Quality Management System in Implementation of Outcome Based Education at Faculty of Mechanical Engineering, Universiti Malaysia Pahang

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ABSTRACT

This paper presents the implementation of outcome-based education (OBE) in terms of course delivery, assessment and evaluation at the Faculty of Mechanical Engineering, Universiti Malaysia Pahang (UMP). The implementation was formalized based on the quality management system (QMS) of the Faculty which is formulated its philosophy on OBE as well as on teaching and learning to facilitate the implementation. The process of implementation involved training the representatives, planning the implementation and formulating the outcomes. The conventional teaching approaches were modified to make a classroom participative in nature in order to achieve the outcomes. The aspects of delivery, assessment and evaluation are discussed.

Keywords: Outcome-based education, quality management system, teaching and learning, mechanical engineering program

INTRODUCTION

The proponents view Outcome based education as a valuable replacement of the traditional model of relative ranking by ability and getting credit for merely sitting through class. Liberal politicians often support OBE because of its vision of high standards for all groups. The conservatives like the idea of measuring outputs rather than inputs (such as money spent or number of hours of lecture given) and insisting that student demonstrate learning rather than just showing up.

Board of Engineers Malaysia thru Engineering Accreditation Council (EAC) has directed that Outcome-Based Education (OBE) learning approach is to be adopted in engineering academic programs in Malaysia. OBE is a method of curriculum design and teaching that focuses on what students can actually do after they are taught [1]. Furthermore, OBE recognizes that a complex organization is more likely to produce what it measures, and to downplay anything it considers unimportant. The adoption of measurable standards is seen as a means of ensuring that the content and skills covered by the standards will be a high priority in the education of students.

The standards-based education movement rejects social promotion and the inevitability of inferior performance by disadvantaged groups. While recognizing that some students will learn certain material faster than others, the standards movement rejects the idea that only a few can succeed. All students are capable of continuous improvement [2].

The opportunities that were previously afforded to those at the top of a bell curve are opened up to the diversity of all students, in a democratic vision, sometimes connected to social justice.

In 2002, UMP established its vision and mission. The university revised its vision and mission statement to account for the surge of activities and development, both academic and with regard to research experiencing and world environment. The reflection was necessary as UMP is still at its initial stage of forming its own identity. The vision of the university is to be one of the world-class competency-based technical universities for its achievements and the mission is to provide the highest

quality technical education exceeding the expectations of their stakeholders by offering excellent academic programs through the conducive environment that encourages creativity and innovativeness. The philosophy of the university is knowledge which is trust given by Allah to man, as vicegerent on earth, to be utilized. The emphasis is on applied knowledge and its applications, founded on exemplary morals, and are able to create a person who will contribute to universal harmony and prosperity [3].

The Faculty of Mechanical Engineering vision is to become a world class competency-based mechanical engineering faculty and the mission is dedicated to produce global mechanical engineers with high level of knowledge, lifelong learning capability, competency and integrity. Moreover, the faculty are committed to enhance research and development towards introducing commercially viable products and services in manufacturing and automotive sectors [2].

At its most basic level, OBE is where the school and community first determine what skills and knowledge students should possess upon graduation, then work backwards from there to develop curriculum, strategies and materials to help students achieve those goals, or "exit outcomes"[4]. Generally, in OBE learning, all educational programs and instructional efforts are designed to have produced specific, lasting results in students by the time they leave school. Schools that have successfully implemented OBE program which described auspicious results. Alhambra High School in Phoenix, Arizona, reported significant improvements in attitude and performance by both students and teachers within the first year [5]. And, after four years of OBE, the Sparta School District in Illinois achieved radical gains in grades and test scores in spite of its previous financial and labour problems [6]. On the other hand, the "student-centered" educational approach is focused on course "outcomes" consisting of a list of skills and knowledge in which the students are coached to master and able to demonstrate upon completion of the course [7]. These learning outcomes are designed to inculcate a platform for life-long learning and they are finally assessed in terms of set learning objectives [8]. Based on the Engineering Accreditation Council (EAC) requirement for the implementation of Outcome Based Education (OBE) in all engineering programs, the Faculty of Mechanical Engineering, UMP had taken initiatives to revise its curriculums. The revised curriculum for student intake of July 2006/2007, the students who registered for semester July 2006/2007 onward were taught and assessed according to OBE principles. This is applying to newly registered and current student which is in year 2, 3 and 4 [9].

