Journal of Engineering Education Transformations ,
Volume 35 , No. 3 , January 2022 , ISSN 2349-2473, eISSN 2394-1707

Assessment of Course Outcomes Attainment using Confidence Limits

Manoj Gundalia
mjgundalia@gmail.com

Abstract: Course Outcomes (CO) assessment is one of the most important components of Outcome Based Education (OBE) to describe the specific type and level of learning students. The programs must have an effective end results in every course and their systematic assessment with proper documentation and should evaluate continuously to establish certain standards leading to program accreditation. In the calculation of CO attainment, the mean values are usually considered as a target values but it may create ambiguity in decision making. The target value in conventional method is unbounded on the upper and lower ends, which undermines interpretations of student's category associated with their performance. In this paper an attempt has been made with a new approach for calculation of CO attainments based on Lower Confidence Limit (LCL) and Upper Confidence Limit (UCL) and compared against conventional method. This comparison has shown that the proposed method showed a nontrivial improvement over existing conventional method and found more flexible, relatively well behaved, and applicable to a wide range of students' categories. Further, proposed method has the advantage of being useful in framing appropriate syllabi of courses and in making effective strategy to improve students' performance.

Manoj Gundalia
mjgundalia@gmail.com

Keywords: Outcome Based Education, Lower Confidence Limit, Upper Confidence Limit, Attainment of Course Outcome

1. Introduction

Static material or master classes based traditional teaching methodologies are not always the best approach to promote learning. These methods mainly focus on what is taught. The Outcome Based Education (OBE) is a pedagogical student-centric model entails the restructuring of curriculum, pedagogy and assessment practices to ensure high-order learning. Therefore, to recognize and facilitate the standardization of professional courses, OBE has been recommended by (Washington Accord on 13 June 2014). India is officially a member of the Washington accord from 13thJune 2014 with the permanent signatory status of the National Board of Accreditation (NBA). All India Council for Technical Education (AICTE), a statutory body of India has adopted the OBE to train the engineering graduates for better knowledge, skill sets, attitudes, global mobility and acceptance (Ramchandra et al., 2014). All the higher education level technical institutions of India are following OBE as per the guidelines issued by AICTE. Course Outcomes (CO), Program Outcomes (PO) and Program Educational Objectives (PEO) are the main key components of OBE. Based on how well these components are defined and evaluated, OBE attainment is measured. Literature shows plenty of reports on direct assessment method (Bassi et al., 2015; Biney and Bryant, 2010; Gurocak, 2008; Memon and A Harb, 2009; Rajak et al., 2018;

Roy et al., 2015; Shaeiwitz and Briedis, 2007; Terang et al., 2015; Turkmen et al., 2010). PEO and PO are eventually depended on CO attainment. Recent studies focuses on the methodology for assessment of CO attainment. Chandna, 2015 discussed the methodology for CO assessment and improvement on weak student through Massive Open Online Courses (MOOC) Innovation and Technology. Balasubramani and Chiplunkar, 2017 demonstrated the process of CO attainment and its contribution to PO. Rajak et al., 2019 discussed how gap analysis is performed when CO does not meet to its target. Premalatha 2019 discussed on guidelines of CO-PO mapping and its attainment models. Kulkarni and Barot, 2019 proposed a method based on assigning two step weights best suited to the evaluation scheme of a course and their mapping with CO for engineering course. Therefore, institutes have shifted their focus on CO attainment.

The OBE model involves documentation of students learning outcomes' achievement, setting of appropriate target values, and gap analysis. In OBE, teaching learning activities are planned and organized such that the CO attainment can achieve the set target value. The department critically analysed the deviation of CO attainment from set target value. Department carries out gap analysis for the course which is not achieved expected CO attainment. The subject teacher has to submit justification with the reasons for the non-attainment of course outcome to the department. CO assessment is useful to map the quality of teaching and delivery, across divisions and departments, to evaluate faculty and students performance, to gauge students' understanding and knowledge in different segments of the course. It provides a feedback to the faculty and helps in improving the teaching-learning process.

