning in managerial accounting in Hong Kong," Journal of Case Studies in Accreditation and Assessment, Outcome-based education.

[11] Faizah Abd Majid, "The Use of Reflective Journals in Outcome-Based Education During the Teaching Practicum," *Malaysian Journal Of ELT Research, Volume 4,* ISSN: 1511-8002.

[12] Margery H Davis, "Educational Strategies: Outcome Based Education," JVME 30 (3) 2003 AAVMC.