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SOCIAL SCIENCES & HUMANITIES

JSSH

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A special edition devoted to issues in
Transforming Teaching & Empowering Learning

Guest Editors
Norbahiah Misran, Roszilah Hamid & Badariah Bais

PERTANIKA
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About the Journal

Overview

Pertanika Journal of Social Sciences & Humanities (JSSH) is the official journal of Universiti Putra Malaysia published by UPM Press. It is an open-access online scientific journal which is free of charge. It publishes the scientific outputs. It neither accepts nor commissions third party content.

Recognized internationally as the leading peer-reviewed interdisciplinary journal devoted to the publication of original papers, it serves as a forum for practical approaches to improving quality in issues pertaining to social and behavioural sciences as well as the humanities.

JSSH is a **quarterly** (*March, June, September* and *December*) periodical that considers for publication original articles as per its scope. The journal publishes in **English** and it is open to authors around the world regardless of the nationality.

The Journal is available world-wide.

Aims and scope

Pertanika Journal of Social Sciences & Humanities aims to develop as a pioneer journal for the social sciences with a focus on emerging issues pertaining to the social and behavioural sciences as well as the humanities.

Areas relevant to the scope of the journal include Social Sciences—Accounting, anthropology, Archaeology and history, Architecture and habitat, Consumer and family economics, Economics, Education, Finance, Geography, Law, Management studies, Media and communication studies, Political sciences and public policy, Population studies, Psychology, Sociology, Technology management, Tourism; Humanities—Arts and culture, Dance, Historical and civilisation studies, Language and Linguistics, Literature, Music, Philosophy, Religious studies, Sports.

History

Pertanika was founded in 1978. A decision was made in 1992 to streamline Pertanika into three journals as Journal of Tropical Agricultural Science, Journal of Science & Technology, and **Journal of Social Sciences & Humanities** to meet the need for specialised journals in areas of study aligned with the interdisciplinary strengths of the university.

After almost 25 years, as an interdisciplinary Journal of Social Sciences & Humanities, the revamped journal focuses on research in social and behavioural sciences as well as the humanities, particularly in the Asia Pacific region.

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Our goal is to bring the highest quality research to the widest possible audience.

Quality

We aim for excellence, sustained by a responsible and professional approach to journal publishing. Submissions are guaranteed to receive a decision within 14 weeks. The elapsed time from submission to publication for the articles averages 5-6 months.

Abstracting and indexing of *Pertanika*

Pertanika is almost 38 years old; this accumulated knowledge has resulted the journals being indexed in SCOPUS (Elsevier), Thomson (ISI) Emerging Sources Citation Index (ESCI), Web of Knowledge [BIOSIS & CAB Abstracts], EBSCO, DOAJ, ERA, AGRICOLA, Google Scholar, ISC, TIB, Journal Guide, Citefactor, Cabell's Directories and MyCite.

Future vision

We are continuously improving access to our journal archives, content, and research services. We have the drive to realise exciting new horizons that will benefit not only the academic community, but society itself.

Citing journal articles

The abbreviation for *Pertanika* Journal of Social Sciences & Humanities is *Pertanika J. Soc. Sci. Hum.*

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The Pertanika Journals and Universiti Putra Malaysia takes seriously the responsibility of all of its journal publications to reflect the highest in publication ethics. Thus all journals and journal editors are expected to abide by the Journal's codes of ethics. Refer to Pertanika's **Code of Ethics** for full details, or visit the Journal's web link at http://www.pertanika.upm.edu.my/code_of_ethics.php

International Standard Serial Number (ISSN)

An ISSN is an 8-digit code used to identify periodicals such as journals of all kinds and on all media–print and electronic. All Pertanika journals have ISSN as well as an e-ISSN.

Journal of Social Sciences & Humanities: ISSN 0128-7702 *(Print)*; ISSN 2231-8534 *(Online)*.

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A decision on acceptance or rejection of a manuscript is reached in 3 to 4 months (average 14 weeks). The elapsed time from submission to publication for the articles averages 5-6 months.

Authorship

Authors are not permitted to add or remove any names from the authorship provided at the time of initial submission without the consent of the Journal's Chief Executive Editor.

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Refer to Pertanika's **Instructions to Authors** at the back of this journal.

Most scientific papers are prepared according to a format called IMRAD. The term represents the first letters of the words **I**ntroduction, **M**aterials and Methods, **R**esults, **A**nd, **D**iscussion. IMRAD is simply a more 'defined' version of the "IBC" [Introduction, Body, Conclusion] format used for all academic writing. IMRAD indicates a pattern or format rather than a complete list of headings or components of research papers; the missing parts of a paper are: *Title, Authors, Keywords, Abstract, Conclusions*, and *References*. Additionally, some papers include Acknowledgments and Appendices.

The *Introduction* explains the scope and objective of the study in the light of current knowledge on the subject; the *Materials and Methods* describes how the study was conducted; the *Results* section reports what was found in the study; and the *Discussion* section explains meaning and significance of the results and provides suggestions for future directions of research. The manuscript must be prepared according to the Journal's **Instructions to Authors**.

Editorial process

Authors are notified with an acknowledgement containing a *Manuscript ID* on receipt of a manuscript, and upon the editorial decision regarding publication.

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Pertanika follows a **double-blind peer-review** process. Manuscripts deemed suitable for publication are usually sent to reviewers. Authors are encouraged to suggest names of at least three potential reviewers at the time of submission of their manuscript to Pertanika, but the editors will make the final choice. The editors are not, however, bound by these suggestions.

Notification of the editorial decision is usually provided within ten to fourteen weeks from the receipt of manuscript. Publication of solicited manuscripts is not guaranteed. In most cases, manuscripts are accepted conditionally, pending an author's revision of the material.

As articles are double-blind reviewed, material that might identify authorship of the paper should be placed only on page 2 as described in the first-4 page format in Pertanika's **Instructions to Authors** given at the back of this journal.

