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An Empirical Study on Attainment of Course Outcome for an Engineering course – Case study of Data Structures.

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Abstract: *The most important key aspect in Outcome-Based Education (OBE) is the assessment of the learning outcomes. At the initial stage of OBE implementation, the so called specific learning outcomes or also known as Course Outcomes (CO) for each course were drawn up based on the Program Outcome (PO) and other requirements. COs are the attributes, that the student is expected to have or obtained at the time he or she completing the course. A method to evaluate the achievement or attainment of the COs has been developed. This paper describe the analysis process of the CO and Attainment of CO for Data Structures with C subject, which is offered to 3rd Semester (2nd year) students of Computer Science and Engineering Department. It also describes the background of the method, how the method is used, and the results produced. The method utilizes data obtained from student marks in internal tests and course exit survey. The findings will then be further used for improving the teaching learning process.*

Keywords: *Course Outcome, Data Structures, Outcome Based Education, Program Outcome*

I. Introduction

Accreditation is a formal recognition of an educational program by an external body on the basis of an assessment of quality. It is a process of quality assurance and improvement, whereby a program in an institution is critically appraised to verify that the institution or the program continues to meet and exceed the norms and standards prescribed by the appropriate designated agency. Accreditation provides quality assurance that the academic institution's aims and objectives are honestly pursued, and effectively achieved by the resources available, and that the institution has demonstrated capabilities of ensuring effectiveness of the educational programs over the validity period of accreditation.

II. Importance And Significances Of Accreditation

1) To attain international recognition of the degrees awarded.
2) To provide students a quality education which lead to a wide range of job opportunities and international mobility
3) To make the institute/department aware about strengths and weaknesses of the institution / program offered by it and encourage the institute to move continuously towards the improvement of quality of its program, and the pursuit of excellence.
4) To facilitate institutions for updating themselves in program curriculum, teaching and learning processes, faculty achievements, students' knowledge/skills/abilities.
5) To excel among stakeholders (students, faculty, alumni, parents, recruiters, industries, government/Public Sectors, regulators, management, etc)

III. Course Outcomes

Course Outcomes (COs) are clear statements of what a student should be able to demonstrateupon completion of a course. They should be assessable and measurable knowledge, skills,abilities or attitudes that students attain by the end of the course. The course outcome defined for Data Structures is furnished in table (1).

Table(1): DATA STRUCTURES - Course Outcome

	Course Outcome
CO-1	Understand the concept of Dynamic memory management, data types, array data structure and asymptotic notations
CO-2	Student will be able to choose appropriate data structure as applied to specified problem definition.
CO-3	Able to compare, implement and know when to apply sorting algorithm including bubble sort, selection sort, heap sort
CO-4	Implement DS including stacks, queues and linked list using C/C++ programming language
CO-5	Learn and implement Explain the standard structure of a Tree, Binary trees and Binary Search Trees.

Table(2): Mapping of CO & PO (as defined by NBA)

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	H	M	M	M	M					M		
CO-2	M	H	H	H	H				M	M		
CO-3	H	H	H	H	H				H		M	
CO-4	M	H	H	H	H				M	M		
CO-5	M	H	H	H	H				M	M		

L: Low M: Medium H: High

IV. Bloom's Taxonomy of Educational Objectives

One of the most widely used ways of organizing levels of expertise is according to Bloom's Taxonomy of Educational Objectives. (Bloom et al., 1994; Gronlund, 1991; Krathwohl et al., 1956.) Bloom's Taxonomy uses a multi-tiered scale to express the level of expertise required to achieve each measurable student outcome. Organizing measurable student outcomes in this way will allow us to select appropriate classroom assessment techniques for the course.

