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A Python Tool for Outcome Based Education (APTOBE)

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Abstract – The National Board of Accreditation (NBA) was established by AICTE (All India Council of Technical Education), for periodic evaluations of technical institutions according to specified norms and recommended standards. Such accreditation would enforce the institutions to follow the standard processes, and finally benefit their graduates. Outcome-based education (OBE) has become a critical aspect of accreditation process. OBE specifications are to be adopted in both curriculum and instructional approaches. OBE insists on student centered learning. It concentrates on measuring students' achievement in accordance with the program outcomes based on summative and formative assessments. Faculty are currently using Microsoft spread sheets towards these assessments. These are customized to measure the outcomes in different courses, laboratories, Mini projects and projects. APTOBE is a tool developed to assist in this process. This paper describes the development and utilization of this tool along with an example evaluation of the course entitled 'Data ware Housing and Data mining'. This tool assists faculty to construct queries based on the structure of blooms Taxonomy. It also addresses the respective course outcomes and program outcomes. This tool generates reports depicting the query density on course and program outcomes. The systematic approach adopted in this tool, has improved faculty alertness in designing relatively good questions.

Index Terms – Python, Outcome-based Education, Cognitive domain, course outcomes, program outcomes, assessment, DWDM (Data ware Housing & Data Mining), OBE (Outcome Based Education).

1. INTRODUCTION

Accreditation Provides Assurance about Program Quality. It provides evidence of an independent and rigorous assessment by a recognized and trusted third party .Accreditation supports graduate employability by ensuring programs are responsive to Industrial needs. It centers on a review of a programs content & delivery and includes areas such as relevance, coherence, challenge, assessment, staffing, quality assurance and resources[1]. The implementation of NBA recommendations into curricula is critical to the success of engineering education. The NBA Criteria emphasizes an outcome based systematic approach to engineering education. The educational objectives of an engineering degree program are the statements that describe the expected achievements of graduates in their career, and also in particular, what the graduates are expected to perform and achieve during the first few years after graduation

The program outcomes need to be understood by all stakeholders, even though some of the outcomes are difficult to attain, assess and evaluate. Outcomes assessment provides important information about the educational goals that are being satisfied and the ones that are not. This information provides motivation for improving courses and curriculum[2]. A course in Engineering programs is designed and conducted to facilitate students to acquire a set of competencies to meet a subset of Program Outcomes(Graduate Attributes), identified by the accreditation agency. Formative and summative assessments, if in alignment with the competencies, enable the instructor to guide the students to learn well, and to measure the level of attainment of competencies. The difficulty levels of the assessment items are a measure of mastery of the competencies[3].

2. ROLE OF BLOOMS TAXONOMY IN OBE

Industry demands specific technical skills to be provided by higher educational institutions. Technology-based disciplines that are constantly impacted by the rapid growth and changes in technology present greater challenges to faculty. Engineering programs are designed to enable students to acquire a set of Program Outcomes. Each course of an engineering program must formulate competencies that foster attainment of subset of these Program Outcomes. Each competency statement is mapped to one of the cognitive levels and one or more categories of knowledge of Anderson-Blooms taxonomy[4]. Benjamin Bloom's Taxonomy identified six levels within the cognitive domain, each becoming increasingly complex and abstract. These are knowledge(Cl), comprehension(C2), application (C3),analysis (C4), synthesis (C5) and evaluation (C6).

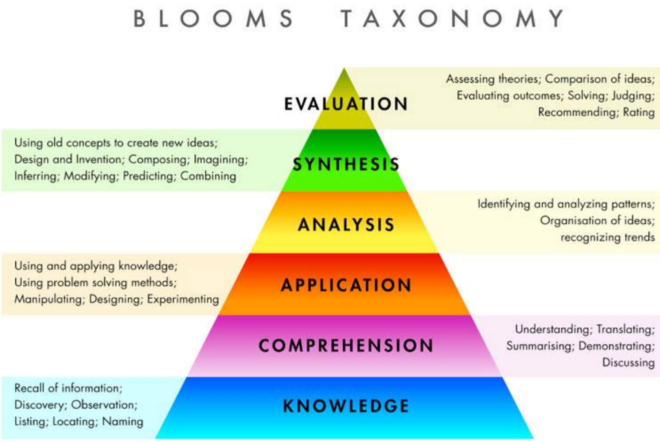


Figure I. Hierarchy of Learning in Bloom's Taxonomy (Courtesy: Benjamin Bloom)

