Assessment Method for Course Outcome Attainment: A Case Study in Engineering Education


1* Dept. of Information Technology, CVR College of Engg, Hyderabad, India
2 Dept. of Information Technology, CVR College of Engg, Hyderabad, India
3 Dept. of Information Technology, CVR College of Engg, Hyderabad, India
4 Dept. of Information Technology, CVR College of Engg, Hyderabad, India
5 Dept. of Information Technology, CVR College of Engg, Hyderabad, India
6 Dept. of Information Technology, CVR College of Engg, Hyderabad, India

*Corresponding Author: hnlakshmi@gmail.com
Available online at: www.ijcseonline.org

Received: 26/Jul/2017, Revised: 03/Aug/2017, Accepted: 26/Aug/2017, Published: 30/Aug/2017

Abstract — the accreditation process conducted by National Board of Accreditation (NBA) in India is a quality assurance process to determine whether educational institutes are meeting the program objectives. The process involves measuring the attainment of program objectives in terms of Program Outcomes attainment and Course Outcome attainment levels. In this paper we describe the methodology for computation of Course Outcomes attainment we have designed and implemented in Information Technology department as part of the accreditation process. A running example of how the method is shown for one of the core courses in engineering program. Also, a discussion on the utilization of Course Outcome attainment values is done.

Keywords - Course Outcome, Internal Assessment, Attainment calculation, NBA

I. INTRODUCTION

With growing number of technical institutions in the country it becomes necessary for one to measure the quality of an institution, especially in terms of objectives achieved by students graduating from the institutions. In this regard All India Council for Technical Education (AICTE) set a committee called National Board of Accreditation, which accredits various programs in Technical institutions in India.

The accreditation process conducted by National Board of Accreditation in India is a quality assurance process to determine whether educational institutes are meeting the objectives. Any student completing graduation is expected to possess certain qualities, during and after the completion of his/her program and are referred to as Program Outcomes (PO), also called Graduate Attributes.

In order to measure the Program Outcomes, each institute defines Course Outcomes (CO) for all the prescribed courses in the various programs offered by it. These parameters need to be assessed periodically to understand whether the Program Outcomes are achieved or not.

In this paper we describe the methodology for computation of Course Outcomes attainment we have designed and implemented in Information Technology department as part of the accreditation process. Section II describes the various assessment tools we have considered for computation of Course Outcome attainment. Section III explains in detail the process of computation of CO attainment utilizing these tools. A running example of how the method is also shown in this section for one of the core courses in engineering program. Section IV gives a discussion on various usages of Course Outcome attainment values.

II. ASSESSMENT OF COURSE OUTCOMES

In this section we present the various tools and how they are mapped for calculation of Course Outcome attainment.

II.I Tools for Course Outcome assessment

The various assessment tools evaluates student’s knowledge and ability to apply their skills in continuous assessments like internal examinations, end semester examinations, presentations, assignments, Projects, tutorials etc. These tools are the evidence of student learning. The various tools used for the assessment of Course Outcome are as follows:
1. Internal Assessments for theory courses - 2 mid exams and 2 assignments per semester.

2. Computer Lab Exercises / examinations (Weekly lab exercises, internal examination and end semester external examination).

3. End Semester Examinations for theory courses.

Description of different types of course assessment and evaluation methods:

1. Internal Assessment:
   Performance of students in each subject is evaluated internally through MID exams and assignments.
   a. Mid Exams: Mid examination consists of two parts: part A comprising of 5 compulsory questions each of which carries 2 marks and Part B comprising of 5 questions of 10 marks each of which the student needs to answer any 3 questions. While descriptive questions test the candidate’s ability to express the concept in detail, the short answer questions shows his/her ability to grasp the main concept and to apply the concept concisely on a problem. A satisfactory performance is an indication of attainment of Course Outcomes.

   b. Assignments: Minimum of two assignments per semester are to be submitted by the students. The assignments are basically exercise problems to check the ability of the student in applying, solve/implement the concept.

Total Internal assessment is for 25 marks per subject (20 for mid exam and 5 for assignments). There are minimum two mid exams per semester and average of these mid marks is taken for final evaluation.

2. Computer Laboratory Exercises:
   To evaluate a student’s performance in practical oriented subjects, labs are prescribed as part of the syllabus. A set of prescribed lab programs are given in the lab syllabus for each lab course. Lab sessions are conducted weekly for such subjects and a weekly evaluation is done in every lab session. At the end of the semester internal and external lab exams are conducted. This continuous practical sessions and end semester evaluation helps students to gain practical knowledge on theory as well in application program development. The performance assessed is an evaluation of course outcome.