CO is set of statements that describe what students should be able to do at the end of a course or subject. The CO attainment largely depends on set target value. Target value usually taken as mean value. The target values are revised from time to time based on the degree of attainment of the vision and mission of the department or institute. Thus setting of target value has been a key issue in the process of CO attainment. In this paper, lower confidence limit (LCL) and Upper confidence limit (UCL) are deployed in place of mean to set target values for determination of expected CO. The main objective of this study is to assess CO attainment more effectively using confidence limits. Finally, the overall applicability of the traditional method and proposed method are examined by evaluation of CO attainment for six coursesof semester 5 of B. Tech Civil Engineering Program.

2. Methodology

OBE formulates content around activities that leads to increase the proficiency of a particular skill, knowledge, or behaviour of the student. In this approach the learner's mastery over a particular skill is demonstrated and measured and the curriculum are driven by the exit learning outcomes of the students at the end of the program. CO attainment mapping is critical part of OBE and hence, CO should be stated in clear, specific, and measurable terms. The main focus is on what the student will be able to do as a result of taking the course and describe what the learner can draw from the knowledge, skills, and experiences acquired in a course.This assessment can be done directly or indirectly. In the present study only direct assessment is taken into consideration.

In traditional method CO attainment measured by comparing output with target value (average (AVG) value of the marks. Instead of a single estimate for the mean, a confidence interval generates a lower and upper limit for the mean. Confidence limits for the mean (Snedecor and Cochran, 1989) are an interval estimate for the mean. Interval estimates are often desirable because the estimate of the mean varies from sample to sample. The interval estimate gives an indication of how much deviation occur in true mean estimation. Narrower interval indicates more precise estimation. The motivation of this study is to articulate the outcome based process to achieve CO attainment based on LCL with 95% confidence for any under graduate (UG) program. They can be used to categorise students in to three different levels according to their level of understanding. The LCL indicates the minimum attainment level whilst the UCL indicates the maximum attainment level of CO and both can be reported with 95% confidence. In the present study target value set based on LCL.AVG method is based on sample mean which is the most common point estimate. It is easy to calculate and understand but it gives no indication of how accurate the estimation really is. To deal with uncertainty, an interval estimate LCL method is proposed. It provides a range of values that best describe the population.The interval estimate is a range of values used to estimate a population parameter and is associated with a specific confidence level.

In this study, CO of six courses of semester 5 of B. Tech Civil Engineering Program was assessed based on LCL. Traditionally CO attainment determine by taking means of marks obtained by the students in the courses.In statistics, the confidence interval is the range that a population parameter is likely to fall into, for a given probability. For given population and a probability of 95%, the confidence interval is the range in which a population parameter is 95% likely to fall.Note that the accuracy of the confidence interval relies on the population having a normal distribution.

To calculate the confidence limits for a measurement variable, multiply the standard error of the mean times the appropriate critical Z-value. The critical Z-value is determined by the probability (0.05 for a 95% confidence interval) and the sample size. The confidence interval tells you how confident you are in your results.

Confidence limits for the mean (M) are an interval estimate for the mean (Snedecor and Cochran, 1989). The mean value has characteristic to vary sample to sample therefore, Interval estimates are often desirable. A confidence interval generates a lower and upper limit for the mean. The LCL and UCL are calculated by using Equation (01) and (02) respectively.

$$LCL=M-Z_{(\alpha/2)}*\frac{\sigma}{\sqrt{n}} \qquad 01$$

$$UCL=M+Z_{(\alpha/2)}*\frac{\sigma}{\sqrt{n}} \qquad 02$$

Where Z is a numerical critical value calculated based on the alpha (α=1-confidence level). Mathematically we use the Z table to calculate the critical Z value. To calculate the confidence interval we need to calculate the margin of error ($Z(\alpha/2)*\sigma/\sqrt{n}$). Subtracting this error value from mean value will give the lower limit of interval and adding the error value to mean value will provide the upper limit of the interval. Confidence limits are expressed in terms of a confidence coefficient. The confidence coefficient may be expected to contain the true mean.After determination of LCL and UCL, students are categorized in three different levels (L1<LCL, L3>UCL and LCL=<L2=>UCL). Estimate the individual CO attainment in % based on LCL. After completion of direct assessment estimate individual CO. Units of the course not equally contribute to the final average, some unit contributes more weight than others. The weighted mean (Everitt and Skrondal, 2010) makes it possible to account effect of units in computation of CO. Weighted COwi for each course are determine by considering LCL based individual CO for each course and equivalent weight of unit using the following equation (03):

