INTI JOURNAL | eISSN:2600-7320
Vol.2020:020

A Malaysian Outcome-Based Engineering Education Model: The Implementation and Challenges in Future

Sam Man Keong[1], Soong Cai Juan[2*], Kok Ching Wen[3]

[1,3]Faculty of Engineering and Quantity Surveying (FEQS), INTI International University, Persiaran Perdana BBN, Putra Nilai, 71800 Nilai, Negeri Sembilan, Malaysia.
[2]Centre for Emerging Technologies in Computing (CETC), INTI International University, Persiaran Perdana BBN, Putra Nilai, 71800 Nilai, Negeri Sembilan, Malaysia.

*Email: caijuan.soong@newinti.edu.my

Abstract

Malaysia is one of the signatories member of the Washington Accord as well as the Engineering Accreditation Council (EAC) in the country. The change to an Outcome-Based Learning (OBE) is an entitle transformation mode where students are educated, assessed and graduated. Even though the EAC's 1999 issued guidebook listed 12 graduate attributes, but yet less effort to ensure engineering education appreciate and implement it. In 2000, the Malaysian Engineering Education Model also precede for engineering education to adopt OBE but the spirit of MEEM was not entirely comprehended and there was no force to obey to the recommendations. Since 2004, Malaysia Higher Education Ministry has adopted the OBE to emerge with few engineering education providers leading the way. Although many educational institutes have prefer in implementing OBE curriculum to deliver Engineering Education, but yet challenging and tedious tasks to implement it successfully. Hence, the aim of this study is to scrutinize a variety of challenges encountered by instructors in implementing the OBE in conveying technical subjects in tertiary university. A preliminary test of OBE is conducted in this study. Data are collected from 13 instructors from private university through questionnaire survey as well as interviews. Data collected are analysed and exploiting both descriptive statistics and statistical tests to delineate the primary challenges. Consequently, the novelty findings established significantly in OBE implementation especially these vital facts should be right direction and aid to unlock frontiers for preparing instructors in facing future challenges which impeded the effective implementation of OBE curriculum in teaching and learning in tertiary university.

Keywords

Outcome-based, Challenge, Engineering Education

International Conference on Innovation and Technopreneurship 2020
Submission: 25 August 2020
Acceptance: 24 September 2020

Introduction

Outcome based education (OBE) is adopted by Malaysia Higher Education Ministry for all tertiary education. In fact, OBE is claimed as the newest paradigm shift sweeping the education system from traditional content driven curriculum in handling teaching and learning instructions at tertiary education with the intention to produce job ready graduates and meet the demand of economic changes (Mohayidin *et al*, 2008; Pauzi *et al.*,2014; Gurukkal, 2020).

The OBE is the guidance to reach the Graduate Attributes (GAs) or Program Outcomes (POs) (Palmer and Ferguson, 2008). OBE is a formal teaching–learning system of purpose, goals and quality (Ramírez, 2013; Oliver, 2013). Hence, it can concluded that implementation of OBE generally requires a restructuring of the entire education system especially in engineering.

Hence, Engineering Programmes in Malaysia adopts the Engineering Criteria originated from the ABET – Engineering Criteria 2000. The latest version contains 12 Programme Outcomes (POs) developed from the 12 Graduate Attributes (adopted by all signatories of the Washington Accord) as shown in Table 1:

Table 1. 12 Graduate Attributes

PO	Graduate Attributes
1	**Engineering Knowledge** – Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialisation to the solution of complex engineering problems.
2	**Problem Analysis** – Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
3	**Design/Development of Solutions** – Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
4	**Investigation** – Conduct investigation into complex problems using research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
5	**Modern Tool Usage** – Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering problems with an understanding of the limitations.
6	**The Engineer and Society** – Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities
7	**Environment and Sustainability** – Understand and evaluate the sustainability and the impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts.
8	**Ethics** – Apply ethical principles and commit to professional ethics & responsibilities and norms of engineering practice and contribute to the National Aspirations.

International Conference on Innovation and Technopreneurship 2020
Submission: 25 August 2020
Acceptance: 24 September 2020

9 **Communication** – Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

10 **Individual and Team Work –** Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.

