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The Hurdle of Program Outcomes Attainment and the Aid of Mathematical Approach

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***Abstract*:-- Outcome based education system is the need of higher engineering education. It specifies learning objective for the students. To get the accreditation of a program through NBA, it is required to analyze the attainment of outcomes. Course Outcome, Program Outcome and Program Specific Outcome are three main outcomes through which we can measure the success of any program run for the engineering students.**

This paper describes the process to quantify the program outcomes using course outcomes. The mathematical approach will be applied in this process. The performance of the student is the key element of the evaluation of attainment of any program outcome.

***Index Terms*— Assesment methods, Attainment value,Course outcomes, Program outcome .**

I. INTRODUCTION

William G. Spady, is one of the developer of Outcome Based Education. According to Spady (1994) [1], "OutcomeBased Education means clearly focusing and organizing everything in an educational system around what is essential for all students to be able to do successfully at the end of their learning experiences. This means starting with a clear picture of what is important for students to be able to do, then organizing the curriculum, instruction, and assessment to make sure this learning ultimately happens".

Measure the attainment of the outcomes is the focus of OBE. Previously, I.Z. Abidin et al [2] work in this field. The authors developed a method to find CO attainment and implemented on a computerized system using MS-Excel. In the same line S. Rawar and S. Karkare [3] work to find CO% of assessment method.

Chethan & Naidu [4] presented a case study on Obeject Based Education (OBE). They described each and every aspects of OBE towards the academic excellence.
In [5], authors provided a comparison of traditional technique and OBE techniques and shows that OBE is an effective teaching learning process.

The authors of [6] and [7] mentioned the rubrics as the measurement tool for the attainment of the program outcomes. In this paper we present a mathematical approach to find attainment of CO, PO and PSO. The paper is divided into five sections. Section-II includes various outcomes describe in NBA. In section- III, we will discuss about the tools involve for the attainment. Section-IV contains mathematical formulae. Concluding remark is included in section –V.

II. BASICS OF OUTCOMES

There are three types of outcomes discussed for accreditation through NBA.

Course Outcomes

Course outcomes(CO) are connected with each course (or Subject) included in the program. These are simple statements which describe expected knowledge and ability to be developed in the students after completing the course.

These expectation may be related to some skill, social behaviour, leadership quality etc. that students acquire through the course. Example of course outcome is shown in table-1.

CO Statements :

Course Name : BESI-1 Applied Mathematics-I

	Students will be able to
CO1	Understand successive differentiation process and to find the limiting value of the function with indeterminate form .Also able to expand the function of one variable in series notation.
CO2	handle the functions with two or more variables and use it to solve the engineering problems
CO3	Apply concepts of matrices to solve the system of linear equations which will be used to solve engineering problems.
CO4	Differentiate different first order first degree DE and its applications in engineering problems.
CO5	Differentiate different higher order DE and its applications in engineering problems.
CO6	Understand the complex no., hyperbolic function & its inverse & its applications in Engineering.

Table 1: Example of CO

Program outcomes

Program outcomes (PO) are statements which define the qualities to be develop in the student after completing the

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program. The program outcome defined by NBA[8] are as follows :

1. Engineering Knowledge
2. Problem Analysis
3. Design/Development of solutions
4. Conduct investigations of complex problems
5. Modern tool usage
6. The engineer and society
7. Environment and sustainability
8. Ethics
9. Individual and team work
10. Communication
11. Project management and finance
12. Life-long learning

Program Specific outcomes

Program outcomes (PO) define general outcomes can be acquire by the students after completing graduation where as Program Specific Outcomes (PSO) define the qualities which are expected to be acquired by the students through specific graduation program. (i.e. specific branch of graduation program like Mechanical, Computer Science and Engineering etc)

Interrelationship between different outcomes

Every course included in the graduation program have their own course outcomes. These course fullfil the requirement of the program. That means the course outcomes are connected with program outcomes as well as program specific outcomes. The relationship of CO & and PO represented by the matrix known as CO-PO matrix. In this matrix each CO is mapped with some PO. Similarly each CO is also mapped with some PSO.

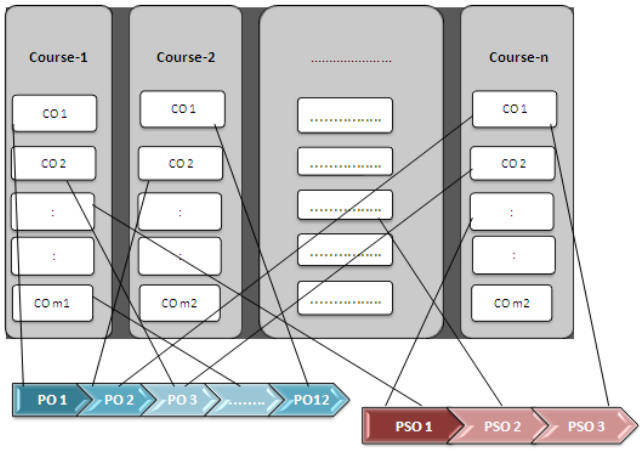

Fig.1 : Relation of CO-PO-PSO

Tools towards attainment of outcomes

According to [2], after specifying course outcome it is necessary to design the delivery method and assessment methods in such a way all stated CO can be attained. Delivery method includes all those methods using which students will able to acquire knowledge. Assessment method used to ensure the attainment of CO.

