Assessment Strategy for an Outcome Based Education

by
M.S. Jaafar*, N. K. Nordin, R. Wagiran, A. Aziz, M.J.M.M. Noor, M.R. Osman, J. Noorzaei and F.N.A. Abdulaziz
*Faculty of Engineering, Universiti Putra Malaysia, 43400 UPM-Serdang, Malaysia

Index Terms: outcome based education, assessment and evaluation, automation system.

Abstract

Malaysian engineering education is now embracing an Outcome Based Education (OBE) approach. This approach emphasizes on the outcomes, as opposed to the process in an educational strategy. The approach now becomes one of the important for an engineering degree to obtain accreditation from the Malaysian Engineering Accreditation Council (EAC). The approach is relatively new in the country, and it requires extensive assessment and evidence to demonstrate that an outcome has been achieved. The Faculty of Engineering at Universiti Putra Malaysia has developed an office automation system to assist the respective departments to monitor the development of their respective program outcomes. This paper describes the office automation system and its strength and weakness after one year of its first implementation.

Introduction

Wikipedia defines Outcome-based education (OBE) as "…a recurring education reform model. It is a student-centered learning philosophy that focuses on empirically measuring student performance, which are called *outcomes*. OBE contrasts with traditional education, which primarily focuses on the resources that are available to the student, which are called *inputs*. Unlike many pedagogical models, such as project-based learning or whole language reading, OBE does not specify or require *any* particular style of teaching or learning. Instead, it requires that students demonstrate that they have learned the required skills and content" [1].

There have been many debates on the advantages and disadvantages of OBE. Some of the arguments for the proponents of OBE inlcude [2];

- OBE is able to measure—'what the students are capable of doing'—something which the traditional education system often fails to do.
- OBE goes beyond 'structured tasks' (e.g. memorisation) by demanding that students demonstrate his/her skills through more challenging tasks like writing project proposals and completing the projects, analysing case studies and giving case presentations
- OBE also identifies higher levels of thinking (e.g. creativity, ability to analyse and synthesise information, ability to plan and organise tasks).

Some of disadvantages of OBE as proposed by its opponents are [3];

- OBE is not about academics such as reading, writing and arithmetic, but OBE are about attitudes and outcomes
- OBE uses students as guinea pigs in a vast social experiment
- OBE offers no method of accountability to students, parents, teachers, or taxpayers – it is expensive
- OBE is a dumbed-down egalitarian scheme that stifles individual potential for excellence and achievement by holding the entire class to the level of learning attainable by every child.
- In an OBE system, academic and factual subject matter is replaced by vague and subjective learning outcomes

Despite the ongoing reservation on its implementation, it is now being implemented in the Faculty of Engineering, UPM. The faculty believes that the approach is appropriate for the types of students it gets, and above all, it is required by the local accreditation body. The OBE implementation is now a compulsory requirement for obtaining the accreditation from the Engineering Accreditation Council (EAC), Malaysia [4]. Its

implementation in the Bachelor of Engineering programs is mainly to prepare graduates to have knowledge and skills required by the industry. This paper describes strategies of its implementation, especially with respect to assessment strategy.

OBE Implementation Strategy

The Faculty of Engineering of Universiti Putra Malaysia (UPM) had taken initiatives to revise its 2000-2005 curriculums. The revised curriculum (based on 2006-2010 programs) was first implemented in the 2006 academic year. The OBE approach requires better planning, implementation and monitoring of an engineering program. It calls for a total support from the management, academic and supporting staff. In general, OBE requires an engineering program to address four important questions that are [5]:

i) What do you want the students to have or able to do?
ii) How can you best help the students achieve it?
iii) How will you know that they have achieved it?
iv) How do you close the loop?

The questions are to be answered by the head of program and individual lecturers. The first question calls for the development of program objectives, program outcomes and course outcomes. The second question calls for the appropriate teaching/ learning facilities and techniques to be employed in various programs or courses. The third question calls for appropriate assessment to demonstrate that the students have obtained the required outcomes. The fourth question calls for the evaluation on the effectiveness of all the plans and implementation of the learning outcomes and ascertain rooms for improvement either in learning or teaching.

