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An Attainment Tool for measuring Course Outcomes and Program Outcomes

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ABSTRACT

The key aspects of Outcome-Based Education (OBE) is the assessment of course outcomes. At the initial stage of OBE implementation, the Course Outcomes (CO's) for each course are defined based on the Programme Outcome (PO's) and other requirements. At the end of each course, the COs needs to be assessed and evaluated, to check whether it has been attained or not. This paper describes the background of the method used to assess the attainment of the COs and the results produced for the Computer Networking (CNE-17429) course in diploma engineering. This assessment was conducted for Computer Science & Engineering program for second-year diploma with the strength of 57 students. The method uses data that has been obtained from student's marks in final theory and practical exams. A computerized system using spreadsheet has been developed based on this method to expedite the analysis process. The findings are then used for continuous quality improvement.

Keywords: NBA, OBE, DA, IA, EA, CO, PO, CNE.

1. INTRODUCTION

The movement towards Outcome-Based Education (OBE) has been one of the most important trends in engineering education in recent years and has been adopted in USA and Australia for many years. For the last few years, Indian education system has already adopted Outcome-Based Education (OBE), with the local accreditation body, National Board of Accreditation (NBA). A formal definition of OBE can be stated as "a comprehensive approach to organizing and operating an education system that is focused on and defined by the successful demonstrations of learning sought from each student".

Thus for OBE implementation, initially it is necessary that the desired or defined outcomes are determined and then according to defined outcomes, programme curriculum, teaching and learning methodology and supporting facilities are designed. During the course of the programme, various measurement methods are used to measure the attainment of outcomes. The assessment of CO attainment largely depends on the student's performance output or marks obtained in final theory and practical examination, test, and submission of assignments which indicates students learning achievements. Therefore, it is necessary and important to carry out a proper attainment method in order to measure student learning achievement and to predict the student's performance in future. The purpose of this paper is to measure the student's CO and PO attainment in Computer Networking course for second-year diploma in CSE. The measurement is based on the sessional test marks and the final result of the student.

2. OBE AND NBA

Outcome-based education is an approach to education in which decisions about the curriculum are driven by the exit learning outcomes that the students should display at the end of the course. The National Board of Accreditation (NBA) has adopted OBE approach and has laid out guidelines for institutions to pursue excellence in order to get accreditation. Those guidelines are followed to define the programme outcomes and the course outcomes.

A. Programme Outcomes

Programme Outcomes are narrower statements that describe what students are expected to know and be able to do upon the graduation. These relate to the skills, knowledge, and behavior that students acquire in their matriculation through the programme.

B. Course Outcomes

Course Outcomes are narrower statements that describe what students are expected to know and be able to do at the end of each

course. These relate to the skills, knowledge, and behavior that students acquire in their matriculation through the course.

C. Assessment

Assessment is one or more processes, carried out by the institution, that identifies, collect, and prepare data to evaluate the achievement of programme educational objectives and programme outcomes.

D. Attainment

Attainment is the action or fact of achieving a standard result towards the accomplishment of desired goals. Primarily attainment is the standard of academic attainment as observed by test or examination result.

3. METHODOLOGY

A. CO – PO Mapping

To measure the attainment of Course Outcome (CO), the Course Outcome should be mapped to Programme Outcome (PO). The method of mapping should be in such a way that the attainment of Course Outcome (CO) should contribute to the attainment of Program Outcome (PO). CO attainment is calculated by using the existing data obtained from student’s mark, for example from the sessional test results and final exam results. The tests which are conducted in the semester and which are assessed by respective course teacher is named as Internal Assessment (IA) and the tests which are conducted by MSBTE is named as External Assessment (EA). As the information about the marks is readily and directly available after each assessment method it is called as Direct Assessment (DA).

B. Distribution of Weight

The Computer Networking (CNE) course consists of 3 parts, i.e, theory (TH), practical (PR) and External Oral (POE). The assessment methods used are grouped into 2 categories:

- (1) Internal Assessment (IA) – Includes Sessional Test-I and Sessional Test-II (30%)
- (2) External Assessment (EA) – Includes Term Work (TW) and Theory (TH) (70%)

Each of these categories contributes a certain portion of the marks into some of the CO’s. In Computer Networking (CNE) course, the student performance is evaluated based on IA (30%) and EA (70%).

C. Assessment Pattern

The program (Department) has decided total 13 assessment pattern with different weightages for all courses (subject). For example, CNE has TH – 100 marks, TW – 25 marks and POE – 50 marks, the marks which are assigned in MSBTE curriculum. Based on these marks the program has decided weightage of TH – 50%, TW – 20% and POE – 30%. The program also calculates the contribution of each CO for EA gained through TH, TW, and POE. Based on this assessment pattern the CO attainment for EA is calculated.