Delivery Mehtod

Chethan & Naidu [4] have described different modes of course delivery. These modes are

1. Lectures using chalkboard or presentations interspersed with discussions.
2. Tutorials
3. Demonstrations in laboratory
4. Practical exercises
5. Projects
6. Industrial Training
7. Seminars

There may be some other mode of delivery like group discussion, group task and organizing the event etc.

Assessment Tools

Assessment method can be divided into two categories Direct Assessment Method and Indirect Assessment Method.

These two major categories include following methods

1. Direct Assessment Method
   a. Continuous Internal Evaluation Tests (CIET)
   b. Semester end Internal Examination (SIE)
   c. Semester end University Examination (SUE)
   d. Assignments
   e. Quizzes
   f. Practical Test (Internal & External)
   g. Project
   h. Seminar
2. In paper [4], Indirect Assessment Methods includes
   a. Employer Survey (Industry Survey)
   b. Alumni Survey
   c. Parents Survey
   d. Student Feedback Survey

III. MATHEMATICAL APPROACH TO MEASURE ATTAINMENT

IV.

As we have discussed in section III program outcomes attainment can be measure through CO attainment.

CO Attainment

The mathematical approach presented in this paper includes following steps to calculate CO Attainment.

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1. Define CO in such a way that every unit can mapped with a CO. That means, if we have six units in the certain course then we must have six CO related with each unit.

2. Collect the existing data from various assessment tools like marks of various test, assignment, seminars etc.

3. Correlate marks distribution of each assessment tool with units of course which will directly connect the question with COs.

4. Define the % weightage of each CO of a course corresponding to each assessment tool.

5. Generate Assessment Method-CO matrix (as described in [2] & [3]) to show weightage distribution of the percentage of marks distribution for each CO. The calculation provide better results if at least three assessment method include a CO in their assessment process. Following table 2 shows the Assessment Method – CO matrix for Applied Mathematics-I

Direct Assessment Method	Course Outcomes						
	CO1	CO2	CO3	CO4	CO5	CO6	Total
SUE	16.25%	17.50%	16.25%	16.25%	17.50%	16.25%	100.00%
CIET-1	50.00%	50.00%					100.00%
Seminar	20.00%	40.00%	40.00%				100.00%
CIET-2			60.00%	40.00%			100.00%
Assignment-1				40.00%	40.00%	20.00%	100.00%
SIE	16.25%	17.50%	16.25%	16.25%	17.50%	16.25%	100.00%
Assignment-2					50.00%	50.00%	100.00%
Average	25.63%	31.25%	33.13%	28.13%	31.25%	25.63%	175.00%

Table 2: Assessment Method –CO matrix

Each row of the table is describes the distribution of marks in a particular assessment method. This process is described in the table below:

CO% distribution for Semester end University Examination (SUE)							
Units /Topic ->	I	II	III	IV	V	VI	Total
Marks	13	14	13	13	14	13	80
CO Assessed	CO1	CO2	CO3	CO4	CO5	CO6	
CO% Distribution	16.25%	17.50%	16.25%	16.25%	17.50%	16.25%	100.00%

Table 3: Marks distribution-CO % distribution

6. Generate the table related to overall percentage distribution of marks according to the marking scheme of university. For example according to RTMNU, Nagpur marks distribution is shown in table 4.

Assessment	SUE		CIET-1	Seminar	CIET-2	Assign ment-1	SIE	Assign ment-2	Total
Total Marks as per Examination Scheme	80		3	2	3	4	4	4	100
Overall %	80.00%		3.00%	2.00%	3.00%	4.00%	4.00%	4.00%	100.00%
Ovarall % for Calculation	70.00%	10.00%	3.00%	2.00%	3.00%	4.00%	4.00%	4.00%	100.00%

Table 4: Percentage distribution of marking scheme

We consider that 80% of semester end university examination plays an important role to find CO% attainment. As such we subdivide this 80% into two parts – 70% and 10%, considering the fact that university result is not only dependent on the efforts or methods adopted by the faculty members of the institute to attained the CO's but also it depends upon the understanding of the subject by an individual student and difficulty level of question paper.

7. Both the tables generated in step 5 and 6 are to be considered for calculation of assessment of COs.

In order to calculate CO's, first of all we calculate percentage of successful students of each assessment method and then we apply following formulae for each CO.