APTOBE clusters the cognitive domains that are based on the perception levels of the students, into the following four levels:

Level	Cognitive code	Description	Attributes
I	C1	Low	Ability to understand subject materials. Ability to recall the previously understood material.
II	C2	Medium	Ability to elaborate the ideas. Ability to restate the ideas, using different terminology.
III	C3	Moderate	Ability to use the acquired knowledge in new situations. Ability to create examples of the learned material.
IV	C4	High	Ability to enable others with the acquired knowledge.

Table 1: Perception Levels & Codes

The total examination marks are categorized into the above four levels of Table 1, as per the following weightages, during each semester.

Perception Level	Percentage(%)
I	10% - 20%
II	30% - 40%
III	20% - 30%
IV	10% - 20%

Table II. Distribution of Final Exam marks

3. OUTCOME BASED EDUCATION

Curriculum, Assessment and Evaluation are the major tools by which Program Outcomes are attained. APTOBE considers all of these together. An outcomes based assessment system comprises of several components. Following are the twelve components required by the National Board of Accreditation.

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and engg. specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, research literature, and analyze engineering problems to arrive at substantiated conclusions using first principles of mathematics, natural, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components, processes to meet the specifications with consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.

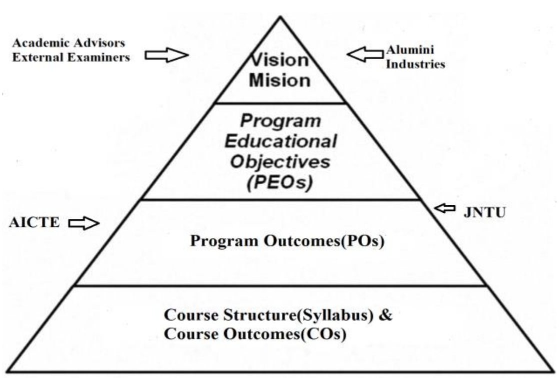
10. Communication: Communicate effectively with the engineering community and with society at large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team. Manage projects in multidisciplinary environments.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

The teaching and learning process is based on the above 12 factors, in order to get accreditation by the NBA. Jawaharlal Nehru Technological University (JNTU) also contributes to the process, with its own directives. Also, guidelines from senior academic advisors and External Examiners are taken into consideration. In addition, feedback from Alumni, Employers and Industries are being considered too.

The whole process is described in a pyramid as as shown in the following in Figure 2.



As a result of this process, the course outcomes of each course are mapped onto the program outcomes, and program educational objectives respectively. This ensures that the graduates produced have the necessary skills and attributes. All the above 12 program outcomes may not be applicable to all the courses. The following table describes the performance target against each applicable program outcome.

Program Outcome	**Attributes**	**Performance Target**
PO-1	Engineering knowledge	At least 50% of the students, must obtain a minimum score of 65%
PO-2	Problem analysis	At least 50% of the students, must obtain a minimum score of 60%
PO-3	Design/development of solutions	At least 50% of the students, must obtain a minimum score of 65%
PO-4	Conduct investigations Of complex problems	At least 50% of the students, must obtain a minimum score of 60%
PO-5	Modern tool usage	At least 50% of the students, must obtain a minimum score of 60%
PO-6	Engineer and society	At least 50% of the students, must obtain a minimum score of 60%
PO-7	Environment and Sustainability	At least 50% of the students, must obtain a minimum score of 60%
PO-8	Ethics	At least 50% of the students, must obtain a minimum score of 60%
PO-9	Individual and teamwork	At least 50% of the students, must obtain a minimum score of 60%
PO-10	Communication	At least 50% of the students, must obtain a minimum score of 60%
PO-11	Project management	At least 50% of the students, must obtain a

	and Finance	minimum score of 60%
PO-12	Life-long learning	At least 50% of the students, must obtain a minimum score of 60%