3. End Semester (external) Examination:
   The external examination is for 75 marks comprising of two parts: part A comprising of 10 compulsory questions each of which carries 2 marks and Part B comprising of 8 questions of 11 marks each, of which the student needs to answer any 5 questions. The performance of this along with internals is taken for giving the final program performance for the student. End semester examination becomes primary evaluation criteria for student’s performance either in placements or in higher studies such as MS or M.Tech./PhD. In other words this assessment tool is primary for evaluation of attainment for the program.

II.II Mapping assessment tools for calculation of Course Outcomes attainment levels:

1. Internal Assessment:
   Performance of students in each course is evaluated internally through MID exams and assignments by the respective faculty teaching the course. Questions in the mid exam and assignments are mapped to the CO’s of the respective subject by the faculty. On completion of evaluation of the mid exam scripts and also the assignment given to students, the faculty tabulates the marks obtained in mid exam with their respective CO’s in the format as shown in Fig 1.

   \[ GCA = \frac{\text{Total marks obtained by all students}}{\text{No. of students attempting the question}} \]

   ii. The number of students having marks greater than or equal to the Class Average marks for each question is then calculated (GCA).

   iii. Percentage of students having marks greater than the Class Average marks, P.CA, for each question is calculated as

   \[ P.CA = \frac{GCA}{\text{No. of students attempting the question}} \]

   iv. For each Course Outcome of the course calculate Course Outcome attainment as follows:
2. End Semester (external) Examination:
The process for calculating the CO’s attainment for external examination is very much similar to the one used for internal examination, however the process of data collection is different. The questions in the external examinations are also mapped to the CO’s of the respective course by subject experts. Since our institution is autonomous, we obtained special permissions from Dean Academics and Controller of Examinations through Principal to collect question wise marks obtained by the students in end examinations to enable us to calculate CO attainment for all courses of the program. Faculty were deputed from the department to collect the data from examination department and tabulate the same in the format as shown in Fig 2. The process for calculation of Course Outcome Attainment for end exam is same as that used for internal assessment, as explained before.

Fig 2. CO Mapping Format for external exam

3. Computer Laboratory Exercises:
At the end of the semester there will be internal and external lab exams with an evaluation for 25 and 50 marks respectively. The lab programs are mapped to the CO’s of the respective lab course by subject experts. Each student is given any one or two programs from the prescribed set for both internal and external exams. The corresponding faculty tabulates the marks obtained in internal and external exam with their respective CO’s in the format as shown in Fig 3.

Fig 2. CO Mapping Format for external exam

III. CO ATTAINMENT CALCULATION
In this section we describe the methodology used for calculating CO attainment levels in general for any course. The same method was applied for all the courses in the program. Also, we present a running example for better understanding of the methodology.

III.I Calculating the final CO attainment levels for a Course:
Once the CO attainment values for a course using the assessment tools have been calculated, the final CO attainment values are calculated using the formula stated below:

\[
CO_{i, AL} = x \times CO_{i, Int} + y \times CO_{i, Ext}
\]

Where,
- \(CO_{i, AL}\) is the Course Outcome Attainment level for \(i^{th}\) Course Outcome of the course,
- \(CO_{i, Int}\) is the Course Outcome value obtained from the internal assessment for \(i^{th}\) Course Outcome of the course,
- \(CO_{i, Ext}\) is the Course Outcome value obtained from the external examination for \(i^{th}\) Course Outcome of the course,
- \(x\) is the weight given for internal assessment and \(y\) is the weight given for external examination.

The weights used for theory courses and lab courses are as below:
- For Theory Courses (Maximum Marks =100)
  - \(x = 0.25\), i.e., 25% weightage given to Internal assessment.
  - \(y = 0.75\), 75% weightage given to External examination.
For Lab Courses (Maximum Marks = 75)

- x = 0.33, 33% weightage given to Internal assessment.
- y = 0.67, 67% weightage given to External examination.

**III.II A Running Example:**

CO attainment calculation is shown for one of the core courses “Design and Analysis of Algorithms” which is a course taught in III year I Semester.

**Internal Assessment:**

There are 2 mid exams for every course. At the end of the mid exam the corresponding faculty tabulates the marks obtained in the format shown previously. The questions in the 2 mid exams of “Design and Analysis of Algorithms” course map to the COs as shown in Table 1.

