

## **Achievement of Programme Outcomes for Chemical Engineering and Biochemical Engineering Graduating Students of Session 2013/2014: Result of an Exit Survey**

**Nordin, D.<sup>1,2\*</sup>, Anuar, N.<sup>1,2</sup>, Rohani, R.<sup>1,2</sup> and Othman, N. T. A.<sup>1,2</sup>**

<sup>1</sup>*Department of Chemical and Process Engineering, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia*

<sup>2</sup>*Centre for Engineering Education Research, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia*

### **ABSTRACT**

This study was conducted to evaluate the performance of students through the achievement of programme outcomes (PO) for two programmes offered at the Department of Chemical and Process Engineering (JKKP), namely, Chemical Engineering and Biochemical Engineering. Implementation of the Outcome-Based Education (OBE) approach from the 2005/2006 session has opened a new chapter in the process of teaching and learning (TnL) at the departmental level in particular. Special emphasis was given to the ability of students to use, apply and relate engineering knowledge in order to solve complex engineering problems. Therefore, regular monitoring is important to look at the trend of PO student achievement for each session. The assessment was conducted by distributing questionnaires to final-year students of the department at *Majlis Mesra Bakal Graduan* (MMBG), an event that is held at the end of the second semester of every session. Questionnaires were distributed to students to get their feedback on the implementation of the programme during their four years at JKKP and the proposed improvements to the programme and their evaluation of the performance of the POs set by the department for both programmes. Comparison of the results from sessions 2012/2013 and 2013/2014 shows a slight decrease in terms of performance of the PO achievements.

### **ARTICLE INFO**

#### *Article history:*

Received: 09 October 2015

Accepted: 31 March 2016

#### *E-mail addresses:*

[darman@ukm.edu.my](mailto:darman@ukm.edu.my), [darman2502@gmail.com](mailto:darman2502@gmail.com) (Nordin, D.),

[nurina@ukm.edu.my](mailto:nurina@ukm.edu.my) (Anuar, N.),

[rosiah@ukm.edu.my](mailto:rosiah@ukm.edu.my) (Rohani, R.),

[tantiyani@ukm.edu.my](mailto:tantiyani@ukm.edu.my) (Othman, N. T. A)

\* Corresponding author

*Keywords:* Outcome-based education, exit survey, chemical engineering, biochemical engineering

### **INTRODUCTION**

Malaysia's acceptance as a full-signatory status member in the Washington Accord in 2009 has shown the quality

of its engineering education amongst internationally recognised countries (Dixit & Pathak, 2012). This success is the result of the implementation of Outcome-Based Education (OBE), introduced in the Malaysian Qualification Framework (MQF), which requires each lecturer to identify the elements that need to be mastered by students at the end of their studies (Muhd Nor et al., 2013). This method placed special emphasis on the development of students to produce graduates who not only have deep knowledge of engineering fundamentals and who are sensitive to the latest technological developments, but who also have a responsible attitude towards social change, the environment and the community around them (Embi, 2010). The Faculty of Engineering and the Built Environment (FKAB) has been carrying out OBE thoroughly by varying the method of delivery to include methods such as project-based learning, project-orientated problem-based learning, active learning and cooperative learning (Felder & Brent, 2006). Each course and teaching and learning activity is designed based on the programme outcomes (PO) and the programme educational objectives (PEO) that have been determined by the faculty and department. POs are knowledge, abilities and skills that the students of the chemical and biochemical engineering programmes must acquire upon completion of their studies while PEOs refer to objectives that should be demonstrated by each graduate in their career and their professional life after graduation.

Currently, in the Department of Chemical and Process Engineering, FKAB, chemical and biochemical programmes are designed based on 12 POs and six PEOs. Measurements of these elements need to be carried out in order to evaluate the effectiveness of the programme in the department. Typically, the PO element is measured at the end of the second semester of each year while the PEO is measured within three to five years after the students have graduated. Therefore, this study focussed only on the POs because data collection of the PEOs would have required more time for each batch of students. There are various methods that can be used to measure the achievement of PO, such as through survey forms, integrated project evaluation, laboratory activities etc. Data from this study were collected by distributing questionnaires to final-year students during the *Majlis Mesra Bakal Graduan* (MMBG), which is held at the end of the second semester of each academic session in order to honour all of the students who would soon be finishing their studies. Several studies have been previously conducted with other groups of final-year students from session 2010/2011 to 2012/2013 and the results showed positive development in terms of achievement of each PO. To ensure the continuity of these studies, it is necessary to continue monitoring efforts to ensure that implementation of elements of this PO is always on the right track. In addition, changes often occur in the process of accreditation by the

Engineering Accreditation Council (EAC) for engineering programmes in Malaysia, which further contributes to the importance of conducting this study from time to time. In 2012, the EAC introduced its latest manual to remodel most of the POs for each engineering programme at higher educational institutions (IPT) in Malaysia (EAC, 2012). An addition of complex engineering elements caused extensive change to the previously used 12 POs. Therefore, starting with the 2012/2013 session, PO measurement has been carried out using the 12 new POs. This study, then, will look at the achievements of the 12 new POs for graduating students in the 2013/2014 session and compare these achievements with a group of students from the previous session.