The Journal's peer-review

In the peer-review process, three referees independently evaluate the scientific quality of the submitted manuscripts.

Peer reviewers are experts chosen by journal editors to provide written assessment of the **strengths** and **weaknesses** of written research, with the aim of improving the reporting of research and identifying the most appropriate and highest quality material for the journal.

Operating and review process

What happens to a manuscript once it is submitted to *Pertanika*? Typically, there are seven steps to the editorial review process:

1. The Journal's chief executive editor and the editorial board examine the paper to determine whether it is appropriate for the journal and should be reviewed. If not appropriate, the manuscript is rejected outright and the author is informed.

2. The chief executive editor sends the article-identifying information having been removed, to three reviewers. Typically, one of these is from the Journal's editorial board. Others are specialists in the subject matter represented by the article. The chief executive editor asks them to complete the review in three weeks.

   Comments to authors are about the appropriateness and adequacy of the theoretical or conceptual framework, literature review, method, results and discussion, and conclusions. Reviewers often include suggestions for strengthening of the manuscript. Comments to the editor are in the nature of the significance of the work and its potential contribution to the literature.

3. The chief executive editor, in consultation with the editor-in-chief, examines the reviews and decides whether to reject the manuscript, invite the author(s) to revise and resubmit the manuscript, or seek additional reviews. Final acceptance or rejection rests with the Edito-in-Chief, who reserves the right to refuse any material for publication. In rare instances, the manuscript is accepted with almost no revision. Almost without exception, reviewers' comments (to the author) are forwarded to the author. If a revision is indicated, the editor provides guidelines for attending to the reviewers' suggestions and perhaps additional advice about revising the manuscript.

4. The authors decide whether and how to address the reviewers' comments and criticisms and the editor's concerns. The authors return a revised version of the paper to the chief executive editor along with specific information describing how they have answered' the concerns of the reviewers and the editor, usually in a tabular form. The author(s) may also submit a rebuttal if there is a need especially when the author disagrees with certain comments provided by reviewer(s).

5. The chief executive editor sends the revised paper out for re-review. Typically, at least one of the original reviewers will be asked to examine the article.

6. When the reviewers have completed their work, the chief executive editor in consultation with the editorial board and the editor-in-chief examine their comments and decide whether the paper is ready to be published, needs another round of revisions, or should be rejected.

7. If the decision is to accept, an acceptance letter is sent to all the author(s), the paper is sent to the Press. The article should appear in print in approximately three months.

   The Publisher ensures that the paper adheres to the correct style (in-text citations, the reference list, and tables are typical areas of concern, clarity, and grammar). The authors are asked to respond to any minor queries by the Publisher. Following these corrections, page proofs are mailed to the corresponding authors for their final approval. At this point, **only essential changes are accepted**. Finally, the article appears in the pages of the Journal and is posted on-line.

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AN INTERNATIONAL PEER-REVIEWED JOURNAL

ABSTRACTING/INDEXING

Pertanika is now over 38 years old; this accumulated knowledge has resulted the journals being indexed in SCOPUS (Elsevier), Thomson (ISI) Emerging Sources Citation Index (ESCI), Web of Knowledge [BIOSIS & CAB Abstracts], EBSCO, DOAJ, ERA, AGRICOLA, Google Scholar, ISC, TIB, Journal Guide, Citefactor, Cabell's Directories and MyCite.

Preface

This special issue of the Pertanika Journal of Social Sciences and Humanities (JSSH) features selected extended papers presented at the K-Novation on Learning and Teaching 2015 by Centre for Teaching and Learning Technologies, Universiti Kebangsaan Malaysia (UKM) from 11-12 February, 2015, at Dewan Canselor Tun Abdul Razak (DECTAR), UKM. The collection of papers was published in the *Prosiding K-Novasi Pengajaran dan Pembelajaran UKM (Pendidikan Kejuruteraan dan Alam Bina) (PeKA 2014)*. This Pertanika JSSH special issue brings together the best practices in engineering and built environment education that are implemented at the Faculty of Engineering and Built Environment (FEBE), UKM.

Exploring the theme “Transforming Teaching and Empowering Learning”, the conference aimed to transform traditional teaching and learning into more creative and innovative methods.

Papers published in this special issue of Pertanika JSSH underwent strict editorial processes in keeping up with the journal’s status as one of the leading research-based, internationally recognised journals.

Research into engineering and built environment education in Malaysia is part of an ongoing effort towards realising the vision of the national educational philosophy in producing human capital that is robust, competitive, well-educated and intellectually challenging. These attributes are necessary facets of character for the nation’s professionals, of whom engineers and architects form the largest group, in facing and overcoming the challenges of globalisation and technological advancement and in guiding them in designing and shaping the socio-economic development of the country and the attainment of national unity. Among the contributions featured in this special issue are papers discussing various themes, which include innovation in teaching and learning; development of staff and students; measurement, assessment and evaluation; continuous quality improvement and industry and community networking.

Special thanks goes to the FEBE, UKM specifically to the Dean, Prof. Dato’ Ir. Dr. Abdul Wahab Mohammad, Centre for Engineering Education Research, FEBE, UKM and the guest editorial board members for ensuring the successful publication of this special issue.

The full commitment given by the Pertanika Editorial Office and its dedicated team, under the leadership of its Chief Executive Editor, Dr. Nayan Kanwal, is also highly appreciated.