<table>
<thead>
<tr>
<th>Question No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Outcome Mapped in Mid I</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Course Outcome Mapped in Mid I</td>
<td>4</td>
<td>6</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>4</td>
<td>6</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

It is clearly seen that the Course Outcomes of the course are distributed among questions – both short answer type and descriptive in both the mid exams.

For each internal exam the total marks obtained by all students for each question is calculated. Utilizing this the class average is computed and then the percentage of students obtaining marks greater than or equal to class average is obtained as explained earlier. The calculations for mid I and II exams for “Design and Analysis of Algorithms” course computed are shown in Fig 3 through 6 respectively.

<table>
<thead>
<tr>
<th>Question No.</th>
<th>Part A (Max Marks = 2)</th>
<th>Part B (Max Marks = 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO Mapping</td>
<td>1 3 2 2 1 1 3 2 2 2</td>
<td></td>
</tr>
<tr>
<td>Total marks obtained by all students (In a class of 60)</td>
<td>90 71 61 49 47 196 171 149 102 115</td>
<td></td>
</tr>
<tr>
<td>No. of students attempted the questions</td>
<td>51 50 47 38 34 43 33 28 22 18</td>
<td></td>
</tr>
<tr>
<td>No. of students obtaining marks ≥ class average</td>
<td>51 50 47 38 34 29 22 17 11 16</td>
<td></td>
</tr>
<tr>
<td>Percentage of students with marks ≥ class average marks</td>
<td>100 100 100 100 85.3 66.7 60.7 64.71 88.9</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Outcome No.</th>
<th>( \sum CF ) of Questions mapped to the CO No of questions mapped to this CO</th>
<th>P.CO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Outcome 1 (100+100+45.29411765)/3</td>
<td>95.1</td>
<td></td>
</tr>
<tr>
<td>Course Outcome 2 (100+100+67.1428571+64.70588235+88.88888889)/5</td>
<td>82.86</td>
<td></td>
</tr>
<tr>
<td>Course Outcome 3 (100+66.6666667)/2</td>
<td>83.33</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question No.</th>
<th>Part A (Max Marks = 2)</th>
<th>Part B (Max Marks = 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO Mapping</td>
<td>4 6 5 4 6 4 6 4 5 6</td>
<td></td>
</tr>
<tr>
<td>Total marks obtained by all students</td>
<td>84 77 73 62 62 203 221 215 149 153</td>
<td></td>
</tr>
<tr>
<td>No. of students attempted the questions</td>
<td>47 46 44 41 40 29 33 29 20 20</td>
<td></td>
</tr>
<tr>
<td>No. of students obtaining marks ≥ class average</td>
<td>47 46 44 41 40 11 26 20 13 14</td>
<td></td>
</tr>
<tr>
<td>Percentage of students with marks ≥ class average marks</td>
<td>100 100 100 100 37.9 78.8 68.97 65 70</td>
<td></td>
</tr>
</tbody>
</table>
Calculations for both the mid exams for each section are computed similarly. Final values of Course Attainment for internal assessment are obtained by taking an average of section A, B and are tabulated as shown in Table 2.

**Table 2. CO Attainment for internal assessment**

<table>
<thead>
<tr>
<th>CO No.</th>
<th>P.CO for section A</th>
<th>P.CO for section B</th>
<th>Final P.CO for Internal Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO 1</td>
<td>95.1</td>
<td>86.11</td>
<td>90.60</td>
</tr>
<tr>
<td>CO 2</td>
<td>82.86</td>
<td>85.57</td>
<td>84.22</td>
</tr>
<tr>
<td>CO 3</td>
<td>83.33</td>
<td>87.5</td>
<td>85.42</td>
</tr>
<tr>
<td>CO 4</td>
<td>98.95</td>
<td>76.72</td>
<td>87.84</td>
</tr>
<tr>
<td>CO 5</td>
<td>100</td>
<td>82.5</td>
<td>91.25</td>
</tr>
<tr>
<td>CO 6</td>
<td>100</td>
<td>87.19</td>
<td>93.60</td>
</tr>
</tbody>
</table>

**End Semester (external) Examination:**

On completion of evaluation of external scripts and result announcement a few deputed faculty from the department tabulates the marks obtained in the external exams in the format shown previously. The questions in the external exams of “Design and Analysis of Algorithms” course map to the COs as shown in Fig 7.

**Calculations for End Examination:**

For the external exam the total marks obtained by all students for each question is calculated. Utilizing this the class average is computed and then the percentage of students obtaining marks greater than or equal to class average is obtained as explained earlier. The calculations for external exam for “Design and Analysis of Algorithms” course computed are shown in Fig 8 and Table 3 shows the CO attainment calculations for the same.