$$CO_{wi} = \frac{\sum_{j=1}^{N} CO_j \, UN_j}{\sum_{j=1}^{N} UN_j} \qquad 03$$

Where

COwi=Weighted CO for each course i in a semester

N=Number of Units

COj=Individual CO measured based on LCL for course j

UNj=Unit weightage in % for each CO j

The composite COci is calculated as the weighted average of the COwi by accounting the credits of each course. Estimate the composite COc for each semester. The COci is computed by using equation (04):

$$CO_{ci} = \frac{\sum_{j=1}^{N} CO_{wj} \, CR_j}{\sum_{j=1}^{N} CR_j} \qquad 04$$

Where

COci=Composite CO for each semester i

N=Number of courses

COwj=weighted CO of each course j

CRj=Credit for each course j

The procedure of CO attainment and scaling it in 1 to 3 is presented in flowchart (Fig. 1).

3. Result and Discussion

In order to attain the PO, the course curriculum of the program is designed in a manner that the students get trained in the entire 12 PO of the Program. The courses are taught to the students by various teaching methodologies like class room teaching, laboratory experiments, seminar, projects, invited talks, internships, supplemental instructions (Peer group study), etc. Each course is designed with specific CO

and each CO is mapped to the PO. The CO was formulated by subject expert taking inputs from various stake holders from Academician, Alumni, and Industry etc. A CO and Course units are formulated and presented in Table 2. In this procedure care must be taken that each CO must be mapped at least one unit (Chapter) of the course. The department has to formulate 12 PO based on twelve NBA graduate attributes. A CO-PO correlation is mapped in scale 1 to 3 as shown in Table 2.

In this study, an innovative methodology to measure CO attainment for course and semester is proposed and presented. Question paper should adequately be addressed the weightage assigned to each unit and the entire CO of the course. The weighted CO for each course and composite CO for each semester are calculated by using equation (03) and (04) respectively. Calculations of CO for all six subjects of 5thsemester of B. Tech Civil Engineering program are presented in Table 3-8.

CO attainment for each course by both the method (LCL and AVG) are presented in Table 3-8. In this study, internal assessment of 115 students of 5thsemester was carried out. Similar methodology can be applied for external and practicals assessment. In this method students can be categorized into three different levels L1-Slow learner, L2-Medium learner and L3-Advance learner according to their performance. Faculty members can prepare action plan according to students' level for better performance. The highest difference (20.64) is observed in CO6 of (30040506) course while lowest difference (-2.54) is shown in CO1 of (30040502) course between LCL and AVG method. According to LCL method, highest CO1 attainment is recorded 89% for (30040505) course and lowest CO6 attainment noted 15% for (30040506) course. AVG method measured highest CO1 attainment 91% for (30040505) course and the lowest CO6 attainment 19% for (30040506) course. Table 9 shows the individual CO attainment for each course by both the method. It is reveal from Table 9 that LCL method explicitly indicates overall class level of students. L1 implies poor and medium performance while L3 indicates medium and strong performance of students in particular course. It is seen that CO1 and CO2 strongly attained, CO4 and CO5 are moderately attained and CO3 and CO6 are not adequately attained. This is due to CO3 and CO6 have more marks as compared to others. Depending on the weightage of marks, in this section analysing, evaluating and designing problems were usually asked.

