An Innovative Interdisciplinary Teaching and Learning Methodology for Outcome Based Education

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Abstract: The Outcome-Based Education (OBE) is a scholastic method that emphasizes on what students can learn after the completion of their course or programme. Today exploring different ideas and innovation of new techniques at inter-disciplinary areas are mandatory for a fresh engineering graduate. OBE is an active learning-teaching methodology providing solution for the above problem. The courses relating to different disciplines are integrated together to implement different innovative ideas in the area of engineering education. An Innovative Interdisciplinary Teaching and Learning Methodology (IDTLM) is essential in the area of Electronics and Computer Engineering Education at under graduate level or any other engineering area. This paper describes about the procedure to develop IDTLM and is successfully implemented for interdisciplinary courses like Operating System and Embedded System courses for engineering graduates at Vidya Jyothi Institute of Technology, Hyderabad. This paper presents the process of implementation of IDTLM for different engineering courses and how it is useful to develop course/open-ended/academic/in-house/mini/major projects in the area of Electronics and Communication Engineering Education. This paper also explores the effective usage of IDTLM with the case study results and is compared with benefits over the Conventional Methodology (CM). The result shows the better attainment values for Course Outcomes (COS) and Program Outcomes (POS) achieved using IDTLM in OBE implementation.

Keywords: Outcome-Based Education (OBE), Interdisciplinary Teaching and Learning Methodology (IDTM), Interdisciplinary Courses, Program Outcomes, Course Outcomes, Electronics and Communication Engineering Education.

1. Introduction

OBE recently has become a focus in learning-teaching enhancement in the field of engineering education system all over the globe. The motivation towards OBE implementation has been supported by most academic institution, which offers engineering courses in India and abroad. The process of execution of OBE is not an easy task, it requires a lot of effort to design Program Educational Objectives (PEOs) after defining the Vision and Mission of the Department, which is derived from the Institute's Vision, and Mission. POs are narrower statements that describe what students are expected to know and be able to do after completion of the course or program. COs are student focused and these are specific enough to be measurable and to attain the abilities to the central discipline of the program. In this paper Outcome-based approach is designed for engineering education and discussed an innovative interdisciplinary methodology is developed and implemented.
successfully for various courses in the area of Electronics and Computer Engineering Education for not only effective attainment of COS and POS also for execution of course/open-ended/academic/in-house/mini/major projects at Department of ECE, Vidya Jyothi Institute of Technology, Hyderabad, India.

2. Literature Review and Related Work

Rubýn Sýnchez-Dams proposes methodology with practical approach for creating theories related to computing for embedded systems [1]. M.Rajendra Prasad implemented project based teaching methodology for embedded engineering education for effective attainment [2]. Holliger & W. Elspass presented Project Oriented Learning Environment (POLE) to innovative design and practice interdisciplinary practice for technical students [3]. M.Rajendra Prasad explained the methodology to implement a Computer based teaching Methodology (CBTM) for different engineering education courses and how it is useful to develop applications or projects in the area of Electronics and Computer Engineering Education [4]. This paper describes the procedure to develop an interdisciplinary teaching methodology for two or more courses in engineering education at Department of ECE, Vidya Jyothi Institute of Technology, Hyderabad, India.

3. Modelling of Outcome-Based Education

Modeling of Outcome-Based Education at Electronics and Communication Engineering Department, Vidya Jyothi Institute of Technology, Hyderabad is shown in the figure 1. The institute's Vision and Mission statements are circulated to all the stake holders such as Employers, Alumni, Industry, Senior students, Faculty, Professional Bodies and Department Advisory Board, seeking their views, opinions and comments for defining the Vision and Mission of the department [5].

Thereby collecting the inputs from above mentioned, the Program Assessment and Evaluation Committee (PA&EC) committee in co-ordination with programme co-coordinator will discuss keeping in view the present trends in the development of this profession, requirements of industry, society and future data related to Electronics and Communication [6]. The development process of Vision and Mission is depicted in the figure 2.