Guest Editors
Norbahiah Misran *(Prof. Dr.)*
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Badariah Bais *(Assoc. Prof. Dr.)*

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Effects of an Awareness Programme on the Perception of Engineering Students at the Universiti Kebangsaan Malaysia Towards Solid Waste Recycling Practices

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ABSTRACT

The Malaysian government through the National Department of Solid Waste (JPSPN) is targeting to achieve the national recycling rate of 22% by the year 2020. Currently, the recycling rate is estimated at approximately 10.5%. One of the key strategies in solid-waste management is to change the perception and attitude of the Malaysian public in order to encourage receptivity towards the practice of recycling. The objective of this study was mainly to investigate effects of an awareness programme on the perception of engineering students at the Universiti Kebangsaan Malaysia (the National University of Malaysia, UKM) towards the recycling of solid waste. This study provides an answer to one of the questions as to why students do not practice recycling even though recycling facilities are provided by the university. In this study, survey forms were distributed to Bachelor of Civil Engineering students, UKM regarding their perception towards recycling practices, awareness of the issues regarding solid waste generation and management in Malaysia as well as knowledge of recycling facilities provided at the university. From the results of this study, it can be concluded that the students are aware of the importance of recycling and individual responsibility to protect and conserve the environment. However, there are some conflicting attitudes towards practicing recycling even though the students are informed on the availability of recycling facilities at the university.

Keywords: Perception, recycling, solid waste management

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INTRODUCTION

Increasing population and urbanisation have become a significant contributing factor in the problem of the increasing volume of solid waste generation in developing countries (Troschinetz & Michelcic, 2009). The issue of unsustainable disposal of municipal solid waste has continuously been one of the major environmental challenges posed by modern society that is being faced by municipalities around the world (Omran et al., 2010). Total domestic waste is expected to increase to 30,000 tons/day by 2020 (Yazid, 2010). Recycling as a solution offered by environmental innovation in overcoming solid waste disposal issues has been an approach used by the Malaysian government since 1993 (Sakawi, 2011). The recent recycling rate in Malaysia is estimated at 10.5% (Hakimi, 2014). In order to achieve a recycling rate of 22% by the year 2020, one of the key strategies of solid-waste management is to change the perceptions and attitude of Malaysians in order to encourage receptivity towards the practice of recycling. Recycling can reduce the amount of solid waste disposed because most of the components in Malaysian solid waste consist of materials that can be recycled such as paper, plastic and glass (Jabatan Pengurusan Sisa Pepejal Negara, 2012).

According to Hassan et al. (2001), household participation is an important driver in recycling activities; however, participation in recycling programmes can be hampered in various ways. One major obstacle would be the lack of clear guidelines for local households regarding recycling programmes. Thus, improved education and better recycling facilities are required to promote positive attitudes towards recycling. Another study conducted by Mongholnchaiarunya (2005) in Yala, Thailand, recommended that recycling be practised in order to reduce congestion at waste disposal sites through effective campaigns such as the ‘waste for egg programme’, which was a strong motivation for local residents, especially the poor, to practise recycling. The campaign rewarded residents who brought recyclable items with eggs, and this was highly appreciated by the low-income group. As a result, waste sent to landfills was reduced; prior to the campaign, the recycling rate was found to have doubled. Public adoption of recycling also requires active involvement of households. Omran’s (2008) research in Alor Setar, Kedah on household attitude towards recycling indicated that participation in recycling of household waste relied on level of awareness, understanding of recycling tasks and accessibility of recycling facilities.

The purpose of this study was to obtain initial perception of engineering students towards solid waste management issues and to identify the status of the level of awareness of recycling practices among engineering students. According to Wang et al. (1997), if the public’s initial perception towards a recycling programme is negative, their future involvement will also be negative. Participation is closely related to the individual's knowledge of the recycling rate in Malaysia i.e. the individual must awaken to his or her personal contribution towards achieving a higher recycling rate for Malaysia. Various initiatives have been implemented to increase the recycling rate in Malaysia such as improving recycling facilities and enhancing the awareness campaigns.

METHODOLOGY

The Department of Civil and Structural Engineering at the Universiti Kebangsaan Malaysia (UKM) organised an environmental awareness programme in November 2014 titled *'Mengasihi Alam, Mengasihi Allah*' (MAMA). The content of this programme contained both technical and non-physical aspects including issues on adverse impact on public health and the environment arising from improper solid-waste management and integrated solid-waste management such as recycling and composting. The non-physical aspect included topics on the creation of the universe, the earth, the environment and ecosystem, the creation of human beings and the responsibility of human beings towards their Creator.

The participants numbered 26 and were second-year students from the Bachelor in Civil Engineering Degree programme, with 13 students registered in the Civil and Environmental Engineering programme and the other 13 registered in the Civil and Structural Engineering programme. The awareness programme was designed to create an understanding among the participants regarding the importance of and their responsibility towards environmental conservation. Twenty-six questionnaires were distributed to the participants during the programme. The questionnaire referred to the perception of the students; this was divided into six parts consisting of knowledge about UKM's Recycling Centre (PKSUKM), the importance of recycling, the actual condition of the recyclable items, individual recycling rate, issues on solid-waste management and individual responsibility towards recycling waste.

The objective of the first part was to find out whether the students had prior knowledge of the existence of the UKM recycling centre. The objective of the second was to determine whether the students understood the important function of recycling activities, which was considered part of the environmental conservation initiative. The third part was designed towards identifying whether the students were willing to recycle solid waste if they knew the actual condition of the recyclable items. The objective of the next part was to find out whether the students knew how much recyclable material they could recycle daily. Next was to have the students' perception towards current solid-waste management issues in Malaysia identified. The last part intended to find out whether the students had prior knowledge of their individual responsibility towards environmental conservation through the practice of recycling solid waste.

RESULTS AND DISCUSSION

All the participants of the MAMA programme were female students. No specific reasons were given by male students from both Civil Engineering programmes for choosing not to participate in the MAMA programme. All the respondents were aged between 20 and 23 years. Figure 1 shows the percentage of participants by age group, with the majority of the participants being 20 years old. Background information provided by the students indicated that most of them had completed their studies at Matriculation level for a one-year programme. The students aged 21 years had completed a two-year programme for Matriculation level, while those aged 23 had completed a diploma-level programme before entering the university.

