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A Process Model for Mapping Course Outcomes to Programme Outcomes

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Abstract: In recent past several higher education programmes are adopting outcomes based education (OBE) to address the technical developments and challenges effectively and efficiently. The essential element in OBE of any programme is Programme Outcomes (POs). Several courses are aggregated to address the POs of any programme. Many programmes in engineering education invariably concentrating on achieving outcomes prescribed by accreditation bodies. In this context Course Outcomes (COs) play major role as it is must for developing the assessment of student learning. To achieve this there is a need for proper mapping of courses to POs. Hence a methodology for mapping CO to PO based on key elements is provided in this paper highlighting the importance of each PO. In our methodology we evaluate the attainment of POs, which indeed based on the COs attainment considering the data from the results obtained by the students in various test items. The methodology is validated using the case study on the course taken from computer science. Further the methodology is highly useful in attainment of POs for improving POs which in turn improve the engineering programme vision and mission.

Keywords: Course Outcomes (COs), Educational Institutions, Outcomes Based Education (OBE), Programme Outcomes (POs)

1. Introduction

In this global scenario expectation of graduate engineers are addresses through various Accords, like Washington Accord, Sydney Accord, Dublin Accord addressing the knowledge, skill and attitude levels. The graduate engineers must have abilities according to the Washington Accord. Washington Accord essentially defines characteristics of a graduate engineer. These graduate attributes are taken into consideration while developing Programme outcomes (POs) by respective accreditation agencies like Accreditation Board for Engineering and Technology (ABET), National Board of Accreditation (NBA) etc. POs are essentially to be addressed by various courses and co-curricular activities of a Programme. The activities of the student are aggregated into attainment of POs. for this essentially a proper mapping of Course outcomes (COs) to POs is required. The PO attainment will be more accurate if understand the PO clearly. Proper care has to be taken in understanding POs with key elements and then mapping COs to POs.

In recent past, with the tremendous technical developments in the field of higher education, an effective and efficient education has always been a major challenge. The major challenges for many educational institutions have always been to improve the quality of the education they provide, the methods used, have always been the same (ABET, Curriculum Coordinating Council).

The increase in the numbers of engineering educational institutions, the healthy competitions among these institutions is also been raised. These competitions have let to the recognition of new ways of satisfying the stakeholders and providing international standards to imbibe quality education to the students making them more efficient in various fields of life. The standards of these organizations can be evaluated by the process of accreditations. These procedures will be within the Washington Accord and several other accords reflecting the graduate attributes. Several Institutions are establishing quality educational cells within the campus for the procedures adapted by accreditation.

The efficient assessment techniques both in internal and external quality has to be followed for evaluating the qualitative competence of the educational institutions in engineering and technology and related disciplines. Many of these institutions have invented their own methodologies for teaching and assessing the students. The major objective of these methodologies is to provide quality technical education to its students. To achieve this, the curriculum is to be developed into courses and each course has to be presented in the form teaching lesson plan consisting of topics and session outcome known as COs, that easily map into different POs. Those POs, which can be measured at the time of graduation must have a consistency in terms of course delivery and test items like internal and final exam, quiz, lab report, project report, assignment etc..

To achieve the profession and career accomplishments stated in the POs, the assessment of different courses is a strong way to measure the POs by considering a cohesive mapping of COs to POs. In general the faculty define the goals of the course i.e., COs, develop teaching lesson plan, develop POs that the course should address with respect to PO of the Programme.

Whenever a course is designed with some objectives, the teaching – learning process has to be defined appropriately. While designing the curriculum enough brainstorming sessions are done so that the COs and teaching – learning activities designed align with the POs and all these three fall in the same line so that this course would help in the attainment of the POs. It becomes very important that at the end of each course as to what level it helped in the attainment of POs. This is done in two methods called direct method which involved a semester end examination or by taking surveys from the various stakeholders of the organization (DILA).

The CO-PO mapping for a course based on the detailed weightages will be helpful in measuring the COs and also attainment of POs of the programme. Further it is more important to improve the successive curriculum development. The author in [6] developed a mathematical approach to generate indicators for the alignment of course content with CO and PO. Student performances were considered to derive these indicators and are hence used in assessing the CO and PO achievement. These results are used in realignment of the course content.

A framework that aligns the assessment of an outcome with the learning of the outcome is termed as 'Unit of learning' is proposed in (Forehand, 2009). This model takes into account only the learners, assessors and delivery methods, the assessment method and their relationships alone. It fails to provide an insight on how individual unit of learning can be consolidated to provide an assessment of achieving the POs.

An office automation system for assessment strategies important to improve the Programme design and delivery is developed by the faculty of engineering at Universiti Putra Malaysia (UPM). This system helped the faculty to monitor the OBE implementation.

Keeping the above discussion in view, we identified the importance of CO-PO mapping in the assessment of the Programme. Hence in this paper, the focus is on developing a methodology to well define the mapping of CO-PO. An illustrative case study is also presented in this paper

2. Basic Terminology

2.1 Accords

The Washington Accord is an international agreement responsible for accrediting engineering degree programs since 1989. The accord recognizes the substantial equivalency of programs accredited by those bodies and recommends that graduates of programs accredited by any of the signatory bodies be recognized by the other bodies as having met the academic requirements for entry to the practice of engineering. Flowing from the Washington Accord, a similar Agreement was developed for Engineering Technologists or Incorporated Engineers, called the Sydney Accord (SA), which was signed in June 2001.The Dublin Accord is an agreement for the international recognition of Engineering Technician qualifications signed in 2002 (International Engineering Alliance).

