

Key Factor for Evaluation of the Engineering Program: PO and PSO Attainment

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Abstract: Professional Engineering Educational Program today, has a wide spectrum of roles and responsibilities to adhere to. In today's rapidly changing technological context, and multidisciplinary work environments, the need of application based knowledge, skills and attitude widens the horizon of the Education Program towards creation of conducive environments for learning and Research. It impels the Institution to emerge as a centre of excellence with a responsibility of grooming socially responsible professionals. In this context, the Program Outcome attainment is a benchmark for aligning the goals of the engineering discipline. This review paper demonstrates the calculation of the Program Outcome and Program Specific Outcome attainment. As evaluation of the Program is a key factor that determines the level of attainment of the Program Outcomes against the target level attainment, the understanding of the attainment level facilitates introspection, investigation, reflection leading to redesign, modification and application of new concepts at the course level for higher attainment of Program Outcomes. Further mapping of the PO and PSO Attainment with the Program Educational Objectives, can be carried out.

Keywords: Program Outcome, attainment, key factor, evaluation

1. Introduction

Traditionally Professional Engineering Education, generally restricted itself to imparting fundamental knowledge as understood by the academic community, and agreed upon by the stakeholders in view of their limited need and context. It is imperative for an Engineering Program today to establish Industry and academia collaboration and orient the teaching, training, research to achieve congruency with the Industry approaches and practices. Engineering Graduates will have to work in challenging professional environments and contribute to core engineering projects, with the dimension of environmental sustainability. He will have to be an effective team member/ leader with ethical values, versatile, quick learner and adapt to the professional context with lifelong learning capability. The Program Outcomes (PO's) are the graduate attributes, as to what he will be able to do by the time of Graduation. These relate to the skills, knowledge and behaviors that the student will acquire as he pursues the program. The Program Specific Outcomes (PSO's) are what the graduate of a specific Engineering Program will be able to do. Calculating the PO and PSO Attainment is the first step in understanding the relation of the various factors like Course Outcomes (CO), the CO direct and indirect attainment, CO-PO Mapping, PO and PSO Attainment, Program Articulation Matrix and be able to

make design changes in the course curriculum and in the course outcomes to meet the desired targeted outcomes.

2. Methodology

- 1) Calculation of the co-relation factor for each course of the Program
- 2) Calculation of the Overall Course Outcome Attainment
- 3) Mapping of the course outcomes with the Program Outcome
- 4) Calculating the Course Outcomes and the Program Outcomes for each course of the Program and Program Articulation Matrix generation.
- 5) The Overall PO Attainment
- 6) Overall PSO attainment
- 7) Observations and action

Calculation of the co-relation factor for each course of the Program: The Course Outcome Attainment for one course is shown below, for the batch 2015-2019:

Total Number of students = 83

Course code: CV302

CO1-CO6 = Cumulative score by students in all the Continuous Internal Evaluation (CIE) of tests and activities (in the first column in the table below)

CO1-CO6 = Cumulative score by students in the Semester End Examination (SEE)

SL. No.	Marks scored by each student (All the CIEs+ activites)						Marks scored by each student SEE					
	CO1	CO2	CO3	CO4	CO5	CO6	CO1	CO2	CO3	CO4	CO5	CO6
	35	0	23	25	22	0	25	15	20	20	40	40
1	14		2	6			13			12	5	10
2	14		11	11	11		18			13	20	20
3	15		13	24	12		17		19	20	14	17
--	--	--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--	--	--
81	12		9	21	10		10			14	34	15
82	21		6	7			9			12	16	8
83	22		9	20	14		23	10		16	14	15
Total	1394	0	770	1133	742	0	1267	227	563	1021	1463	910
Average	76.09	0	63.6	82.1	84.3	0	79.2	52.2	65.7	71.9	65.1	80.1

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	CO1	CO2	CO3	CO4	CO5		CO1	CO2	CO3	CO4	CO5	CO6
Co-relation level	3		2	3	3		3	1	2	3	2	3
For 50-60% CO attainment, co-relation Level is 1												
For 60-70% CO attainment, co-relation Level is 2												
For more than 70% CO attainment, co-relation Level is 3												

a) **Calculation of the Overall Course Outcome Attainment** (considering 80% of direct + 20% of indirect outcome) The Indirect Outcome here is the

course end student feedback. Feedback is taken from the student at the end of the course based on the course outcomes