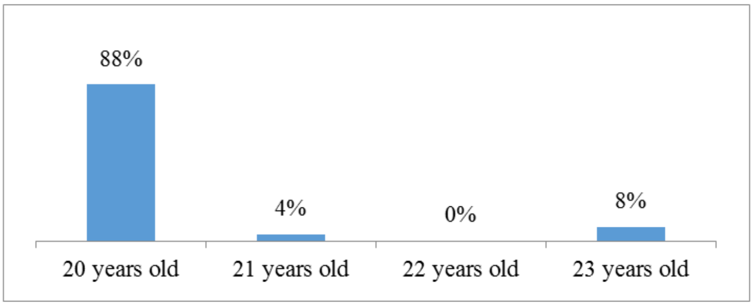

Figure 1. The percentage of participants according to age.

Students' Perception on the Knowledge of the UKM Recycling Centre (PKSUKM)

PKSUKM is a recycling centre on the UKM Bangi campus that was constructed for the purpose of facilitating on-campus recycling activities and the nearby community of Bandar Baru Bangi. It is located near the campus' main entrance and two residential colleges (Kolej Tun Hussein Onn and Kolej Dato' Onn). With the existence of PKSUKM and also the provision of recycling bins in various strategic locations on campus, it was expected that students would participate actively in recycling activities.

Figure 2(a) shows that a high percentage of the students in this research i.e. 96% were aware of the existence of the recycling centre on campus. Figure 2(b) shows that 77% of the students knew the actual functional use of PKSUKM. The results obtained from Figure 2(a) and Figure 2(b) led to the conclusion that most of the students had knowledge of the existence of the recycling centre and its actual functional use. Therefore, the recycling centre was a positive asset of the university in encouraging students to participate actively in recycling activities on campus. PKSUKM is a role model provided by UKM that fulfils Dahle and

Neumayer's concept of how a higher-educational institution can serve to model good environmental behaviour by implementing an appropriate recycling system on campus (Dahle & Neumayer, 2001).

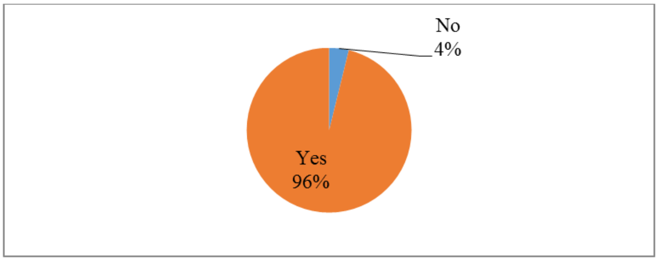

Figure 2(a). The percentage of students who know of the existence of PKSUKM.

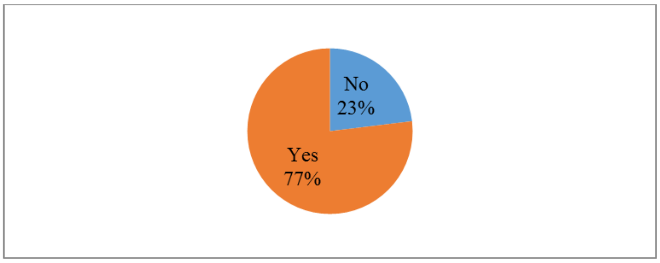

Figure 2(b). The percentage of students who know about the actual functional use of PKSUKM.

Students' Perception of the Importance of Recycling

The 3R environmental campaign (Reduce, Reuse and Recycle) implemented in Malaysia since the 1990s to encourage environmental conservation indicates awareness at the governmental level of the importance and benefit of recycling to Malaysians. With respect to Islam, environmental conservation is considered the individual's responsibility towards God, the Creator of the universe.

Figure 3(a) demonstrates that 92% of the students agreed that by recycling, problems linked to solid-waste disposal can be reduced. The practice of recycling materials such as paper, plastic, glass and others can reduce the volume of waste sent to landfill sites. Figure 3(b) shows that 96% of the students agreed that recycling is one way to protect the environment, while Figure 3(c) shows that 96% of the students agreed that the practice of recycling appreciates the natural environment created by God as Lord of the universe.

This section demonstrated that from the students' perception, recycling was important with respect to solid-waste management, environmental conservation and religion. The majority of the students were aware of the importance of recycling, which can be seen from the results shown in Figure 3(a), Figure 3(b) and Figure 3(c). Thus, by providing education and conducting awareness campaigns, students may gain knowledge on the importance of recycling. In this respect, encouragement and incentives should be provided to them so that they will be keener to participate in on-campus recycling activities. A student who has learnt the value of waste as a resource and the importance of recycling will continue doing so later in life and will impact other individuals in their recycling behaviour (Christakis & Fowler, 2009).

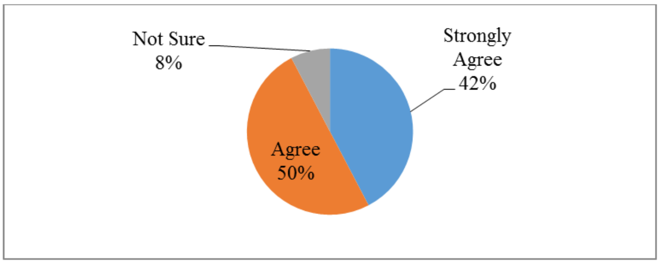

Figure 3(a). The perception of students towards the practice of recycling to reduce the problem of solid-waste management.

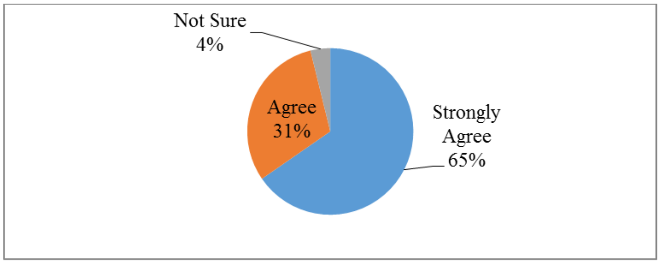

Figure 3(b). The perception of students towards the practice of recycling for environmental conservation.

