

COURSE OUTCOMES ATTAINMENT FOR DATA STRUCTURE COURSE USING DIRECT AND INDIRECT METHODS

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Abstract: The term Course Outcomes (COs) plays a vital role in Outcome-Based Education (OBE). The attainment of Program Educational Objective (PEOs) and Program Outcomes (POs) is depends on the attainment of Course Outcomes (COs). In this paper, we have measured the CO attainment for Data Structure course on the basis of two methods; one is direct method in which students' marks have been considered as an input data. While another method, indirectly measures the CO attainment by taking feedback from Course Exit Survey. A suitable weight-age is given to direct and indirect method i.e. 80% and 20% respectively. The course Data Structure is chosen for this study of CO attainment because this course is very important for students' employment i.e. placement as well as competitive exams. The attempt is made here to find out accurate attainment of COs so that corrective actions can be taken for the next batch to improve the teaching learning process and intern higher attainment of COs and intern PEOs. Finally the analysis of results obtained by both direct and indirect methods is also shown in this paper.

Keywords: Outcome-Based Education (OBE), Program Educational Objective (PEOs), Program Outcomes (POs), Course Outcomes (COs).

1. INTRODUCTION

In India Engineering education system already adopted Outcome based Education (OBE), from last few years along with home accreditation body, National Board of Accreditation (NBA) [1]. In OBE, individual course outcomes need to be attained up to some minimum level [2]. In OBE, individual course outcomes need to be attained up to a desired level. The level may vary with different courses but at least 50% attainment is mandatory for all courses. In our Rajarambapu Institute of Technology (RIT), we have extended that range up to 75%. In this paper we have given detail explanation for evaluation of CO attainment. Here we select data structure course which is for Second Year B. Tech. students of Information Technology branch at our institute. The reason behind selection of this course is not only to focus on core courses but also this subject is equally important for students' employment i.e. placement as well as competitive exams like GATE. The next section explains CO attainment measurement methods both direct and indirect in details, and subsequent sections give the analysis of CO attainment methods along with overall CO attainment by both methods.

CO-ATTAINMENT Measurement Methods

There are various methods available to measure the attainment of COs. There are total five course outcomes are specified for data structure course i.e. it is expected that after completing this course successfully, students must be able to demonstrate these things.

1. Discuss strengths, primitive operations and applications of Data structures.
2. Implement various data structures using C language
3. Describe various terminologies and traversal techniques related to tree and graph

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4. Demonstrate the use of various hash functions with example.
5. Choose appropriate data structure while building application.

Generally, the approach in evaluating the attainment of CO is using existing data from students' marks, for example from the test results, final exam, quizzes and lab report [3]. These assessments are referred as formal assessment. Here we have considered two methods one is direct and another is indirect to measure the attainment of data structure course in academic year 2014-15. The brief explanation of each method along with sample evaluation is given below.

A] Direct Method

In our RIT institute, the assessment methods are divided into 3 categories: (1) End Semester Examination (ESE) (2) Mid Semester Examination (MSE) (3) In Semester Examination (ISE). Highest weight-age (i.e. 50%) is given to ESE and 30% weight age is given for MSE. ISE (20% weight-age) is again divided into 2 sub tasks one is Objective Test and another is Debugging Test in which 10% weight age is given for each sub task respectively. The data used for evaluating CO attainment is obtained from the students' mark from these assessments.

In this paper we calculate Co attainment of data structure course for academic year 2014-15. Following Procedure has been applied to calculate score of each CO:

Algorithm1: CO Attainment Measurement through direct approach

- Input: 1) Marks of all students in ESE, MSE, ISE
2) Mapping of Question Paper to CO

Output: Score of each CO in %

To explain the total evaluation procedure, here we consider one sample input i.e. marks of 10 students in MSE examination (Table 1) along with MSE question paper mapping with Cos (Table 2).

Table1: Sample Marks of 10 students

Roll No.	Marks								
	Q.1			Q.2			Q.3		
	A	B	C	A	B	C	A	B	C
R1	8	4	7		4	4	4	6	7
R2	8		8		8	5	6	6	9
R3	2		6	3	5	4	6	7	7
R4		2	2		2	5	9	6	3
R5	3		8	6	8	7	9	6	8
R6	3		6		2	4	9	6	
R7	8		8	3	5	3	3	7	4
R8	2		8	2	8	5	6	6	
R9	8		8	4	3	7	9	6	9
R10	2	4	7	0	8	6	6	6	7
Total Mark	44	10	68	18	53	50	67	62	54
Avg Mark	4.8	3.3	6.8	3	5.3	5	6.7	6.2	6.7
	8	3	6.8	3	5.3	5	6.7	6.2	5

Table2: MSE Question Paper (2014-15) to CO Mapping

CO	Questions								
	Q.1			Q.2			Q.3		
	A	B	C	A	B	C	A	B	C
CO1	✓				✓			✓	
CO2		✓		✓			✓		
CO3			✓						
CO4						✓			
CO5									✓

Step 1: Calculate average marks (AvgM) associated with each Course outcome (CO_i).

