Strategic Pathways to Engineering Education Research: case study of a top-down initiative

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Abstract: *In this paper we first present a line of research into potential pathways to facilitate broader participation of engineering educators in education research, one that we propose to develop in various international contexts. Then in the main part of the work we focus on an application of our approach in one specific national context, that of Malaysia. A top-down pathway is proposed to describe recent developments in engineering education research in Malaysia. Analysis of publications from 2000 to date has indicated an increase in engineering education research since the introduction of outcome based education in the country. A Community of Practice in engineering education is beginning to emerge and some research universities are establishing research groups and centres of excellence for research in the field.*

Background

At both the 2008 REES in Davos and the following one in Cairns in 2009, concern was expressed about the need to find ways to encourage more engineering faculty to become involved in engineering education research. Subsequently a small international group of researchers began exchanging ideas online around the issue and these exchanges later came to assume the form of the seven Strategic Pathways to Engineering Education Research (EER) that are outlined in Table 1.

Table 1 Seven strategic pathways to engineering education research

Pathway	Designation	Description
Pathway 1	Scaffolded Paths	Classroom-based research which may often lead to case-study or "show & tell" papers at subject-specific engineering conferences.
Pathway 2	Linking with the world of enterprise	Work with engineering practitioners in companies.
Pathway 3	Outreach	Attracting a larger and more diverse intake to undergraduate engineering courses through linking with schools or direct outreach to young people
Pathway 4	Spontaneous Generation	Where a department or institution spontaneously develops EER
Pathway 5	Top-down initiatives	EER arising from structural changes in the educational system.
Pathway 6	PhD studies	Provision and structure of PhD programs for engineering or social science graduates provides a path to EER.
Pathway 7	Technology Stewardship	Selecting, designing or adapting tools to facilitate learning, evaluation and competence-building on engineering courses.

The overall aim of the Strategic Pathways approach is to produce data and conclusions which will be of use to those involved in engineering education at departmental, institutional or national policy level who are interested in developing strategies to encourage engineering educators to pursue the scholarship of teaching and learning in addition to their specialized engineering research.

Although our overall research questions would be general ones about the potential of this framework, in the present work we confine ourselves to considering just one of the proposed pathways and hence we formulate it as:

Can a study based on Pathway 5 of the Strategic Pathways to EER framework provide useful lessons for institutions wishing to encourage the practice of research in this area?

Methodology

As we believe this topic has not been explored systematically up to now we have opted for an exploratory qualitative methodology (Creswell 2002), which in this paper is in the form of a case study of the Malaysian EER context using bibliometric data.

The Strategic Pathways Framework

Before considering the framework itself, a word about the underlying theoretical concept: our potential members are typically engineering faculty members whose research activity has been in engineering and who identify with a community of researchers in their specialist area but often feel less comfortable about participating in educational research. Although various approaches to the social character of learning can be found in the literature (Bandura, 1977; Vygotsky, 1978), Lave and Wenger's characterization of legitimate peripheral participation in a community which may lead with time to core participation seems a useful way of viewing the entry path of these potential EER community members (Lave & Wenger, 1991). This framework this has been sucessfully used as a lens to study analogous processes in a number of relevant fields ranging from technology, where John Seely Brown uses it to the describe learning process of new researchers the Palo Alto Research Center (Brown and Duguid, 2000; Schrage, 2002), to the preparation of engineering graduate students for faculty careers (Crede et al, 2010).

Given that our first objective was to suggest pathways that would help lead non EER practitioners into EER, we started to look at ways of defining a relatively small number of broad pathways – i.e. aiming to give priority to simplicity rather than exhaustive completeness in our framework. We initially looked at attempts to map recent or future research trends: for example, there have been a number of approaches to mapping EER themes in publications over the years (Wankat, 1999 and Wankat, 2004; Whitin and Sheppard, 2004; Osorio & Osorio, 2005; Osario & Osario 2002; Borrego, 2007 and Jesiek et al 2011). However, these approaches tended to give priority to analysis of journal articles i.e research by relatively experienced EER practitioners whereas we are more focussed on novice EER practitioners who might be expected to begin their involvement at the level of conference papers. Also they tend to present exhaustive lists of research categories (recent examples range from 20 to 38 separate categories). Similarly there have been attempts to propose EER research agendas (Demetry, 1980 and NEERC, 2006) but again the focus here has been on proposing research frameworks for practiced researchers rather than novices.

