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Measurement and Evaluation of Program Outcomes in the Civil Engineering Courses

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Abstract

Outcome Based Learning System (OBL) contains six programme objectives and 12 programme outcome (PO) that can be measured in some certain courses. Measurement and evaluation are important aspects in determining whether or not a programme outcome is achieved. Nevertheless, measurement is one of the hardest aspects to be done because there is no proper method or range that can be used. This paperwork contains the measurement of programme outcome as an implementation in Civil Engineering Programmes' courses. Those courses are Computer Programming (KF1243), Engineering Measure (KH2243), Liquid Mechanic (KH2133), Design Project II (KH4253) and Academic Project II (KH4203). Aside from that, there is also a comparison made between the measurements of the programme outcome done by lecturers with ones from the perspective of final year students of 2005/2006 session. It is hoped that this implementation of measurement method will be used as reference by lecturers at the Engineering Faculty, Universiti Kebangsaan Malaysia (UKM) particularly, and in Malaysia generally.

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Keywords: Measurement; Evaluation; Outcome Based Learning; Programme Outcomes; Final Year Students

1. Introduction

Outcome based learning system (OBL) had been introduced in Engineering Faculty, Universiti Kebangsaan Malaysia (UKM) since 2003 after Malaysia was admitted to the Washington Accord as a provisional signatory nation alongside Singapore and Germany (Basri et al., 2004). In order to implement this system, a program must formulate the program educational objectives and identify the program outcomes (PO) that directly address the educational objectives and incorporate certain specified outcomes (Felder & Brent, 2003). Various approach and steps had been introduced as well as series of courses, workshops and seminar had been carried out to ensure that this system is a success. Measurement and evaluation of PO as shown in Figure 1 is one on the most important aspect to determine the OBL system is successful. This is to ensure the OBL system is improved constantly. Besides

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that, data and evidence collecting system of measurement and evaluation carried out in the courses should be introduced so that records can be kept and compiled safely and effectively.

Since measurement and evaluation are important in accreditation programme at Civil and Structural Engineering Department (CSED), this paperwork will discuss a few important matters to fulfil the stated objectives:

- (a) to discuss methods to perform measurement and evaluation of programme outcome at CSED;
- (b) to analyse direct measurement of programme outcome of some courses in Civil Engineering Programme; and
- (c) to analyse indirect measurement of programme outcome of some courses in Civil Engineering Programme.

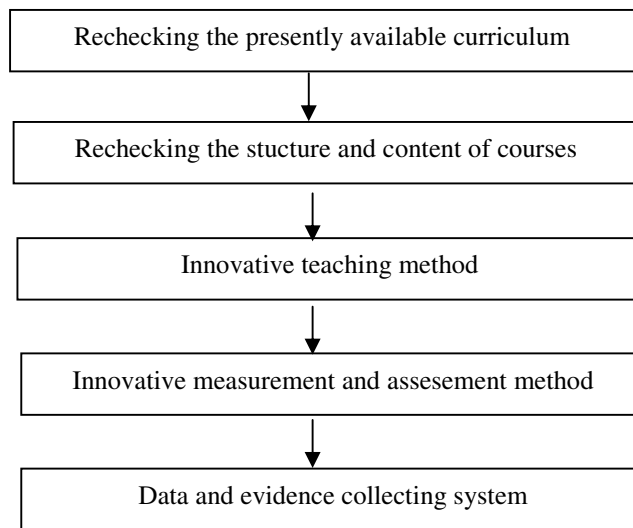


Figure 1. Steps to perform outcome based learning system

2. Definition of measurement and evaluation

According to Wan Hamidon, 2005;

- 1) **Measurement** is a process of identifying, collecting, using and preparing data to asses the achievement of programme objective and outcome, while
- 2) **Evaluation** is a process to interpret data and evidence from the measurement and to identify whether or not the programme outcome had been achieved and steps that need to be taken to improve the programme.

In order to improve and increase the courses offered, the measurement and evaluation process as shown in Figure 2 is carried out. Suitable assessment method needs to be chosen, depending on the expected course outcome and the delivery method (Rashid et al 2008, Jaafar et al 2008).