11 **Life Long Learning –** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

12 **Project Management and Finance –** Demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

Background Studies

One of the earlier supporters of OBE approach, Spady (1994) believed that all students can learn and succeed, but not all at the same time or in the same way, and success would breed more success. In other words, students can achieve high standards if they are given appropriate learning opportunities. While, Larry (2012) mentioned that USA identifies two main challenges in OBE: First, In OBE, time is flexible and the outcomes are fixed; Second, Because OBE requires learners to take responsible for their own learning and have flexible, individualized learning options, faculty roles shift to be being advisors, mentors, and guides. Third, Jonathan (2017) highlighted four guiding principles for the successful implementation of OBE: (1) Clarity of Focus (Instructors aware and conscious about the outcomes of education each student must manifest to these outcomes); (2) High expectations (level of performance ensures that students successfully meet desired learning outcomes); (3) Expanded opportunity: Every student is a unique learner; students vary on thinking or cognitive styles (students in the process of learning and more importantly in assessing their performance); (4) Design down : Top-down approach (designing and stating the outcomes of education (i. e., culminating --- enabling --- discrete outcomes). Moreover, Joseph, *et al* (2007) evidenced that on medical education using case studies, the successful implementation of OBE required the mixed use of teaching and learning methods: Self-directed learning; Small group tutorials; Interactive sessions; Didactic methods. Further details shown in Table 2 and Table 3.

Table 1 Summarizes the OBE Experience in other countries.

No	Researchers/Country	Findings

1	Liliya (2013) from Simon Fraser University in **Canada.**	1. Current students are resistant to change and unwilling to exercise creative thinking skills necessary for the designed qualities of 21st century learners. Very often students prefer to passively receive information rather than actively participate in their own learning. 2. Managing large (and increasing) class sizes from 60 – 180 students.
2	Wang (2005) from Hong Kong Institute of Education, **Hong Kong**	1. Content is still important. 2. Well written outcome statement are not easy to design due to the complexity of the learning. 3. Educators need to be well prepared to help learners and to achieve the outcomes, using varieties of instructional methods. 4. Teachers need to be flexible in the way they present information to learners, give them diverse opportunities to learn, and be flexible in their approaches to assessments. 5. Capacity Building: development of technical skills required to implement an outcome-based instructional system. 6. Students: over-burdened with multiple assessment tasks.
3	Richard (2004) from the School of Education, University of Notre Dame, **Australia**	1. OBE is confusing; 2. Good teachers have always educated via Outcomes. 3. Education is not a product defined by specific output measures; it is a process, the development of the mind. 4. OBE : increase in paperwork; the paperwork took them away from their real job teaching. 5. OBE is suffocating teachers (Overarching learning outcomes). 6. OBE suffers from assessment overloads. 7. Teachers are expected to produce never-ending tonnes of evidences, usually in the form of student portfolios.

Submission: 25 August 2020
Acceptance: 24 September 2020

Table 3 Summarizes the OBE Experiences in Malaysia

No	Researchers	Findings
1	Goh, et al (2019) from University of Nottingham-Malaysia Campus (UNM)	1. Achieved : PO1 – Engineering Knowledge; PO2 – Problem Analysis; PO5 – Modern Tool Usage. 2. Not achieved : PO9 – Communication; PO10 – Individual and Teamwork. [Board of Engineers Malaysia (BEM) Requirements : 12 Programme Outcomes (POs)] (12 POs as adopted by all the signatories of the Washington Accord)
2	Aziz, et al (2017) from Universiti Putra Malaysia (UPM)	1. Successfully developing the Civil Engineering programme from **first principle** : Courses to support Programme Education Objectives (PEOs) and Programme Outcomes (POs). 2. Grouping the Programme Outcomes (POs) into four categories: Knowledge; Hard Skills; Soft Skills; and Attitude. 3. 12 POs based on Engineering Accreditation Council (EAC) Attributes.@ The spirit of continual improvement is integrated within the curriculum➔ Continuous Quality Improvement (CQI)
3	Norhayati, et al (2016) from KPJ Healthcare University College	1. OBE was implemented at Faculty of Health Sciences in 2014. 2. Nine POs. 3. 19 students were involved in study (13 BMI graduating students; 6 BPY graduating students). Respondents were generally satisfied with the programme learning outcomes (POs).