![Image](image.png)
<table>
<thead>
<tr>
<th>CO 1</th>
<th>90.60</th>
<th>93.18</th>
<th>92.54</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO 2</td>
<td>84.22</td>
<td>89.44</td>
<td>88.13</td>
</tr>
<tr>
<td>CO 3</td>
<td>85.42</td>
<td>89.1</td>
<td>88.18</td>
</tr>
<tr>
<td>CO 4</td>
<td>87.84</td>
<td>85.53</td>
<td>86.11</td>
</tr>
<tr>
<td>CO 5</td>
<td>91.25</td>
<td>89.31</td>
<td>89.79</td>
</tr>
<tr>
<td>CO 6</td>
<td>93.60</td>
<td>85.71</td>
<td>87.69</td>
</tr>
</tbody>
</table>

IV. CONCLUSION

In this paper we have discussed the methodology we have used for computation of Course Outcome attainment for the courses prescribed in the syllabus of engineering program. The method so described can be utilized for inferring information on attainment of individual Course Outcome, attainment of a Course as a whole and finally attainment of various Program Outcomes to which the course is mapped to. The method described has been applied to all the courses in a similar manner and the CO attainment values has been obtained. Course Outcome attainment target levels for each CO in each course was set based on the importance and level of difficulty of the CO by subject experts in the department. The target CO attainment level differ for internal assessment, end examination and also differ across the various courses of the program. Also, the set levels are higher for the internal assessment when compared to the ones set for external examination for each course of the program. The computed values of CO attainment was compared to the target values to infer whether a Course Outcome is attained or not. Based on the discrepancies between the set target level and attainment level of each CO, necessary actions are recommended to improve the program curriculum. Improvements may be made by suggesting changes in course structure like adding new courses, additional electives, incorporating many training programs including modification of regulations.

ACKNOWLEDGMENT

We express our gratitude to Dr. C. Madhusudan Reddy our Advisor, Dr. C. V. Raghava our Chairman for extending their support and motivating us for publishing papers in all genres. A special thanks to Dr. Rama Sastrri our Director who has been guiding us through the process of defining our methodology described in the paper. We also express our thanks to all the faculty of Dept of IT, CVR College of Engg, who have spent their valuable time in calculation of Course Outcomes for all the courses.

REFERENCES


Authors Profile
Dr. Lakshmi. H.N is currently working as a professor in Dept of IT, CVR College of Engg, Hyderabad. She has completed her PhD in Computer Science from University of Hyderabad. She has published 7 papers in various international conferences and journals which are available online. She completed her M.S in Software Systems from BITS Pilani and B.Tech from BMS College of Engg, Bangalore University. She has over 17 years of teaching experience. Her main research work focuses on web service search and composition and has interests in the area of Big Data Analytics, Algorithms and programming.

Mrs. G.Bhagyasri is currently working as a Assistant Professor in Dept of IT, CVR College of Engg, Hyderabad. She has completed her M.Tech in Computer Science and Engg. from University College of Engg., Osmania University, Hyderabad and B.Tech from JNTU College of Engg., JNTU Hyderabad. She has over 12 years of teaching experience. Her interests in the area of Big Data Analytics and Machine Learning.

Mrs. Yashasree J is currently working as Assistant Professor in the Dept of IT, CVR College of Engg, Hyderabad. She has completed her M.Tech from University College of Engg, Osmania University, Hyderabad and B. Tech from Scient Institute of Technology, JNTUH. She has 5 years of experience in teaching and has interest in the area of Cloud Computing.

Mr. S.Bhargav is currently working as a Assistant Professor in Dept of IT, CVR College of Engg, Hyderabad. He completed his M.Tech in Computer Science and Engg from Netaji Institute of Engg. & Technology and B.Tech from Arjun College of Technology & Science, Hyderabad. He has over 2 years of teaching experience. He has interests in the area of Big Data Analytics and Data Mining.
Mr. B. Satheesh Kumar is currently working as an Assistant Professor in Dept of IT, CVR College of Engg, Hyderabad. He completed his M.Tech in Computer Science from CVR College of Engg. and B.Tech from Sri Indu College of Engg. He has over 3 years of teaching experience. He has interests in the area of Cloud Computing and Machine Learning.

Mrs K. Anusha is currently working as Assistant Professor in the Dept of IT, CVR College of Engg, Hyderabad. She completed her M.Tech in Computer Science and Engg from Netaji Institute of Engg. & Technology and B. Tech from JNTUH. She has 2 years of experience in teaching and has interest in the area of Cloud Computing.