After discussions of departmental vision and mission PEOs are defined in tune with the vision and mission of the institute. PEOs of ECE department are designed with the three important objectives/points technical competency is the first objective of our program. The main goal is to lay solid foundation and provide necessary skills to analyze, design, test hardware/software(s) as shown in the figure 3.
5. Results and Discussions

4. Interdisciplinary Teaching Learning Methodology for Operating System Course

This Methodology is suitable and huge field of reference for 3rd year and final year level courses to implement active learning methods to design course/open-ended/academic/minor/major [12]. We have incurred Operating Systems from Computer Science Engineering and Embedded Systems from Electronics and Commutation Engineering domain and successfully implemented IDTLM at Vidya Jyothi Institute of Technology, Hyderabad [13]. The course outlines an Operating System course, which specifies the course outcomes as shown in the figure.

<table>
<thead>
<tr>
<th>Course Name</th>
<th>Operating System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Number</td>
<td>56034</td>
</tr>
<tr>
<td>Course Description</td>
<td>This course provides the basic knowledge about the Operating Systems concepts, such as process, main memory management, secondary memory management, CPU and disk scheduling etc.</td>
</tr>
<tr>
<td>Prerequisite(s)</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>4. Operating System A Design Approach, C++/THI</td>
</tr>
<tr>
<td></td>
<td>3. Operating System A Design Approach, C++/THI</td>
</tr>
<tr>
<td>Course Organization</td>
<td>Four 30 min lectures per week for classes</td>
</tr>
<tr>
<td>Course Evaluation</td>
<td>25 marks for Internal Evaluation</td>
</tr>
<tr>
<td></td>
<td>75 marks for the End Examination</td>
</tr>
<tr>
<td></td>
<td>Mini Project (Optional)</td>
</tr>
<tr>
<td></td>
<td>Open-Ended Experiment (Optional)</td>
</tr>
<tr>
<td></td>
<td>Standards (Optional)</td>
</tr>
<tr>
<td></td>
<td>Quizzes (Optional)</td>
</tr>
</tbody>
</table>

A course project relating Operating System course to process creation and process ID display on Linux operating system is depicted as shown in the figure 6. This is an example how theory is taught with practical approach [14].

```c
#include <unistd.h>
#include <sys/types.h>
#include <stdlib.h>

#define TRACK
main(){
    pid_t pid;
    printf("My pid = \%d \n", getpid());
    getc(stdin);
    pid = fork();
    if (pid == CHILD)
        printf("Child: My pid = \%d \n", getpid());
    else
        while(1);
    // parent
    child
        printf("My pid = \%d \n", getpid());
    // new child
        printf("Newly created child pid = \%d \n", pid);
}
```
Fig. 6. Implementation of Process Management Linux OS

An academic project entitled by Analysis of open source Linux Source Code is depicted in the figure 7.

Fig. 7. Analysis of Linux operating System Code

With this knowledge of Operating Systems our students are able to developed test open source Linux kernel for IPv6 support. The testing and evaluation commands of linux kernel are shown in the figure 8 and kernel with IPv6 supported is developed and is booted successfully is cited in the figure 9 with IPv6 address.

Fig. 8. IPv6 support testing on linux kernel

Fig. 9. IPv6 support on linux operating system

A. Interdisciplinary Teaching Learning Methodology for Embedded System Course

The second course to implement IDTLM is Embedded Systems, which is studied at next Semester i.e at 4th year I-Semester [15]. This course consists of sequence of lessons that emphasizes on the embedded system design concepts and the course outline of Embedded System is described in the figure 10. In this course, Instructor explains the usage and linkage between the concepts and features of operating systems and customized hardware. Instructor also explains the procedure to develop the embedded system for a specific application using any processor board [16]. In our class, the Instructor discussed architecture of the X86, ARM 7, ARM 9 and ARM 11 processor board and features of operating system running on these processor boards. Instructor also expressed many active learning methods like demonstrating linux operating system code from open source website kernel.org. As a result these discussions and clarifications with different issues, students are able to transplant latest kernel from kernel.org as their major project and they are able to analysis the ARM9 and ARM 11 and X86 processor board for telecom application as shown in the figure 11. A cross compiler environment of PowerPC, ARM is created and executable difference is analyzed as shown in the figure 12.
This IDTLM is compared with the Conventional Methodology (CM), where CM is defined as the pedagogy where the faculty leads and controls the class, orally exhibits the course lessons while students listen and take notes passively. There is no active interaction with the faculty and the students. The difference between CM and IDTLM is compared for MID1 & MID2 examination marks and calculated CO attainment and graphically represented as shown in the figure 13. From the analysis, IDTLM got very good attainment than CM [17]. CO-PO mapping is depicted in the figure 14.