The overall OBE implementation strategy at UPM is shown in Figure 1. The figure shows the development of the Bachelor of Engineering (BE) programs and its implementation strategies. Basically it contains three main elements that are (a) development, (b) implementation, and (c) monitoring/review. Appropriate assessment strategies are important in the review process, which will be used to improve the program design and delivery.

Assessment Strategy

From Figure 1, it is clear that there are two cycles of "develop-implement-review" in order to achieve improvement of the program. There is an internal cycle for continual improvement that involves the courses outcomes i.e. course implementation-course assessment relationship. The other cycle is the external cycle that involves the program outcomes-program implementation-program assessment/evaluation relationship.

The faculty had adopted 15 generic program outcomes for all its BE programs that encompass the three main domains and addresses the minimum requirement by EAC and the Department of Higher Education, Ministry of Higher Education. All BE graduates of UPM are expected to have the following attributes by the time they graduate i.e. they are able to;

1. Apply knowledge of mathematics and engineering sciences.
2. Design and conduct experiment
3. Analyse and interpret data.
4. Design a system, component or process to meet the design requirement
5. Use principles of sustainable design and development
6. Function effectively as an individual in a group
7. Demonstrate leadership or managerial characteristics
8. Identify, formulate and provide creative/innovative/effective solution to the problem.
9. Explain of professional and ethical responsibility.
10. Communicate effectively with engineers, other professionals and community at large
11. Explain the impact of engineering solutions in societal, cultural, global and environmental context.
12. Recognize the need for and able to engage in lifelong learning.
13. Discuss relevant contemporary issues
14. Use necessary skills, techniques and modern engineering tools for engineering practice.
15. Solve problems in advanced design and development

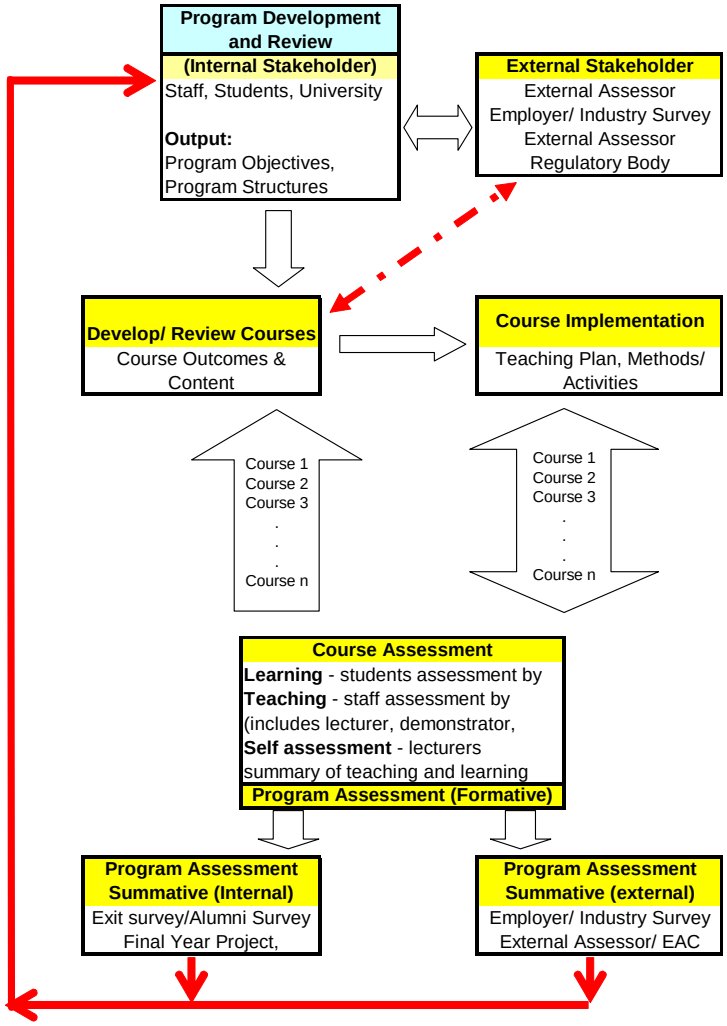


Figure 1: Overall Flow for the Program Development, Implementation and Monitoring