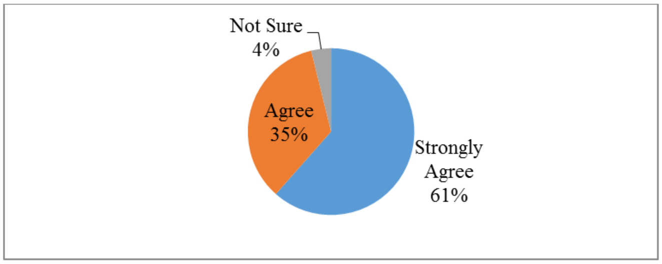

Figure 3(c). The perception of students that the practice of recycling is to appreciate the environment created by God.

Students' Perception on the Actual Condition of Recyclable Items

The actual condition of recyclable items involves concerns over cleanliness and the willingness to recycle even though recycling may be considered a dirty task. According to a study conducted by Gurder-Adams (1990) and Burca et al.

(1994), individuals who were interested in recycling activities generated more waste that could be recycled in comparison to individuals who were less interested to participate in recycling activities. On the other hand, situational factors such as the inconvenience of recycling also plays a role in individuals' intention to recycle (Derksen & Gartrell, 1993; McCarty & Shrum, 1994; Domina & Koch, 2002; Kelly et al., 2006).

Figure 4(a) shows that 53% of the students thought that recycling was not a dirty task; however, 16% thought that recycling was a dirty task, while 31% were uncertain about the issue. When asked about their willingness to recycle even though it was perceived as a dirty task, 46% of the students agreed that they would recycle even though the task was dirty, with 8% strongly agreeing and 38% agreeing, while 42% of the students were unsure. However, 12% of the students did not agree to recycle due to the task often involving working with materials that are dirty. This is shown in Figure 4(b). In conclusion, most of the students did not agree that items that could be recycled were dirty. This is because they believed that if an item that could be recycled was separated before disposal, there would then be no problems in terms of cleanliness. Most of the students were willing to recycle even though the waste was likely to be in a dirty condition.

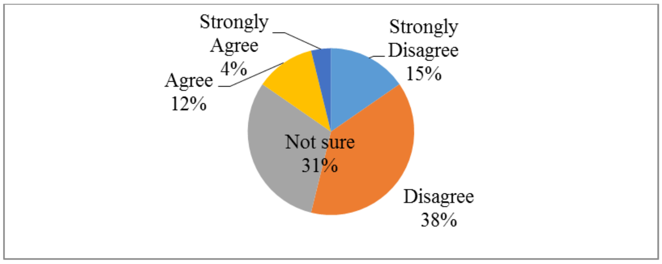

Figure 4(a). The perception of students towards the actual condition of recycling seen as a dirty task.

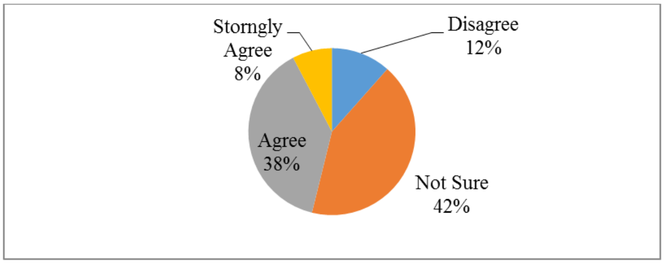

Figure 4(b). Percentage of students who were willing to practise recycling even though it was perceived as a dirty task.

Students' Perception on Individual Recycling Rate

The recycling rate in Malaysia is 10.5%, which is still low considering the target is 22% by the year 2020. In order to achieve the target, various efforts are being pursued by the Malaysian government. Among the implementations are improvement to recycling facilities and enhancing awareness campaigns. Some studies show that an individual is more likely to recycle if he or she thinks recycling is morally correct behaviour (Beck & Ajzen, 1991; Conner & Armitage, 1998; Chu & Chiu, 2003). Therefore, the objective of the next section of the questionnaire was to show what the students' perception towards recycling was if recycling was seen to be morally correct behaviour.

In the fourth part of the questionnaire, the students were asked if they knew the recycling rate per day of the average Malaysian. Figure 5(a) shows that 50% of the students agreed (31%) and strongly agreed (19%) with the statement that the recycling rate per day for the average Malaysian was very low, while 16% of the students disagreed (8%) and strongly disagreed (8%) with the statement. However, 34% of the students were unsure. The students were also asked if they knew the recycling rate per individual at UKM. Figure 5(b) shows that 57% of the students were unsure about whether the recycling rate in UKM was low, while 35% of the students agreed (27%) and strongly agreed (8%) with this statement, while 8% did not agree. Finally, Figure 5(c) shows that 46% of the students could estimate their own recycling rate in a day, while 27% of the students were unsure and another 27% of the students did not know their own recycling rate.

By analysing the results shown in Figure 5(a), Figure 5(b) and Figure 5(c), it can be concluded that most of the students were aware that the recycling rate of the average Malaysian was considered low, and the trend was the same among UKM students. Further, they also thought that their own recycling rate was low. This could be due to the fact that the students themselves realised that they did not play their part in recycling. There were some conflicting attitudes demonstrated by the students themselves in that they failed to practise recycling even though they were informed of the availability of the recycling facilities at the university. Therefore, further action is needed to change the mentality of the students as part of the effort to increase the recycling rate in Malaysia.

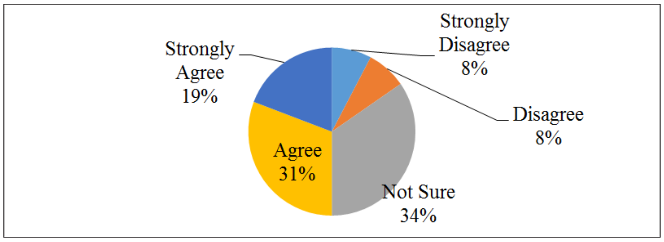

Figure 5(a). Response to the statement that the recycling rate of the average Malaysia was very low.