Consequently we have opted for subjectively defining 7 potential strategic pathways from our own experience of attending EER conferences over a number of years. This is one aspect on which we would welcome discussion during the REES session.

Pathway 5 case-study

In the present paper we exemplify one of the proposed Strategic Pathways, number 5, in the case of top-down support for EER in Malaysia as a result of the influence of the ABET Engineering Criteria 2000 and the Washington Accord.

Historical context of engineering education in Malaysia

Engineering education in Malaysia started as early as 1957 and today 25 public and private universities including four foreign branch campuses are providing engineering education in Malaysia (Mohd Yusof & Mohamad, 2010). To enhance the international mobility and global employability of Malaysian engineering graduates, efforts were made by the Malaysian Engineering Accreditation Council (EAC) to be accredited by international accrediting agencies and becoming a member of the Washington Accord was a means to achieve this objective. EAC was accepted as a provisional

member of the Washington Accord in 2003 and the existing Engineering Accreditation Manual was revised to pave the way for Outcome-based Education (OBE) implementation as required. The implementation of OBE was seen as a remedy for some of the weaknesses attributed to the traditional engineering education programme and in 2009 EAC Malaysia was finally admitted as a full member of the Washington Accord (Mohd Yusof & Mohamad, 2010).

Top-down directives may provide opportunities that lead to research activity in areas that were previously untried. This was the case in Malaysia when the Malaysian Ministry of Higher Education together with the Engineering Accreditation Council made a decision to adopt outcome based education (OBE) as the guiding principle in the design of all new engineering programmes in tertiary education institutions beginning from 2004. To help characterize the development of EER in Malaysia we will consider the following aspects:

1. EER publication trends before and after OBE;
2. the focus of research interest after OBE;
3. researchers involved;
4. research designs used;
5. available support.

For this particular case study, the information on how EER came into being through Strategic Pathway 5 was gathered from 33 papers on engineering education in Malaysia (Appendix 1) that were published in the various conference proceedings and journals. Although, some of the papers from post OBE implementations may not be related to OBE directly, we believe they do reflect the research culture on EE at this time.

Findings

The distributions of papers (and percentage in brackets) reviewed are shown in Table 2 and corresponding chart. As expected, publications intensified after the complete cycle of the OBE implementation.

Table 2 Distributions of EE publications according to year

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011(April)
-	-	2(6.3)	1(3.1)	0(0)	2(6.3)	2(6.3)	4(12.5)	5(15.6)	7(21.9)	7(21.9)	2(6.3)
←Pre-OBE implementation→				←OBE implementation cycle 1→				←	Post OBE cycle		→