Definitions of the different levels of thinking skills in Bloom's taxonomy

1. Remember – recalling relevant terminology, specific facts, or different procedures related to information and/or course topics.At this level, a student can remember something, but may not really understand it.
2. Understand – the ability to grasp the meaning of information (facts, definitions, concepts, etc.) that has been presented.
3. Apply – being able to use previously learned information in different situations or in problem solving.
4. Analyze – the ability to break information down into its component parts. Analysis also refers to the process of examininginformation in order to make conclusions regarding cause and effect, interpreting motives, making inferences, or finding evidence to support statements / arguments.
5. Evaluate – being able to judge the value of information and/or sources of information based on personal values or opinions.
6. Create – the ability to creatively or uniquely apply prior knowledge and/or skills to produce new and original thoughts, ideas, processes, etc. At this level, students are involved in creating their own thoughts and ideas

Table(3): Cognitive Level of CO

	Course Outcome	Cognitive Level
CO-1	Understand the concept of Dynamic memory management, data types, array data structure and asymptotic notations	Understand
CO-2	Student will be able to choose appropriate data structure as applied to specified problem definition.	Understand
CO-3	Able to compare, implement and know when to apply sorting algorithm including bubble sort, selection sort, heap sort	Apply
CO-4	Implement DS including stacks, queues and linked list using C/C++ programming language	Apply
CO-5	Learn and implement the standard structure of a Tree, Binary trees and Binary Search Trees.	Apply

V. What Is Assessment?

According to Palomba and Banta (1999) assessment involves the systematic collection, review, and use of evidence or information related to student learning. Assessment helps faculty understand how well their students understand course topics/lessons.Assessment exercises are often anonymous. This anonymity allows students to respond freely, rather than trying to get the "right" answer or look good. Assessment exercises attempt togauge students' understanding in order to see what areas need to be re-addressed in order to increase the students' learning.

In other words, assessment is the process of investigating (1) What students are learning and (2) how well they are learning it in relation to the stated expected learning outcomes for the course. This process also involves providing feedback to the students about their learning and providing new learning opportunities/strategies to increase student learning

Course learning outcomes are statements that describe significant and essential learning that learners have achieved, and can reliably demonstrate at the end of a course. In other words, learning outcomes identify what the learner will know and be able to do by the end of a course.

Course learning outcomes should be stated in clear, specific, and measurable terms, describe what the learner can accomplish as a result of completing a course, focus on what the learner will be able to do as a result of taking the course, describe what the learner can draw from the knowledge, skills, and experiences acquired in a course. In addition, they should be aligned with the program learning outcomes and represent the minimum requirements to complete a course

VI. Attainment of Course Outcome

Attainment of the COs can be measured directly and indirectly.

Direct attainment basically displays the student's knowledge and skills from their performance. It can be determined from the performance of the studentsin all the relevant assessment instruments – like internal assessments, assignments, quiz and final university examination. These methods provide a sampling of what students know and/or cando and provide strong evidence of student learning.

Indirect methods such as surveys and interviews ask the stakeholders to reflect onstudent's learning. They assess opinions or thoughts about the graduate's knowledge orskills. Indirect measures can provide information about graduate's perception of theirlearning and how this learning is valued by different stakeholders.Indirect attainment here is determined from course exit surveys.

RUBRICS: A rubric is an assessment tool that clearly indicates marking criteria. It can be used for marking assignments, class participation, or overall grades.When provided with the assignment, a rubric establishes expectations. It is an authentic assessment tool which is growing in popularity due to its useful in assessing complex and subjective criteria.

Advantages of using rubrics in assessment include:

- allowing assessment to be objective and consistent
- allowing the instructor to clarify his/her criteria in specific terms
- clearly showing the student how their work will be evaluated and what is expected
- providing useful feedback regarding the effectiveness of the instruction
- provide benchmarks against which to measure and document progress

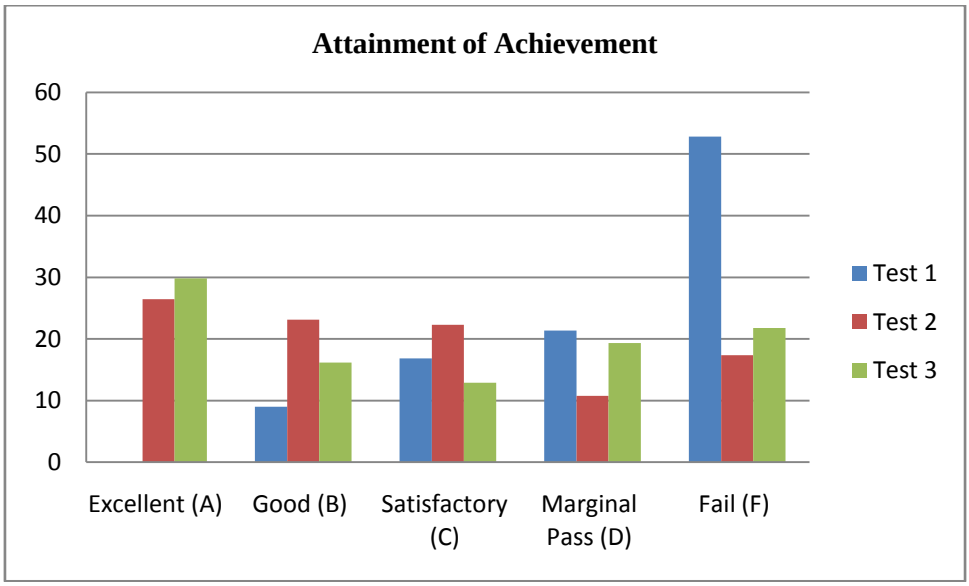
Table(4): Assessment rubrics that was adopted for direct attainment is depicted in below table