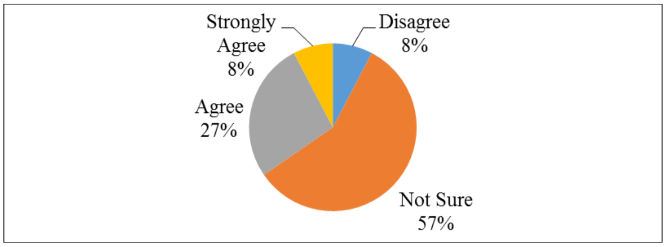

Figure 5(b). Response to the statement that the recycling rate at UKM was very low.

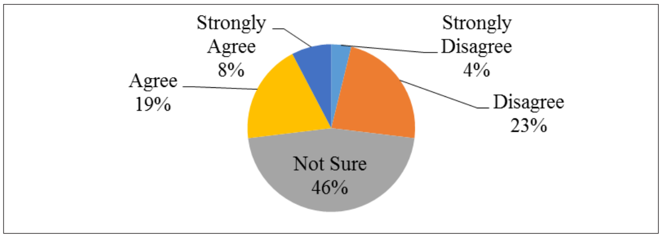

Figure 5(c). Response to the statement that the students' individual recycling rate was low.

Students' Perception on Issues Affecting Solid-Waste Management

Figure 6(a) shows that 62% of the students disagreed (31%) and strongly disagreed (31%) with the statement that Malaysia was a clean country and had no problems regarding solid-waste management, while 34% of the students were unsure and 4% agreed with the statement. During the environmental awareness programme held at the department, the students were exposed to solid-waste management issues in Malaysia. Figure 6(b) shows that 73% of students agreed and strongly agreed that Malaysia faces issues on solid-waste management, while 23% of the students were unsure and 4% did not agree with the statement.

The results shown in Figure 6(a) and Figure 6(b) indicate that the students became aware of the issues on solid-waste management in Malaysia as a result of the awareness programme. Therefore, awareness programmes should be continuously organised by the university in order to educate students on becoming responsible citizens who will conserve the environment.

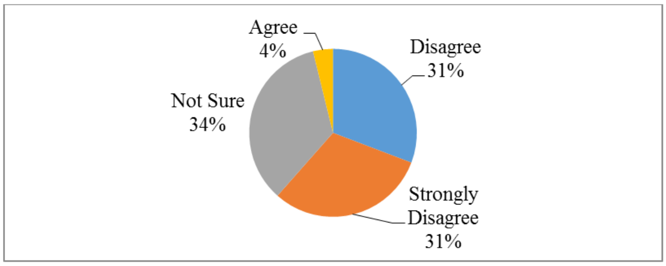

Figure 6(a). Perception of students that Malaysia is a clean country and there is no issue regarding solid-waste management.

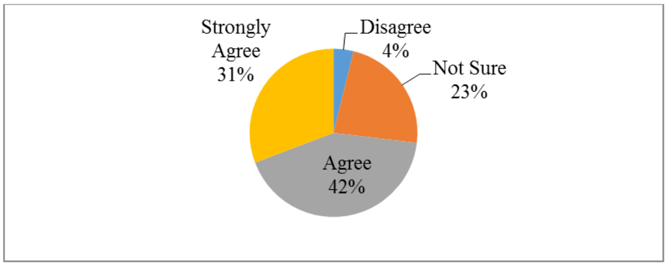

Figure 6(b). Perception of students that Malaysia is facing a critical solid-waste management issue.

Students' Perception of Individual Responsibility to Recycle

Conserving the environment is the responsibility of each individual. This responsibility is not assigned to the local authorities or the Department of Environment. Knowledge about the technical aspects of recycling e.g. which materials belong in which bin, has been found to increase individuals' motivation to recycle (De Young, 1989; Hornik et al., 1995; Schultz et al., 1995; Oskamp et al., 1998). Therefore, individuals need to be made aware that it is their responsibility to take care of and protect the environment from being polluted. It is also important for every individual to conserve the environment for future generations.

Figure 7(a) shows that the majority of the students (84%) disagreed (46%) and strongly disagreed (38%) with the statement that environmental responsibility was the duty of the local authorities, while 12% were unsure and 4% agreed with this statement.

The environmental awareness programme held at the department was intended to create understanding among students of the importance of conserving the environment. This study was also conducted to identify the effectiveness of this programme in increasing the level of awareness of the need for environmental conservation. Figure 7(b) shows that 92% of the students agreed (58%) and strongly agreed (34%) that protecting the environment was very important, while

8% of the students were unsure. The programme also aimed to raise awareness of the need for improving understanding among the students of the responsibility of each individual to protect the environment from being polluted. Taking into consideration the percentage of students who answered 'agree' (58%) and 'strongly agree' (38%) as shown in Figure 7(c), it can be concluded that this programme had succeeded in alerting the participants about their responsibility to care for the environment.

The duty to conserve the environment is not just the responsibility of the local authorities, but in fact also that of every individual. Therefore, the local authorities should work hand in hand together with each community to ensure that the environment is being protected.

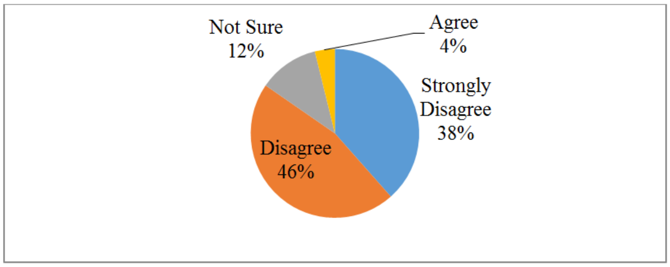

Figure 7(a). Perception of students that environmental conservation is the responsibility of local authorities only.