Table 2: Performance Target against Pos

Achieving a score of 60% to 65% from the total assessment activities is considered as an indicator that the student has acquired the respective attribute. If a student consistently scoring at least this score for each PO, he or she will eventually be treated as a graduate with a first class honors. The conventional grade point system does not give information about student's ability with respect to the program outcomes, other than the students 'cognitive skills. Whereas PO scoring system reflects the students capabilities against each Program outcome. Key Performance Index(KPI) is based on the PO scoring system. A good PO score results in a strong KPI. By applying this ranking system, student's' performance can always be monitored, tracked or compared between one to another. Also, faculty can analyze the performance of each CO or PO and make recommendations for improvement by modifying the syllabus, improvise the delivery methods or make changes in the assessment used. The following table depicts PO scores and their corresponding Rank Levels.

PO score(%)	Rank Level	Description	Color Code
0-49	1	Weak	Red
50-64	2	Moderate	Yellow
65-100	3	Strong	Green

Table 3: PO scores & Rank Levels

4. ASSESSMENT

Assessment helps the institution as well as the faculty to fulfill the educational mission. Each program has to develop and implement plans to assess the learning outcomes of the students as course level and program level. Assessment tools are used to measure the outcomes of each undergraduate engineering course. The assessment activities are divided into six components i.e. examinable courses, non-examinable course, lab courses, Micro project courses, Mini project courses and final year project courses. Each of these components has its own customized measurement methodology for outcome based performance, as depicted in the following table.

No.	Description	Formative Activity	Summative Activity
I	Examinable courses	Test, Assignment, Quiz	Final Exam
II	Non-examinable course	Presentations, Demonstration	Presentations
III	Lab courses	Test,VivaVoce	Final Test, VivaVoce
IV	Micro project courses	Presentations	Presentation, Demonstration
V	Mini project courses	Presentations	Presentation, Demonstration
VI	Final project courses	Presentations	Presentation, Demonstration

Table 4: Course Measurement Tools

APTOBE was developed to assist faculty in designing examination questions with respect to Bloom's Taxonomy cognitive levels. APTOBE encourages faculty to adhere to the Taxonomy by displaying the keywords of different levels, along with the syllabus, while designing the question paper. The tool has performance indicators showing the performance evaluation of students in terms of respective COs and POs achievement. By using this tool, faulty can suggest recommendations for continual improvement by analyzing and diagnosing the class performance. Faculty submits a Continual Quality Improvement (CQI) report for the taught course, once during every academic year.

5. DATA WARE HOUSING & DATA MINING (DWDM)

Data ware Housing & Data Mining (DWDM) course is taught to the undergraduate Computer Science & Engg. students, during the fourth year, first semester. The assessment of this course consists of two mid term examinations, and, one Final examination. The mid exams carry 40% of the weightage, and the remaining 60% is towards the final examination. DWDM deals with the important concepts of Data ware Housing and Data Mining such as: Data warehouse Schemas, Knowledge Discovery from data (KDD), Data Preprocessing, Data Transformation, Association Rules, Classification and Clustering. The main attributes of this course is to enable students to discover the knowledge from the vast amounts of data in the data ware houses. Database Management systems, is a pre-requisite of this course. The four COs of DWDM course and its respective mapping to the POs are listed in the below table.

CO	Description	PO Mapping
CO-I	Ability to understand why the data warehouse in addition to database systems	PO-1
CO-II	Ability to perform preprocessing of data and mining techniques on it.	PO-3
CO-III	Ability to identify the association rules, classification & clustering on large data sets.	PO-2
CO-IV	Ability to solve real business world problems & extract scientific information using data mining.	PO-5

Table 5: COs and POs mapping.

6. RESULTS

APTOBE tool is a Python based software, used to design structured and balanced queries with respect to student's capability levels based on Blooms Taxonomy. The following figure shows the comparison of distribution of marks between proposed and final exam question during the 2015-16 academic year. These proposed distributions are within the specifications, as mentioned previously in Table II. The tool checks for the differences, and advises the faculty, if the difference is beyond the tolerance range of plus or minus 5%. This process resulted in fair and justified questions to the students. The following figure shows that the weightage of the constructed exam question marks is within the defined range and tolerance.