## METHOD

This study was conducted during the MMBG to honour the graduating final-year students of the 2013/2014 session consisting of 24 and 23 students of the Chemical Engineering (CE) and Biochemical Engineering (BE) programmes, respectively. During the event, an exit survey was administered by distributing a questionnaire regarding PO achievement to the students. This study required the students' consent to the achievement of the entire 12 new POs based on the latest EAC manual. The questionnaire was divided into two main parts. The first part (Part A) of the questionnaire was about the demographics of the respondents i.e. gender and programme. The second

part (Part B) contained statements on the process of learning and teaching that the students experienced throughout their four years in JKPP. There were six main sections in Part B. The first part consisted of 12 statements concerning the POs consisting of engineering knowledge (PO1), problem analysis (PO2), the design and development of problem solving (PO3), investigation (PO4), the use of modern tools (PO5), engineers and the public (PO6), environment and sustainability (PO7), ethics (PO8), communication (PO9), individual and teamwork (PO10), lifelong learning (PO11) and project management and finance (PO12). Evaluation was based on a 5-point Likert scale. A Likert scale was used because it is balanced on both sides of a neutral option and allows for a less biased measurement (Norman, 2010). Overall, PO achievement was measured for both the chemical and biochemical engineering programmes in the 2013/2014 session and the results were compared with achievements in the previous session.

## RESULTS

### General Information

In the 2013/2014 session, a total of 47 students were about to graduate from the department, of whom 24 students were from the CE programme and 23 from the BE programme. Table 1 shows the percentage of students in the final year of CE and BE who answered the questionnaire. The percentage of respondents who participated in this session was very encouraging, that is 85% of the total student number.

Table 1  
*Number and Percentage of Graduating Students who Answered the Questionnaire*

Programme	Number of Students	Number of Respondents	% of Respondents
Chemical Engineering (CE)	24	19	79
Biochemical Engineering (BE)	23	21	91
Total	47	40	85

**Achievement of Programme Outcomes**

Programme outcomes in this questionnaire encompassed all 12 of the new POs as stated in the 2012 EAC manual. This section required the respondents to provide feedback on their performance for each PO outlined for each programme as to whether their

performane was “Poor”, “Fair”, “Good”, “Very good” or “Excellent”. The analysis method used was summated scale ratings on data obtained and is shown in Figure 1 and Figure 2, which, respectively, denote percentage points of each PO achievement of the KK and KB programmes.

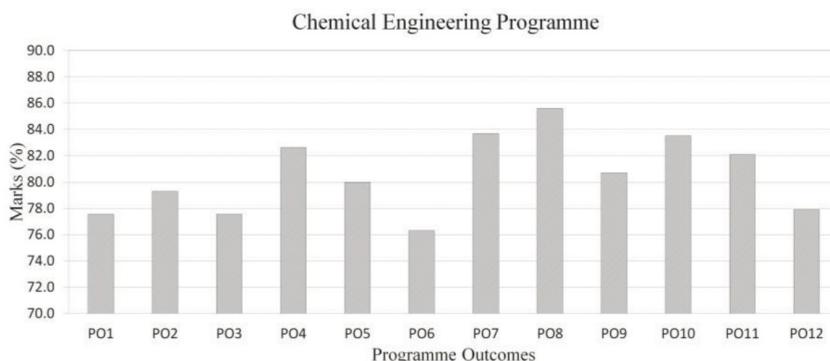


Figure 1. Percentage of respondents who noted achievement in the attainment of programme outcomes (PO) for Chemical Engineering.

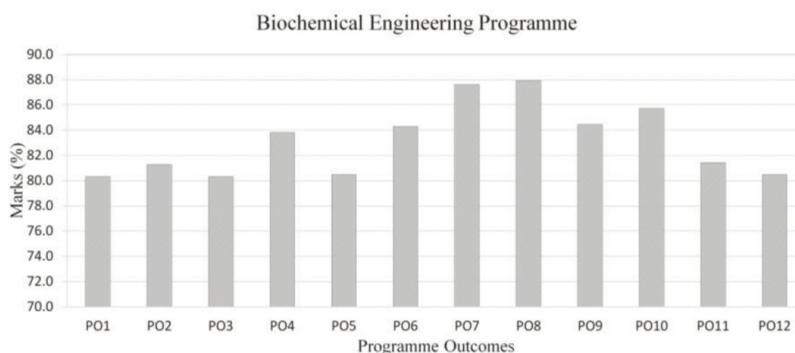


Figure 2. Percentage of respondents who noted achievement in the attainment of programme outcomes (PO) for Biochemical Engineering.