Weighted CO for each course by taking into account weightage of course units and Composite CO for entire semester was computed based on credit of course. Weighted CO and Composite CO are computed and displayed in Table 10. LCL method computed highest weighted CO 71.63% for (30040502) course and lowest weighted CO 45.21% for (30040506) course while AVG method estimated highest weighted CO 66.33% and lowest weighted CO 45.39% for the same courses. LCL method underestimated the weighted CO for 30040504 and 30040506 courses. The results obtained by LCL method differ the results of AVG method in range from -0.21% to 7.99%. LCL method overestimated composite CO. The difference in composite CO estimation is 3.14%. Attainment of weighted CO and Composite CO can be useful in upgradation of course contents and teaching schemes.

4. Conclusions

In the present study the CO attainment method based on confidence level limit is proposed for Under Graduate Engineering Program. The results obtained by traditional (AVG) method and proposed (LCL) method are compared. The results obtained by proposed (LCL) method are indicated that LCL method contributes towards making the more effective CO attainment with specific confidence level. In this study, internal assessment of 115 the pre-final year students was carried out and the methodology can be applied for external and practicals assessment. Attainment of weighted CO and Composite CO can be useful in up gradation of course contents and teaching schemes. Proposed methodology divides students in three different levels based on LCL and UCL target values which would help in making action plan for further improvement of students of equal level. Weighted CO by considering weights of units and Composite CO by taking into account of course credit is proposed for upgradation of course contents and teaching schemes. Attainment of weighted CO and Composite CO are helping in upgradation of course contents and teaching schemes. This work will help in assessing the teaching learning process of the department and thus would help in calculating the CO attainments of each semester of the Under Graduate Engineering Program.

References

[1]Rajak, Akash, Shrivastava, Ajay Kumar and Shrivastava, Divya Prakash. (2018) Automating Outcome Based Education for the Attainment of Course and Program Outcomes,The Fifth HCT Information Technology Trends (ITT 2018), Dubai, UAE, 373-376.

[2]Roy,Amit Kumar, Varshney,Gunjan and Chandna,V., K. (2015) Learning through modern tools in power quality to evaluate course outcome, MOOCs Innovation and Technology in Education (MITE) 2015 IEEE 3rd International Conference on, 96-99.

[3]Hakan, Gurocak. (2008) Direct Measures For Course Outcomes Assessment For ABET Accreditation. Paper read at American Society Engineering Education, 22 - 25 June 2008, at Pittsburgh, PA.

[4]Turkmen,N.,Khaled, A., R., A.,al-Raghbi, O., M., Zaki, G., Siddique,M., Gari,A., and Bokhary, A. (2010) A Procedure to Assess Engineering Courses based on Program Outcomes. Retrieved October 15, 2010 from http://ipac.kacst.edu.sa/eDoc/2007/168457_1.pdf.

[5]Biney,O., Paul, and Milton, Bryant, R. (2010) A Novel Strategy for the Direct Assessment and Improvement of Engineering Programs Developed and Implemented by Prairie View A&M University. Retrieved October 15, 2010 from http://engg.kau.edu.sa/AAU/AssExample.pdf.

[6]Terang, Parveen, P., Terang, Kr, Sanjiba. Bisoyi, Chandna, Vinay Kumar. (2015) Weightage factor analysis between programme Outcomes and course Outcomes: A case study, MOOCs Innovation and Technology in Education (MITE) 2015 IEEE 3rd International Conference on, 84-87.

[7]Memon, Q., A., and Harb, A. (2009) Developing Electrical Engineering Education Program Assessment Process at UAE University. Australian Journal of Engineering Education, 15 (3):10.

[8]8.Ramchandra, S., Maitra, S, Mallikarjuna Babu, K. (2014) Method for estimation of attainment of program outcome through course outcome for outcome based education, 2014 IEEE International Conference on MOOC, Innovation and Technology in Education (MITE), 7 – 12.\

[9]Shaeiwitz, Joseph, and Daina, Briedis. (2007) Direct Assessment Measures. Paper read at American Society of Engineering Education, 24 - 27 June, Honolulu, Hawaii.