CHALLENGES IN IMPLEMENTATION OF OBE

The first challenge in the outcome-based education at the faculty of mechanical engineering is to Program Educational Objectives (PEO) and Program Outcomes (PO), which is meet the requirement and have the ability to be accessed and evaluated in the near future. The Program Educational Objectives and Program Outcomes as shown in subsequent sections in below [3]:

Program Educational Objectives

The Bachelor of Mechanical Engineering strives to produce graduates with the following four attributes:

- *Programme Objective 01: Global Engineers*
  Become competent mechanical engineers that view engineering as a profession with extensive global interactions
- *Programme Objective 02: High Level of Knowledge*
  Able to apply engineering principles with an ability to adapt the changes in latest tools in the design, analysis and synthesis of engineering system
- *Programme Objective 03: Integrity*
  Aware and practice professionalism and responsible in conducting their careers
- *Programme Objective 04: Competency and Learning Capability*

Competence in communication skill, able to work in team, demonstrate high moral values with the ability to continue and expand learning necessary

Programme Outcomes and Assessment

Program outcomes are specific statements of graduates' knowledge, skills and attitudes that are evidences in the programme objective achievements. Consistent with world-class mechanical engineering programme, the faculty had adopted 11 generic program outcomes for all its Bachelor of Mechanical Engineering programmes addresses the minimum requirements by Engineering Accreditation Council and Department of Higher Education, Ministry of Higher Education, Malaysia. All the graduates of the Faculty of Mechanical Engineering, UMP are expected of all graduates receiving the bachelor degree in mechanical engineering [3]. The program educational objective and program outcomes are listed in the Table 1 and 2 respectively.

Table 1: Program Educational Objectives

No.	Program Educational Objectives
1	Become competent mechanical engineers that view engineering as a profession with extensive global interactions
2	Able to apply engineering principles with an ability to adapt the changes in latest tools in the design, analysis and synthesis of engineering system
3	Aware and practice professionalism and responsible in conducting their careers
4	Competence in communication skill, able to work in team, demonstrate high moral values with the ability to continue and expand learning necessary

Table 2: Program Outcomes

POs	Program Outcomes
a	an ability to apply knowledge of mathematics, science, and engineering
b	an ability to design and conduct experiments, as well as to analyze and interpret data
c	an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d	an ability to function on multi-disciplinary teams
e	an ability to identify, formulate, and solve engineering problems
f	an understanding of professional and ethical responsibility
g	an ability to communicate effectively
h	the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i	a recognition of the need for, and an ability to engage in life-long learning
j	a knowledge of contemporary issues
k	an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

The program outcomes are developed through a comprehensive curriculum design and application of appropriate teaching methodologies and strategies. The relationships between these program outcomes and the Program Educational Objectives are given in Table 3. The faculty articulated a set of strategies for achieving these program outcomes. Table 4 is listed the strategies for achieving the program outcomes. Once the program educational objectives and program outcomes are finalized, faculty members are developed the course contents with related course outcomes. The course outcomes that were formulated for each course, address part or all of the stated program outcomes. All of these outcomes are categorized into three main domains including the Cognitive, Psychomotor, and Affective domains.

Domain of taxonomy that needs to be assessed may vary from courses to courses. Each course within a program addresses each of the domains with appropriate taxonomy level. Taxonomy levels are referred to as different level of attainment for each domain. This should have been earlier identified and decided during the coordination and harmonization at the program level. Table 5 shows the levels of taxonomy in each domain, which has been categorized into level 1- Basic; 2 – Intermediate; and 3- Advanced with related PO's addressing each domain.