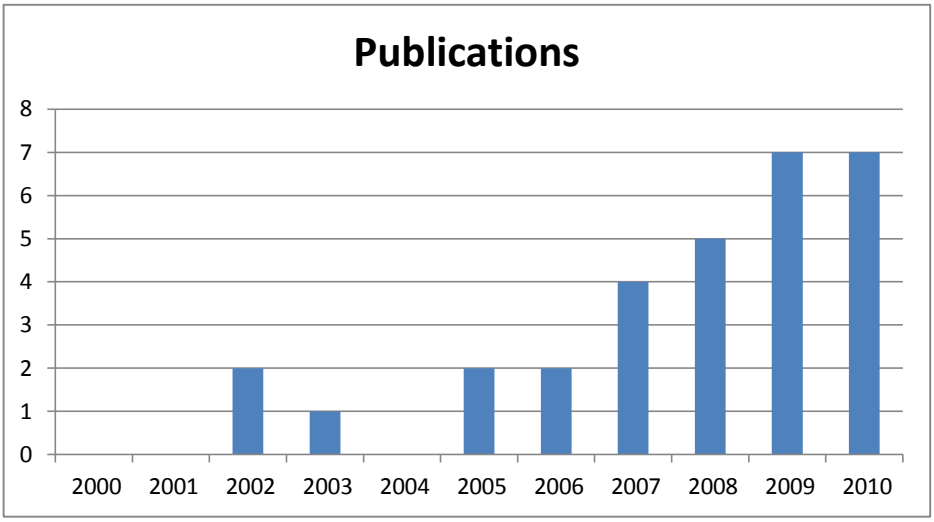

Figure 1 Distribution of EE publications according to year based on Table 2

Research Trends before and after OBE implementation

Prior to the implementation of OBE in Malaysia, there had been few research publications on engineering education apart from Alias, Black & Gray (2002), Alias, Black & Gray (2003) and Alias, Gray & Black (2002). With the implementation of OBE as early as 2004 in some Universities interest in engineering education - based on published papers – intensified (Mohd Yusof & Mohamad, 2010). Initially, in the early stages of OBE implementation, the publications were mainly of the "sharing of knowledge" and "sharing of experience" type. This is understandable since sharing of experience was much needed at this stage as academicians, education administrators and managers tried to grasp the implications of the new OBE concept for their own practices. A picture of what went on during this early stage can best be understood from publications by Noor et al. (2009). Publications on research oriented activities emerged naturally at a later stage of the OBE implementation. This was probably due to the need for academicians to identify the impact of OBE on learning and student attributes as well as the need to identify best practices to achieve the desired learning outcomes. Therefore, the publications progressively change from the "sharing of experience" type to work describing research as it is set out in the REES criteria.

Research Focus

The research questions posed by the engineering education researchers reflect research interests of the EE researchers which can be broadly classified into five areas namely, teaching & learning, assessment and evaluation, curriculum design, effect of OBE on student learning and the impact of industrial attachment on graduate attributes.

Teaching and learning

Seven of the research papers reviewed are on teaching and learning and academic success (Akasah & Alias, 2010; Sidhu and Kang, 2010; Mohd Nopiah et al., 2009; Kassim & Mohd Radzuan, 2008; Md Kamaruddin et al., 2008; Alias & Md Saleh, 2007 and Alias & Boon, 2005). The teaching and learning methods investigated include problem-based learning (Mohd Nopiah et al., 2009 and Alias & Md Saleh, 2007); explicit teaching (Alias & Boon, 2005), contextual teaching (Md Kamaruddin, 2008); conflict scenarios (Kassim & Mohd Radzuan, 2008) and whole-to-part approach (Akasah & Alias, 2010). Of great concern was also on how best to integrate technology into engineering teaching and learning (Sidhu & Kang, 2010)

Assessment and evaluation

Irrespective of the approach used, prescribing valid assessments of learning outcomes is always an issue that needs to be reckoned with. In OBE, this issue raises particular concern as successful implementation requires valid assessment of multiple dimensions of learning outcomes. So great is the concern around this issue that it became the research focus of two research Universities, Universiti Teknologi Malaysia and Universiti Kebangsaan Malaysia (Saidfudin, et al. 2010). In addition, another research University, Universiti Putra Malaysia, developed an ICT tool for managing assessment (Jaafar, et al, 2008).

Curriculum design

The implementation of OBE, intensified concern on curriculum design and its impact on the quantity and quality of engineering graduates among engineering educators as indicated by Zaharim, et al., (2007), Osman, (2009), Mustafa, et al., (2008) and Sivapalan (2009). Zaharim et al., (2007), Zaharim, et al., (2009) and Mustafa et al., (2008) were using their research findings for decision- makings in curriculum design and revisions for enhancing graduates' attributes. Still looking at curriculum design although for a different reason, i.e., the declining trend of enrolment rate in engineering programmes, research by Mustafa et al. (2008) involved gathering feedback from multiple groups of stakeholders. A fourth study by Sivapalan, (2009) - a language instructor - was concerned with the English communication skills of engineering graduates and efforts to improve the existing English curriculum through student feedback.

Effect of OBE on student learning

With the implementation of OBE, educators were naturally curious whether the desired outcomes were achieved as planned. Therefore studies such as that by Zaharim et al., (2007), were conducted to assess the impact of OBE on learning. Zaharim et al., (2007) compared groups before and after OBE implementations and discovered that students' performance declined after the OBE implementation as might be expected when students try to cope in the new learning environment pertaining to learning methods, assessment methods and language used in the classroom. Researchers also were interested in getting a better understanding on factors that contribute to learning success. Zaharim, et al., (2006) investigated the association between difficulty levels of questions and grade acquired by students while other researchers looked at the contribution of other factors on learning success such as learning styles and teaching styles (Shafie & Alias 2007), students' motivation (Paimin, Hadgraft, Prpic & Alias, 2011) and students' initial career decisions (Alias, & Abu Bakar, 2010). Interestingly, EER is not limited to University degree programmes; pre-engineering degree programmes were also of interest to EE researchers. An example was a study by Husain & Mustapha (2009) on employability skills of polytechnic students. Such a study is also important as some of these students would later on further their studies in engineering degree programmes.