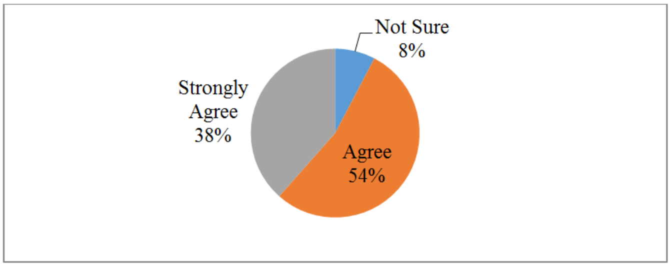

Figure 7(b). Perception of students of the importance of protecting the environment.

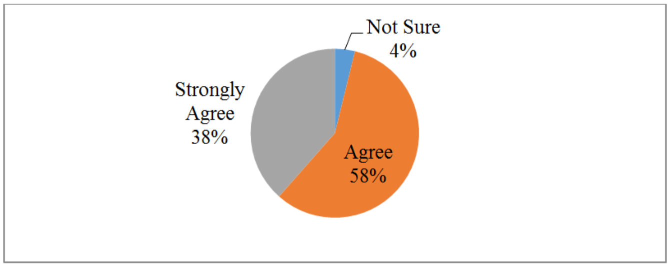

Figure 7(c). Percentage of students who were aware of their responsibility to conserve the environment.

CONCLUSION

Based on all the results obtained as shown in the figures above, it can be concluded that most of the students had knowledge of the existence of the recycling centre on campus and understood its actual functional use. In the students' perception, recycling was important with respect to solid-waste management, environmental conservation and religion. Most of the students were willing to recycle even though the waste could be dirty. However, there were some conflicting attitudes among the students as not all practised recycling even though they were informed of the availability of the on-campus recycling facilities. Therefore, further action is needed to change the mentality of the students as part of the effort to increase the recycling rate in Malaysia. Awareness programmes should be continuously organised at the university in order to educate students on becoming responsible citizens who will conserve the environment in the future. Awareness programmes such as the MAMA programme are useful in increasing awareness of the need for recycling because it combines spiritual value and environmental value. Such programmes can be developed into modules for future use. To improve recycling practices, it is important that this study be monitored over a period of years. In this case, the best target group is first-year students of any field to enable monitoring of the results and to allow for the research methodology to be improved over time. Finally, the local authorities should work hand in hand with each community to ensure that the environment is being protected.

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Distinguishing Between Civil and Structural Engineering (CSE) and Civil and Environment Engineering (CEE) Programme from Student Perspective

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ABSTRACT

This study uses descriptive data to assess students' perceptions about the differences between the two programmes offered by the Department of Civil and Structural Engineering (JKAS). The programmes offered are Civil and Structural Engineering (CSE) and Civil and Environmental Engineering (CEE). Confusion about the name may be the key issue affecting programme selection by prospective students in their application for placement in the department, thus curtailing their keenness to join the department out of fear of choosing the wrong programme. A total of 95 respondents consisting of new intake students of Semester 1 Year 1 of the 2014-2015 session engaged in the questionnaire survey process conducted in this research. Data obtained were analysed using the percentage of the score on a Microsoft Excel 2010 spreadsheet. The results showed that the students may have understood and may have had some basic knowledge about the field of study and the syllabus offered designed exclusively for each programme. Therefore, from the perspective of the students, efforts aimed at rebranding the programme names were not necessary. However, there were some existing courses that were identified and proposed for rebranding as their names were misleading for the students.

Keywords: Programme rebranding, perception of engineering students, civil and structural engineering programme, civil and environmental engineering programme

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INTRODUCTION

Since 2008, Malaysia has been a member of the Washington Accord (Cui et al., 2012) that requires all Institute of Higher Learning (IHLs) members to adopt and implement the holistic Outcome-Based Education (OBE) system approach. For quality assurance, WA requires that all programmes be accreditated by a signatory body and in Malaysia, the body responsible for this is the Engineering Accreditation Council (EAC). The objective of the accreditation is to ensure that graduates of the accredited engineering programmes satisfy the minimum academic requirements in order to be registered as a graduate engineer with the Board of Engineers Malaysia (B. Malaysia, 2012) and for admission to graduate membership of the Institution of Engineers Malaysia (IEM) (M. Malaysia, 2011).

The results of the recent EAC accreditation visit to the Department of Civil and Structural Engineering (JKAS), Universiti Kebangsaan Malaysia (UKM) in 2013 raised the issue of the existence of the two programmes in JKAS, namely Civil and Structural Engineering (CSE) and Civil and Environmental Engineering (CEE). The accreditation-appointed panelists found that the implementation of the programmes did not reflect the name of the programme in the specialisation field of structural or environmental engineering. In addition, their report concluded that both the CSE and CEE programmes be run as a single Civil Engineering Programme. This was due to the fact that the depth and breadth of coverage and scope of the courses did not clearly distinguish between the two programmes. Hence, the accreditation reports from the EAC panels in 2013 suggested that the two specialised programmes be given fair reconsideration and and that essential revision of the curriculum structure should be implemented to ensure that the courses offered were appropriate and relevant to each programme name.

Confusion over the name of the engineering programmes has affected the management and implementation process of the programmes and has been studied through scientific research to overcome the problem. The profession ‘engineer’ is difficult to define and tends to be recognised by specific specialisation (Depieri & Lopes, 2014). A quantitative study by Marshall (2007) showed that the respondents’ views about the word ‘engineer’ varied widely. His research found that only respondents who had advance knowledge of engineering were capable of distinguishing one engineering field from another and they could distinguish that the work of professional engineers is more creative and complex compared to that of other professions.

Apart from this confusion, statistics obtained from the Ministry of Education (MOE) found that some programmes scored lower in choice (FKAB, 2015). Thus, from the point of view of university management, a merger between the two programmes was seen to be the solution for a more economical, effective and efficient university management system.