[10]Shallu Bassi, V.,Chandna, K., and Sangeeta Singh. (2015) Analysis of course outcomes of HVE-a tool for assessment of programme outcomes, MOOCs Innovation and Technology in Education (MITE), 2015 IEEE 3rd International Conference on, 35-37.

[11]Snedecor, G., W., and Cochran,W., G. 1989 Statistical methods. Iowa State University Press, Ames, Iowa.

[12]Chandna, Vinay Kumar. (2015) Course outcome assessment and improvement on weak student, MOOCs Innovation and Technology in Education (MITE) 2015 IEEE 3rdInternational Conference on, 38-40.

[13]Washington Accord, [online] Available: www.ieagreements.org/accords.

[14]Everitt, B. S. and Skrondal, A. (2010), The Cambridge Dictionary of Statistics, Cambridge University Press, ISBN-13 : 978-0521766999, 4th edition (August 1, 2010).

[15]Kulkarni, Pravin G. and Barot, Ami R. (2019) Methodology for Course Outcomes Attainment Analysis for An Engineering Course, International Journal of Scientific & Technology Research, 8(03), 16-19.

[16]Rajak, Akash, Shrivastava, Ajay Kumar and Shrivastava, Divya Prakash (2019) Course Outcome Attainments in OBE for Weak Students, International Journal of Innovative Technology and Exploring Engineering (IJITEE), 8(11), 506-509.

[17]Balasubramani, R., and Chiplunkar, Niranjan N. (2017) Attainment of Programme Outcomes

Through Course Outcomes In Outcome Based Education: A Case Study, Journal of Engineering Education Transformations, 31(02), pp. 26-30.

[18]Premalatha K., Course and Program Outcomes Assessment Methods in Outcome-Based Education: A Review (2019) Attainment of Programme Outcomes Through Course Outcomes In Outcome Based Education: A Case Study, Journal of Education, 199(3):111-127. doi:10.1177/0022057419854351

Table 1 : CO Attainment calculation for each Course

<table>
<tr><th colspan="2">DIRECT TOOLS</th></tr>
<tr><td>SUBJECTS (Theory) Internal and External</td><td>Calculate CO based on LCL for Internal and External Evaluation and scale it 1 to 3.
<table>
<tr><td>CO %</td><td>>60</td><td>>=50 and <=60</td><td><50</td></tr>
<tr><td>Score</td><td>Strong</td><td>Medium</td><td>Poor</td></tr>
<tr><td>Attainment</td><td>3</td><td>2</td><td>1</td></tr>
</table>
Net CO=40% Internal + 60% External</td></tr>
<tr><td>SUBJECTS (Practical/ Laboratory, Internship and Projects)</td><td>Calculate CO based on LCL for Internal and External Evaluation and scale it 1 to 3.
<table>
<tr><td>Mark %</td><td>>50</td><td>>=40 and <=50</td><td><40</td></tr>
<tr><td>Score</td><td>Strong</td><td>Medium</td><td>Poor</td></tr>
<tr><td>Attainment</td><td>3</td><td>2</td><td>1</td></tr>
</table>
Net CO=40% Internal + 60% External</td></tr>
<tr><th colspan="2">INDIRECT TOOLS</th></tr>
<tr><td>Feedbacks (Students, Employers, Parents, Industries)</td><td>Calculate average of all CO based on feedbacks received and scale it 1 to 3</td></tr>
</table>

Table 2 : CO-Course Unit Formulation

	CO_1	CO_2	CO_3	CO_4	CO_5	CO_6
UNIT 1						
UNIT 2		√				
UNIT 3			√			
UNIT 4				√		
UNIT 5					√	
UNIT 6						√

Table 3: CO Calculation for Railway, Bridges and Tunnels Engineering (30040501)