Industrial attachment and student attributes

Of great interest to researchers was the impact of industrial attachment/placement on graduate attributes and with that, comes the challenge of how best to assess the impact. Many studies such as those by Omar et al., (2006), Omar et al., (2008), Omar et al., (20009), Abdullah & Zaharim (2008), Zaharim et al., (2007) and Yusoff (2010) adopted a survey design based on questionnaires. Ab Rahman (2009) however used a pre-post survey design to look at the effect of industrial attachment on student attributes while Jamil (2011) conducted a similar study at a later date into the implementation of OBE in 2009. The numerous studies conducted in this area have resulted in accumulated knowledge on the employability skills required of engineering graduates and this has been synthesized into a framework for employability skills by Zaharim, et al., (2010).

Researchers' involved

Out of the 33 papers reviewed, 21 (63.6%) of the studies were conducted by engineering core course lecturers. Typically, the same researchers are involved in more than one study. Although the number of researchers is relatively small compared to the pool of researchers in the national engineering field, the number is definitely an improvement from the pre-OBE era when there were effectively only one or two people publishing EER. Thus a top-down directive requiring the implementation of OBE has clearly resulted in a pathway to EER for engineering faculty members where previously EER had not had a place even on the periphery of their research focus.

Research designs

Over 75% of the publications studied refer to the use of the survey research designs based on statistical analysis methods that are relatively simple in nature. This indicates that there is a great focus on describing phenomena. Only five studies used designs that would permit the establishment of causal relationships between variables. It could be that engineering education researchers are not interested in establishing causal relationships or simply lacking in the necessary research skills which is perhaps understandable as expertise in education research methods is still in the process of being acquired.

Support available

Engineering education interest groups were formed in two research Universities, Universiti Kebangsaan Malaysia and Universiti Teknologi Malaysia, both of which set up research groups to focus exclusively on engineering education in their respective Universities. Although these two have contributed a major share of published research there have also been significant contributions from others such as the Universiti Tun Hussein Onn Malaysia (UTHM) which supports EER through its Faculty of Technical Education (FTE): for example, studies by Alias & Boon (2005) and Akasah &

Alias (2010) were the result of joint research between researchers from the FTE and the engineering faculty at UTHM, supported by the national Fundamental Research Grant Scheme.

There are no specific research grants for EER but researchers can compete for the available grants from the Ministry of Higher Education namely, Fundamental Research Grant Scheme, Long-term Research Grant Scheme, Exploratory Research Grant Scheme and Prototype Research Grant Scheme.

Discussion

In summary, this article shares the Malaysian experience on how a top-down directive to implement OBE in the engineering sector has opened up a new pathway for EER in Universities. The publications studied have quite a broad focus ranging from teaching and learning to industrial attachments. While the research tends to be of the descriptive type this may be a consequence of the developing skills among the researchers involved. The volume of research by core course lecturers appears to be directly related to institutional support provided and although the increase in output is notable, most of these studies are done by the same group of researchers and the more prolific researchers come from the more supportive Universities such as UKM that has its own EER Centre and UTM that has a doctorate programme focusing on EER. Although the national EER activity is relatively concentrated and involving a minority of engineering educators, it is certainly increasing and this case study has indeed clearly illustrated the positive role of a top-down directive in promoting EER.

Conclusions

We have described how a decision at ministerial level resulted in a significant flowering in EER activity extending over a range of research categories. Although this process it is probably best considered as the product of a particular national context at a specific moment in the history of its engineering eduction system, we believe that the case study presented here could provide useful strategic pointers for those in other national contexts where such measures may be contemplated in that it suggests that strong support for top-down change did in this context bring about significant quantitative and qualitative development in engineering education research.

References

Bandura, A. (1977). Social Learning Theory. Englewood Cliffs, NJ: Prentice Hall.

