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Measuring Attitude and Skill Based Program Outcomes - Issues and Solution

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Abstract: Considering the transformation that is happening in the education system, the changing global focus and their demands to have ready employable students, has made the education system to adopt new tools and techniques to enhance student learning and develop professional attitude in them. Incorporating Outcome Based Education (OBE) is a way to achieve this. The paper focuses on various practical issues in implementation of OBE concerned with the structure of engineering curriculum. The paper has revealed the considerable gap in the curriculum structure for the attainment of the attitude and skill based outcomes. An implemented solution to these issues is presented and its execution is discussed in detail. Rubric is the most suitable assessment tool for the measuring these outcomes. The various concerns in the design of rubrics are also identified and clarified with sample rubrics.

Keywords: Engineering curriculum, program outcomes, rubrics, attitude, skill

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1. Introduction

With the advancements in the technological domains, the engineering curriculum too undergoes updating to keep it relevant and effective. The engineering curriculum is divided into three branches— engineering basic science, systems and design and professional practice. The focus of engineering curriculum has been more on the streams of engineering science and on systems and design through its content and is designed with an application to deliver as much as possible the information of the program in the four year course period. The curriculum puts less emphasis on the attribute of engineering professionalism.

The introduction of outcome based education has transformed the education system throughout with a drastic modification observed in the teaching learning process. 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 (Davis MH. 2003). The OBE expects the curriculum, instructional materials and assessment tools to be created to support the intended outcomes. But the existingcurriculum structure of the engineering institutes especially those affiliated to university pattern are rigid (with respect to the number of lecture and practical hours) and do not foster in-line with the needs of OBE. Even though the engineering curriculum is undergoing the transformational phase, the real picture is different and still afar from the 21st century skill requirements.

There are certain difficulties in calculating attainment of Course and Program Outcomes particularly in programs affiliated to university (Admuthe et al., 2016).

The issues that arise are: whether the engineering curriculum really focuses on all these attributes of OBE? If it does then, is it covering these attributes to the level expected by OBE? If not, is there a systematic approach which could be implemented to achieve this? These and many more such issues are addressed in this paper.

2. Understanding OBE

OBE intends to measure the skills acquired by the students. The OBE intends to imbibe knowledge, attitude and skills in the graduates. The OBE approach offers students the opportunity to develop employability skills, preparing them for effective participation in global market, and allows learning and knowledge to be applied and integrated with work time and life time (Lam2009). Indirectly OBE intends the facilitators to plan the curriculum delivery in a way that could lead to maximum student learning.

The OBE measures the attainment of student learning in the form of the program outcomes defined through Washington Accord. The program outcomes are the generic engineering graduate capabilities. The categorization of program outcomes is presented in Table 1. Out of 12 program outcomes, four are exclusively knowledge based whereas the remaining 8 POs are entirely focusing on attitude and skills. Table 1 clearly reveals that only 33% of POs are knowledge based whereas 66% cover attributes of attitude and skill.

Table 1. Categorization of Program Outcomes

PO no.	Program Outcomes	Attribute
PO1	Engineering Knowledge	
PO2	Problem Analysis	Knowledge
PO3	Design and Development of solutions	
PO4	Conduct investigation of complex problems	
PO5	Modern tool usage	Skill
PO6	The Engineer and Society	Attitude
PO7	Environment and Sustainability	Attitude
PO8	Ethics	Attitude
PO9	Individual and Team Work	Skill
PO10	Communication	Skill
PO11	Project Management and Finance	Knowledge,
PO12	Life Long Learning	Skill

The inclusion of attitude and skill based outcomes are essential to develop professionalism in the students at the time of their graduation. Many surveys prove that collaboration skills, creativity and innovation, communication skills, honesty, accountability, etc. are prioritized much more than technical skills among graduates (Sujata 2016).

3. OBE Issues with Engineering Curriculum Structure

The engineering curriculum affiliated to universities has a fixed pattern. There are 5 to 6 courses every semester with almost 2-3 courses supported with practical sessions. More than 90% courses are technical courses whereas only 10% are skill based courses. Out of 35 contact hours per week, almost 30-32 contact hours' students are engaged in academic schedule (lecture & practical sessions). Moreover, in a semester excluding holidays and exam period, maximum 75 days are available for teaching. With these practical limitations, the facilitator has to utilize the major part of teaching days and contact hours exclusively for teaching the curriculum and the remaining in executing the assessment process. It clearly indicates that the facilitator is made to restrict with covering more of knowledge based program outcomes and later assess it through test and examination tools. The engineering curriculum structure, therefore, focuses more on the inculcation of first four program outcomes.