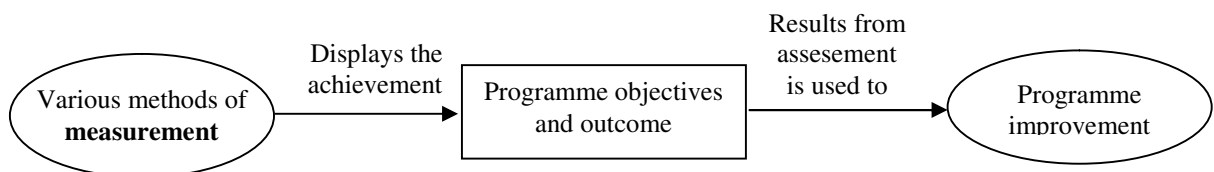


Figure 2. Process of measuring and assessing programme objectives and outcome

3. Implementation approaches at CSED

A few series of workshop were held to ensure the OBL approach at CSED is a success. A workshop held in 16 February 2006 venue at the Danau (Annual Report 2006), UKM had agreed that programme outcome for Civil and Structural Engineering and Civil and Environmental Engineering Programme are followed as in Table 1 and Table 2. Contributions by each compulsory course to the program's learning outcomes were also revised in this workshop to make sure that the programme outcome had been stressed reasonably from each compulsory course. List of contribution is shown in Figure 3 (Annual Report, 2006).

Table 1. Programme outcomes for Civil and Structural Engineering Programme

PO #	Program Outcomes
PO1	Ability to gain and apply basic engineering knowledge
PO2	Ability to communicate effectively not only among engineers, also with non-technical society
PO3	Possessed high technical skills in the field of civil and structural engineering
PO4	Ability to identify civil engineering problems also able to obtain solution using modern engineering tools
PO5	Ability to adapt systemic approaches in designing civil engineering infrastructure and performing economical evaluation.
PO6	Ability to function effectively individually or in group with capabilities to become a leader or manager, as well as an active group member.
PO7	Understanding the responsibility and ethics as a professional engineer from social, cultural, global and environmental aspect as well as the need for an eternal development.
PO8	Posses a prediction of needs to undergo lifelong learning, and the capacity to do so.
PO9	Ability to design and execute tests, and also able to analyse and interpret data.
PO10	Ability to function in a multi-discipline group.
PO11	Possessed knowledge of current issues related to civil and structural engineering
PO12	Understanding the elements of managing construction projects, wealth management, civil regulations, administration, business and entrepreneurship.

Table 2. Programme outcomes for Civil And Environmental Engineering Programme

PO#	Program Outcomes
PO1	Similar to Table 1
PO2	Similar to Table 1
PO3	Possessed high technical skills in the field of civil and environmental engineering
PO4	Similar to Table 1
PO5	Similar to Table 1
PO6	Similar to Table 1
PO7	Similar to Table 1
PO8	Similar to Table 1
PO9	Similar to Table 1
PO10	Similar to Table 1
PO11	Possessed knowledge of current issues related to civil and environmental engineering.
PO12	Similar to Table 1