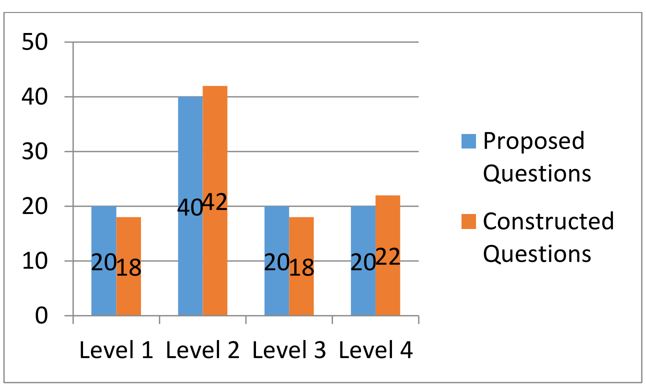


Figure 3. Marks Distribution w.r.t Bloom's Taxonomy

In the above Figure 3, X-axis represents the Blooms Taxonomy levels, and Y-axis represent the %ge of marks.

The APTOBE tool is also used to identify the mapping between course outcomes and program outcomes. The mapping would be automatically printed in a tabular format as shown below. Only the strongest program outcome is mapped for each course outcome. This mapping ensures that the relationship between COs and POs is properly addressed and observed.

Q.No.	1A	1B	2A	2B	3A	3B	4A	4B	5A	5B
Marks	12	8	10	10	10	10	12	8	15	5
COs vs.POs	CO1	CO2	CO2	CO4	CO3	CO2	CO2	CO3	CO2	CO3
PO1	√									
PO2					√			√		√
PO3		√	√			√	√		√	
PO4										
PO5				√						

Table6: CO-PO MAPPING WITH RESPECT TO QUESTIONS

In the above table, it can be observed that relatively more questions are concentrated on the course outcomes CO2 and CO3.

This eventually leads to more marks being given to PO3 and PO2, as depicted in the following figure. In other words, the

capabilities of students to analyze the problems, and design the solutions are tested more in DWDM course.

The following figure shows the percentage of distribution of questions against course outcomes.

Moderate ranking level is achieved with CO2 and PO3, while the rest shows weak performance by students. These mean scores indicate that majority of the students could not attain the main attributes, required by the course.

Also, students could not grasp enough contents related to CO1 and CO4. The faculty panel for the course mentioned that this poor performance is due to the topics for CO4, were covered in a short time at the end of the semester. Hence, students could not get enough time to practice them.

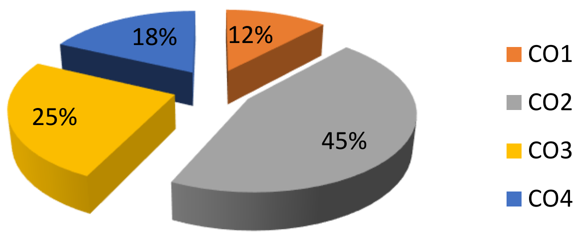


Figure 4: Distribution of Questions against Course Outcomes

The following figure shows Distribution of COs against POs.

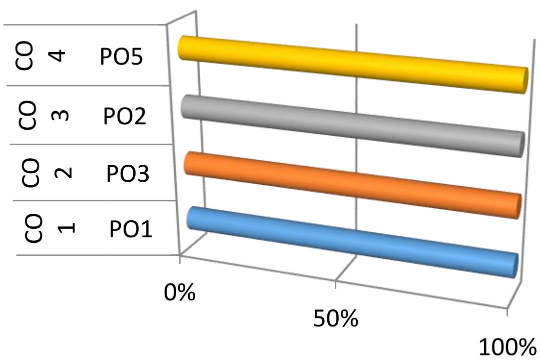


Figure 5: Distribution of COs against POs

7. CONCLUSION

There is considerable improvement in the quality of questions, in terms of using the Blooms Taxonomy. This is because of the assistance provided by APTOBE while designing the queries. However, the overall student results are not upto the mark. This can be improved by adopting various measures like diversifying delivery methods, and, by motivating students to actively participate in the class room sessions. More Class tests and quizzes are recommendable for forthcoming student batches. Brain storming sessions can be applied to force the students to think further, particularly when solving the problems with deeply nested logic. Also, students can be encouraged to perform micro projects, by combining two or more problems into a micro project

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