Table 3: Mapping between PEO and PO

POs	Programme Outcomes	Programme Educational Objectives			
		PEO1	PEO 2	PEO 3	PEO 4
a	an ability to apply knowledge of mathematics, science, and engineering		√		
b	an ability to design and conduct experiments, as well as to analyze and interpret data		√		
c	an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability		√		
d	an ability to function on multi-disciplinary teams	√			√
e	an ability to identify, formulate, and solve engineering problems		√		
f	an understanding of professional and ethical responsibility	√		√	√
g	an ability to communicate effectively	√			√
h	the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	√	√		
i	a recognition of the need for, and an ability to engage in life-long learning				√
j	a knowledge of contemporary issues	√		√	√
k	an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice		√		√

Table 4: Strategies for achieving the program outcomes

No.	Strategies for improving PO
1	To teach effectively courses whose objectives support the PO
2	To offer seminars, lectures and specific events which broaden students' perspective and enhance their professional development
3	To provide an infrastructure that effectively supports and enhance academic and research programs
4	To seek input from others on issue related to curriculum content
5	To advise and council students effectively on academic and to some extent, career options
6	To encourage student participation in organizations, particularly student chapters of national and international professional societies
7	To encourage student participation academic and technical competitions
8	To encourage student participation in undergraduate research activity

Table 5: Levels of taxonomy in each domain

Level/Domain	Cognitive/Knowledge (K)	Psychomotor/Skills (S)	Affective/Attitude (A)
1 – Basic	1 - Knowledge 2 - Comprehension	1 - Perception 2 - Set	1 - Receiving 2 - Responding
2 – Intermediate	3 - Application 4 - Analysis	3 - Guided Response 4 - Mechanism	3 - Valuing 4 - Organisation
3 – Advanced	5 - Synthesis 6 - Evaluation	5 - Complex Response 6 - Adaptation 7 - Origination	5 - Characterisation
Program Outcomes	PO-a , PO-c , PO-e , PO-f , PO-h and PO-j	PO-b and PO-k	PO-d , PO-g and PO-i

The flowchart illustrated in Figure 1 summarizes the procedure that explains in general of the OBE-Continuous quality improvement (CQI) process in teaching and learning.

ROLE OF A LECTURER/INSTRUCTOR IN OBE IMPLEMENTATION

The procedure would be more meaningful if it could be described in a simulated manner by taking the role of the process owner. In this example we shall assume the role of a lecturer having to implement a course, for example BMM4723 Mechanism Design. Having been given the teaching assignment by the Dean, a lecturer will have to prepare and develop his/her Teaching Plan taking into account all the POs to be addressed. In this example the POs to be addressed by this course as shown in Figure Mapping CO - PO in Appendix, are as follows:

After identifying the POs of the course, the lecturer needs to determine the appropriate modes of delivery based [on the required program outcomes. Next he/she needs to determine the appropriate assessment methods and tools to be used in assessing student achievements. All these parameters are already included in the Teaching Plan.

Based on the required outcomes the lecturer may have proposed the followings as his/her modes of delivery and his/her assessment methods as shown in Table 6.

Table 6: Assessment and delivery methods for program outcomes

POs	Criteria	Delivery	Assessment method
a	PO-a(3)	1. Lecture 2. SCL	1. Test 2. Quizzes
b	PO-b(2)	Laboratory Work	Use related rubrics
e	PO-e(1) PO-e(2) PO-e(3)	1. Lecture 2. SCL	1. Test 2. Quizzes
g	PO-g(1) PO-g(2)	Presentation Project Work	Use related rubrics
k	PO-k(3)	Project Report	Project Assessment