Total 115 students	**CO_1**	**CO_2**	**CO_3**	**CO_4**	**CO_5**	**CO_6**	**Total**
Marks assigned	06	06	08	06	06	08	40
Marks Obtained	467	449	489	429	418	478	2730
Average	4.0609	3.9043	4.2522	3.7304	3.6348	4.1565	23.7391
Marginal Error (for $Z_{(0.05/2)}$	0.2710	0.2271	0.2203	0.2249	0.2183	0.2603	1.2658
LCL	3.79	3.68	4.03	3.51	3.42	3.90	22.47
UCL	4.33	4.13	4.47	3.96	3.85	4.42	25.00
L_1	38	49	57	59	57	33	47
L_2	30	29	0	0	0	27	24
L_3	47	37	58	56	58	55	44
CO Attainment (LCL)	63	61	50	58	57	49	56.18
CO Attainment (AVG)	68	65	53	62	61	52	59.35
Diff %	-6.67	-5.82	-5.18	-6.03	-6.01	-6.26	-5.33

Table 4 : CO Calculation for Concrete Technology (30040502)

Total 115 students	CO_1	CO_2	CO_3	CO_4	CO_5	CO_6	Total
Marks assigned	06	06	08	06	06	08	40
Marks Obtained	601	577	550	605	546	486	3365
Average	5.2261	5.0174	4.7826	5.2609	4.7478	4.2261	29.2609
Marginal Error (for $Z_{(0.05/2)}$	0.1327	0.1981	0.2758	0.1747	0.2122	0.2956	1.1094
LCL	5.09	4.82	4.51	5.09	4.54	3.93	28.15
UCL	5.36	5.22	5.06	5.44	4.96	4.52	30.37
L_1	73	40	50	57	44	35	49
L_2	0	21	25	0	0	32	10
L_3	42	54	40	58	71	48	56
CO Attainment (LCL)	85	80	56	85	76	49	70.38
CO Attainment (AVG)	87	84	60	88	79	53	73.15
Diff %	-2.54	-3.95	-5.77	-3.32	-4.47	-6.99	-3.79

Table 5 : CO Calculation for Analysis of Indeterminate Structures (30040503)

Total 115 students	CO_1	CO_2	CO_3	CO_4	CO_5	CO_6	Total
Marks assigned	06	06	08	06	06	08	40
Marks Obtained	536	478	472	508	440	348	2782
Average	4.6609	4.1565	4.1043	4.4174	3.8261	3.0261	24.1913
Marginal Error (for $Z_{(0.05/2)}$	0.2333	0.2317	0.2461	0.2258	0.2325	0.2378	1.2308
LCL	4.43	3.92	3.86	4.19	3.59	2.79	22.96
UCL	4.89	4.39	4.35	4.64	4.06	3.26	25.42
L_1	42	38	32	55	43	42	42
L_2	0	26	34	0	34	36	25
L_3	73	51	49	60	38	37	48
CO Attainment (LCL)	74	65	48	70	60	35	57.40
CO Attainment (AVG)	78	69	51	74	64	38	60.48
Diff %	-5.01	-5.57	-6.00	-5.11	-6.08	-7.86	-5.09

Table 6 : CO Calculation for Water Resources Engineering - I (30040504)

Total 115 students	CO1	CO2	CO3	CO4	CO5	CO6	Total
Marks assigned	06	06	08	06	06	08	40
Marks Obtained	536	442	340	465	411	182	2376
Average	4.6609	3.8435	2.9565	4.0435	3.5739	1.5826	20.6609
Marginal Error (for Z(0.05/2)	0.2053	0.2304	0.3495	0.2211	0.2097	0.2562	1.1513
LCL	4.46	3.61	2.61	3.82	3.36	1.33	19.51
UCL	4.87	4.07	3.31	4.26	3.78	1.84	21.81
L1	37	48	42	41	54	62	51
L2	0	32	20	31	0	0	20
L3	78	35	53	43	61	53	44
CO Attainment (LCL)	74	60	33	64	56	17	48.77
CO Attainment (AVG)	78	69	51	74	64	38	51.65
Diff %	-4.40	-5.99	-11.82	-5.47	-5.87	-16.19	-5.57

Table 7 : CO Calculation for Fundamentals of Environmental Engineering (30040505)