- (a) Measure no of questions(Que_i) mapped with respective CO_i
- (b) Perform summation of average marks obtained by students in respective questions.

Below is one sample calculation for CO1 by refereeing Table no.1 as total 3 questions are mapped with CO1 i.e. Q.1(a), Q.2(b) and Q.3(b)

$$\begin{aligned} \text{AvgM} &= \text{AvgMQ.1(a)} + \text{AvgMQ.2(b)} + \text{AvgMQ.3(b)} \\ &= 4.88 + 5.3 + 6.2 \\ &= 16.38 \end{aligned}$$

Step 2: Calculate summation of Total Marks (TotalM)_i in step 1 questions associated with respective CO_i

Here we assume each question carries 10 marks, hence TotalM for CO1=30

Step3: CO attainment can be measured by applying following formulae:

$$\text{AttCO}_i = \sum_{E=1}^N \frac{\sum_{Q=1}^K (\text{AvgM})_i}{\sum_{Q=1}^K (\text{TotalM})_i} \times \text{Weight}_E \dots (1)$$

Where

I = Total number of Course Outcomes

N = Total number of exams conducted

E = Type of Exam (ESE, MSE, Quizzes, Problem solving contest)

AvgM(Q1 to k)_i = Average Marks obtained by students in question 1 to k

(Where questions 1 to K associated with CO_i)

TotalM (Q1 to k)_i = Total Marks assigned to question 1 to k (Where questions 1 to K associated with CO_i)

Step 4: To calculate attainment in percentage divide AvgM by TotalM and multiply it by 100.

Hence we get value 54.6%. Thus CO1 attainment for MSE is 54.6% for above sample example.

This same procedure has been applied for remaining exams to get CO attainment by direct method for data structure course.

CO Attainment Evaluation by Direct Method:

Here we have considered data obtained in academic year 2014-15 to measure CO attainment of data structure course. Total 80 students marks in below mentioned assessment types have been considered to analyse CO Attainment. Table 3 shows the result obtained by applying above mentioned algorithm. The CO-Attainment-marks can be calculated as:

$$ATT_{CO} = AvgM_{ESE} \times 0.5 + AvgM_{MSE} \times 0.3 + AvgM_{OT} \times 0.10 + AvgM_{DT} \times 0.10$$

Where,

AvgM_{OT} = Average Marks obtained in Objective Test

AvgM_{DT} = Average Marks obtained in Debugging Test

To evaluate the attainment of course learning outcome indirectly, it is essential that to take feedback from students in terms of course exit form filling activity[4]. The Questionary based on students course learning outcomes

Table 3 : CO Attainment of data structure course in Academic Year 2014-15

Assessment	Marks	%	Course Outcome Attainment (in %)					
			CO1	CO2	CO3	CO4	CO5	
ESE	100	50	82.5	80.5	77.2	88.1	74.5	
MSE	50	30	77.3	67.3	88	72.4	82.4	
ISE	Obj. Test	20	10	86.2	82.2	83.5	77.8	79.8
	Debug Test	20	10	88.1	83.4	87.2	72.5	70.3
Average			83.5	78.35	83.9	77.7	76.7	

B] Indirect Method:

The another method applied for measuring CO attainment do not considered the marks obtained by students directly from various examinations taking in particular academic year. Instead the feedback at the end of course have been taken from all registered students and below mentioned steps applied to evaluate CO attainment. Course Exit Surveys (CES) are an excellent means to obtain feedback from students.

has been prepared and uploaded on local MOODLE server. All students who had registered for data structure course need to fill that course exit form. Table 4 shows some sample questions asked in course exit survey form.

Algorithm2: CO Attainment Measurement through indirect approach

Step1: Collect all information in subjective manner. Total 5 questions were asked in CES form which is corresponding to one of the CO. Each question has 5 options and each option has some weight-age assigned. For example consider following questions along with corresponding course outcome.