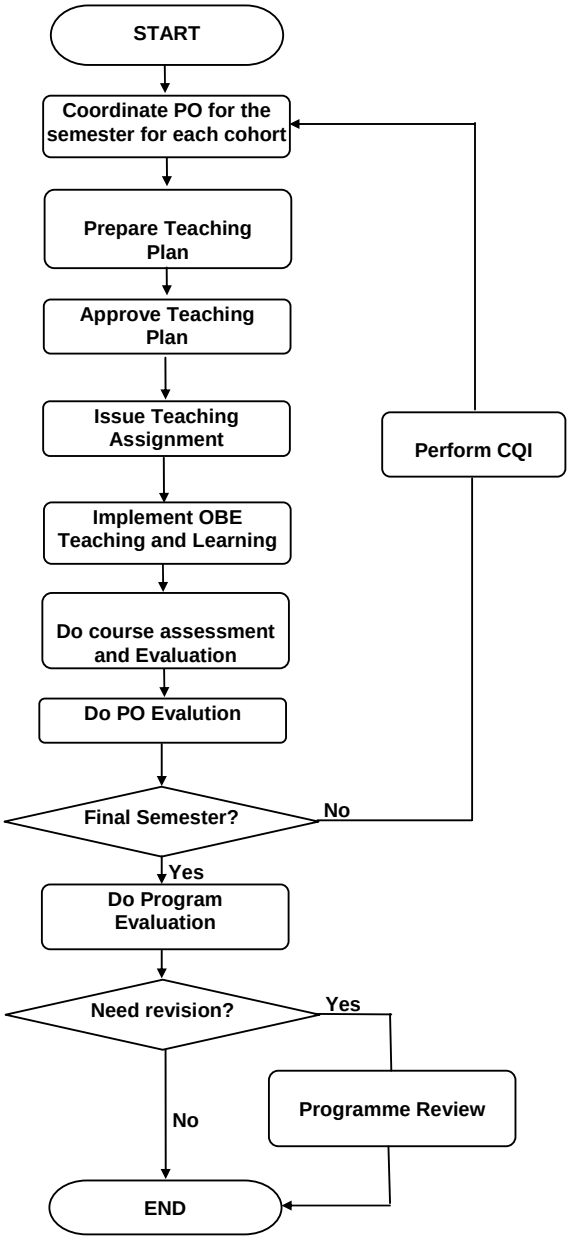

Figure 1: OBE-CQI in Teaching & Learning

ASSESSMENT TOOS

The tools that we have in place to assess effectiveness of our program and making changes when needed fall into direct and indirect evidence categories. Among the indirect evidence category is selected to conduct and analyze several surveys including course learning outcomes surveys, exit surveys, annual student satisfactory surveys, alumni surveys etc. Course learning outcomes surveys in all courses at the end of each semester conducted to determine self assessment of students on how well the course outcomes are met. Exit surveys on program outcomes conducted at the time of graduation to obtain self assessment of the graduates on how well the program outcomes are met. Annual student satisfactory survey conducted annually to determine the student satisfaction with the

program Alumni survey for measuring the impact of program outcomes in the performance of graduates.

The direct evidence tools consist of:

1. Industrial Advisory Board that provides input on performance and expected qualifications of graduates
2. Employer survey for measuring effectiveness of the program outcomes in the work force
3. Final Examination (FE) results
4. Feedback forms for course outcomes survey results completed and submitted at the end of each semester by the faculty teaching the courses
5. Panel evaluations in key courses that involve final project reports or presentations in front of an audience of faculty and fellow students
6. Instructor's assessment of student performance in course outcomes via evaluation of key exams, projects and homework against the course outcomes

It is to be noted that the course outcomes surveys are independent of the course and instructor evaluations. While the course outcome survey results are shared with all faculties, course and instructor evaluation survey results are confidential and shared only with the individual faculty as a means of feedback to improve his or her teaching.

The assessment methods used to assure that the program outcomes are achieved. The methods for assessment of achievement of program outcomes are given in Table 7.

Table 7: Methods for assessment of achievement of program outcomes

No.	Methods use to assess program outcomes
1	Conduct exit survey with graduate seniors
2	Conduct alumni surveys
3	Conduct employer surveys
4	Conduct student satisfactory survey in every semester
5	Conduct course evaluation survey
6	Conduct reviews by academic area committees
7	Conduct the survey based on cognitive domain for every course
8	Maintain records on student performance on Final exam
9	Maintain records of students' progress through the curriculum
10	Maintain records of students' pursuing graduate or professional school

FACULTY FEEDBACK ON COURSE OUTCOMES

In order to systematically analyze the survey results, the faculty members are asked to provide feedback on the survey results explaining the reasons for the lowest two or three outcomes, reflect upon the adequacy of the outcomes, indicate any changes made in the course or any suggestions for changes. The suggestions are implemented if approved by the faculty academic committee (FAC). The benefits of these forms are:

- To give faculty opportunity to analyze the results and provide feedback
- To document any changes or suggestions made
- To guide those who might be teaching the same course in subsequent semesters

These completed feedback forms are included in the course portfolios prepared by the faculty for each course and kept as a faculty record on the faculty's assessment database.