Formulae:

i. CO 1= (16.25% x SUE x 70%) + (SUE x 10%) + (50% x CIET-1 x 3%) + (20% x seminar x 2%) + (16.25% x SIE x 4%)

ii. CO 2= (17.50% x SUE x 70%) + (SUE x 10%) + (50% x CIET-1 x 3%) + (40% x Seminar x 2%) + (17.5% x SIE x 4%)

iii. CO 3= (16.25% x SUE x 70%) + (SUE x 10%) + (40% x Seminar x 2%) + (60% x CIET-2 x 3%) + (15% x SIE x 4%)

iv. CO 4= (16.25% x SUE x 70%) + (SUE x 10%) + (40% x CIET-2 x 3%) + (40% x Assignment-1 x 4%) + (16.25% x SIE x 4%)

v. CO 5= (17.50% x SUE x 70%) + (SUE x 10%) + (40% x Assignment -1 x 4%) + (50% x Assignment -2 x 4%) + (17.5% x SIE x 4%)

vi. CO 6= (16.25% x SUE x 70%) + (SUE x 10%) + (20% x Assignment-1 x 4%)+(50%x Assignment-2 x 4%)+ (16.25% x SIE x 4%)

Evaluation of CO is based on CO % from assessment method and overall percentage distribution of marks. Since the target of attainment level is set on the basis of pass % for example "70% students scored more

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than 40% marks", therefore calculation of CO is also related with pass% of each assessment method.

As per the scheme CO can be 3 (substantially), 2 (Moderately) and 1 (slightly). In our calculation this values can be obtained in following ranges

CO% (calculated)	Attainment values
70 and above	3
Between 70 & 65	2
Between 65 & 50	1
Below 50	0

Table –5: CO ATTAINMENT VALUES

Finally we can find CO attainment for the particular course using average of the attainment values of CO 1 to CO n.

Attainment of PO and PSO

Each CO will be mapped with one or more PO and PSO. As discussed in section II relation between CO and PO represented by CO-PO matrix. We called it Expected PO Attainment of the course (shown in table- 6) and similar matrix can be prepared for CO and PSO.

	PO1	PO2	PO3	PO4	PO 5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2							1	3	3	
CO 2	3	1							1	3	3	
CO 3	3	3							1	3	3	
CO 4	3	1							1	3	3	
CO 5	3	1							1	3	3	
CO 6	3	1							1	3	3	
Average	3	1.50							1	3	3	

Table – 6 : Expected PO Attainment Corresponding To Each CO

Actual PO attainment can calculate using CO attainment of the course. For example if average of CO of a course is 2.83 according to this average PO attainment will be shown in the table below (highlighted with grey colour)

	PO1	PO2	PO3	PO4	PO 5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2							1	3	3	
CO 2	3	1							1	3	3	
CO 3	3	3							1	3	3	
CO 4	3	1							1	3	3	
CO 5	3	1							1	3	3	
CO 6	3	1							1	3	3	
Average	3	1.50							1	3	3	
PO Attainment	2.83	1.42							0.94	2.83	2.83	

Table – 7: Expected and Actual PO Attainment Corresponding To each CO

IV. CONCLUSION

In this paper we have calculated PO and PSO attainment using CO attainment. The CO attainment is measured in a structured way through some mathematical formulae which largely depends on the performance of students in various assessment methods. This quantification of CO and PO attainment provide the academic progress of any program run by an institute, also it helps to take corrective measure in the direction to achieve desired outcomes.

REFERENCES

[1] W. G. Spady, "Outcome-based education: Critical issues and answers". American Association of School Administrators, Arlington,VA.ISBN-0-87652-183-9,p.p 12, 1994.

[2] I.Z. Abidin, A. Anuar,N. H. Shuaib, "Assessing the attainment of course outcomes (CO) for an engineering course", Preceedings of the 2nd International Conference of Teaching and Learning (ICTI-2009), INTI University College, Malaysia.

[3] S. Rawat, S. Karkare, "An empirical study on assessment of CO attainment for a diploma course", International Journal of Electronics and Communication Engineering & Technololgy(IJECET), ISSN 0976-6464 (print), ISSN 0976-6472 (online), Vol 6, Issue 2, Feb 2015, PP. 06-12

[4] Chethan K.C.S., N V R Naidu, " Achieving Academic Excellence through Outcome based education- A case study", Journal of Educational Research & Medical Teacher, 2013, PP 40-47

[5] Shreenivas B.,Archana H. R. , C. Gururaj, Ambika K, " Leveraging the assesment methods for outcome based education", Journal of Engineering Transformations, Special Issue : Jan 2015, eISSN 2394-1707.

[6] D. Dandge, Dr. S. Desai, " Rubrics: An effective assessment tool for outcome-based accreditation", The Journal of Engineering Education, July 2013.

[7] T. Y. Mahesh, Y Thomas, K. L. Shunmuganathan, " Analysis of program outcomes attainment for engineering graduates for NBA accreditaion", Journal of Information Technology and Sciences,Vol-1, No. 2, 2015.

[8] National Board of Accreditation, Self Assessment Report (SAR) Format, Undergraduate Engineering Programs (TIER-II), www.nbaind.org, June 2015

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