Computing Attainment of Program Outcomes by Associating Credit Based Weight Factor of the Components of Curriculum

S. Subbaraman[1], V. B. Dharmadhikari[2], B. G. Patil[3]
Walchand College of Engineering, Sangli

1: shaila.subbaraman@walchndsangli.ac.in,
2: vidhyadhar.dharmadhikari@walchndsangli.ac.in,
3: babasaheb.patil@walchndsangli.ac.in

Abstract— The attainment of program outcomes (POs) is generally computed by considering 80% contribution from the Course Outcomes (COs) of courses of study and 20% contribution from the Graduate Exit Survey. This contribution of COs to POs takes into account the strength of mapping of COs based on Bloom's taxonomical level to the corresponding POs.; however ignores the fractional contributions of the components of the curriculum in terms of the ratio of cumulative credits of that component to the total credits of the entire curriculum. In this paper, we propose the computation of attainment of POs by associating this additional weight factor- to be called as Credit Weight Factor (CWF)- by considering the AICTE proposed model curriculum for UG program in Engineering.

Keywords: Program Outcomes, Course Outcomes, Bloom's Taxonomy, Graduate Exit Survey, Graduate Attributes, Washington Accord

1. INTRODUCTION

Defining appropriate course outcomes and their mapping to generic program outcomes and program specific outcomes (PSOs) is of vital importance in implementing Outcome Based Education philosophy [1,2,3,4]. Generic program outcomes have to map with graduate attributes defined through Washington Accord and do not offer any flexibility in redefining except rewording [5,6,7,8]. However a freedom can be exercised by the program in defining course outcomes appropriately with restriction that every CO maps to at least one PO/PSO with proper strength. Attainment of PO/PSO is computed by considering the weighted average of attainment of corresponding COs of all courses using the following formula.

Corresponding Author:

Dr. S. Subbaraman, WCE, Sangli
shails.subbaraman@walchandsangli.ac.in
Attainment of the ith PO/PSO =

$$\sum_{i=1}^{n} \sum_{j=1}^{m} W_{ij} C_{ij} \quad \text{------} \quad (1)$$

where n are the number of POs/PSOs (12 for POs while 3 for PSOs), m is the total number of course outcomes from the entire curriculum mapping to i^{th} PO, W_{ij} and CO_{ij} is the weight factor (strength) and attainment respectively of the jth CO mapping to i^{th} PO.

Further to this computation of attainment of PO, this paper proposes to use another weight factor dependent upon the relative percentage credits of the component of curriculum with reference to total credits of curriculum for more accurate and realistic computation of attainment of POs.

2. CREDIT WEIGHT FACTOR

Curriculum of any program consists of various components. AICTE model curriculum for UG program in Engineering recommends the curriculum to be divided into the following components [9].

HSS: Humanities and Social Sciences
BS: Basic Sciences
ES: Engineering Sciences
PC: Professional Core
PE: Professional Electives
OE: Open Electives
MC: Mandatory Courses

The credits allotted to each part of composition as per the typical current curriculum of one of the autonomous institutes is as given in Table 1. Credit Weight Factor (CWF) defines the relative stress of each

component in the entire curriculum and is computed as a ratio of number of credits of that component of curriculum to the total number of credits of the curriculum considering all components. The last column of Table 1 represents the computed value of this factor.

Table 1
Curriculum Composition and
Credit Weight Factor

Curriculum Component	No of Credits allotted	% Contribu-tion	CWF
HSS	7	4.0	0.04
BS	20	11.0	0.11
ES	27	15.0	0.15
PC	88	49.0	0.49
PE	10	5.5	0.055
OE	15	8.3	0.083
PR	13	7.2	0.072
MC	-- (Env Studies audit)	--	--
Total	180	100%	1.00

It is seen from above table that the CWF for the component corresponding to domain specific courses (i.e. Professional core courses) has a much higher value than that for non-core courses like Humanities and Social Sciences. If this difference in CWF is taken into account while computing attainment of POs, a more realistic figure of attainment of POs will be obtained. The next section justifies this concept by presenting the case studies of computing PO attainment with and without CWF.