Definisi kekunci		Hubungan Kursus dengan Programme Outcomes													
1 Memenuhi PO tanpa penilaian rasmi		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		
2 Memenuhi separa PO dengan penilaian rasmi															
3 Memenuhi penuh PO dengan penilaian rasmi															
Semester	Kod	Kursus	Mendapatkan dan menggunakan ilmu asas	Komunikasi	Pengetahuan teknikal mendalam	Penyelesaian masalah dan alat moden	Pendekatan sistem	Bekerja dalam kumpulan lain mengurus	Etika dan kemahiran profesional	Pembelajaran sepanjang hayat	Rekabentuk eksperimen	Bertinggi dalam kumpulan multi-disiplin	Pengetahuan isu semasa	Pengurusan projek, pembinaan dan keusahawanan	
I	KKKF1133	Pengenalan kepada Kejuruteraan	1	2				1	1	2		1	2		
	KKKF1153	Sains Bahan	3		1	1		1		2	2		1		
	KKKF1243	Pengaturcaraan Komputer		1		2	3	1		1			1		
	KKK01113	Matematik Kejuruteraan I (Aljabar)	3			2		1		1		1			
	ZT1012	Kenegaraan Malaysia & Tamadun Islam I							3						
II	KKKF1043	Asas Mekanik Gunaan	3		2	3		1			2				
	KKKF1063	Pengenalan Kejuruteraan Elektrik	3		2	3	1	1		1	2				
	KKKF1083	Pengenalan Termodinamik Kejuruteraan	3		2	3	1	1		1	2				
	KKK01213	Matematik Kejuruteraan II (Kalkulus)	3			2		1		1		1			
	KKKF1173	Grafik Kejuruteraan	2	2	1	2	1			1					
Inter-sesi	KKKF1333	Asas Kemahiran Kejuruteraan	2	1		1		1	1	1	2	1	1		
	VH2073	Bahasa Inggeris untuk Jurutera													
III	U2	Kursus PPU	3												
	KKK02113	Matematik Kejuruteraan III (Persamaan Kefahaman)	3			2									
	KKKH2123	Kekuatan Bahan	3		2	3		1			2				
	KKKH2133	Mekanik Bendalir	2	1	3	3		2		1	3		1		
	KKKH2173	Alam Sekitar	2	2		2	1	2	3		3	1	2		
	KKKH2243	Ukur Kejuruteraan	3	2	3	2		2	1	1			1		
IV	H	Kokurikulum	3												
	KKK02013	Statistik Kejuruteraan	3		3	3		3			2	3			
	KKKH2253	Geoteknik I													
	KKKH2273	Mekanik Struktur	3	1	3	3		1			2		1		
V	KKKH2263	Teknologi Bahan	3		1	1		2		2	2		1		
	ZT1022	Kenegaraan Malaysia & Tamadun Islam II	3			3			1						
	KKK03013	Pengiraan Berangka	3			3									
VI	KKKH3153	Geoteknik II	2	3	3	3				1	3	1	1		
	KKKH3233	Hidrologi Kejuruteraan	3	2	3	2	1	1	2	1	2		2		
	KKKH3243	Kejuruteraan Jalan Raya	2		2	2		1			3				
	KKKH3223	Analisis Struktur	3	1	3	3		1					1		
VII	KKKF3283	Etika Kejuruteraan dan Perkembangan Teknologi	3		1	1			3	3			2		
	KKKH3263	Pengurusan Kejuruteraan Awam		2	1	2	1	2		2		3	3		
	KKKH3133	Hidraulik Saluran Terbuka	3	1	3	3	1	1	1	1	3		2		
	KKKH3143	Kejuruteraan Pengangkutan	3		1	1							1		
	KKKH3273	Konkrit Tetulang	3	2	3	3		2	1		2	1	2		
VIII	Inter-sesi	KKKF3066	Latihan Industri												
	KKKF4133	Pengurusan Kejuruteraan	3		3						3		3		
	KKKH4103	Projek Ilmiah		3		3			1	3	3		3		
	KKKH4073	Kejuruteraan Bekalan Air dan Sistem Pembentungan	3		3	3	1						3		
	KKKH4223	Amalan Kejuruteraan Geoteknik	3	2	3	3				1	3	1	1		
	KKKH4xx3	Elektif I													
	KKKH4193	Pengurusan Projek	2	3	1	2		3	2	1			1		
	KKKH4203	Projek Ilmiah II		3		3			1	3	3		3		
	KKKH4213	Projek Rekabentuk	3	2		3	3	3	2	3		3			
	KKKH4323	Struktur II (Keluli & Kayu)	3		3	3									
KKKH4xx3	Elektif II														

Figure 3. Contribution of course outcomes to programme outcomes (Source: Annual Report, (2006))

The CSED had also appointed a Programme Outcome's Mark Coordinator to generate a data collecting system and assessing the PO from the PO marks measured in offered courses (CO). The approaches used in the system are shown in Figure 4.