All these outcomes are categorized into three main domains that are:

i) Cognitive domains
ii) Psychomotor domains
iii) Affective domains

Each course within a program needs to address each of the domains with appropriate taxonomy level. Taxonomy levels are referred to different level attainment for each domain. Each of the domains and the taxonomy levels need to be addressed and assessed within the appropriate course. The course outcomes to program outcomes matrix is developed in such a way that the domains are appropriately developed. Using appropriate assessment tools, a course lecturer will report to the program head on the achievement of the students with respect to the outcomes he/she was supposed to address.

Figure 2 shows a program matrix to indicate the overall plan for assessment at the Faculty of Engineering UPM. The implementation plan starts with the assessment for the entry students. The students' preparation with respect to knowledge and affective skills are assessed through their grades and self assessment when they first enter into the program. The assessment of students' attainment for each program outcomes are carried out at the end of every session so their program outcomes may be monitored and any intervention may be adopted. This continuous assessment throughout their four year study is considered as formative assessment. Each faculty member is expected to provide data for this continuous assessment, depending on the outcomes he/she is expected to address within his/her course.

To ascertain the effectiveness of the course/ program delivery, summative assessments are conducted using internal and external resources. The internal summative assessment is done by lecturers through final year project, capstone design or industrial training. The external summative assessment is done through the external examiner, exit survey, alumni and employer/ industry survey. The outcomes of all these assessment need to be evaluated and the conclusions from the evaluation are used further improve the program.

Assessment Method/Process for PO (External)	Exit survey	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Employer survey	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Alumni Survey	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	External Examiner				X						X	X	X	X	X	X	X
	Exit Test for Softskill (CADE) - attitude of the student						X	X	X	X	X		X				
Program Outcomes (attributes of students by the time they graduate)		Apply knowledge of mathematics and engineering sciences	Design and conduct experiment	Analyse and interpret data	Design a system, component or process to meet the design requirement	Use principles of sustainable design and development	Function effectively as an individual in a group	Demonstrate leadership or managerial characteristics	Identify, formulate and provide creative/innovative/effective solution to a problem	Explain the professional and ethical responsibility	Communicate effectively with engineers, other professionals and community at large	Explain the impact of engineering solutions in societal, cultural, global and environmental context.	Recognize the need for and able to engage in lifelong learning	Discuss relevant contemporary issues	Use necessary skills, techniques and modern engineering tools for engineering practice.	Solve problems in advanced design and development
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Formative Assessment from individual courses	Course 001																
	Course 002																
	Course 003																
	Course 004																
	Course 005																
	Course 006																
	Course 007	**Course Summary report - data for programme assessment**															
	Course 008																
	Course 009																
	Course 010																
	Course n																
	Course n+1																
Summative Assessment (Internal)	**Industrial Training**																
	Capstone Stone / Design Project																
	Final Year Project																
ENTRY	Students' Entry Qualification (Academic Preparation) and Students' Entry Survey																

Figure 2: Program Assessment Plan at UPM

Office Automation System

The Faculty of Engineering has eight departments that offer eight Bachelor of Engineering programs. With a total number of 120 teaching staff and about 2,000 students, it is obvious that some form of automation system is required to manage information and data, especially for assessment purposes. An office automation system to do this has been developed. The main domain of the system includes;

- **Class Schedule**
- **Teaching Plan**
- **Rubric Assessment**
- **Survey Assessment**

The office automation system starts with the class schedule where teaching assignments are entered by the faculty management. This is done at least one month before the start of each semester. Upon getting the teaching assignment, each lecturer needs to develop teaching plan where teaching and learning strategies are formulated so that appropriate outcomes are addressed. The accumulative results of teaching plan for each cohort of students for each BE program can be assessed by the respective head of department. Figure 3 shows

typical status of teaching plan and Figure 4 shows summary of the score accumulated from the teaching plan. The accumulated score from the teaching plan provide good indicators whether the cohort will receive balance teaching and learning experience in the given semester.