### Comparisons of New PO Achievements

In the 2012/2013 session, the EAC had asked all institutes of higher learning in Malaysia to offer engineering programmes using the new 12 POs as listed in the 2012 EAC manual. The main difference between the new and the old set of POs is an element of complex engineering problems that are included in nearly all PO elements (Anuar et al., 2012). Therefore,

comparison of PO achievement can only be performed for session 2012/2013 and 2013/2014. The comparison is performed using a summated rating scale for the entire PO for each session in which the overall score of the 12 POs has been summarised and presented as a percentage representing the value of KK and KB programmes. Figure 3 shows a comparison of the achievements of the 2012/2013 session and 2013/2014.

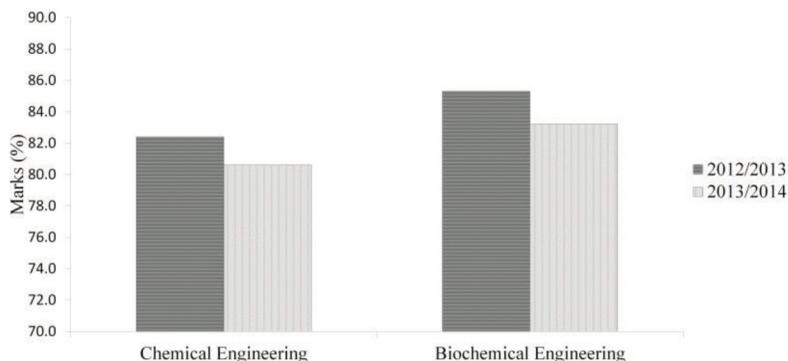


Figure 3. Comparison between the achievement of POs in the comprehensive Chemical Engineering and Biochemical Engineering programmes for 2012/2013 and 2013/2014.

### DISCUSSION

The effectiveness of the survey depended on the number of students who answered the survey (Groves et al., 2004). In session 2012/2013, only about 60% of the students participated. However, the percentage increased in this session to 85% from the total number of final-year students. This is due to the introduction of several exciting activities in the MMBG event such as a talk from the Board of Engineers Malaysia (BEM) and a lucky draw to win student interest in the event. Apart from that, the lecturers had also encouraged the students

to involve themselves in the event so that they could contribute towards the process of improving teaching and learning activities in the department. The high percentage of student attendance also allowed the department to collect a good sample of data and input from the students in order to assist the department in improving the effectiveness of the implementation of the POs that have been outlined by the EAC.

For the CE programme (see Figure 1), the percentages recorded for all 12 POs were over 75%. PO8 recorded the highest score of 86%, followed by the

environment and sustainability (PO7) at 84%. This clearly shows that the curriculum was successfully designed to enhance understanding of the ethical culture of a professional engineer in terms of social, global culture, environment and sustainable development in the graduating students. Five other POs also recorded scores of more than 80% including PO4 (investigation), PO5 (use of modern tools), PO9 (communication), PO10 (individual and teamwork) and PO11 (lifelong learning). The POs that scored less than 80% were PO1 (knowledge engineering), PO2 (problem analysis), PO3 (design and development of problem solving), PO6 (engineers and community) and PO12 (financial and project management). Although the recorded scores were still more than 75%, more attention should be given to the POs. Practical ways to improve teaching and learning activities have to be carried out to ensure that this achievement can be increased in the future. PO1, PO2 and PO3 are related to technical knowledge and problem-solving skills, thus a new teaching and learning approach should be introduced, such as the application of social media and flipped classroom. Both PO6 and PO12 can be improved by providing more opportunities to the students to organise activities that can benefit communities such as the introduction of Chem E Car in secondary school (Kamaruddin et al., 2012).

There were measurable differences for the Biochemical Engineering programme (see Figure 2). These results were very

good and encouraging for all 12 POs, with scores of more than 80%. PO7 and PO8 still gave the highest score of the 12 POs, which both registered a score of 88%. PO1 (knowledge engineering) was also one of the lowest compared to other POs. This means that greater emphasis should be given in terms of the ability of students to apply their knowledge of engineering in solving complex engineering problems. Overall, the 12 POs offered in both the CE and BE programmes have achieved satisfactory results. This can be seen from the feedback of the respondents of both programmes, who did not choose “Poor” or “Fair” for the POs collected in the survey form. However, attention should be given to POs for which respondents still chose “Good” to ensure that the effectiveness of the new POs can be enhanced.