Borrego, M. (2007) Engineering education as a rigorous discipline: A study of the publication patterns of four coalitions, Journal of Engineering Education, 96(1), pp. 5–18.

Brown, J. S., and Duguid, P. (2000). The Social Life of Information, Chapter 5, Watertown MA: Harvard Business School Press.

Crede, E., Borrego, M. and McNair, L., (2010), Application of Community of Practice Theory to the Preparation of engineering Graduate students for Faculty Careers, Advances in engineering education, Summer 2010

Creswell, J. (2002), Research Design, Qualitative, Quantitative and Mixed Methods Approaches, Sage, pp 22

Demetry, J. (1980) Getting started in educational research, Engineering Education, 70(5), 1980, pp. 404–405.

Jesiek, B. K., Borrego, M., Beddoes, K., Hurtado, M., Rajendran, P., and Sangam, D. (2011). Mapping Global Trends in Engineering Education Research, 2005 - 2008. International Journal of Engineering Education, 27(1): 77-90.

Lave, J. and Wenger, E. (1991) Situated Learning: legitimate peripheral participation Cambridge: Cambridge University Press, pp. 14 -16

NEERC, (2006) The Steering Committee of the National Engineering Education Research Colloquies, Special report: The research agenda for the new discipline of engineering education, Journal of Engineering Education, 95(4), pp. 259–261.

Osorio, N. and Osorio, M. (2002) Engineering education in Europe and the USA: An analysis of two journals, Science and Technology Libraries, 23(1), pp. 49–70.

Osorio N. And Osario, M. (2005) What every engineer should know about engineering education, Proceedings of the American Society for Engineering Education (ASEE) 2005 Illinois-Indiana Sectional Conference, DeKalb, Illinois, USA, 1–2 April.

Schrage, M. (2002). The Debriefing: John Seely Brown. Retrieved April 10, 2011 from http://www.wired.com/wired/archive/8.08/brown_pr.html

Vygotsky, L.S. 1978. Mind in society: The Development of Higher Psychological Processes. Cambridge, Ma: Harvard university Press.

Wankat, P. (1999) An analysis of the articles in the Journal of Engineering Education, Journal of Engineering Education, 88(1), pp. 37–42.

Wankat, P. (2004) Analysis of the first ten years of the Journal of Engineering Education, Journal of Engineering Education, 93(1), pp. 13–21.

Whitin, K. and Sheppard, S. (2004) Taking stock: An analysis of the publishing record as represented by the Journal of Engineering Education, Journal of Engineering Education, 93(1), 2004, pp. 5–12.

Appendix 1: Publications included in the analysis

Abdullah, S. and Zaharim, A. (2008). Benefits of industrial training to engineering students. *5th WSEAS / IASME International Conference on Engineering Education* (EE'08), Heraklion, Greece, July 22-24, 2008.

Akasah, Z.A & Alias, M (2010). Bridging the Spatial Visualisatin Skills Gap using the whole-to-parts approach, *Australasian Journal of Engineering Education*, Vol. 16, No. 1, pp. 81-86.

Alias, M. and Md Saleh, H. H. (2007). The effect of blended problem-based learning method on acquisition of content specific knowledge in mechanical engineering. *World Transactions on Engineering and Technology Education*, 6(2), 249-252.

Alias, M. and Abu Bakar, M.N.F. (2010). Factors Contributing to Programme Choice and Subsequent Career Selection among Engineering Students. The 3rd Regional Conference On Engineering Education And Research In Higher Education, Kuching, Sarawak, 6-9 June 2010

Alias, M., Black, T. R. and Gray, D. E. (2003). Relationship between spatial visualization and problem solving in structural design. *World Transaction on Engineering and Technology Education* vol. 2, no. 2, 274-276,

Alias, M., Black, T.R. and Gray, D.E. (2002). Effect of instructions on spatial visualization ability in civil engineering students. *International Education Journal*, 3 (1), 1-12, http://ehlt.flinders.edu.au/education/iej/articles/v3n1/Alias/paper.pdf

Alias, M., Gray, D.E. and Black, T.R. (2002). Attitude towards sketching and drawing and the relationship with spatial visualization ability in engineering students. *International Education Journal*, 3 (3), 165-175, http://ehlt.flinders.edu.au/education/iej/articles/v3n3/alias/paper.pdf

Alias, M. and Boon, K. H. (2005). The effect of explicit teaching of qualitative structural analysis method on learning in structural design. *World Transactions on Engineering & Technology Education.* Vol. 4, no.1, 63-66.