The major issues identified concerned with the curriculum and OBE implementation are:

· Issue 1: How to incorporate attitude and skill based program outcome attributes among the students in the regular academic schedule?

· Issue 2: Could the attitude and skill based program outcomes be achieved from all the courses of the program?

· Issue 3: What tools are required to measure the attainment of these attitude and skill based program outcomes?

4. Solution to the OBE Issues

Issue 1 basically points to the problem of how to inculcate in the students the attitude and skill based program outcome attributes like: Individual and Team Work, Communication, Ethics, Project Management

and Finance, Life Long Learning etc. from the curriculum. This can be achieved by systematic planning of activities that should create platform for these attributes of program outcomes. A facilitator having certain experience or expertise in handling a course can identify certain assisting tools that can be incorporated in the course delivery and thus create a platform to the students for inculcating these program outcomes.

A layout of planning the curriculum to incorporate activities supporting these outcomes that we implemented in Electronics Department is presented in Fig. 1. The Fig. 1 lists all the courses of the program from second to final year. Mapping of selective courses with the attitude and skill based program outcomes is shown. For example, the course Electronic Circuit and Design –I (ECAD-I) of second year, we planned activity like – Mini project competition. We initiated the students to make a team of three students, build and develop mini projects using the electronic components they learnt in this course. Such activity can be planned on non-academic days (like Saturdays) without hampering the regular academic activities. Through this event we could now measure the outcomes related to team ability, communication skill (through project demonstration) and ethics (considering whether the students developed the project on their own).

Similarly we identified courses wherein we could plan activities like giving (home) assignments for a group, conduct seminars and group discussion (can be conducted during practical hours), carry out Think-pair –share activities (in the classroom) etc. Few courses are identified for final year as the Project (Dissertation work) is a course that covers all the POs. It is extremely important to set up such an environment that is positive and reinforcing to maximize the likelihood of student engagement and achieve all the intended outcomes. Such activities have led to involvement of every student and have also facilitated the instructor.

Fig. 1 also provides solution to issue 2. It is not necessary that every course of the program should contribute in attaining all the program outcomes. The facilitator can correctly identify the program outcomes that the course can imbibe in the students.

Once the students undergo such activities, the next issue that arises is the measurement of these soft POs using appropriate assessment tools. The assessment method is strongly influenced by the assessed learning outcomes. Different types of learning outcomes require different assessment methods (Crespo et al., 2010). The direct assessment tools like test, assignments, and tutorials cannot be applied to the attitude and skill based program outcomes like Individual and Team Work, Communication, Ethics, Project Management and Finance, Life Long Learning etc. Specific decisions have to be made about the criteria by which the students work related to these outcomes could be

Second Year					
PO	Comm	team work	Ethics	Eng & Soci	Envi. & Sus
Subject					
Engg. Maths III					
EMI	Acti			Extracurricular activities (Social activities)	
ECAD I	Acti	Acti	Acti		
AC	Acti				
NA					
LIC					
PL		Acti			
ECAD II	Acti	Acti	Acti		
DSA					
DSM		Acti	Acti		
CS		Acti	Acti		
Expected level	3	2	3	1	1

Third year					
PO	Comm	team work	Ethics	Eng & Soci	Envi. & Sus
Subject					
SS					
Mi.C		Acti	Acti		
EE					
VLSI Design	Acti				
DC					
PL II	Acti	Acti	Acti	Acti	Acti
DSP		Acti			
VE	Acti				
PE					
CAOS					
ESD	Acti				
MP	Acti	Acti	Acti	Acti	Acti
Expected level	3	3	3	2	2

Finalyear					
PO	Comm	team work	Ethics	Eng & Soci	Envi. & Sus
Subject					
ITCD					
ESD		Acti	Acti		
CN					
IP					
SC					
Project-I	Acti	Acti	Acti	Acti	Acti
ME					
WC N/W					
PED					
SC					
Project-II	Acti	Acti	Acti	Acti	Acti
Expected level	3	3	3	3	3

Fig. A planned curriculum structure for covering soft POs

5. Framing Rubrics

Rubrics are the measurement tools for the attainment of the program objectives (Therese2015). Rubrics consist of clearly defined descriptors to assess learning outcomes at different levels that help the assessment process to be more specific and transparent. Rubrics are framed for the outcomes which are complex and not directly quantifiable. Rubrics are also used to assess events which do not support evaluation with standardized tests or surveys and which creates a diverse impact level on the attendees. The rubrics thus essentially involve an objective type guide for assessment.