The comparison of PO achievement is performed for session 2012/2013 and 2013/2014. In Figure 3, it clearly shows that a slight decrease in scores occurred in the 2013/2014 session, and this should be given immediate attention. This is probably due to the fact that it was still the early stage of the implementation of the new set of POs in 2012, which meant that complex engineering problems were emphasised on in each of the TnL activities. The graduating students of session 2012/2013 had only been exposed to changes in the POs that had been exercised in the department for two semesters compared to the students of session 2013/2014, who had been exposed to the changes for four semesters. Hence, lack of understanding of the new concept

behind the complex engineering problems stated in the POs could have been one of the factors that contributed to the difference in the PO achievement although both sessions scored good results i.e. above 80%. In order to improve this survey, all students in the department should be given a detailed explanation of the programme outcomes so that towards the end of their final year in UKM, they will understand each of the 12 POs for the two programmes offered at the department.

Apart from the exit survey, the department also conducted other programmes such as a student dialogue for every semester, a feedback session at the end of integrated projects (Rahman et al., 2013) and open-ended lab (Kofli & Rahman, 2012) activities to obtain constructive feedback regarding the matters related to the POs that required further improvement.

## CONCLUSION

The PO achievement shown by graduating students of the Department of Chemical and Process Engineering was good and laudable. However, there was a slight decrease in the overall percentage scores (1-2%) of those registered in the 2013/2014 session compared to those registered in the previous session. Although this is a slight decline, attention should be given to ensure that graduates of the programme in Chemical Engineering and Biochemical Engineering will be able to acquire and apply knowledge of basic science and engineering, identify problems, formulate

and seek solutions of complex engineering problems, work effectively as individuals and in a group and show ability to be a leader, a manager or a team member effectively, be able to work ethically and communicate well. Therefore, it is the responsibility of the department and/or faculty to continue to improve the quality of teaching and learning in the future. Regular monitoring is one of the important aspects in the process of continuous quality improvement and is important for this kind of study to be repeated every year.

## ACKNOWLEDGEMENT

The authors would like to thank the Universiti Kebangsaan Malaysia for allocating the research grant, namely, PTS-2014-034 for conducting research related to engineering education. Special acknowledgement goes to the Centre for Educational Research (P3K), Faculty of Engineering and Built Environment, UKM for supporting the researchers formally or informally in completing this study.

## REFERENCES

- Anuar, N., Abdullah, S. R. S., & Mohamad, A. (2012). The measurement of program outcomes through research project in the Department of Chemical and Process Engineering. *Procedia Social and Behavioral Sciences*, 60, 124–129. <http://dx.doi.org/10.1016/j.sbspro.2012.09.357>
- Dixit, R. K., & Pathak M. (2012). An overview of international engineering accords with special reference to the Washington Accord. *Journal of Engineering, Science and Management Education*, 5(2), 467–471.

- Embi, M. A. (2010). *Panduan amalan pengajaran & pembelajaran berkesan*. UKM, Bangi, Malaysia.
- Engineering Accreditation Council (EAC). (2012). *Engineering programme accreditation manual*. Board of Engineers Malaysia (BEM).
- Felder, R. M., & Brent, R. (2006). How to teach (almost) anybody (almost) anything. *Chemical Engineering Education*, 40(3), 173–174.
- Groves, R. M., Presser, S., & Dipko, S. (2004). The role of topic interest in survey participation decisions. *Public Opinion Quarterly*, 68(1), 2–31. doi: 10.1093/poq/nfh002
- Kamaruddin, S. K., Kofli, N. T., Ismail, M., Mohammad, A. B., & Takriff, M. S. (2012). Soft skill development via chem-e-car project. *Procedia Social and Behavioral Sciences*, 60, 507–511. doi:10.1016/j.sbspro.2012.09.415
- Kofli, N. T., & Rahman, N. A. (2011). The open ended laboratory for measurement of communication skill for chemical/biochemical engineering students. *Procedia Social and Behavioral Sciences*, 18(0), 65–70. doi: <http://dx.doi.org/10.1016/j.sbspro.2011.05.010>
- Muhd Nor, N. H., Azlan, M. A., Kiong, S. C., Mohamad, F., Ismail, A. E., Kasmin, A., Ahmad, M. F., & Seiji, Y. (2013). Development of course management and monitoring system as a quality tools in engineering education. *Applied Mechanics and Materials*, 465, 395–400.
- Norman, G. (2010). Likert scales, levels of measurement and the “laws” of statistics. *Advances in Health Sciences Education*, 15(5), 625–632.
- Rahman, N. A., Abdullah, S. R. S., Kofli, N. T., Tasirin, S. M., Kamarudin, S. K., & Jahim, J. M. (2013). Enhancement in monitoring for integrated project implementation. *Procedia Social and Behavioral Sciences*, 102(0), 92–99. doi: <http://dx.doi.org/10.1016/j.sbspro.2013.10.718>.