From this input, head of department will decide the appropriateness of each teaching plan, before approving them. In the event of discrepancies in any of the teaching plan, the head of department will return the plan to respective lecturer for modification. All this is done on-line and is normally completed before the start of the semester.

During the semester, lecturers are expected to do continuous assessment for the respective outcomes. To do this, they may download the forms in the Rubric Assessment. Figure 5 shows sample of rubrics available in the system. By the end of the semester, lecturers would have accumulated the evidence or data to indicate the attainment of the outcomes by students. The summary of the outcomes are reported in Course Assessment Summary (CAS). Figure 6 shows a typical template for the CAS. The accumulated reports from the CAS are then collected by head of department and the data are then fed into the Program Assessment Report, as described earlier (see Figure 2).

The outcomes assessment from lecturers and head of department only constitutes one third of the triangle of a complete assessment system. Third parties assessment such as those obtained from external assessor, employers, alumni and practicing engineers who supervise students during their industrial training are conducted. Sample of such assessment is shown in Figure 7. The comprehensive data collection from lecturers, students and other stakeholders allow the faculty management to triangulate or evaluate the effectiveness of the program.

The office automation system is about one year old, but it has shown great advantages. The old system of having to do assessment is costly and not timely. The paper works involve for the assessment to satisfy OBE implementation are tremendous and the results always come late as the process require different office and expertise. The office automation system, however, has helped the faculty to reduce the cost and provide real time results. Based on the experience gathered so far, once established and accepted by all members, the system will allow harmonization of all teaching and learning opportunities for students. The monitoring can be made easier and the records are always accessible to the management for ongoing review and improvement.

Conclusion

OBE implementation is relatively new in Malaysia and has been made compulsory by the accreditation body in the country. It was realized that the OBE implementation required a lot of coordination in planning and implementation and involved a lot of assessment. With this realization, an office automation system was developed in UPM. The system has helped the faculty management to monitor the OBE implementation.

References

1) http://en.wikipedia.org/wiki/Outcome-based_education
2) http://www.cdtl.nus.edu.sg/link/nov2003/obe.htm
3) http://www.ourcivilisation.com/dumb/dumb3. htm
4) Board of Engineers Malaysia, Engineering Accreditation Manual 2007.
5) Bahagian Akademik, A Guide to Putra 3Q Outcome Based Teaching and Learning, Faculty of Engineering, Universiti Putra Malaysia, 2007.

Department : Kejuruteraan Aeroangkasa Semester : Semester 1 - 2007/2008

No.	Course Code	Course Name	Program(sem)	Group	Status	Action
1.	EAS 3101	PENGATURCARAAN FOTRAN	KAA (Sem1)	1	No submission	Download
2.	EAS 3202	AERODINAMIK I	KAA (Sem4)	1	No submission	Download
3.	EAS 3204	AERODINAMIK II	KAA (Sem5)	1	No submission	Download
4.	EAS 3211	TERMOBENDALIR	KAA (Sem2)	1	No submission	
5.	EAS 3302	GETARAN	KAA (Sem3)	1	No submission	Download
6.	EAS 3304	KAWALAN DAN KESTABILAN PESAWAT	KAA (Sem6)	1	Approved	Activate to resubmit | Download
7.	EAS 3304	KAWALAN DAN KESTABILAN PESAWAT	KAA (Sem6)	2	No submission	
8.	EAS 3412	STATIK DAN DINAMIK	KAA (Sem2)	1	No submission	
9.	EAS 3511	AEROTERMODINAMIK	KAA (Sem3)	1	No submission	
10.	KAA 3214	ALIRAN BOLEH MAMPAT	KAA (Sem5)	1	No submission	
11.	KAA 3711	REKABENTUK DAN LUKISAN KEJURUTERAAN	KAA (Sem2)	1	Rejected	Download

Figure 3: Typical sample of status for teaching plan for each cohort of students

JADUAL MATRIKS KURSUS DAN HASIL PEMBELAJARAN EAC.