Level of Achievement	Elaboration on Course Grading Description	Bench Mark Set (out of 25)
Excellent (A)	The student's performance is outstanding in almost all the intended course learning outcomes.	24 & 25
Good (B)	The student's performance is good in most of the intended course learning outcomes.	21 to 23
Satisfactory (C)	The student's performance is satisfactory. It largely meets the intended course learning outcomes.	18 to 20
Marginal Pass (D)	The student's performance is barely satisfactory. It marginally meets the intended course learning outcomes.	15 to 17
Fail (F)	The student's performance is inadequate. It fails to meet many of the intended course learning outcomes.	Less than 15

In Data Structures course the direct attainment is based on 3 internal tests that were conducted during the course of the semester**.**

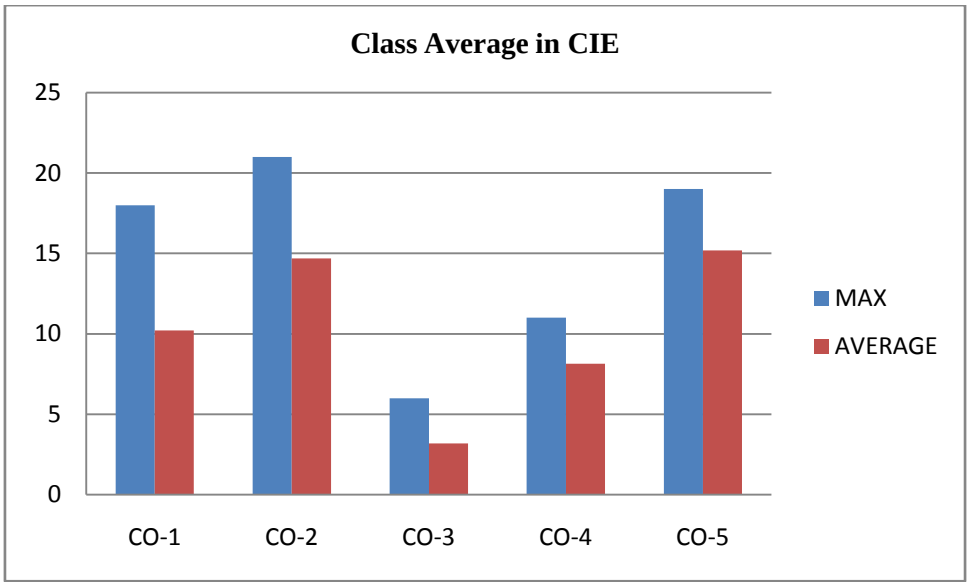
Table(5): Attainment of Achievement (%age)

Level of Achievement / Test	Test 1	Test 2	Test 3
Excellent (A)	-	26.45	29.84
Good (B)	8.99	23.14	16.13
Satisfactory (C)	16.85	22.31	12.90
Marginal Pass (D)	21.35	10.74	19.35
Fail (F)	52.81	17.36	21.77