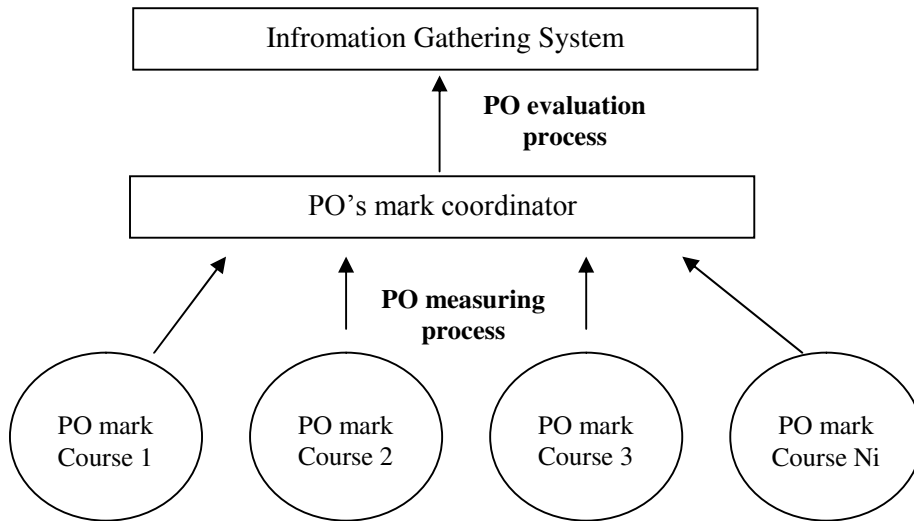


Figure 4. Collection of marks from measurement and evaluation of PO process

An information gathering system was established as shown in Figure 5. This enables the department to record and assess the PO performance of students for each session until their graduation. Figure 6 shows how the program can be improved. Measurement and evaluation on programme outcome not only showed the lowest PO but also the list of weak students for a particular PO. This enables the department to take more proactive measures to aid the students identified as weak.