3. CASE STUDY

Case study of computing the attainment of one of the POs say PO1 mapping to Graduate Attribute of Engineering Knowledge is presented below.

Design of Experiments:

Attainment of PO1 by each component of curriculum on a scale of 3 by taking into consideration the attainment of corresponding COs of the concerned courses and the strength of mapping of these COs with PO1 was considered for two distinct cases as follows:

- Case A: Better attainment in courses other than professional courses while poor attainment in professional courses.

- Case B: Better attainment in professional courses with attainment in other components of curriculum remaining same as that of Case A.

The attainment values computed on a scale of 3 for Case A are indicated in the following table. The average attainment of PO1 without CWF and the weighted average with CWF taken into consideration for all components of curriculum is also displayed in the following table.

Table 2
Comparison of Attainment of PO1
With and Without CWF (Case A)

Curriculum Component	Contribu-tion to attainment of PO1	CWF	Weighted Contribu-tion to attainment of PO1
HSS	2.3	0.04	0.092
BS	2.4	0.11	0.264
ES	2.5	0.15	0.375
PC	**1.7**	**0.49**	**0.833**
PE	2.1	0.055	0.1155
OE	2.2	0.083	0.1826
PR	2.4	0.072	0.1728
MC	--	--	--
Average without CWF= **2.23** (Simple Average Method)		Average with CWF= **2.04** (Weighted Average Method)	

The attainment values on a scale of 3 considered for Case B are exactly same as those for Case A except for the attainment of Professional Core component which is better than that for Case A and are displayed in the Table 3. The average attainment of PO1 without CWF and the weighted average with CWF taken into consideration for all components of curriculum is also displayed in the following table.

Table 3
Comparison of Attainment of PO1
With and Without CWF (Case B)

Curriculum Component	Contribu-tion to attainment of PO1	CWF	Weighted Contribu-tion to attainment of PO1
HSS	2.3	0.04	0.076
BS	2.4	0.11	0.22
ES	2.5	0.15	0.315
PC	**2.6**	**0.49**	**1.274**
PE	2.1	0.055	0.1155
OE	2.2	0.083	0.1826
PR	2.4	0.072	0.1584
MC	--	--	--
Average without CWF= **2.36** (Simple Average Method)		Average with CWF= **2.46** (Weighted Average Method)	

It is seen from above results that when the attainment of professional core courses with CWF ~= 0.5 is less in comparison with the attainment of other components of curriculum; the overall attainment of PO1 (e.g. 2.04 in this case) works out to be lower than that computed using simple average method (e.g. 2.23 in this case).

Conversely, when the attainment of professional core courses is higher than the attainment of other components of curriculum as in Case B, the overall attainment of PO1 (e.g. 2.46 in this case) works out to be higher than that computed using simple average method (e.g. 2.23 in this case).

This case study illustrates the fact that computation of Program Outcome is influenced by CWF with more realistic attainment being obtained with CWF taken into account. Hence the final computation of attainment of POs must take into account the emphasis of the components of the courses in terms of CWF after computing contribution of COs to POs by taking into consideration the strength of mapping. For computation of attainment of knowledge related POs (PO1 to PO4) the recommended flow is as follows.

A. Categorize the Courses from First Year to Final Year as HSS, BS, ES, PC, PE, OE, Project, MC
   a. Find out the total credits to each component of Curriculum.
   b. Find out the Credit Weight Factor for each component of curriculum.

B. Check for
   a. Proper definition of COs of courses of component
   b. Mapping to POs with strength appropriately defined.

C. Prepare a matrix M1 –
   a. As shown in Appendix I for the components of curriculum with tick mark in the cells indicating mapping to corresponding POs.
   b. A background exercise needs to be done for detailing the courses under each component of curriculum and indicating the mapping of their COs to POs with appropriate strength of mapping.
   c. This matrix (M1) will act as a template and is to be prepared for every batch admitted till it passes out after four years.