Rubrics could be framed for events like seminars, project evaluation, evaluating impact of new teaching methodology, evaluation of impact of guest lectures, rubrics for measuring the impact of trainings and workshops, performances and group activities. Defining the rubric descriptors involves a thorough thinking process. The rubrics thus serve the dual purpose of not only assessing the student work but also assisting the facilitators to assess well. Framing rubrics is not so challenging if one has a clear vision of what is exactly expected from the assessment. From the student's perspective, rubrics convey what is expected from them and how their performance is evaluated.

Points to be considered while framing rubrics:

- Identify the program outcomes to be assessed.
- A rubric evaluating a particular outcome should be framed in context with the event and how it covers that PO attribute.
- A rubric may be stated one for each evaluating PO or combining two to three POs.
- The rubric descriptors/statements should give clear understanding of what is expected at each level of performance
- The rubric descriptors should make a clear differentiation among the different levels of evaluation.

6. Sample Rubrics and its Attainment

Some sample rubrics are presented here for activities like evaluation of industrial training undergone by the students in their winter vacation and evaluation of mini project.

The industrial training activity which the student undergoes for a period of 15-20 days is not directly the part of curriculum. But it is an additional activity that the Department has undertaken for the students which helps them in exposing to the industrial environment. This activity assists in measuring the attitude and skill based POs like team work, ethics and communication skill. Accordingly the rubric descriptors are framed as shown in Table 2 and the instructor evaluates each student. Similarly the mini project evaluation which is part of curriculum can be evaluated using rubrics. Table 3 shows the rubrics designed for mini project evaluation wherein attributes like teamwork, presentation skill, time management and lifelong learning are measured. The attainment of these soft POs is presented in Table 4 and Table 5. The attainment is done as per the guidelines of June 2015 SAR.

Table 4. Attainment of Program Outcomes through Industrial Training (Number of students considered = 54)

Program Outcomes evaluated	PO1	PO10	PO10	PO8	PO9	PO10
Average marks	6.241	6.51	6.14	6.57	5.94	5.82
Average attainment(%)	56.86	67.27	60	61.81	61.81	60
Attainment Level	1	2	2	3	3	2

Table 5. Attainment of Program Outcomes through Mini Project Activity (Number of students considered = 58)

Program Outcomes evaluated	PO2	PO9	PO10	PO11	PO12	PO8
Average marks	4.16	3.95	3.98	3.91	4.02	3.69
Average attainment(%)	77.58	74.13	72.41	70.68	77.58	87.93
Attainment	3	3	3	3	3	3

7. Conclusion

In this paper we identified the gap that exist in the implementation of OBE in the engineering curriculum due to the rigid curriculum structure. We presented a solution to balance all the streams of engineering curriculum focus — engineering basic science,