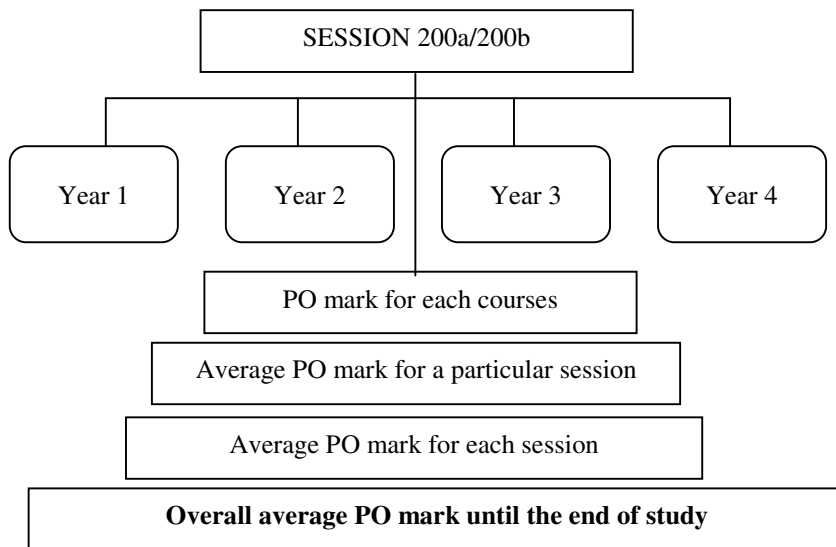


Figure 5. Information gathering systems

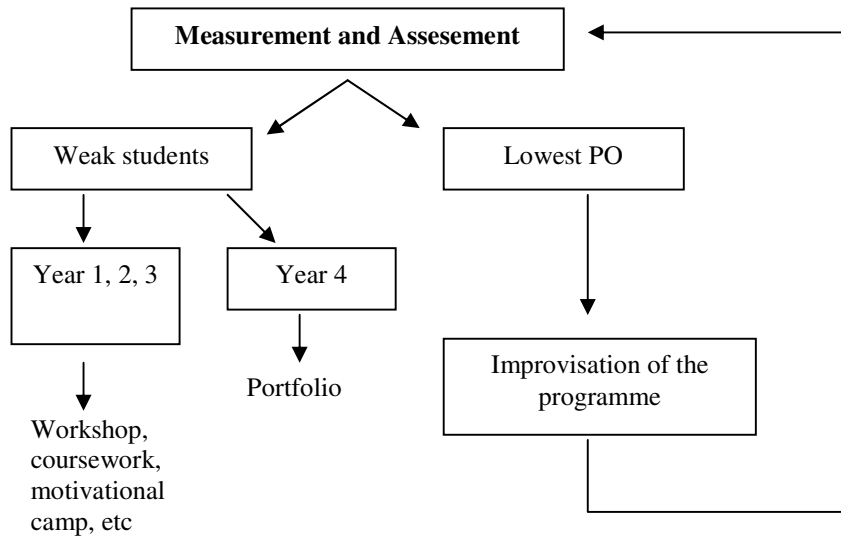


Figure 6. Continuous quality improvement processes

4. Measurement

4.1. Direct Measurement

Measurement of programme outcome had been done in a few courses for Civil Engineering Programme such as KH1243 Computer Programming, KH2243 Engineering Measure, KH2133 Liquid Mechanics, KH4203 Academic Project, KH4213 Design Project and KH4543 Town's Mobility Planning.

A formative and summative measurement is obtained by giving out test and exam questions to the level of its application, synthesis and evaluation in Bloom taxonomy. This process went on during the evaluation of the questions by the board of evaluation. Measurement of learning outcome related to exams and tests such as steep knowledge and analytical skills, was measured by collecting the marks of courses that contribute to the direction of achieving the particular learning outcome. Personal skills measurement such as ability to work in groups, communication and lifelong learning is carried out by observing the students' behaviour while conducting assignments and projects.

Starting on the first semester of 2006, measurements of learning outcome listed in department's courses had been started. More attention should be given to academic project and final year design project (Capstone project). Figure 7-10 shows the average overall point for courses that had undergo PO measurement. Only the 4th year overall PO mark such as in Diagram 10, shows the total mark for 12 PO because it involves two identical courses and all 12 PO were measured.

