

IMPLEMENTING OUTCOME BASED EDUCATION TOOL TO ENHANCE STUDENT LEARNING

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ABSTRACT

Outcome based education (OBE) in higher-education institutions is to improve the quality of teaching-learning experience. This paper presents a “OBE”, a web based software system for the implementation of OBE in Higher Education institutions. This web based system extends higher education institution programme design, based on well-defined Programme educational objectives, Programme Outcomes and programme specific outcomes. This model uses criterion-referenced assessment, membership functions and rubrics for performance evaluation. Iterative software development approach is used in this system development to support corrective actions for the objectives and outcome of stakeholders. This paper includes a case study with software engineering programme in a university. Results show that the teaching-learning quality of Outcome Based Education outperforms conventional educational system. The result also show that the proposed system assist faculties in understanding students’ performance and skill their set in their courses.

KEYWORDS: Outcome Based Education, Higher Education, Criterion-Referenced

OBE ARCHITECTURE

The architecture of the OBE, implemented in PHP and MySQL, is shown in Fig. 1. It consists of a graphical user interface that manages interaction with the stakeholders, Institution Module that represents University Vision and Mission, Department Vision and Mission, Programme Educational Objective and Programme outcome, Evaluation Module that evaluates the outcome of students, faculties and other resources, Course Module that represents course preamble, course objective, course outcome, course content and topic level outcome, Assesment module that assess appropriate domain types and level of the students, Mapping module that maps programme educational objective, programme outcome, programme specific outcome and course outcome.OBE database that stores all the interaction in the architecture.

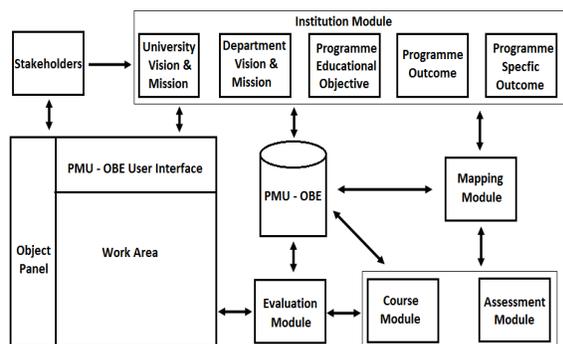


Figure 1: OBE Architecture

OBE User Interface

The OBE user interface is responsible for all the interactions with the stakeholders. A snapshot of the interface can be seen in the figure 1.

Institution Module

University Vision and Mission

Vision is the aim of the goal. It shows where want to go. Mission is the steps of how to achieve the goal. Users to enter, update, delete and view university vision and mission information. Figure 2.



Figure 2: Institution Module

Department Vision and Mission

Department vision and mission is correlated with university vision and mission. It is more focused on the theme of the department. The mission name of your program is to your primary purpose by providing your primary functions or activities to your stakeholders and additional statements. Users to enter, update, delete and view department vision and mission information.

Programme Educational Objective

Programme educational objectives are board statements that describe the career and professional accomplishment that the program is preparing graduates to achieve. The vision of the institute articulated through the mission statement is accomplished through the defined PEOs. The educational objectives of a Programme are the statements that describe the

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expected achievements of graduates within first few years of their graduation from the programme. The PEO are subject to modification based on the suggestions from the stakeholders (Table 1 & 2). A web tool has the provision that support users to enter, update, delete and view Programme education information.

Table 1: Vision and Mission Report

Department Vision and Mission	
VISION	To be a leading center department in the field of software development and digital design that offers the software education with the state-of-the-art skills. The Graduates will be equipped in global companies to solve domain real applications suitable digital solutions for the society.
MISSION	
CO1	To enhance the software related technical skills among the students.
CO2	To practice the cutting edge technologies in the real scenarios of digital design and software development.
CO3	To contribute towards the betterment of the society by producing suitable software solutions through research.
CO4	To promote the spirit of inquiry, team work, creativity and professional values among the students.

Table 2: Programme Educational Objectives Report

Programme Educational Objectives(PEO)	
PEO1	To be a leading center department in the field of Software Engineering that offers the education with the state-of-the-art skills. The Graduates will be recognized as innovators, competent and an entrepreneur in their domain fields and produce suitable software solutions for the society.
PEO2	To enhance the technical skills among the students using Software Engineering techniques such as design, development, implementation and testing the software.
PEO3	To practice excellence in the various areas of Software Engineering with respect to the cutting-edge developments.
PEO4	To contribute towards the betterment of the society by producing suitable software solutions.
PEO5	To promote the spirit of inquiry, team work, creativity and professional values among the students.