Calculating Overall CO Attainment for CV 302:				
1. Finding the average of co-relation factor for each CO from CIE and SEE.	Overall CO Attainment			
	Direct			Indirect
2. Overall average will be the CO attainment for the course.	CO	CIE	SEE	AVG
	CO1	3	3	3
3. 80% Direct (CIE+ SEE) + 20% Indirect attainment is considered for Overall Attainment	CO2		1	1
	CO3	2	2	2
	CO4	3	3	3
	CO5	3	3	2
4. 80% (2.5) + 20% (3) =2.6 (86.6%)	CO6		3	3
		COA	2.5	3
				0.6
	80%+2%		2	
Overall CO Attainment	COA			2.6
	%			86.60

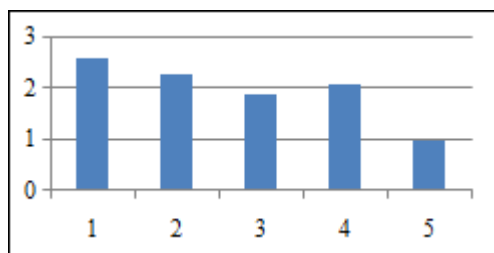
b) **Mapping of the course outcomes with the Program Outcome** based on the level of co-relation

Mapping of the course outcomes with the Program Outcomes													
	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
co-relation High =3, Medium=2 Low=1	CO1		3	3									
	CO2	3	3			2							
	CO3		3			1							
	CO4			2	3								
	CO5	3		2		1							
	CO6		2		2	1							
	AVERAGE	3	2.7	2.3	2.5	1.2							
	COA 2.6	2.6	2.3	1.9	2.1	1							

PO Attainment PO1 = average of COs corresponding to PO1 / 3 (highest co-relation factor) X 2.6 (CO Attainment) 3/3x 2.6= 2.6.....Same process to be followed for PO2-PO5

c) After calculating the Course Outcomes and the Program Outcomes for each course of the Program, a **Program Articulation Matrix** consisting of all the courses of the Program from 1st semester to the 8th semester is generated as follows:

Program Outcome Attainment (1-5 are the PO1-PO5)



MAPPING OF ALL COURSES OF THE PROGRAM WITH POs and PSOs for batch 2015-2019														
Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
MA 102	3	3	3											
CH 101	3	3												
EC 103	2.2	2.2												
ME 104	2.2	2.2												
CS 105	3	3	3											
CH 106	3	3												
CS 107	3	3	3						3	3		3		
PH 201	3	3												
MA 202	3	2	1											