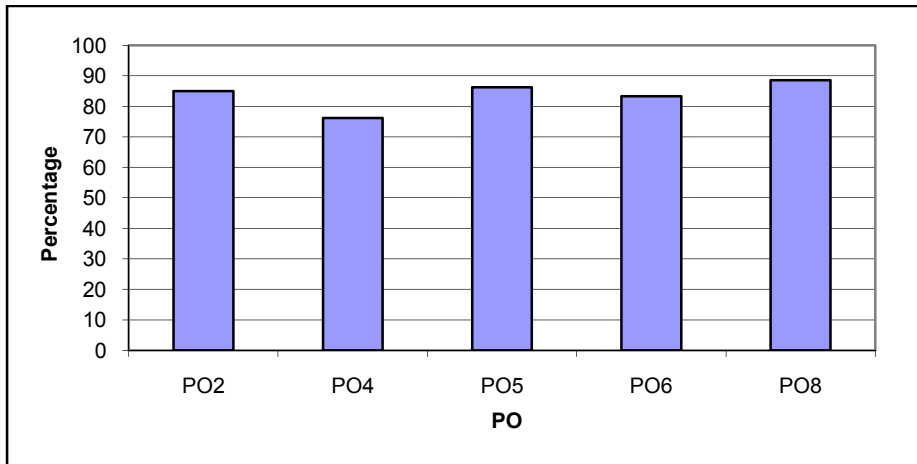


Figure 7. Average PO measurement mark for KH1243

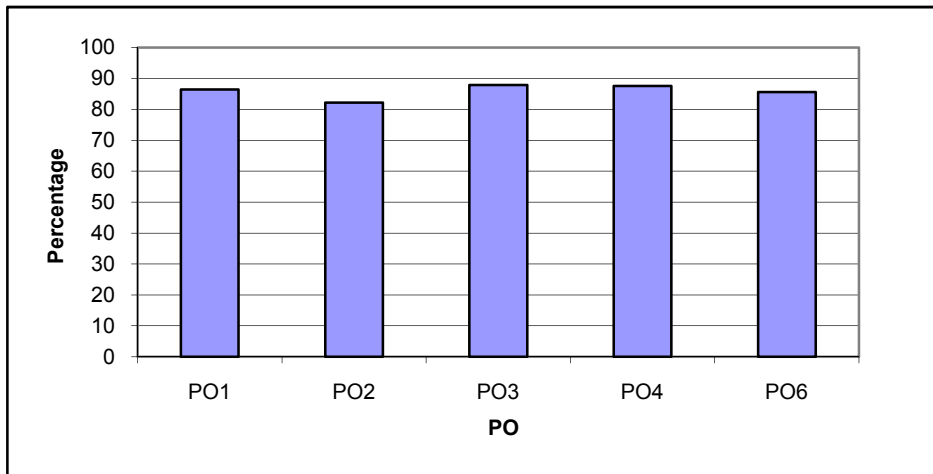


Figure 8. Average PO measurement mark for KH2243

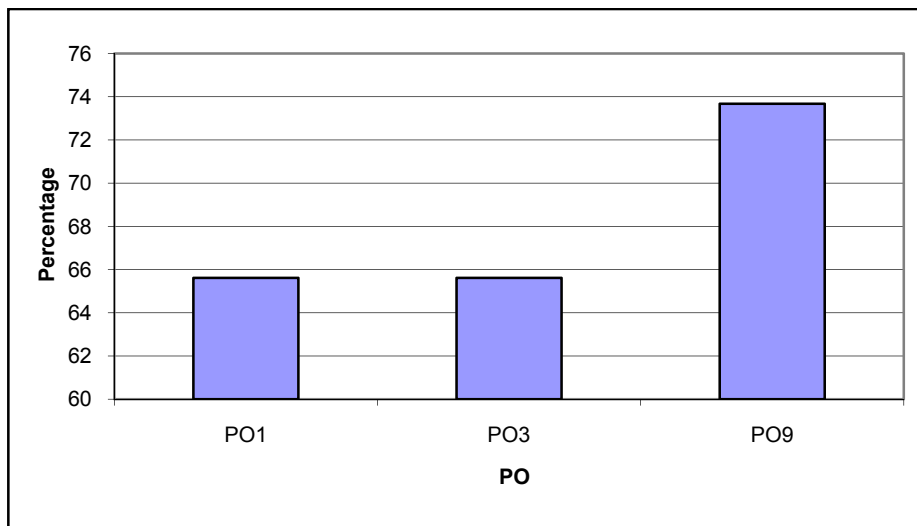


Figure 9. Average PO measurement mark for KH2133

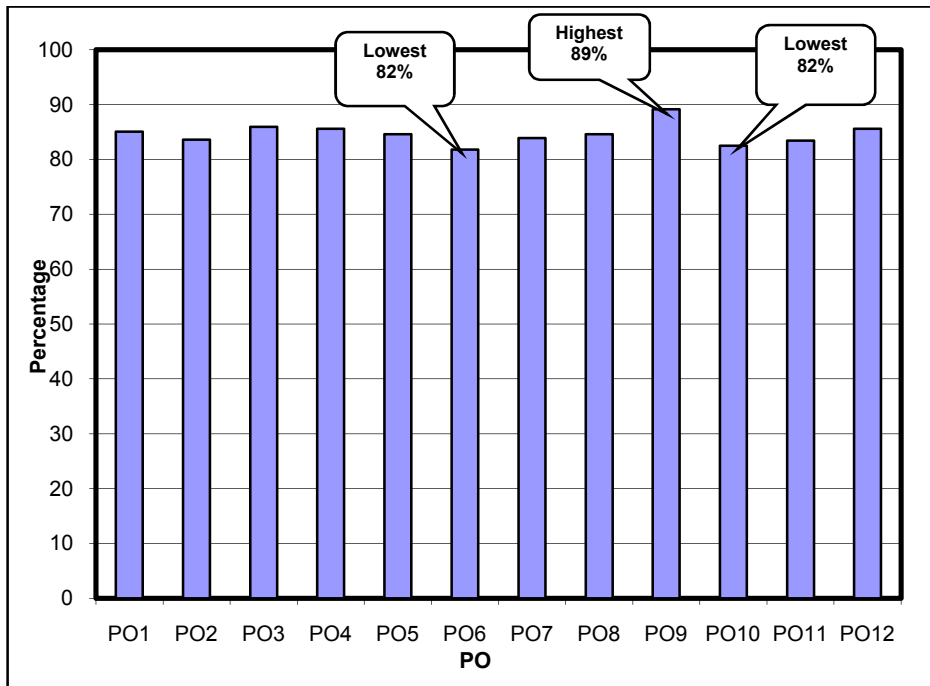


Figure 10. Average PO measurement mark for KH4213 and KH4203

4.2. Indirect Measurement

Indirect measurement had been used to conduct an exit survey and peer assessment. Survey forms had been distributed to all final year students of CSED. Results form the survey is shown in Table 3. From this, it is known that achievement aspect for all programme outcomes (PO) is good except for PO5 where its achievement is moderate.

Table 3. Ranking of PO achievements from the student’s perspective

EXIT SURVEY		
PO10	4.08	Good
PO7	4.00	Good
PO8	3.90	Good
PO1	3.88	Good
PO2	3.88	Good
PO6	3.88	Good
PO9	3.85	Good
PO3	3.83	Good
PO11	3.73	Good
PO12	3.64	Good
PO4	3.61	Good
PO5	3.39	Moderate