Methodology

This research work was carried out in two main parts which are survey method and interviews. Survey forms were distributed to instructors in selected Engineering Faculty of Higher Educational Institution (HEI) in February 2020. The Survey Form consists of three main parts: Part A – Profile of Instructors and Part B – Questions on selected Challenges in implementation in OBE (B1 – B10) using Likert Scale (1 – Strongly Disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; 5 – Strongly Agree). For interview part selected 'instructors/experts' who have participated in Part 1 (Survey) were interviewed based on the 'Structured Questions' and 'Open-ended Questions related to issues related to OBE, eg Class-Size; teaching load; OBE Curriculum; online assessment.

Submission: 25 August 2020
Acceptance: 24 September 2020

Data analyzes by Descriptive Statistics and Hypothesis Testing. Descriptive Statistics included mean and standard deviation for each Challenge will be computed. Rankings based on Mean will be adopted. Hypothesis Testing included t-test (single sample means): To determine whether the challenge is statistically significant for 'instructors'.[Hypotheses:$\mu_0 = 3$; $\mu_1 > 3$]

Results and Findings

In this present study, descriptive statistics and t-test (Single sample mean) are shown in Table 4 and Table5.

Table 4 - Summary of **Descriptive Statistics** on Challenges of Outcome-Based Education (OBE) implementation in Higher Learning Institutions (**Instructors' Perspective**)(n = 13)

No	Challenge	Mean	SD	Ranking (Based on Mean)
B1	Increased workload of Instructors	**4.615**	**0.650**	**1.5**
B2	Increased Time devotion of instructors in regular preparation time in the online environment.	**4.615**	**0.650**	**1.5**
B3	Instructors are reluctant to think and rework their practices to meet students' needs.	**2.769**	**0.927**	**7**
B4	Instructors lack of willingness to be trained or counselled.	**2.462**	**0.967**	**10**
B5	OBE require high level of student discipline and responsiveness.	**4.308**	**0.855**	**3**
B6	Increased time devotion of students to participate in the discussion on a regular basis.	**4.0769**	**0.641**	**4**
B7	Adaptation of OBE in the traditional University Culture.	**3.692**	**0.855**	**5**
B8	Lack of support by institution concerning logistics including technical support and management of the learning environment.	**3.538**	**1.127**	**6**
B9	Students know how to learn.	**2.615**	**0.768**	**8.5**
B10	Students have the knowledge and Know-hows.	**2.615**	**0.870**	**8.5**

Table 5 - Summary of **t-test (Single Sample Mean)** on Challenges of Outcome-Based Education (OBE) implementation in Higher Learning Institutions (**Instructors' Perspective**)(n = 13) .[Hypotheses:$\mu_0 = 3$; $\mu_1 > 3$]

No	Challenge	Mean	SD	p-value	Remark @

B1	Increased workload of Instructors	**4.615**	**0.650**	**1.5**	*******
B2	Increased Time devotion of instructors in regular preparation time in the online environment.	**4.615**	**0.650**	**1.5**	*******
B3	Instructors are reluctant to think and rework their practices to meet students' needs.	**2.769**	**0.927**	**7**	**NS**
B4	Instructors lack of willingness to be trained or counselled.	**2.462**	**0.967**	**10**	**NS**
B5	OBE require high level of student discipline and responsiveness.	**4.308**	**0.855**	**3**	*******
B6	Increased time devotion of students to participate in the discussion on a regular basis.	**4.0769**	**0.641**	**4**	*******
B7	Adaptation of OBE in the traditional University Culture.	**3.692**	**0.855**	**5**	******
B8	Lack of support by institution concerning logistics including technical support and management of the learning environment.	**3.538**	**1.127**	**6**	**NS**
B9	Students know how to learn.	**2.615**	**0.768**	**8.5**	**NS**
B10	Students have the knowledge and Know-hows.	**2.615**	**0.870**	**8.5**	**NS**

@Remarks

p-value	Remarks
➢ 0.05	Not Significant (NS)
< 0.05	Significant (*)
<0.01	Very Significant (**)
<0.001	Extremely Significant (***)

The top FIVE (5) challenges from Descriptive Statistics (Table 4) are:

(1) B1- Increased work load for instructors.
(2) B2- Increased time devotion for instructors in regular preparation time in the online environment.
(3) B5- OBE require high level of student discipline and responsiveness.
(4) B6 - Increased time devotion of students to participate in the discussion on a regular basis.
(5) B7- Adaption of OBE in the traditional University Culture.