2.2 CO-PO Mapping

The procedure followed in mapping CO to PO as mentioned in Table 1 is done in a traditional way i.e. without allocating the weightage to the mapping. However our approach is addressing this limitation

with the generic process model mentioned in section 3 and with the methodology mentioned in section 4.

Table 1 Sample Co-PO Mapping

CO-PO Mapping				
PO / CO	a	b	c	d
CO1	X	X		X
CO2		X	X	X
CO3	X	X	X	
CO4	X	X	X	X
CO5	X		X	X

3. Process Model

The generic process model used to obtain the CO to PO mapping matrix is shown in Figure 1 and the steps are explain in the methodology mentioned in section 4.

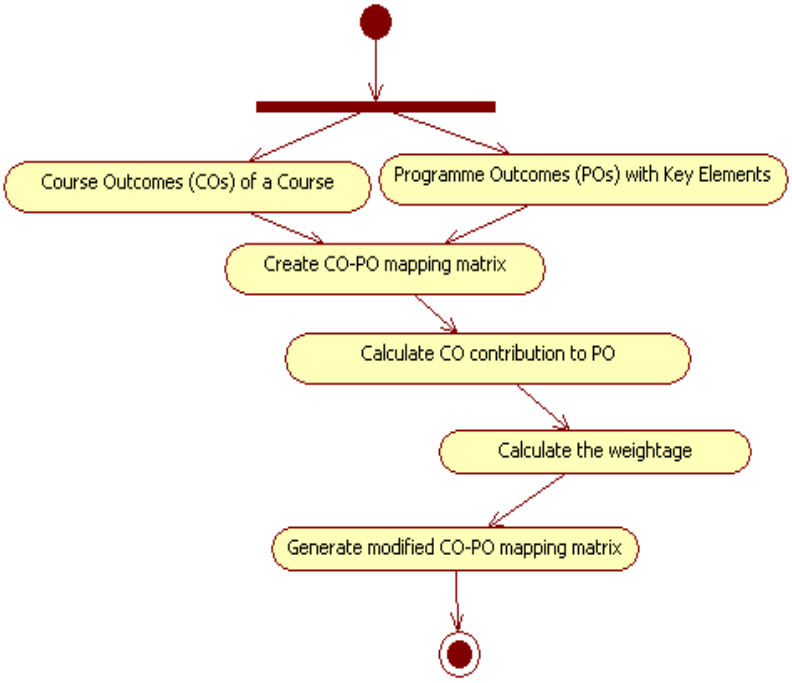

Figure 1. CO to PO Mapping Process Model

4. Methodology

To obtain the CO-PO mapping matrix, the steps described in the methodology are as follows

- Consider the POs (a) through (k) specified by ABET
- Generate a two column matrix Considering the POs along with their key elements given by (Besterfield-Sacre, M.E., et al , 2000)
- Consider the COs of a course and generate CO-PO mapping matrix for that course by

considering the POs key elements that are satisfied by each CO of a course

- Create a final CO-PO matrix based on the following 2 steps
  i. Calculate each CO contribution to PO as follows
  Contribution (C) = [(no. of key elements of a PO satisfied by the CO) / (no.of key elements
  belongs to the PO]*100
  ii. Calculate the weightage as follows
  If C is >=70 then assign grade '3' or if C is >=50 and <70 then assign grade '2' otherwise assign grade '1' to CO-PO mapping and obtain the final CO-PO mapping matrix

5. Methodology Illustration and Discussion

To illustrate the methodology consider a sample computer science course CA with course outcomes CO1 to CO5. Also consider the sample POs (*PO-a to PO-d)* related to the course CA along with their key elements as shown in Table 2.

Table 2: PO with key elements

Matrix1	
POs	No. of Key elements
a	3
b	4
c	14
d	15

The key elements pertaining to each PO as mentioned in Table 2 which are satisfied by an individual course outcome for the illustrated course are provided in Table 3.

Table 3: Key elements satisfied by each CO

No. of key elements each CO fulfills against the PO (Matrix2)				
PO / CO	a	b	c	d
CO1	2	1	0	10
CO2	0	2	10	12
CO3	3	3	7	0
CO4	3	4	5	9
CO5	1	0	8	5

From Table 3 it is observed that CO1 satisfies 2 key elements of PO-a, one key element of PO-b, no key elements of PO-c and 10 key elements of PO-d. Similarly CO2, CO3, CO4 and CO5 key elements list against the each PO can be observed in Table 3. Each CO contribution to PO is given a weightage based on the steps in the methodology. The results obtained are mentioned in Table 4.

Table 4: Final CO-PO mapping considering key elements

Resultant Matrix of CO-PO Mapping based on Key Elements (Matrix3)				
PO / CO	a	b	c	d
CO1	2	1	0	2
CO2	0	1	3	3
CO3	3	3	1	0
CO4	3	3	1	2
CO5	1	0	2	1

From Table 4 it is observed that the weightage acquired by CO1 against the PO-a to PO-d are 2,1,0,2 respectively. Similarly for other COs the list is also available in Table 3. This weightage is useful in assessing the contribution of a particular course in achieving the POs.

6. Conclusion

In educational accreditation process of several agencies, POs plays a major role. In designing curriculum understanding of key elements of POs is imperative. In this paper we developed a methodology that supports assessment of POs in the form of CO to PO mapping by considering the key elements supported by each PO. The methodology is validated with a case study on computer science course. This approach is useful in calculation of the attainment of POs which contains several courses of a programme. Further the approach is also useful in computing the PO attainment for improving the other engineering Programmes vision and mission

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