Aziz, A.A. , Megat Mohd Noor, M.J. Abang Ali, A.A. and Jaafar, M.S. (2005). A Malaysian outcome-based engineering education model. *International Journal of Engineering and Technology*, Vol. 2, No.1, 2005, pp. 14-21 http://www.ijet.feiic.org/journals/J-2005-V1003.pdf

Husain, M.Y. and Mustapha, R. (2009) Penilaian kemahiran employability dalam kalangan pelajar kejuruteraan politeknik Kementerian Pengajian Tinggi Malaysia (Evaluation of Employability Skills among polytechnic students under the Ministry of Higher Education), *Seminar Kebangsaan Pembangunan Keusahawanan UKM* 2009,

Jaafar, M.S., Nordin, N. K., Wagiran, R., Aziz, A., Megat Mohd Noor, M.J., Osman, M.R., Noorzaei, J. and Abdulaziz, F.N.A., (2008). Assessment strategy for an outcome based education. *International Conference of Engineering Education ICEF 2008*, 27-31 July, Pecs-Budapest, Hungary. http://www.ineer.org/Events/ICEE2008/full_papers/full_paper46.pdf

Jamil, M., Omar, M.Z., Osman, S.A., Kofli, N.T., Rahman, M.N.A, Mat, K. (2011). Competencies achieved through industrial training programme. *Latest Trends in Engineering Education*, 404-408

Kassim, H. and Mohd Radzuan, N.R. (2008). Resolving conflict: Enhancing engineering students' English fluency through workplace situation. *The International Journal of Learning*, 14(11), 51-60.

Mohd Nopiah, Z., Ahmat Zainuri, N., Ashaari, I., Othman, H. and Abdullah, S. (2009). Improving generic skills among engineering students through problem based learning in statistics engineering course. *European Journal of Scientific Research* .33 (2), pp.270-278. http://www.eurojournals.com/ejsr.htm

Mohd Yusof, K. and Mohd, S. (2010). Impact of the Washington Accord Membership on Engineering Education in Malaysia. *The 3 rd Regional Conference on Engineering Education (RCEE 2010) and Conference on Research in Teaching and Learning in Higher Education*, Kuching, Sarawak June 2010

Mustafa, Z., Norkisme, Z. A., Suradi , N. R. M., Ismail, W. R., Shahabuddin, F. A. A., Ali , Z. M., Zaharim, A. (2008). Engineering education, profession and employer: perception of engineers in electronic sector. EE'08 Proceedings of the 5th WSEAS/IASME international conference on Engineering education World Scientific and Engineering Academy and Society (WSEAS), Stevens Point, Wisconsin, USA ©2008 ISBN: 978-960-6766-86-2. Online at http://portal.acm.org/citation.cfm?id=1581120.1581184

Md Kamaruddin, N. K., Jaafar, N., Ishak, N., Wan Ahmad, W.M. R., Alias, M. & Md Amin, Z. (2008). Measuring the effectiveness of the contextual teaching and learning engineering statistics at the Universiti Tun Hussein Onn Malaysia (UTHM). Proceedings of the 8th Annual SEAAIR Conference, 4-6 November 2008, Surabaya, Indonesia. Online at http://mams.rmit.edu.au/7lcxlffi2jelz.pdf [accessed on May 7, 2009].

Noor, M.M., Kadirgama, K., Rahman, M.M., Rejab, M.R.M., Bakar, R. A. and Ibrahim, A. (2009). Education Reform Model at Faculty of Mechanical Engineering, Universiti Malaysia Pahang. *International Journal of Recent Trends in Engineering*, Vol. 1, No. 5, May 2009 166-171. Academy Publisher 2009

Omar, M.Z., Kofli, N.T., Mat, K., Darus, Z.M., Osman, S.A., Rahman, M.N.A., Abdullah, S and Zaharim, A., (2009). Assessment of engineering students' perception after industrial training placement. *European Journal of Social Sciences* 8(3), 420-431.