Perception of PO achievement is categorized as Good, Neutral or Weak achievement. This is shown in Figure 11. There are 5 POs that is weak in achievements, which are PO5, PO8, PO9, PO11 and PO12. PO5 tops the list of weak achievement result with 8% and modest achievement for PO5 leads the good achievement at 47% and 44% respectively. PO12 is the second lowest good achievement with 64% compared to 34% and 2% for modest and weak achievement respectively. Most of the PO achievement perception shows percentage of good achievement is above 70%, where PO10 shows the highest good achievement with 88%.

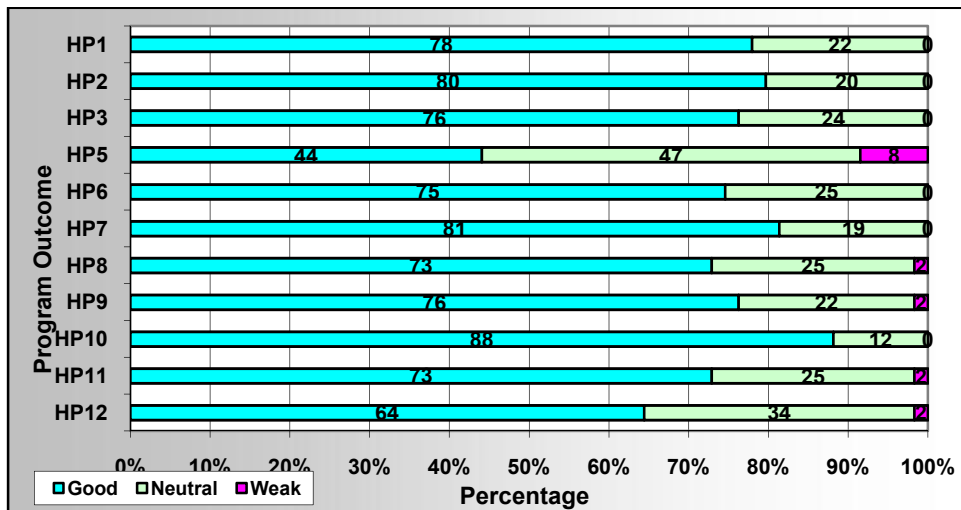


Figure 11. Aspects of 12 PO achievements throughout the study

Direct measurement was also conducted by the lecturers in Designing Project and Academic Project courses. Comparison between direct and indirect measurement (exit survey) is shown in Figure 12. The results of PO achievement is rather different or contra, where, through direct measurement, PO9 is the highest while PO6 and PO10 is the lowest. Contrary to the student’s perception, they thought that their PO10 is the highest and PO5 is the lowest.