Table 1: Assesment Pattern for EA in %

| CNE-WEIGHTAGE % FOR *EA | TH | POE | TW |
|-------------------------|----|-----|----|
| | 50 | 30 | 20 |

Table 2: Contribution of Each CO FOR EA in %

| Pattern / CO | CW403.1 | CW403.2 | CW403.3 | CW403.4 | CW403.5 | TOTAL % |
|--------------|---------|---------|---------|---------|---------|---------|
| TH | 20 | 20 | 20 | 18 | 22 | 100 |
| POE | 21.42 | 28.6 | 21.42 | NA | 28.56 | 100 |
| TW | 21.42 | 28.6 | 21.42 | NA | 28.56 | 100 |

D. Course Workbook

Each program follows a workbook for each respective course for calculating the CO and PO attainment. The workbook includes:

- Index (Basic information and all contents in the workbook)
- Students list (with roll call, seat number, and enrollment number)
- CO-PO-PSO workbook (summary of all attainment done in the workbook)
- ST-I and ST-II marks the entry with CO attainment
- Another method which includes – Paper solving / Assignments / MCQ’s.
- MSBTE result which includes – Theory (TH) + Practical / Oral (POE) + Termwork (TW) etc.
- PO attainment with its attainment level.
- Course end survey.
- Summary of all attainment in form of “Graphs”.

E. Course Outcome Attainment (DIRECT ASSESMENT)

The course outcomes are measured in terms of Internal Assessment (IA) and External Assessment (EA). Course Outcome attainment level is set for each course in the respective program. The attainment level has been set considering average performance levels in the MSBTE examination for the assessment years. Attainment level is measured in terms of student performance in internal assessments (IA) with respect the COs of a course plus the performance in the Board examination (External Assessment (EA)).

Internal Assessment (IA) 30% + External Assessment (EA) 70% = 100%

Measuring CO attainment through Internal Assessments (IA)

The CO attainment through IA includes ST-I and ST-II. The attainment is calculated by considering the CO belonging to particular question with particular marks. The whole paper is of 36 marks (including optional) and from which 25 marks is considered. The CO attainment for particular question is calculated by considering following formula:

No. of students secured marks >=2 in that question

CW403.1 for Qno.1. a =

No. of students attempted the question

Table 3: CO Attainment of CNE-St-I For IA in %

| QUESTION | Q1_ANY 3_9 MARKS | | | | Q2_ANY 2_8 MARKS | | | Q3_ANY 2_8 MARKS | | |
|--------------------|------------------|---------|---------|---------|------------------|---------|---------|------------------|---------|---------|
| CO | CW403.1 | CW403.2 | CW403.1 | CW403.2 | CW403.1 | CW403.1 | CW403.2 | CW403.1 | CW403.2 | CW403.2 |
| MARKS | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 4 | 4 |
| Q. Attempted Count | 52 | 35 | 42 | 42 | 44 | 23 | 41 | 39 | 28 | 45 |
| Count > 2 marks | 38 | 18 | 29 | 35 | 28 | 19 | 36 | 31 | 25 | 38 |
| % attainment | 73.08 | 51.43 | 69.05 | 83.33 | 63.64 | 82.61 | 87.80 | 79.49 | 89.29 | 84.44 |

| | | | |
|----------------------------|-------|------------------------------|-------|
| Attainment of CW403.1 in % | 73.57 | WEIGHTAGE OF CW403.1 IN ST-I | 50.00 |
| Attainment of CW403.2 in % | 79.26 | WEIGHTAGE OF CW403.2 IN ST-I | 50.00 |

After calculating CO attainment for each bit belonging to that question, the final attainment of respective CO is considered by summation of all % of attainment / No. of question belonging to that CO. For example, from table 3 consider **CW403.1**. The final attainment is **73.57%** which is considered by summing up values $(73.08 + 69.05 + 63.64 + 82.61 + 79.49) / 5$. The same procedure is followed for ST-II where the remaining CO's are covered from that respective subject.

Measuring CO attainment through External Assessment (EA)

The CO attainment through EA includes TH, TW, and POE. The attainment is calculated by considering the total marks achieved in TH, TW, and POE. The CO attainment for particular is calculated by considering following formula:

$$\text{CW403.1} = [(0.50\text{TH}) * (0.20)] + [(0.30\text{POE}) * (0.2142)] + [(0.20\text{TW}) * (0.2142)]$$

Where,

0.50 is weightage for TH
 0.30 is weightage for POE
 0.20 is weightage for TW

All divided by 100.
i.e. 50 / 100 = 0.50

0.20 is a contribution for CW403.1
 0.2142 is a contribution for CW403.1 of POE
 0.2142 is a contribution for CW403.1 of TW

Refer Table 3

of TH

Based on this formula for particular **CO**, the max marks are calculated which a student can get for that **CO**. The target for EA is **50%** i.e. the max marks gained from respective CO is divided by 2 and **50%** marks of that CO is used for comparison.