Programme Outcome

Program outcomes are narrower statements that describe what students are expected to know and be able to do by the time of graduation. Program Outcomes or POs are abilities that a graduating should have after successful completion of the program. Users to enter, update, delete and view Outcomes (Table 3 & Figure 3).

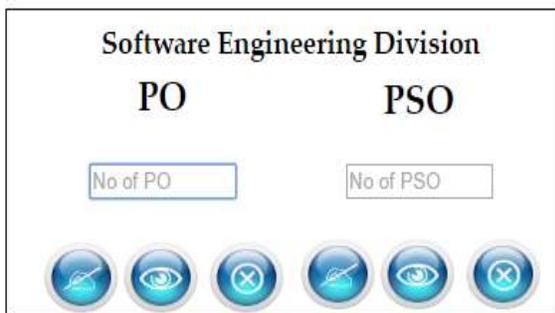


Figure 3: Programme Outcomes Module

Programme Specific Outcome

Table 3: Programme Outcome report page

Programme Outcome(PO)	
1	Recognize the impact of professional software solutions in the economic, social and environmental perspectives to enhance the user's health and productivity.
2	Understand the professional and ethical responsibility of a software engineer and its function as an individual in a team member/leader in the work/development team.
3	Create and/or apply suitable form of the software, contemporary practices, software development tool, software framework and programming language to solve complex software engineering problems.
4	Design, implement, verify, validate and maintain software systems to meet the desired needs of the users.
5	Identify the existing principles, technologies and methodologies of the right perspective for the development of software products to address customer requirements.
6	Apply the knowledge of mathematics, science and computer science for solving software related problems in order to solve complex software systems.
7	Apply the software development in interdisciplinary environments and recognize the need for independent and life-long learning to adapt to the technological innovations.
Programme Specific Outcome(PSO)	
1	Develop the software packages which follow the software engineering principles.
2	Design the professional software solutions with user friendly environment.

Course Module

Course module specifies a brief curriculum that includes the course code, course name, Lecture credits, Tutorial credits, Practical credits and total credits. It also specifies Domain levels that include Cognitive, Psychomotor and Affective. The Figure 4 shows the relationship for programme outcome, course outcome and domain levels.

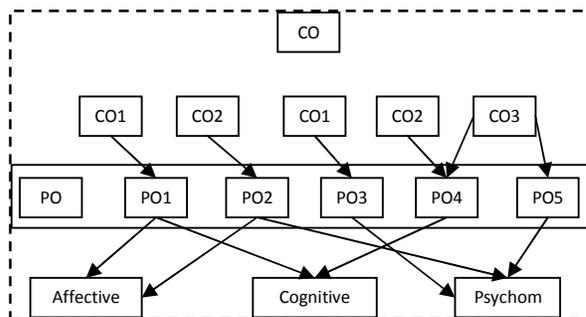


Figure 4: Relationship for Course Outcome, Programme Outcome and Domain Levels

This module has an interface that supports faculties to enter course preamble, course objective, course outcome, course content, Topic level outcome, mode of Assessment and evaluation. Corresponding domain levels and its action verbs are to be entered and viewed by the user. As specified in, provisions are specified in the web tool to modify the Course Outcome based on course evaluation. Logic specified in is followed to modify the Course Outcomes in order to enhance the student learning outcome. Users can also

take their Syllabus and lesson plan topic wise report from the system. Figure 5 specifies the course outcome report for the subject “Data Structures and Algorithm” for the M.Sc Software Engineering Programme.