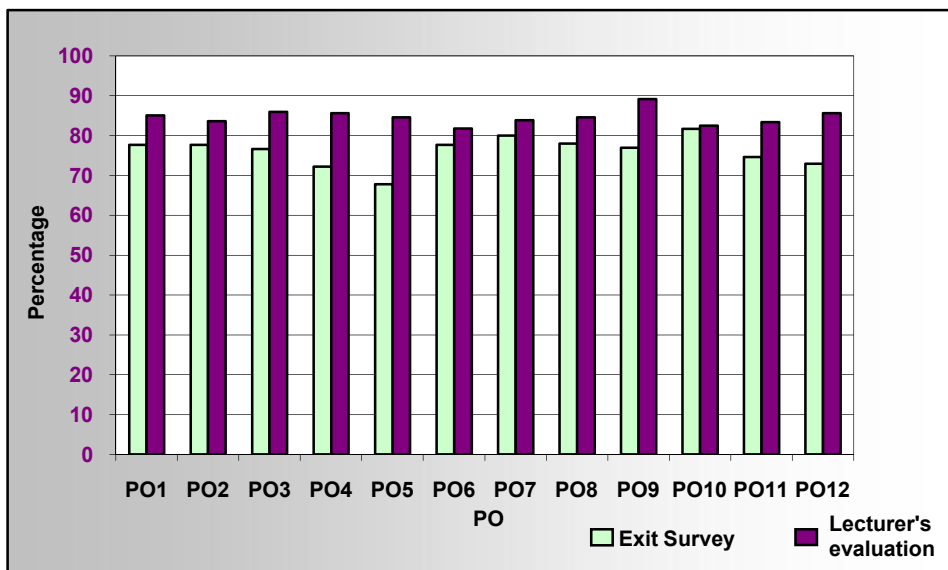


Figure 12. Achievement aspect of 12 PO throughout the study

5. Conclusion

A committee should be established to develop an integrated 'tool of assessment and evaluation' that can be used by all lecturers to measure and evaluate programme outcome. In the department level, the standard operating system was introduced which includes collection of marks from the POs assessment, information gathering system and process of continuous quality improvement. Two types of measurements have been conducted in CSED to measure the achievement of the POs. Direct measurement was carried out in few courses while the indirect measurement had been used in the exit survey of final year students. In direct measurement PO9 is the highest score while PO6 and PO10 are the lowest. This is contrary to the student's perception where they thought that their PO10 achievement is the highest and PO5 is the lowest. Hopefully with that this start of implementing courses measurement can be used as references to all the lecturers at Faculty of Engineering in UKM and all around the world.

Acknowledgement

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References

- Basri H., A.B. Che Man, W.H. Wan Badaruzzaman and M J.M. Nor, (2004). Malaysia and the Washington Accord – What it takes for full membership. *International Journal of Engineering and Technology*, 1(1), 64-73.
- Jawatankuasa Semakan Kurikulum dan OBE. (2006). *Annual Report 2006*, Department of Civil and Structural Engineering, UKM.
- Jaafar M.S., N. K. Nordin, R. Wagiran, A. Aziz, M.J.M.M. Noor, M.R. Osman, J. Noorzaei and F.N.A. Abdulaziz. (2008). *Assessment Strategy for an Outcome Based Education*. International Conference on Engineering Education.
- Rashid R.A., R. Abdullah, A. Zaharim, H.A Ghulman and M.S. Masodi. (2008). *Engineering Students Performance Evaluation of Generic Skills Measurement: ESPEGS Model*. 5th WSEAS / IASME International Conference on Engineering Education (EE'08).
- Felder R.M. and R. Brent, (2003). Designing and teaching courses to satisfy the ABET engineering criteria. *Journal of Engineering Education*, 92(1), 7-25.
- Badaruzzaman W.H.W. (2005). *Outcome-Based Approach to Education – An Overview*. Port Dickson, 21hb Disember 2005.