Jabatan : Kejuruteraan Aeroangkasa

Sesi Kemasukan : Semester 1 (2006/2007)
Semester Semasa : Semester 1 (2007/2008)

Bil	Kod Kursus	Kursus	Sem	Kredit	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
1.	EAS 3101	PENGATURCARAAN FOTRAN	1	3(2+1)		2			2	2	2	1		2			2	3	
2.	EAS 3401	BAHAN AEROANGKASA DAN PROSES	1	2(2+0)															
Jumlah						2			2	2	2	1		2			2	3	
3.	EAS 3211	TERMOBENDALIR	2	3(3+0)		2	2		2	1	1	1		3	2	3	3		3
4.	EAS 3412	STATIK DAN DINAMIK	2	2(2+0)															
Jumlah						2	2		2	1	1	1		3	2	3	3		3
5.	EAS 3302	GETARAN	3	3(3+0)	2	2		2		2	2	2		3	3	3	3	3	
6.	EAS 3511	AEROTERMODINAMIK	3	3(3+0)															
Jumlah					2	2		2		2	2	2		3	3	3	3	3	
Jumlah Keseluruhan					2	6	2	2	4	5	5	4		8	5	6	8	6	3

Program Outcomes :

PO1(C)	Apply knowledge of mathematics and engineering sciences.	PO2(C)	Design and conduct experiment
PO3(C)	Analyse and interpret data.	PO4(C)	Design a system, component or process to meet the design requirement
PO5(C)	Use principles of sustainable design and development	PO6(C)	Explain the professional and ethical responsibility.
PO7(C)	Explain the impact of engineering solutions in societal, cultural, global and environmental context.	PO8(C)	Solve problems in advanced design and development
PO9(P)	Identify, formulate and provide creative/innovative/effective solution to a problem.	PO10(P)	Use necessary skills, techniques and modern engineering tools for engineering practice.
PO11(A)	Function effectively as an individual in a group	PO12(A)	Demonstrate leadership or managerial characteristics
PO13(A)	Communicate effectively with engineers, other professionals and community at large	PO14(A)	Recognize the need for and able to engage in lifelong learning.
PO15(A)	Discuss relevant contemporary issues		

Figure 4: Typical summary of accumulated score from teaching plan

Name	: Group 3	Term/Year	: Semester 1, 2007/2008
Course	: GETARAN	Assignment	: Individu
Code	: EAS 3302		
Lecturer	: Cik Lecturer		

Scale	1	2	3	4	5	6	Score
Criteria	Poor		Acceptable		Excellent		
1. Effectiveness of experimental design and or proceduress	Very ineffective.Would not allow experiments to achieve most goals.		Somewhat effective.Would allow experiments to achieve most goals.		Effective.Would allow experiments to achieve goals.		3
2. Execution of procedures	Demonstrated little or no ability to conduct experiments.Did not collect meaningful data.		Demonstrated adequately ability to conduct experiments.Collected most of the needed data.		Demonstrated superior ability to conduct experiments.Collected an appropriate data.		5
3. Statiscal methods	Statiscal methods were completely misapplied or absent.		Statiscal methods were attempted.Most methods were correctly applied but more could have been done with the data		Statistical methods were fully and correctly applied.		5
4. Focus of results and discussion	No insight.Entirely missed the point of the exoeriment.		Adequated insight.Missed some important points.		Excellent insight.Results and discussion well focused.		3
5. Interpretation of data	Little or no attemption to interpret data or over interpret data.		Interpreted most data correctly.Some conclusions maybe suspect or over interpreted.		Data completely and appropriately.Not over-interpreted.		2

Save Back

Figure 5: Sample of rubrics available in the system

Course	**: PENGATURCARAAN FOTRAN**	Term/Year	**: Semester 1 2007/2008**
Code no	**: EAS 3101**		
Course Coordinator	**: Dr.Ing.Ir. Renuganth a/l Varatharajoo**		