Course Outcome	Domain & Level
CO1: Discuss and Explain the concept of data structures and analysis of algorithms.	Cognitive-Discovered
CO2: Choose the linear and non-linear data structures for solving the problems.	Cognitive-Apply
CO3: Apply and Adapt appropriate C programming techniques such as pointers, dynamic memory allocation, recursion to develop solutions for the problems.	Cognitive-Apply
CO4: Analyse appropriate abstract data types and algorithm techniques.	Cognitive-Create
CO5: Build an application using algorithm design techniques.	Cognitive-Create

Figure 5: Course Outcome Report page

IMPLEMENTATION

Assessment Module

Assessment module is to monitor various assessment methodologies for the courses in a programme. This assessment module uses criterion based assessment for the methodologies and rubrics for each criterion. Some of the assessment criteria’s used in this tool are, class tests, group discussion, quizzes, seminar presentations, assignments, field work and laboratory sessions. The main advantage of this tool is, it supports custom made assessment criteria to support the student learning outcome. The overall score of individual student in a course outcome is calculated based on the weighted mean average of various assessment criteria’s. Product GUI contains a course assessment form for faculties of the course. It is the role of faculties to set up necessary assessment criteria for the courses; provision is included in the assessment form to specify for remedial actions if assessment criteria are not met by students. This module has a provision to monitor the remedial actions taken and recommendation mechanism to have an effective assessment strategies based on previous offering. Faculties can create their own assessment strategies for different cohorts. The following figure shows the assessment interface in tool. Figure 6 & 7.

Name	Type	ID	Title	Other	Title

Figure 6: Creating Rubrics for the course

Outcome	Rubric	ID	Title	Other	Title
Specifications	The specifications and name of the specifications.	The program name and the specification/other specifications.	To design code with the given specification.	The program code and the specification/other specifications.	The program code and the specification/other specifications.
Source Code	The code is correctly written and formatted as per the guidelines.	The code is correctly written and formatted as per the guidelines.	The code is correctly written and formatted as per the guidelines.	The code is correctly written and formatted as per the guidelines.	The code is correctly written and formatted as per the guidelines.
Execution	Code executes the program and the output is as per the specifications.	Code executes the program and the output is as per the specifications.	Code executes the program and the output is as per the specifications.	Code executes the program and the output is as per the specifications.	Code executes the program and the output is as per the specifications.
Documentation	The documentation is correctly written and formatted as per the guidelines.	The documentation is correctly written and formatted as per the guidelines.	The documentation is correctly written and formatted as per the guidelines.	The documentation is correctly written and formatted as per the guidelines.	The documentation is correctly written and formatted as per the guidelines.

Figure 7: Rubrics for Program Demonstration created using system

Mapping Module

This module helps the higher level authorities to evaluate and analyze the assessment data from the users. The module maintains a mapping between the topic outcome, course outcome and programme outcome. Mapping for these outcomes contains four different values namely 3- High Relation, 2- Medium Relation, 1- Low Relation and 0- No Relation. Mapping of Department Mission with University Mission is shown in the figure 8, 9, 10 & 11. This kind of mapping is performed based on the roles assigned to the users of the system. For instance mapping of Course Outcome to Programme Outcome is by done by the course instructor. While mapping CO to PO, this web tool insists that CO should be mapped to the Program outcome either strongly or otherwise.

Department Mission	University Mission	Other	Title

Figure 8: Mapping of Department Mission with University Mission

Home	Academic Calendar	Departmental	Graduate Attributes	PEO	PO	Assessment	Logout
Software Engineering Division Mapping of PEO with Departmental Mission							
PEO1	To be a leader in the field of Software Engineering that offers the education with the finest level of skills. The Graduate will be recognized as someone competent and an entrepreneur in the domain and produce reliable software solutions for the world.	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
	EM 1	EM 2	EM 3	EM 4	EM 5	EM 6	EM 7
	EM 8	EM 9	EM 10	EM 11	EM 12	EM 13	EM 14
PEO2	To conduct the software related technical skills using the students.	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
	EM 1	EM 2	EM 3	EM 4	EM 5	EM 6	EM 7
PEO3	To conduct the software related technical skills using the students using Software Engineering techniques such as design, development, deployment and testing the software.	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
	EM 1	EM 2	EM 3	EM 4	EM 5	EM 6	EM 7
PEO4	To provide education in the various areas of Software Engineering with respect to the cutting edge developments.	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
	EM 1	EM 2	EM 3	EM 4	EM 5	EM 6	EM 7
PEO5	To contribute towards the betterment of the society by producing reliable software solutions.	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
	EM 1	EM 2	EM 3	EM 4	EM 5	EM 6	EM 7