### Course Name
**Embedded Systems**

### Course Number
ECE

### Course Description
The course provides an understanding and design of embedded systems by learning the basic concepts of operating systems and RTOS. The course introduces interfacing the memory concepts and explains the processor design approach.

### Prerequisite(s)
- Microprocessors and Microcontrollers

### Compulsory Text Books
1. Computer as a Component—principles of Embedded computer system design, Wayne Wolf, Elsevier

### Reference Text Books
- Embedded System building blocks, Labrador, via CDP publishers.
- Embedded Systems, Raj Kandpal, TMH.
- Micro Controllers, Raj Chakraborty, TMH.
- Microcomputers, Raj Kandpal, Pearson Education.
- An Embedded Software Primer, David E. Simon, Pearson Education.

### Course Organization
Four 50 min lectures per week for 35 weeks. Four hours of lab per week for 16 weeks.

### Course Evaluation
1. Mid test: 25 %
2. End test: 25 %
3. Attendance: 10 %
4. Assignment: 10 %
5. Project work: 15 %

### Course Learning Outcomes
- Ability to design an embedded application on host system.
- Ability to test OS based embedded system.
- Ability to design and develop ARM based embedded system.
- Ability to apply the knowledge of operating systems for embedded systems.
- Transfer true RTOS to Vedic ARM Processor board.

### Computer Usage
Redhat Linux RTOS/ARM Processor Board Specifications

### Course Coordinator
Prof. M. Arundha Prasad

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**Fig. 10. Course outline of Embedded Systems Course**

**Fig. 11. Proprietary Linux operating system (VJITLINUX) is transplanted on to ARM920T Processor Board**

**Fig. 12. Analysis of Cross Compiler Executables**

**Fig. 13. CO analysis for IDTLM and CM**

**Fig. 14. CO-PO Mapping**

The attainment of CO-PO for embedded system course is calculated and analyzed with the attainment value with the IDTLM and proved with the best results as shown in the figure 15.
The following table compares and analysed with the different parameters such as average MID marks, number of course/open-ended/academic/in-house/mini/major projects and graphically represented for better attainment values as shown in the figure 16. A major project ARM based embedded quad copter is designed and the testing process is depicted in figure 17.

### 6. Conclusion

This paper describes an innovative Interdisciplinary Teaching and Learning Methodology and successfully implemented for different courses. The framework of Outcome Based Approach is developed at the Department of Electronics and Communication Engineering, Vidya Jyothi Institute of Technology, Hyderabad, India to teach various courses and compared differences between CM & IDTLM and implemented successfully for Operating System and Embedded Systems for Electronics Engineering Education. The performance analyses of students with the two methodologies are compared and better methodology is recommended for OBE implementation. This
approach gives students to learn concepts and course contents actively. After this course with the IDTLM concepts students are able to not only design a course/open-ended/academic/in-house/mini/major project also able to present their projects as a technical paper at International/National Conferences or well reputed research journals globally. The IDTLM also helps for better attainment of CO & CO-PO.

Acknowledgement

We would like to thank all faculty members for their continues support for implementation of OBE at Vidya Jyothi Institute of Technology, Hyderabad. We would like to thank Correspondent, Director and Principal of Vidya Jyothi Institute of Technology, Hyderabad for their encouragement to implement OBE framework.

References


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[17] Anna Friesel, “Encouraging students to study theory through interdisciplinary projects, teamwork and e-learning”, International Conference on Computational Technologies in Electrical and Electronics Engineering (SIBIRCON), 2010