1 Attach Teaching Plan.

2 Review of previous years's assessment

Comments: Comments

3 Instructor's assessment of program-related outcome

Program Outcome	50% attainment (Y/N)	Recommendations/comments
1	N (0%)	
2	Y (64%)	Recommendations/comments 1
3	N (0%)	
4	N (0%)	
5	N (0%)	
6	N (0%)	
7	N (0%)	
8	N	

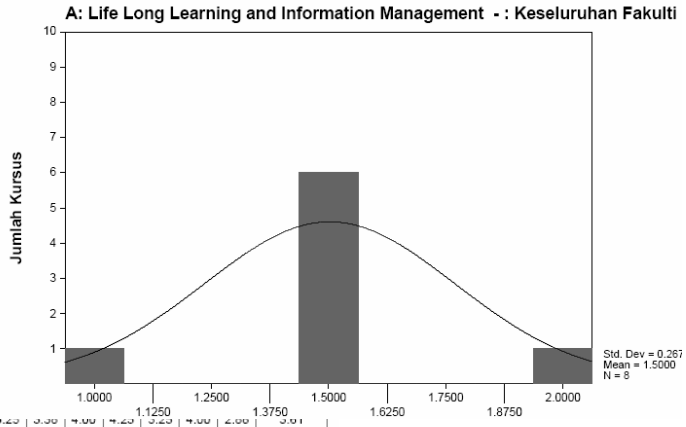
Figure 6: Course assessment summary (CAS) template

ENGINEERING EMPLOYER SURVEY

Fakulti (Faculty) : **Fakulti Kejuruteraan, UPM**
Jumlah Respon (Total Respondents) : 8 dari 8 (100.00%)

Semester (Semester) : Semester 1
Sesi (Session) : 2007/2008

	Kriteria/ Criteria	5 Sangat Setuju	4 Setuju	3 Tidak Setuju	2 Kurang Setuju	1 Sangat Tidak Setuju	Purata (%)/ Average (%)	Purata Mata/ Point Average
A. Pembelajaran Sepanjang Hayat Dan Pengurusan Informasi (Life Long Learning and Information Management)								
Q 1	Kesedaran untuk keperluan pembelajaran sepanjang hayat dan keupayaan untuk melaksanakan. *Awareness of the need for life long learning and the ability to do it.*	0	0	0	1	7	22.50	1.13
B. Kemahiran Komunikasi (Communication Skills)								
Q 1	Komunikasi verbal dengan jurutera, professional dan komuniti yang lain. *Verbal communications with other engineers, professional and community.*							
Q 2	Penulisan untuk pelbagai jenis dokumentasi. *Writing for any kinds of documentation.*							
C. Pendekatan Kemahiran Pemikiran dan Sains (Thinking and Scientific Skills Approach)								
Q 1	Menganalisis dan mentafsir data. *Analysing and interpreting data.*							
Q 2	Mengenalpasti, merumus dan menyediakan penyelesaian yang kreatif, inovatif dan berkesan untuk masalah tertentu. *Identifying, formulating and providing creative, innovation and effective solution for a specific problem.*							



Semester (Semester) : Semester 1
Sesi (Session) : 2007/2008

BIL. (NO.)	NAMA PROGRAM (PROGRAME NAME)	BIL RESPONDEN (RESPONDENTS)	%	A	B	C	D							
1	BACHELOR KEJURUTERAAN (PERTANIAN BIOSISTEM) (KBP)	4 / 4	100.00%	3.60	3.58	3.72	4.25							
2	BACHELOR KEJURUTERAAN (AWAM) (KAW)	4 / 4	100.00%	3.47	3.35	3.77	1.75	2.50	3.63	3.50	3.13	3.50	2.00	4.00	3.47
3	BACHELOR KEJURUTERAAN (AEROANGKASA) (KAA)	4 / 6	66.67%	3.24	3.25	3.52	2.00	2.75	2.88	2.50	2.75	2.55	2.75	2.63	3.16

Figure 7: Sample of employer survey