Total 115 students	CO_1	CO_2	CO_3	CO_4	CO_5	CO_6	Total
Marks assigned	06	06	08	06	06	08	40
Marks Obtained	629	521	490	585	483	359	3067
Average	5.4696	4.5304	4.2609	5.0870	4.2000	3.1217	26.6696
Marginal Error (for $Z_{(0.05/2)}$	0.1537	0.1817	0.3139	0.1930	0.2324	0.3942	1.2433
LCL	5.32	4.35	3.95	4.89	3.97	2.73	25.43
UCL	5.62	4.71	4.57	5.28	4.43	3.52	27.91
L_1	43	44	32	27	31	47	42
L_2	0	0	21	38	28	21	15
L_3	72	71	62	50	56	47	58
CO Attainment (LCL)	89	72	49	82	66	34	63.57
CO Attainment (AVG)	91	76	53	85	70	39	66.67
Diff %	-2.81	-4.01	-7.37	-3.79	-5.53	-12.63	-4.66

Table 8 : CO Calculation for Fundamentals of Basic Geotechnical Engineering (30040506)

Total 115 students	CO_1	CO_2	CO_3	CO_4	CO_5	CO_6	Total
Marks assigned	06	06	08	06	06	08	40
Marks Obtained	506	400	350	438	357	174	2225
Average	4.4000	3.4783	3.0435	3.8087	3.1043	1.5130	19.3478
Marginal Error (for $Z_{(0.05/2)}$	0.2121	0.2129	0.3561	0.2191	0.2806	0.3122	1.0969
LCL	4.19	3.27	2.69	3.59	2.82	1.20	18.25
UCL	4.61	3.69	3.40	4.03	3.38	1.83	20.44
L_1	53	59	41	43	30	64	50
L_2	0	0	20	36	26	0	17
L_3	62	56	54	36	59	51	48
CO Attainment (LCL)	70	54	34	60	47	15	45.63
CO Attainment (AVG)	73	58	38	63	52	19	48.37
Diff %	-4.82	-6.12	-11.70	-5.75	-9.04	-20.64	-5.67

Table 9 : Individual CO attainment for each course by LCL and AVG methods

Courses	CO1	CO2	CO3	CO4	CO5	CO6	Overall Class	Highest Students Level
30040501 (LCL)	Strong	Strong	Medium	Medium	Medium	Poor	Medium	L1
30040501 (AVG)	Strong	Strong	Medium	Strong	Strong	Medium	Medium	
30040502 (LCL)	Strong	Strong	Medium	Strong	Strong	Poor	Strong	L3
30040502 (AVG)	Strong	Strong	Medium	Strong	Strong	Medium	Strong	
30040503 (LCL)	Strong	Strong	Poor	Strong	Medium	Poor	Medium	L3
30040503 (AVG)	Strong	Strong	Medium	Strong	Strong	Poor	Strong	
30040504 (LCL)	Strong	Medium	Poor	Strong	Medium	Poor	Poor	L1
30040504 (AVG)	Strong	Strong	Medium	Strong	Strong	Poor	Medium	
30040505 (LCL)	Strong	Strong	Poor	Strong	Strong	Poor	Strong	L3
30040505 (AVG)	Strong	Strong	Medium	Strong	Strong	Poor	Strong	
30040506 (LCL)	Strong	Medium	Poor	Medium	Poor	Poor	Poor	L1
30040506 (AVG)	Strong	Medium	Poor	Strong	Medium	Poor	Poor	

Table 10 : CO Calculation for Weighted Course CO and Composite CO

Courses	30040501	30040502	30040503	30040504	30040505	30040506	Composite CO
Credits	4	3	4	3	3	4	40
Weighted CO (LCL)	56.82	71.63	59.54	49.52	64.47	45.21	56.82
Weighted CO (AVG)	52.66	66.33	59.36	49.63	62.99	45.39	52.66
Diff %	7.90	7.99	0.31	-0.21	2.35	-0.39	3.14