Step2: To calculate CO attainment following formulae has been used:

$$ATT_{CO_i} = \sum_{OPT=1}^N (Numofstudclick_{OPT} \times Weight_{OPT}) \dots (2)$$

Where,

OPT= options for each question

i = course outcomes 1 to 5

N= Total number of options

Numofstudclick_{OPT}=Number of students click on option OPT

Weight_{OPT}= Weightage assign to each OPT

Step3: To convert it into percentage apply following formulae

$$CO \text{ Attainment (in \%)} = ATT_{CO_i} * 100 \dots \dots \dots (3)$$

Course Exit Survey Questionnaire							
Que. No.	Mapped with CO	Question	Options				
1	CO1	How many of following data structures, advantages and applications you can able to state? Array, stack, queue, circular queue, linked list, doubly linked list, circular linked list, priority queue, de-queue, binary search tree, B tree, AVL tree, heaps, graphs	A] All 14	B] Between 9 to 13	C] Between 4 to 8	D] Between 1 to 3	E] Zero
2	CO2	How many of following data structures you can able to implement in C? Array, stack, queue, circular queue, linked	A] All 14	B] Between 9 to 13	C] Between 4 to 8	D] Between 1 to 3	E] Zero

		list, doubly linked list, circular linked list, priority queue, de-queue, binary search tree, B tree, AVL tree, heaps, graphs					
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Table : CO Attainment of data structure course in Academic Year 2014-15 (by CES)

Que No	Mapped With CO	Course Exit Form Options					CO Attainment In %
		A (Weight-age 10)	B (Weight-age 8)	C (Weight-age 6)	D (Weight-age 4)	E (Weight-age 0)	
		Number of students Marked Options					
Q.1	CO1	20	10	30	10	5	83.9
Q.2	CO2	15	25	20	10	5	80.2
Q.3	CO3	15	20	15	30	0	76.4
Q.4	CO4	12	28	16	24	2	78.3
Q.5	CO5	10	20	20	20	5	67.5

CO Attainment Evaluation by Indirect Method:

Algorithm 2 has been applied to calculate CO attainment of data structure course in academic year 2014-15 which results in below table.

For example to calculate CO1 attainment, Apply Formulae2,

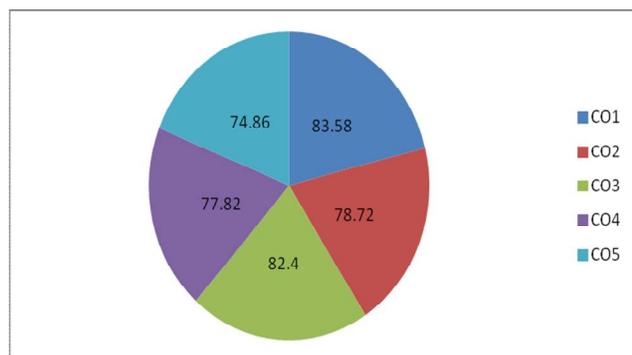
$$ATT_{CO1} = (20/75)*10 + (10/75)*8 + (30/75)*6 + (10/75)*4 + (5/75)*0$$

$$= 0.839$$

Now apply formulae(3) to get attainment in percentage, CO Attainment (in %) = 0.839 *100 = 83.9%

RESULT ANALYSIS

The overall attainment is calculated by considering the separate weight age to each method. i.e. 80% and 20% weight-ages are given to direct and indirect methods respectively.



From above diagram it is observed that the attainment for data structure course for course outcomes 1 to 5 has been satisfying the minimum criteria. It is observed that the students are good in understanding the basic concepts of course as CO:1 attainment is scored the highest percentage.

CO:2 has been attained 78.72 percent, hence we can conclude that around 78% students programming skill is good while CO:3 is also scored good percentage i.e. 82.4, which reflects the students understanding in non linear data structures. CO:4 is attained by 77.8 %, hence hash functioning concepts are also clear up to some extent. Even minimum threshold value is achieved by CO:5 i.e. 74.86, though the students are lagging in mapping the applications of data structure with real life problems up to some extent. This problem can be solved by giving more real life problems during teaching the course.

Table : Result of CO Attainment

Course Outcomes					
	CO1	CO2	CO3	CO4	CO5
Attainment level of CO (in %)	83.58	78.72	82.4	77.82	74.86 (rounded to 75)
Threshold value	75	75	75	75	75
Deviation	+8.58	+3.72	+7.4	+2.82	-0.24
Achievement Goal: 75%)	YES	YES	YES	YES	YES

CONCLUDING REMARKS

In this paper we presented direct and indirect methods to solve the CO attainment of data structure course. The result obtained in academic year 2014-15 has been analysed. The overall CO attainment is obtained by both direct and indirect methods, whereas different weight- ages have been considered for each methodology i.e. 80% for direct and 20% for indirect approach. It is observed that all five course outcomes have been satisfied the minimum requirement of 75%. As course outcome CO5, has attained with negative deviation of -0.24, it is necessary to work on application oriented approach. The students are good in understanding the basic terminologies as CO1 and CO3 attained with 83.58 and 82.4 percentages respectively. The programming skills are satisfactory (CO2:78.72%), but

need to improve by applying innovative teaching methodologies. It is decided to strengthen the threshold value of CO attainment up to 80% in next academic year 2015-16.

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