Table(6): Class Average in CIE

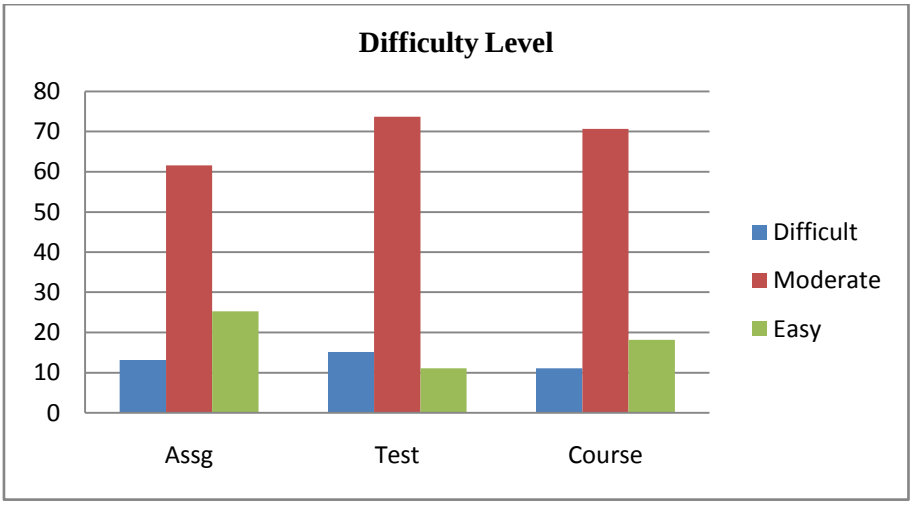
CO	T1 (25)	T2 (25)	T3 (25)	CIE Class Average
CO-1	10.22 / 18			10.22 / 18
CO-2	3.56 / 7	11.12 / 14		14.68/21
CO-3			3.18 / 6	3.18 / 6
CO-4		8.15 / 11		8.15 / 11
CO-5			15.18 / 19	15.18 / 19



Indirect Attainment: Indirect attainment of COs can be determined from the course exit surveys. The exit survey form should permit receiving feedback from students on individual COs.

#	Questionnaire
1	Was the course interesting? i) YES 97.98% ii) NO 2.02%
2	Did the course cover the topics given in the initial syllabus (6 units)? i) YES 94.95% ii) NO 5.05%
3	Rate the difficulty level of the assignments i) Very Difficult 0% ii) Difficult 13.13% iii) Moderate 61.62% iv) Easy 25.25 % v) Very easy 0%
4	Were announcements regarding the assignments posted on time and was clear and understandable? i) YES 98.99 % ii) NO 1.01%
5	Rate the difficulty level of the internal tests i) Very Difficult 0% ii) Difficult 15.15 % iii) Moderate 73.74% iv) Easy 11.11% v) Very easy 0%

6	The learning objectives of the course were clear to me from the start (I knew what I was supposed to learn) i) Agree 50.51 % ii) Partial Agree 42.42 % iii) Disagree 7.07%
7	The learning material used during the course (such as literature, notes, examples) supported my reaching the learning objectives i) Agree 84.85 % ii) Partial Agree 13.13 % iii) Disagree 2.02%
8	The course was boring & laborious i) to some extent 25.25% ii) to a very large extent 2.02% iii) not at all 72.73%
9	What are the marks you are expecting to score in the final University exam? i) less than 40 0% ii) 41-60 2.02 % iii) 61-70 25.25% iv) 71-80 38.38% v) above 80 34.34 %
10	Are you interested in taking up the mock exam? i) YES 68.69% ii) NO 5.05% iii) Let me think 26.26%
11	Rate the overall difficulty level of the course i) Very Difficult 0% ii) Difficult 11.11% iii) Moderate 70.71% iv) Easy 18.18% v) Very easy 0%
12	As a whole, I give the course the following grade (1: lowest, 5:highest) i) 1 1.01 % ii) 2 0% iii) 3 18.18% iv) 4 59.60% v) 5 21.21%



VII. Conclusion

Assessment of educational objectives and learning outcomes involves the systematic and on-going gathering and use of information about student learning for the purpose of improvement. The result of assessment would be a coherent curriculum in which all courses have well-defined and interconnected roles in achieving the program mission. The above paper explains a method of measuring Course Outcomes by using Rubrics. Once the result of the university final examinations are out then the same can be used to find out the Direct CO attainment keeping the CIE in mind and also find out the CO Attainment Gap and action proposed to bridge the gap. From this result, the attainment of each course outcome for the course can be further reviewed and analysed. Action plan to improve any weakness can be identified and implemented in the following semester.

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