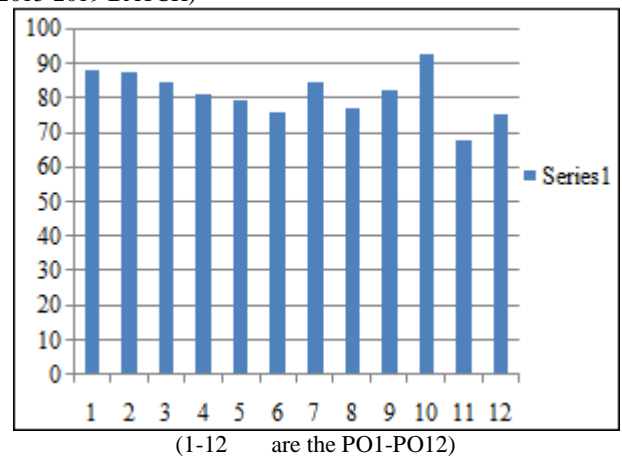
EE 203	3	3	3		3									
MD 204	3									3				
CV 205	3	3												
PH 206	3	3												
PE 207							1	2	2	2		3		
HS001	3			3			3	3	3	3				
MA301	2.6	1.7	1.7											
CV302	2.6	2.3	1.9	2.1	1									
CV303	2.4	2.2			1.3								1	1
CV304	1.7	2.2				1.5	1.3	1.2	1.2		1.2	1.3		
CV305	2.4	2.4	1.6	2.4	1.6									
CV306	1.8	2.2	2.2	1.8	1.2	0.9								
CV307	2.5	3	2.5	2.5	2									
CV308	3	3			2.4				2	3			2	2
MA401	3	2.7	2.3	2.5	1.2									
CV402	2.6	3	1	2	2.5	2								
CV403	2.2	2.2		3	3	2.5							2	1
CV404	2.5	2.5	2.6	2.5	2.5									
CV405	2.5	2.5	2.3	3	2.5									
CV406	3	2.6	2.6	2.7	2.5									
CV407	2.5	3	2.6	3	2.5	2								
CV408	2.6	1.7	2.7	3	3								2	2
HS003						2.8	2.8	1.8	2.8	2.8		1.8		
CV501	2.6	2.6	2.6	2.3	2.1									
CV502	1.9	2.4	2.6	2.1	1.7									
CV503	1.7	2.1	2.6	2.2	2.2									
CV504	2.6	2.6	2.2	2.4	2.6								0.8	1.7
CV505	2.1	2.8	2.3	2.4	2.8									
CV506	1.7	1.9	2.6	2.2	2.6								0.8	2.6
CV507	1.9	2.4	2.6	2.1	1.7								1	1.7
CV508	3	3	3	2.7	2.6									
HS006					2	3	3	3	3	2		1.5		
CV601	3	3	3	2.5	2.6								2	1
CV602	2.7	2.3	2.2	1.9	2.3									
CV603	2.6	2.6	2.6	2.3	2.2	1.7							2.6	2.6
CV604	3	3	3	2.3	2.8								3	3
CV605	2.2	2.2	2.2	1.6	1.9									
CV655	3	3	2.5	2.2	2.5									
CV607	3	3	3	2.5	3									3
CV608	3	3			2.4				2	3			3	3
HS004						3	3	3	3	3		3		
HS005	1.6	1	1.3	1	1	1.6								
CV701	2.1	2.6	2.6	2.1	2.2								2.6	2.6
CV702	3	2.6	2.6	2.4	2.2								3	
CV703	2.5	3	3	2.2	2.8								3	
CV704	2.5	3	3	2.6	2	2							3	
CV705	2.5	3	3	2.5	2.6								3	2
CV755	2.5	3	3	1.7	2.5								3	2
CV763	3	3	1.5	2	1.3									
CV764	2.6	2.6	2.1	1.7	1.9								1.7	1.7
CV708	3	3	2.7	2.5	2									
CV801	2.5	2.3	2.6	3	3	3	3	1	2	2.6		1		
CV802	2	2	3		3	3	3	2	3	3	2		3	3
CV803	2.2	1.98	1.8	2	1.9						2.2		2.2	2.2
CV855	2.6	2.6	2.3	3	3	1.3	1.8	2.6	1.3					
CV863	3	2.7	2.5	3	2.7									
CV893	3	2.5	2.8	2.6	3									
Total	161	155	118	99.1	109	30.3	21.9	19.6	28.3	30.4	5.4	14.6	44.7	38.1
Average	2.57	2.56	2.43	2.32	2.24	2.1	2.43	2.17	2.35	2.76	1.8	2.08	2.24	2.12
%	85.6	85.3	81	77.3	74.6	70	81	72.3	78.3	92	60	69.3	74.6	70.6

d) **The Overall PO Attainment** is then generated by 80% of the Direct PO Attainment + 20% Indirect PO Attainment (Alumni Survey, Student Exit Survey, Parents Survey)

Overall PO attainment = 80% of direct attainment +20% of indirect attainment													
PO DIRECT ATTAINMENT (80%)	PO ATTAINMENT	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
		2.05	2.04	1.94	1.85	1.79	1.68	1.94	1.73	1.88	2.2	1.44	1.66
PO INDIRECT ATTAINMENT (20%) AVERAGE OF	ALUMNI SURVEY												
	STUDENT EXIT SURVEY	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	PARENTS SURVEY												
OVERALL PO ATTAINMENT	OVERALL PO ATTAINMENT	2.65	2.64	2.54	2.45	2.39	2.28	2.54	2.33	2.48	2.8	2.04	2.26
	PERCENTAGE	88.3	88	84.6	81.6	79.6	76	84.6	77.6	82.6	93.3	68	75.3

The questionnaire for the Indirect Attainment surveys are based on the Program Outcomes and the Program Specific Outcomes Statements as they are directed towards the finding of the level of attainment of the Program Outcomes: The Questionnaire was forwarded to the Alumni through Google Forms and feedback was analysis:
 5= strongly agree 4= agree 3= satisfactory 2= less agree 1= do not agree

The PO Attainment Graph for all courses of the Program (2015-2019 BATCH)



Question in relation to the program outcomes and Program Specific Outcomes	Scale of 5-1
1. You are capable of applying knowledge of mathematics, science and engg to meet the challenges at workplace	
2. You have the ability to make positive contribution at the workplace with a professional approach.	
3. You are capable of applying contextual knowledge to assess societal, health, safety, legal and cultural issues relevant to professional engg practice	
4. You have developed an inclination towards higher studies / research and development	
5. You are good in applying modern IT tools for modeling of complex engg problems	
6. You are actively involved in activities of professional societies	
7. You are committed to advancing public health, safety and environmental protection, contributing to sustainable development	
8. You adhere to professional code of Ethics and work in a responsible and professional manner	
9. You have the ability to participate in and lead a group	
10. You are good in communication and able to write effective reports	
11. You can demonstrate knowledge and understanding of management principles and manage projects in multidisciplinary environments	
12. You are capable of updating your knowledge through continuous education in the context of rapid technological changes	
1. You have ability to design a civil engineering system component to meet the desired project needs.	
2. You are familiar with modern civil engineer professional software for the solution of design situations	

e) Overall PSO attainment = 80% of direct attainment +20% of indirect attainment

PSO Attainment (2015-2019)			
PSO direct attainment	Program articulation matrix	PSO1	PSO2
	Alumni survey	3	3
	Student exit survey	3	3
	Parents survey	3	3