ROLE OF A PROGRAM COORDINATOR IN OBE IMPLEMENTATION

The program coordinator plays an important role for evaluating the achievement of cohorts for each semester. The coordinator is collected Course Assessment Summary (CAS) for all courses in particular semester and cohort. The evaluation of CAS is to identify and achieving the program outcomes. The course, BMM4723 was considered for the analysis and results obtained from the analysis that the cohort did not manage to achieve the minimum requirements, i.e. 50% of the cohort attaining 50%. Hence the coordinator ensures that the same PO be addressed again in one or more of the courses for the following semester. This is to be part of continual quality improvement process. This is done every semester. Once the POs are harmonized for the particular cohort, the coordinator updates the POs to be addressed for each course include the information on the updated POs for each course.

The PO Summative Assessment of the program would follow including the external summative assessment like, entry survey, exit survey and final CPA. The internal summative assessment like final year project and industrial training along with formative assessment of all courses is taken by the cohort throughout the study period. All these assessment would be evaluated to gauge against the attainment of Program Educational Objectives in the years to come, usually 5 years after graduation. These data can be obtained through employer survey, alumni survey and among others. The results of the summative assessment would later be used in revised the curriculum and part of the continual quality improvement. The flowchart of the continuous quality improvement for mechanical engineering program is shown in Figure 2.

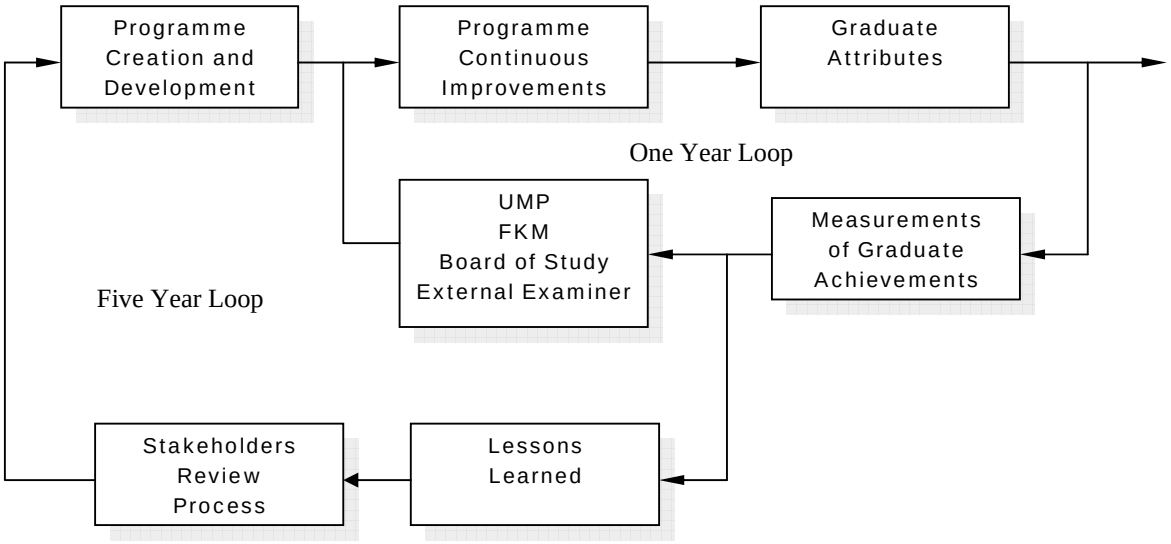

Figure 2: Flowchart of CQI for mechanical engineering program

CONCLUSION

The quality management system for the assessment of the mechanical engineering program in UMP is proposed and the program educational objectives and program outcomes are specified. The program outcomes assessment tools are discussed. The course coordinator or/and lecturers plays the major role to the implementing the OBE in the mechanical engineering program in UMP. The student performance can be measured and continuously improvement.

ACKNOWLEDGEMENT

The authors would like to express their deep gratitude to Universiti Malaysia Pahang for provided the financial support.

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