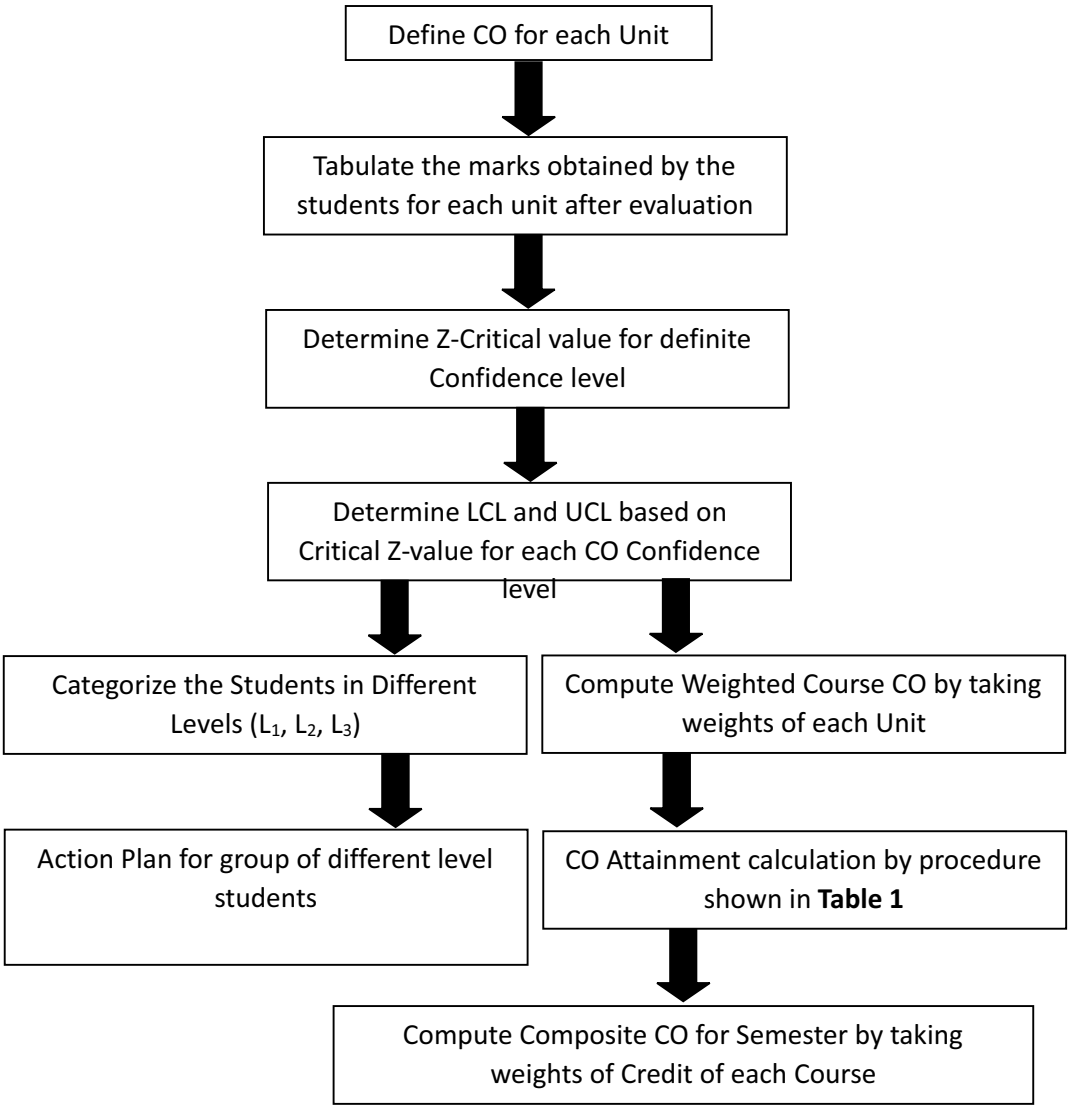

Fig. Flowchart showing procedure to compute CO and estimate CO attainment