Figure 9: Mapping of PEO with Department Mission

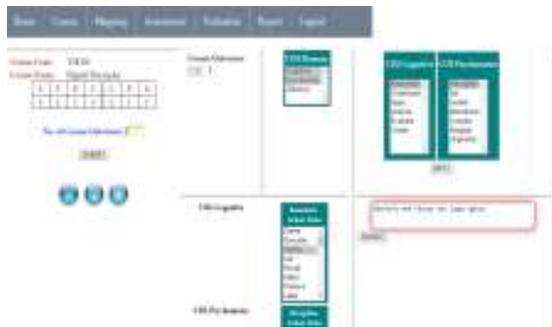


Figure 10: Mapping of Course outcome with domain and level Mapping of Theory Exam Multiple Choice question, Short question and Descriptive question

Course Outcome	Assessment Method	Assessment Level
Required Outcome	Required Method	Required Level
PO1	EM1, EM2, EM3, EM4, EM5, EM6, EM7, EM8, EM9, EM10, EM11, EM12, EM13, EM14	EM1, EM2, EM3, EM4, EM5, EM6, EM7, EM8, EM9, EM10, EM11, EM12, EM13, EM14
PO2	EM1, EM2, EM3, EM4, EM5, EM6, EM7, EM8, EM9, EM10, EM11, EM12, EM13, EM14	EM1, EM2, EM3, EM4, EM5, EM6, EM7, EM8, EM9, EM10, EM11, EM12, EM13, EM14
PO3	EM1, EM2, EM3, EM4, EM5, EM6, EM7, EM8, EM9, EM10, EM11, EM12, EM13, EM14	EM1, EM2, EM3, EM4, EM5, EM6, EM7, EM8, EM9, EM10, EM11, EM12, EM13, EM14
PO4	EM1, EM2, EM3, EM4, EM5, EM6, EM7, EM8, EM9, EM10, EM11, EM12, EM13, EM14	EM1, EM2, EM3, EM4, EM5, EM6, EM7, EM8, EM9, EM10, EM11, EM12, EM13, EM14
PO5	EM1, EM2, EM3, EM4, EM5, EM6, EM7, EM8, EM9, EM10, EM11, EM12, EM13, EM14	EM1, EM2, EM3, EM4, EM5, EM6, EM7, EM8, EM9, EM10, EM11, EM12, EM13, EM14

Figure 11: Assessment mapping for Rubrics assigned for the course

Evaluation Module

Outcomes that are expected from a certain course are assessed and evaluated in this module. The evaluation of a course is quantified with the support of various assessment methods specified by the authorities. In general, the course outcome is evaluated as follows;

$$\text{Course Outcome (CO)} = \frac{\text{sum}}{N}$$

Where, $\sum_{i=1}^n$ = sum
 $\sum_{i=1}^n \text{Number of students} \geq 40\%$
 And N = Total marks for assessment criteria

From the formula, it can be noted that the students with marks greater than 40% are considered in calculating the course outcome. Evaluation module also calculates the PEO and PO from the calculated course outcome. The threshold hold for this calculation remains dynamic to support various programme outcome and students level. Figure 12a, 12b & 13 reveals the evaluation entry and course outcome evaluation attainment results for the “Data Structures and Algorithm” course of M.Sc. Software Engineering Programme.



Figure 12a: Evaluation entry for the rubrics



Figure 12b: Evaluation Entry for the written exam for the course

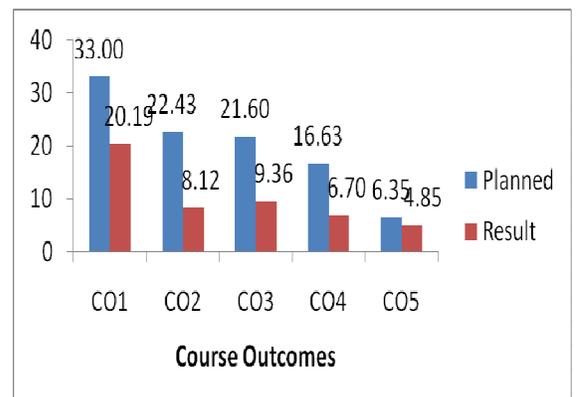


Figure 13: Course Outcome Attainment Report

EVALUATION OF THE TOOL

To illustrate the performance of OBE tool, the system is tested and evaluated. The evaluation is divided into two parts: user satisfaction and the system with conventional translation.