Major findings from the t-test (Single Sample Mean)(Table 5) are:

(1) FOUR (4) Challenges are statistically extremely significant:
  (a) B1 – Increased work load for instructors;
  (b) B2 - Increased time devotion for instructors in regular preparation time in the online environment.

(c) B5- OBE require high level of student discipline and responsiveness.
(d) B6 - Increased time devotion of students to participate in the discussion on a regular basis.

(2) ONE (1) Challenge is statistically very significant: B7 – Adaption of OBE in the traditional approach.
(3) FIVE Challenges are not statistically significant: B3, B4, B8, B9 and B10.

In other words the biggest challenges to the instructors are increased work load and time devotion to preparation. Findings from Challenges B9 and B10 indicated that students are not ready for '**Self-centred Learning (SCL)**' because students did not know how to learn and do not have the knowledge. In other words students still prefer the traditional approach of 'spoon fed' , a culture built-up since Secondary Schools,

Major Findings from interviews with experts are:

(1) **Inappropriate Learning Outcomes** (CLOs or LOs): not clear; too loose; too hard; hard to measure; not realistic or attainable; not drafted by the instructors who are teaching the course.
(2) **Extra burdens** on instructors and educational institutions: An OBE system may require the instructors track and report dozens of separate outcomes.
(3) **Lack of evidence** that OBE actually works, OBE is a loosely bound collective of ideas; difficult to test OBE's effectiveness in a way that applies universally; little published evidence that OBE actually works.
(4) **Class Size**: Too large (50 -60) instead of 20 (Student: Staff ratio = 20 : 1 or better). Hard to monitor or introduce '**Problem-Based Learning** ' (PBL) for better interaction/discussion.
(5) **Curriculum**: still 'traditional', just matching old LOs to POs; no change in Curriculum Structure.

Conclusions

In conclusion, for the successful implementation of OBE are (1) OBE Curriculum must start from PEOs to POs and not trying to match existing LOs (based on traditional approach) to POs and PEOs. (2) The spirit of Student-centred Learning (SCL) must start from young, if possible from Primary Schools. (3) Student's discipline need to start from young, if possible from Primary. (4) Class size needs to be small: 20 or better for 'Lectures'; 10 or better for 'Tutorials and Practicals' to using 'Problem-based Learning (PBL)'. (5) Teaching load for instructors needs to be revised to allow for increased time devotion to preparation and interaction with students in class and online. Therefore, based on this evidence, it persuaded and concluded us that such vital information can be right track and aid to unlock frontiers for preparing instructors in 21st century in tertiary university.