Overall PSO attainment = 80% of direct attainment +20% of indirect attainment

PSO direct attainment (80%)	(2015-2019) Pso attainment	PSO1	PSO2
		1.79	1.69
PSO indirect attainment (20%) average of	Alumni survey		
	Student exit survey	0.6	0.6
	Parents survey		
Overall PSO attainment	Overall PSO attainment	2.39	2.29
	Percentage	79.6	76.3

OVERALL PO AND PSO ATTAINMENT FOR THE BATCH 2015-2019														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Overall PO Attainment	2.65	2.64	2.54	2.45	2.39	2.28	2.54	2.33	2.48	2.8	2.04	2.26	2.39	2.29
%	88.3	88	84.6	81.6	79.6	76	84.6	77.6	82.6	93.3	68	75.3	79.6	76.3

- Target attainment level for Program Outcomes is 75%
- PO1, PO2, PO3, PO4 mainly mapped by the core courses are well attained.
- PO7, PO9, PO10 are also well attained
- PO11 has not attained the targeted level.
- PO5, PO6, PO8, PO12 are adequately attained.

Overall PO and PSO attainment for the batch 2015-2019			
Program Outcomes	Overall PO Attainment	Percentage Attainment	Target Level of 75% Attained
PO1	2.65	88.3	✓
PO2	2.64	88	✓
PO3	2.54	84.6	✓
PO4	2.45	81.6	✓
PO5	2.39	79.6	✓
PO6	2.28	76	✓
PO7	2.54	84.6	✓
PO8	2.33	77.6	✓
PO9	2.48	82.6	✓
PO10	2.8	93.3	✓
PO11	2.04	68	NO
PO12	2.26	75.3	✓
PSO1	2.39	79.6	✓
PSO2	2.29	76.3	✓

of the program, and indicates the areas of concern which can be effectively handled.

References

- [1] <https://youtu.be/eQONQRkprIo> : Template and method by Emmanuel Tom.
- [2] <https://www.nbaind.org/Files/UG%20-%20Tier%20I%20Manual.pdf>, Tier 1 National Board of Accreditation.
- [3] CO-PO/ PSO&PEO Assessment and Attainment process, Department of Electronics and Communication Engineering, Malla Reddy Engineering College for Women, Maisammaguda, Dhulapally, Secunderabad.

Identification of curriculum Gap and action taken for PO11 Attainment:

Program Conducted / date	Resource persons	Focus of the Talk
Technical talk (13.4.19) Under TEQIP-III	Dr. Shankar, Professor of Urban and Regional Planning, School of Planning & Architecture	Demonstration of Engineering and Management principles in multidisciplinary Environments as a team member/ team leader.
	Sri. Murali T. V, Joint Director of Town & Country Planning	
Technical talk (1.3.19)	Sri. Nagesh Puttaswamy, Regional Head, South Karnataka, Ultratech Cement Limited	Smart Technologies for Smart Construction' India Looking Ahead with focus on application of principles of engineering and Management to one's own work
Technical talk (28.11.18)	Col. K. S. Natesh , Consultant to National Highway Authority of India Chairman of Nethaji Public School, President of Ex-Serviceman Association, Ex-Chairman of Children Welfare Committee, Hassan District	Application of the principles of engineering principles and the responsibilities relevant to the professional engineering practice

3. Conclusion

Calculation of the Attainment of PO and PSO of the Engineering Program, makes it possible firstly, to understand the relevance of and the degree of importance of the content and structure of each of the courses in the curriculum. Secondly, it allows for design changes in the quantity and quality of the curriculum content, teaching-learning process, delivery and assessment tools, thereby ascertaining the attainment of the POs and the PSOs at the planning stage itself. Continuous monitoring will allow for changes to be incorporated while the process is going on. Curriculum gaps can be identified and action can be taken on completion of the calculation process. Every step decided upon and carried out of the modifications/ changes become meaningful as one is aware of the impact it will create on the attainment levels. It gives a clear picture of the shortcomings