D. Prepare another matrix M2-
   a. Similar to M1 with figures of attainment of POs of each component of curriculum being entered in the cells after every semester.

b. Both direct and indirect assessment should be taken into consideration while computing CO attainment.
   i. The scale of attainment should be three
   ii. while the levels of attainment can be five.
   iii. The strength of mapping of COs to the corresponding POs (as mentioned in 3(b) above) must be taken into account while computing attainment of POs from the attainment of respective COs.
   iv. The class average of the batch under consideration needs to be computed.

E. Prepare a table similar to Table 2.
   a. Fill in the information of CWF from A above and contribution to PO attainment by each component of curriculum from D above.
   b. Find the weighted average of attainment of PO under consideration using CWF as explained in this paper. (Say X)

F. Compute the final attainment of PO from direct and indirect assessment tools as below.
   a. Collect Graduate Exit Survey (GES) forms from all students of the batch at the time of their graduation. GES will give the information regarding judgment of the students for the attainment of each PO and PSO on a scale of 1(Poor) to 3 (Excellent).
   b. Find the class average of the attainment of each PO (Say Y) from all survey reports collected.
   c. For all knowledge related POs (PO1 to PO4) the overall attainment of Program outcome, say Z, is computed using formula,

$$Z = 0.8 * X + 0.2 * Y \text{ --------- } (2)$$

4. CONCLUSIONS

Any academic program can be said to be running successfully if it ensures that there is continuous improvement in the attainment of POs for the successive pass out batches. It is quite possible to draw the false conclusions regarding the improvement in the program from PO attainment point of view, if computations of POs do not take into account all trivial possibilities. One of such possibilities is difference in the allotted credits to each component of curriculum indicating the relative stress of curriculum on those components. This paper has presented an approach to take this fact in terms of Credit Weight Factor into consideration while finally

computing the attainment of POs. The case study presented in this paper justifies this fact

5. FUTURE SCOPE

This paper deals with computation of knowledge related POs. However, computations of attainment of higher order POs relating to skill and attitude need more consideration for deciding the weighted factor which may not be only in terms of credits. An extension of the approach presented in this paper can be thought of in terms of academic time table hours and self-study hours especially for laboratory courses, seminars and projects. Though laboratory course of 2 hours/week is generally considered to be of 1 credit, students have to work more than 2 hours in a week to obtain the laboratory related skills. A good data base management system on all the academic activities of the students during the 4 years duration of the program with proper and justifiable stress on the weighing factors will lead to more realistic computation of Program Outcomes.

APPENDIX A

Component	PO1	PO2		PO12		PSOn
HSS	√					
BS	√	√				
ES	√		---//---		----//---	
PC	√	√				√
PE	√					√
OE	√					
PR	√	√		√		√
MC	√					

REFERENCES

1. White paper on "Writing and Assessing Course Level Student Learning Outcomes" by Office of Planning and Assessment, Texas Tech University, (806) 742,1505, www.depts.ttu.edu/opa

2. Guidelines on writing learning outcomes - University of Melbourne *about.unimelb.edu.au /__data/assets/.../Guidelines_on_writing_learning _outcomes.pdf*

3. Writing Course Learning Outcomes - University of Adelaide.. *../outcomes/writing-course-learning-outcomes.pdf.*

4. Using Bloom's Taxonomy to Write Learning Outcomes | Pearson Blog *www.pearsoned.com /education... /using-blooms-taxonomy-to-write-learning-outcome...*

5. Washington Accord - International Engineering Agreements *www.ieagreements.org /Washington-Accord/*

6. 25 Years Washington Accord Booklet – International Engineering ...*www.ieagreements.org /25_years/25YearsWashingtonAccord-A5booklet-FINAL.pdf,* George Peterson, *Washington Accord* Secretariat, 2001–2007

7. Washington Accord—Graduate Profiles *www. me.tku.edu.tw/files/recruit/1_601abbb5.pdf*

8. Accreditation docs/National Board of Accreditation nbaind,org/accreditation docs/ug/Tier I/II SAR/October 2015

9. Model Syllabus link on aicte-india.org /modelsyllabus.php