Phase 1 Initial Evaluation with OBE System

The user satisfaction of OBE systems was evaluated at Periyar Maniammai University, Thanjavur. Prior to evaluation of the system, faculties were informed about the role of outcome based education in higher institutions and the faculties were told to bear in mind that the system is aimed at evaluating the students learning outcome. The responses to the questionnaire are measured on a five-point Likert scale ranging from 1-5 Likert scale with interval 1, which means 'very bad', 'bad', 'average', 'good', 'very good', respectively. Additionally the experts are asked to rate the system from 0 (minimum) to 10 (maximum); there is also an open question to answer comments or remarks. The questionnaire and results of are summarized in Table 4. It can be observed, that the satisfaction with technical aspects is high, as well as the perceived didactic potential. Observations from the questionnaire suggested that the PMU-OBE is considered good-looking and satisfactory. The faculties also consider that the system succeeds in evaluating the students learning outcome easily.

Table 4: Questionnaire Employed for the Evaluation of the System

Q.No	Technical quality	Min and Max Likert Scale	Average	Std Dev.
TQ01	Interaction of the system	3/5	4.17	0.69
TQ02	Accessibility of the system	3/4	3.67	0.47
TQ03	Support of the system for Outcome Based Education	4/5	4.83	0.37
TQ04	Performance of the system	5/5	5.00	0.00
TQ05	Whether tool is	4/5	4.67	0.47

	attractive?			
TQ06	Whether tool complements the faculties for setting up OBE?	4/5	4.83	0.37
TQ07	Whether tool provides adequate feedback for assessment criteria?	5/5	5.00	0.00
TQ08	Whether tool provides dynamism for assessment criteria?	4/5	4.67	0.47
TQ09	Is the system fulfilled the evaluation of Outcome Based Learning?	4/5	4.83	0.37
TQ10	Is the system useful for you or not?	5/5	5.00	0.00

From the interactions of the experts with the system, the system is fulfilled an objective evaluation of the application considering the Outcome Based Education. This task achieved 96.56% correctly for the interaction by different experts.

Phase 2 Comparison of Students Academic Performance in OBE tool

To evaluate the effectiveness and the performance of the tool with respect to student academic performance, a study has been conducted at Periyar Maniammai University, Thanjavur. The course taken into consideration for this performance evaluation is "Data Structures and Algorithm" for the M.Sc., Software Engineering Programme. In this course, 60 students of a class are divided into equal two groups namely "OBE groups" and "Non-OBE groups". The study has been tested in the classroom for five classroom periods in a week. After three classroom periods, the students' academic performance was

assessed. Table 5 shows the performance comparison of the two groups.

Table 5: reveals that there is a significant difference in the performance score of OBE students than the non-OBE students.

	Mean	Standard Deviation
OBE Groups	3.0386	0.08037
Non-OBE Groups	2.4359	0.07479

CONCLUSION

This paper has presented the OBE tool. This tool supports Outcome Based Education in Higher Education. The web tool is based on solid pillars such as the outcomes, assessment, mapping and evaluation based on the OBE. The outcomes are used at all the levels of the students' academic learning. These outcomes are inherited from the vision and mission statements of university, department and other stakeholders' suggestion in order to support student-centric learning. Assessment in tool review the students progress work in a course and provide constructive feedback for effective learning. The custom made assessment and criterion-based rubric assessment for all the courses makes the tool different from conventional assessment system. Recommendation mechanisms in assessment of students are another feature that aligns the students learning experience with the outcome of courses and programmes. In particular, the mapping of tool allows the authorities to map custom made assessment criteria to the outcome of department in turn to the university vision and mission. This mapping supports the faculties to understand students performance based on different targeted domains and levels. The evaluation mechanism in this web tool results student's success in the course, it also provides competence matrix for the course outcome evaluation.

Finally, a case study with software engineering programme was presented. The case study reports, the value of the learners' academic experience for the course, formative and summative assessment grades and finally their measure of education to the expected course outcome. Implementation of this work provided lot of insight and thrust areas to explore in future development, this includes visualization mechanisms to understand and to predict the data behavior easily, education is a growing sector as so the data, hence algorithms to handle bigdata is a necessary step in future, this architecture needs a hassle free mobile ad hoc network support to explore the teaching-learning beyond geographical location.

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