Submission: 25 August 2020
Acceptance: 24 September 2020

References

1. Goh, B.H., Lai, C.G., Lee, G.P., and Muthoosamy, K. (2019). Evaluation of student learning outcomes on engineering surveying. International Journal of Engineering & Technology. Volume 8(3), 252-256.
2. Ramírez, B. G. (2013). Studying quality beyond technical rationality: Political and symbolic perspectives. *Quality in Higher Education, 19*(2), 126–141.
3. Gurukkal, R. (2020). Outcome-Based Education: An Open Framework. Higher Education for Future, 7, 1–4.
4. Norhayah, M.Z., Asma, A.H., and Khairiah. (2016). Outcome Based Education: A Perception from Private ealth Sciences Graduating Scholars in Malaysia. European Journal of EDucatiob Studies. Volume 2(6), 78-86.
5. Rohaila, Y., Norasmah, O., Norlia, M.N., Noor Lela, A., and Norasibah, A.J. (2017). Implementation of Outcome-Based Education (OBE) in Accounting Programme in Higher Education. International Journal of Academic Research in Business and Social Sciences. Volume 7(6), 1186-1200.
6. Wang, L.X. (2011). Designing and Implementing Outcome-Based Learning in a Linguistics Course: A Case Study in Hong Kong. Precedia Social and Behavioural Sciences. Volume 12, 9-18.
7. Larry, D.G. (2012). Outcome-Based Medical Education: Implications, Opportunities and Challenges. Korean Journal of Medical Education. Volume 24(4), 281-285.
8. Pauzi, N. I. M., Muda, I. Z. C, Omar, R. C. and Katman, H. Y. (2014). Implementation of Outcome Based Education in UNITEN-Closing the Loop (PEO). Universiti Tenage Nasional Selangor Malaysia.
1. Rajaee, N., Junaidi, S.N.L., Taib, S.F.S., and Munot, M.A, (2013). Issues and Challenges in Implementing Outcome-Based Education in Engineering Education. International Journal fore Innovation Education and Research. Volume 1(4), pp. 9.
2. Kobus, L. and Mary, G. (2008). Critical thinking: are the ideals of OBE failing us or are we failing the ideals of OBE? South African Journal of Education. Volume 28, 561-579.
3. Richard, G.B. (2004). Outcome-Based Education & The Death of Knowledge. Paper presented at the Australian Association for Research in Education. Conference, The University of Melbourne, Victoria, Australia. 2004.

Submission: 25 August 2020
Acceptance: 24 September 2020

4. Joseph, G., Wojciech, P., Thomas, V., Morgery, D., Zubair, A., Rukhsana, W.Z, and Angela, O. (2007). Case Studies in Outcome-based education, Source: Academia.edu/18467404.

5. Aziz, A.A., Megat, M.N., Abang Ali, A.A., and Jaafar, S. (2005). A Malaysian Outcome-Based engineering Education Model. International Journal of Engineering and Technology. Volume 2(1), 14-21.

6. Jonathan, V.M/(2017). Implementing Outcome-Based Education (OBE) Framework: Implications for Assessment of Students Performance Educational Measurement and Evaluation Review. Volume 8(1).

7. Grace, M. (2016). Challenges Facing Teachers in Implementing Competence-Based Curriculum in Tanzania: The case of Community Secondary Schools in Morogogo Municipality. International Journal of Education and Social Science. Volume 3(5), 30-37.

8. Liliya, A., Maurean, H., and Carolyn, J.S. (2013). Overcoming Obstacles to Implementing An Outcome-Based Education Model: Traditional Versus Transformational OBE. Proc. 2013 Canadian Engineering Education Association (CEEA13), Paper 145.

9. Mohayidin, M. G., Suandi, T., Mustapha, G., Konting, M. M., Kamaruddin, N., Man, N. A., Adam, A., & Abdullah, S. N. (2008). Implementation of OutcomeBased Education in Universiti Putra Malaysia: A Focus on Students' Learning Outcomes. International Education Studies, Vol. 1 No. 4:147-152

10. Palmer, S. and Ferguson, C. (2008). Improving outcome-based engineering education in Australia, Australasian Journal of Engineering Education, 14(2), 91-104.

11. Oliver, B. (2013). Graduate attributes as a focus for institution-wide curriculum renewal: Innovations and challenges. *Higher Education Research & Development*, *32*(3), 450–463.

12. Sam, M.K., and Soong, C.J. (2019). A Study of Blended Learning in Higher Learning Education: Implementation and Challenges in 21st Century. ICIT2019 Conference, organized by INTI International University at Sama Sama Hotel, Malaysia.

13. Spady, W.G. (1994). Outcome-based education: Critical issues and answers. ISBN-0-86652-183-9.

14. ABET-Engineering Criteria 2000, Published by Accreditation Board for Engineering and Technology (ABET)

15. Accreditation Board for Engineering and Technology (ABET)(2002): Criteria for Accreditation Engineering Programs. Latest Edition – 2017/2018.

16. EAC2017: Engineering Programme Accreditation Manual. Published by Engineering Accreditation Council (EAC)-Board of Engineers Malaysia.

International Conference on Innovation and Technopreneurship 2020
Submission: 25 August 2020
Acceptance: 24 September 2020