Table 2. Rubrics for evaluation of Industrial training

Rubrics for Evaluation of Industrial Training					
Sr. no.	**Assessment Parameter**	**Excellent (8-10)**	**Good (5-7)**	**Average (3-4)**	**Below Average (0-2)**
1	**Knowledge about the Training work Undertaken (PO1)**	Demonstrated extensive knowledge about the training work undertaken and has learnt new things	Demonstrated good knowledge about the training work undertaken but has learnt very few new things	Demonstrated basic knowledge about the training work undertaken and has not learnt any new things	Lacks basic knowledge about the training work undertaken and has not learnt any new things
2	**Organization of Presentation (PO10)**	Presented in logical sequence; introduction and background of company elaborated; covered all key points of training and conclusions are clear and well outlined	Most information presented in logical sequence; clear introduction; adequate background; training data not focused appropriately	Some problems with sequencing, lacks clear transitions; incomplete or overly detailed introduction; emphasis given to less important information	Little or no organization, difficult to follow; missing or ineffective introduction; technical data completely missing in the presentation
3	**Speaking Skills & Response to Queries (PO10)**	Completely audible; maintains eye contact with listeners; clear, expressive voice; poised, good posture, no distracting mannerisms. All queries answered properly	Quiet audible; eye contact most of the time; clear voice, but not as expressive; a little nervous, not as polished. Partially answered the queries.	Difficult to hear; occasional eye contact; some mumbling, little or no expression; nervous, some distractin g mannerisms; reads much of slides. Gives confusing answers to queries	Not audible; no eye contact; hard to understand, monotone; speaker uncomfortable and uninterested; reads slides word for word. Queries not answered.
4	**Ethics and responsibilities (PO8)**	Attended the training sessions ethically with high commitment to training schedule and demonstrated responsibility towards assigned responsibilities	Attended the training sessions with less commitment to training sche dule , demonstrating less ethical values and responsibilities	Demonstrated poor commitment to training schedule and poor ethical values. Also displayed poor dedication towards assigned responsibilities	Demonstrated no ethical values by partially / not attending all the training sessions. No commitment at all towards assigned responsibilities
5	**Team & Individual Objectives and Roles (PO9)**	Complete clarity of team & individual objectives; Properly demonstrates the assigned roles and the tasks performed	Clarity of almost all team & individual objectives; Moderate demonstration of the assigned roles and the tasks performed	Clarity of only few objectives; Average demonstration of the assigned roles and the tasks performed	Unclear or unaware of the objective s; Not able to demonstrate the assigned roles and the tasks performed
6	**Formatting of project report (PO10)**	Project report is according to the specified format covering all the technical details	Project report is not fully according to the specified format with less technical details	Project report is not according to the specified format with poor technical details	Project report is incomplete having uncorrelated and irrelevant technical details

systems and design and professional practice. Systematically planned activities like seminars, group activities, assignments identified appropriately for each course can help in attaining the attitude and skill program outcomes. A clear guideline about measuring the attainment of these soft POs using some sample rubrics is also presented.

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Table 3. Rubrics for evaluation of Mini Project

Rubrics for Evaluation of Mini-Project					
Sr. no.	**Assessment Parameter**	**Excellent (5-4)**	**Good (3)**	**Average (2)**	**Below Average (1-0)**
1	**Knowledge regarding design and analysis of basic electronics circuits(PO2)**	Demonstrated extensive knowledge about the project work undertaken.	Demonstrated good knowledge about the project work undertaken.	Demonstrated basic knowledge about the project work undertaken.	Lacks basic knowledge about the project work undertaken
2	**Working in a group (PO9)**	Executed the assigned task completely & contributed significantly to the group.	Partially executed the assigned task & moderately contributed to the group.	Merely executed the assigned task & some-what contributed to the group.	No responsibilit y towards assigned group task & hardly contributed to the group.
3	**Presentation skill (PO10)**	Prepared excellent presentation and also presented it well . Answered all questions with proper explanation very fluently	Prepared good presentation but moderately presented it. Fails to elaborate entire project fluently.	Poor preparation of project presentation. Lacks presentationskill reflected through the inability towards expressing and answering questions.	No efforts at all towards preparation of Project Presentation. Completely lacks presentation skill
4	**Time Management (PO11)**	All modules/parts of the project and project report completed in time.	Most of the modules/parts of the project and project repor t completed in time.	Some of the modules/parts of the project and project report completed in time.	No modules/parts of the project and project report completed in time.
5	**Lifelong learning (PO12)**	Excellent responsibility for learning & personal development through complete involvement in PCB design and project report formation.	Somewhat good responsibility for learning & personal development through complete involvement in PCB design and project report formation.	Poor responsibility for learning & personal development through complete involvement in PCB design and project report formation.	Very poor responsibility for learning & personal development through complete involvement in PCB design and project report formation.
6	**Ethics (PO8)**	Student is always on the task, never needs remainders to do the work and encourages other group members to do the work.	Student is usually on the task, seldom needs remainders to do the work	Student is sometimes on the task, seldom needs remainders to do the work	Student is never on the task, constantly has to be remained to do the work