Omar, M.Z., Kofli, N.T., Mat, K., Darus, Z.M., Osman, S.A., Rahman, M.N.A., Abdullah, S. (2008). Employers' evaluation on attributes obtained during industrial training. *Proceedings of the 7th WSEAS International Conference on Education and Educational Technology* (EDU'08)

Omar, M.Z., Nik Mohamad, N. A., Zaharim, A, Abdullah, S., Haris, S. M., Hassan, A., Basri, H. (2006). A study of employers' satisfaction of engineering graduates in Malaysia. *Proceedings of the 3rd WSEAS/IASME International Conference on ENGINEERING EDUCATION*, Vouliagmeni, Greece, July 11-13, 2006 (pp185-189).

Osman, S.A., Omar, M. Z., Mat, K., Tan Kofli, N., Ab. Rahman, M. N. and M. Darus Z. (2009). Outcome based education (OBE) curriculum assessment for industrial training program: Based on students' perception. *WSEAS Transactions on Advances in Engineering Education*, 6(12) December 2009, 454-463

Paimin, A. N., Hadgraft, R.G., Prpic, K. and Alias, M. (2011). Learning strategy, motive and intention: predicting academic performance of engineering undergraduates. International Engineering and Technology Education Conference, 16-19 January 2011, Kuala Lumpur, Malaysia,

Saidfudin, M., Azrilah , A. A., Rodzo'An , N. A., Omar, M. Z., Zaharim, A. & Basri, H. (2010). Easier learning outcomes analysis using Rasch model in engineering education research. *Proceeding EDUCATION'10 Proceedings of the 7th WSEAS Iinternational Conference on Engineering Education.*

Shafie, M. S., and Alias, M. (2007). Hubungan di antara gaya pembelajaran, gaya pengajaran dan minat terhadap subjek kejuruteraan (The relationship between learning styles, teaching styles and students' interest towards an engineering subject). *Jurnal Sains Sosial*, 4 (1), 19 – 40.

Sidhu, M.S. and Kang, L.C. (2010). Emerging trends and technologies for enhancing engineering education: an overview. *International Journal of Information and Communication Technology Education*, 6(4), 38-48, October-December 2010

Sivapalan, S. and Subramaniam, G. (2009). The incorporation of literature in the English language program for engineering students: Learner interest and perception, *3L : Language, Linguistics, Literature*, 14, 45-73

Yusoff, Y.M., Omar, M. Z., Zaharim, A., Mohamed, A., Muhamad, N., Mustapha, R. (2010). Enhancing employability skills through industrial training programme. *Proceedings EDUCATION'10 Proceedings of the 7th WSEAS international conference on Engineering education* ©2010

Zaharim, A., Omar, M.Z., Yusoff, Y.M., Muhamad, N., Mohamed, A., Mustapha, R., (2010). Practical framework of employability skills for engineering graduate in Malaysia. *Engineering Education (EDUCON) 2010*. IEEE. 921-927. 14-16 April 2010.

Zaharim, A., Abdullah, S., Mohd Nopiah, Z. and. Mohd Isa, F.L. (2007). A Longitudinal Study of First Year Engineering Students' Performance at the Universiti Kebangsaan Malaysia: Before and After the Implementation of the OBE Approach. *International Journal of Education and Information Technologies*, 1(2), 52-55

Zaharim, A., Abdullah, S., Omar M.Z., Basri, H. and Mohd Isa, F.L. (2007). Gap analysis on employers' engineering graduates in Malaysia based on generic skill criteria. *The Association of South East Asian Institutions of Higher Education (ASAIHL*) Curtin University of Technology, Perth Western Australia, 5-7 December 2007 Conference Proceedings - Part 2, 78-83.

Zaharim, A., Md Yusoff , Y., Omar, M.Z., Mohamed, A., Muhamad, N., Mustapha, R. (2009). Perceptions and expectation toward engineering graduates by employers: a Malaysian study case. *WSEAS Transactions on Advances in Engineering Education*, Vol. 6, No. 9, September, 2009.

Zaharim, A., Mohd Ihsan, A.K.A., Mohd Nor, M.J. and Ismail, A.H. (2006). A study of the correlation between grades and levels of difficulty for a statistics course at the faculty of engineering, Universiti Kebangsaan Malaysia. *Proceedings of the 3rd WSEAS/IASME International Conference on ENGINEERING EDUCATION*, Vouliagmeni, Greece, July 11-13, 2006 (pp143-145).