Table 4: CO Formulas of CNE for EA

| CO FORMULA FOR EACH CO | | MAX MARKS THAT A STUDENT CAN ACHIEVE |
|------------------------|--|--------------------------------------|
| CW403.1 | $[(0.50TH)*(0.20)] + [(0.30POE) * (0.2142)] + [(0.20TW) * (0.2142)]$ | 14.28 |
| CW403.2 | $[(0.50TH)*(0.20)] + [(0.30POE) * (0.286)] + [(0.20TW) * (0.286)]$ | 15.72 |
| CW403.3 | $[(0.50TH)*(0.20)] + [(0.30POE) * (0.2142)] + [(0.20TW) * (0.2142)]$ | 14.28 |
| CW403.4 | $[(0.50TH)*(0.18)] + [(0.30POE) * (0.0)] + [(0.20TW) * (0.0)]$ | 9.00 |
| CW403.5 | $[(0.50TH)*(0.22)] + [(0.30POE) * (0.2856)] + [(0.20TW) * (0.2856)]$ | 16.71 |

Table 5: CO Attainment of CNE for EA in %

| CO ATTAINMENT THROUGH *EA | CW403.1 | | CW403.2 | | CW403.3 | | CW403.4 | | CW403.5 | |
|---|---------|-------|---------|-------|---------|-------|---------|-------|---------|-------|
| TOTAL NUMBER OF STUDENTS MEETING REQUIREMENTS (M) | 40 | 88.89 | 40 | 88.89 | 40 | 88.89 | 36 | 80.00 | 40 | 88.89 |
| TOTAL NUMBER OF STUDENTS NOT MEETING REQUIREMENTS (N) | 5 | 11.11 | 5 | 11.11 | 5 | 11.11 | 9 | 20.00 | 5 | 11.11 |
| TOTAL NUMBER OF STUDENTS PRESENT FOR *EA | 45 | | 45 | | 45 | | 45 | | 45 | |

Consider Table 5, the CO attainment through external examination (EA) is shown for all the 5 CO's. The table includes total no. of students appeared for the examination, total no. of students who secured marks up to or above the target level (M), total no. of students who secured fewer marks than the target level (N) and final CO attainment.

Table 6: CO Attainment Through IA + EA

| CO | CO Attainment | | ASSESSMENT OF CO | | IA+EA | TARGET | TARGET ACHIEVED Y/N | GAP in % | ACTION PROPOSED TO BRIDGE THE GAP |
|------------------|---------------|-------|------------------|----------|-------|--------|---------------------|----------|-----------------------------------|
| | IA | EA | IA [30%] | EA [70%] | 100% | | | | |
| CW403.1 | 73.57 | 88.89 | 22.07 | 62.22 | 84.29 | 50 | Y | | |
| CW403.2 | 79.26 | 88.89 | 23.78 | 62.22 | 86.00 | | Y | | |
| CW403.3 | 38.06 | 88.89 | 11.42 | 62.22 | 73.64 | | Y | | |
| CW403.4 | 59.97 | 80.00 | 17.99 | 56.00 | 73.99 | | Y | | |
| CW403.5 | 64.24 | 88.89 | 19.27 | 62.22 | 81.49 | | Y | | |
| AVG | 63.02 | 87.11 | | | 79.88 | | | | |
| Attainment Level | 3 | 5 | | | 4 | | | | |

After getting CO attainment through IA + EA, the set target is compared with the achieved target and if the target is not achieved then the respective course teacher has to propose an action to improve the results as well as to achieve the target in next upcoming academic year.

F. Program Outcome Attainment (INDIRECT ASSESSMENT)

The CO-PO mapping done by each course teacher for each respective course can be verified by the CO attainment through IA and EA. The PO attainment for CNE course is shown in table 7.

Table 7: PO-PSO Attainment of CNE Course

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 |
|------------------|-------------|-------------|-------------|-------------|-----|-----|-------------|-------------|-------------|-------------|------|-------------|
| CW403.1 | 2.53 | | | | | | 0.84 | | 0.84 | 2.53 | | 1.69 |
| CW403.2 | 1.72 | 0.86 | 2.58 | | | | | 0.86 | 0.86 | 2.58 | | 1.72 |
| CW403.3 | 1.47 | 0.74 | 0.74 | 0.74 | | | | | 0.74 | 2.21 | | 2.21 |
| CW403.4 | 2.22 | 1.48 | | | | | 1.48 | | 0.74 | 2.22 | | 2.22 |
| CW403.5 | 2.44 | 1.63 | 1.63 | | | | 1.63 | 1.63 | 0.81 | 2.44 | | 2.44 |
| AVG | 2.08 | 1.18 | 1.65 | 0.74 | | | 1.32 | 1.24 | 0.80 | 2.40 | | 2.06 |
| Attainment Level | 4 | 2 | 3 | 1 | | | 2 | 2 | 1 | 4 | | 4 |

4. CONCLUSION

Assessment of course outcomes (CO) and program outcomes (PO) involves the systematic and on-going gathering and use of information about student learning for the purpose of improvement. The result of assessment would be a coherent curriculum in which all courses have well-defined and interconnected roles in achieving the program mission. The above paper explains a method of measuring Course Outcomes by using a spreadsheet. Once the result of the MSBTE final examinations are out then the same can be used to find out the Direct CO attainment and also find out the CO Attainment Gap and action proposed to bridge the gap. From this result, the attainment of each course outcome for the course can be further reviewed and analyzed. Action plan to improve any weakness can be identified and implemented in the next upcoming academic year.

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