The objective of this study was to identify the perceptions of new-intake students towards the two JKAS civil engineering programmes and their ability to distinguish between the two as well as to study how they related to the programme. Two parameters were tested that included programme selection factors and the students' prior knowledge about the selected programme. This study used the questionnaire survey method, which gives non-experimental descriptive statistics data.

Background on Civil and Structural Engineering (CSE) and Civil and Environmental Engineering (CEE) Programmes

JKAS was established in 1984 with permission and instructions from the Ministry of Education Malaysia to distinguish between the civil engineering programme and other civil engineering programmes that existed in other IHLs in Malaysia. At that time, JKAS only offered the CSE programme with the main thrust of study centred on civil engineering. Then, in 1996, JKAS began offering both the CSE and CEE programmes to meet current demand during that period and increasing awareness of the need for global environmental protection and preservation. The CSE and CEE programmes offered six core courses subjects and three elective subjects. Both programmes met the guidelines and fulfilled the requirements stated in Appendix B (FKAB, 2015; B. Malaysia, 2012) for the civil engineering division. Therefore, all JKAS graduates could register as civil engineers under BEM and IEM.

According to the rules of the MQA Programme Standards for Engineering and Engineering Technology (2011), a condition for using the word 'and' or the symbol '&' in the name if an engineering programme requires a 1:1 ratio of elements in the two fields or subjects being combined i.e. a programme combining the two fields of engineering would have to offer 50% subject content in Civil Engineering and 50% subject content in Structural Engineering/Environmental. The naming of the Civil and Structural Engineering programme (CSE) and the Civil and Environmental Engineering programme (CEE) has, a number of times, misled the EAC accreditation expert panelists. Thus, the JKAS administration consulted with the industry advisory panel (IAP) and decided to conduct a questionnaire survey for future direction of JKAS programme naming for all stakeholders.

Students' Perceptions of the Programme

A review by Spoor (2014) focussed on two contexts that affected student perception of courses based on name of course prior to registration; the two contexts were course name and gender of instructor. The study found that the course name influenced the students' choice more than the gender of the instructor. More traditional course names were chosen by the students due to poor perception regardless of the actual content of the courses. Students were likely to choose an attractive programme name for engineering education because new-intake students do not have a clear overview of the engineering profession as a whole. The first year at university is considered a critical learning period that affects the performance of students because of factors such as student expectations and challenges they are bound to face as new students adapting to university life. This can impact upon learning outcomes throughout their years of study (Liu & Chang, 2014).

Prior research has demonstrated that students' initial attitudes towards their diversity-related courses may influence their subsequent engagement in class and the quality of their learning experience (Spoor, 2014). However, there is relatively little research on examining the factors that shaped those initial attitudes. Spoor (2014) also mentioned that students who begin these courses with resistant attitudes and negative expectations tend to be less engaged, resulting in more negative experiences reported during the class. These findings were similar to those of Gati (2012), who found that the efficiency of an educational programme was highly dependable on the learning mode. Thus, students' perceptions of a programme play an important role in the education process.

It is interesting to note that Cui et al. (2012) reported that a successful curriculum relied on combining many different types of course and as such, an optimised curriculum structure is needed to achieve the goals of education. Therefore, in the JKAS context prior to curriculum reform such as the merging of two available programmes, it is necessary to determine which types of course are mostly in need of reformation. All available factors need to be considered, such as students' and other stakeholders' perceptions, course structure, course demand, course names and graduates' employability rate.

METHODOLOGY

This study used the questionnaire survey to determine student perception of the name of the programme. This instrument is more practical and efficient because it can improve accuracy and reliability of responses given by the respondent. Respondents are fully independent in stating their opinions or answering each item given in the questionnaire. In addition, the questionnaire survey method was used because it is one of the easiest ways to obtain information for research into perception, facts, beliefs, feelings and desires, among others.

The profile of the respondents was new-intake civil engineering students. The study was conducted during the first week of their enrolment at the university. Questionnaires were distributed during orientation week in the lecture hall. New-intake students were selected as they were considered fresh in their outlook and experience i.e they had yet to undergo the learning process, thus it was expected that they would answer the questionnaire using their existing knowledge as well as based on their reasons for selecting the programme through the *Unit Pengurusan Universiti* (UPU) system. A total of 95 JKAS students of Semester 1 of Session 2014/2015 were selected as respondents. Of these, a total of

46 students were from CSE specialisation, while the remaining 49 students were from CEE specialisation.

The questionnaire consisted of two main parts: Part A asked for background of the students, including gender, race, highest relevant academic achievement and other demographic items, while Part B consisted of questions that sought to measure the two parameters, namely the reason for having chosen the programme and the student's basic existing knowledge of the selected programme. Questionnaires that were completed by the respondents were analysed using Microsoft Excel 2010 to find the percentage score.

RESULTS

In this section, a summary of the data collected and data analysis will be described in four subsections according to the classification of items contained in the questionnaire survey. Demographics of respondents for both programmes are shown in Figure 1. In Figure 1a, we can see that both the CSE and CEE programmes had a higher percentage of females compared to males. Figure 1b shows that the majority (more than 78%) of the students for both programmes were matriculation graduates, followed by postgraduate diploma holders (about 20% of the students). Up to 98% of the students had a cumulative grade point average (CGPA) of 3.00 and above. This indicates that a higher CGPA score is compulsory for those who want to further their studies in civil engineering. Based on Figure 1d, for the CSE programme, 70% of the students stated that they chose CSE as their first choice compared to only 43% who said the CEE programme was their first choice.

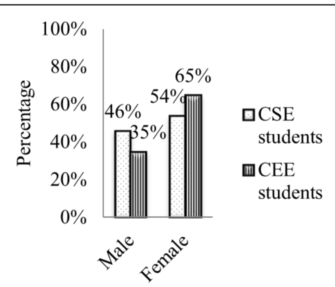


Figure 1a. Student gender.

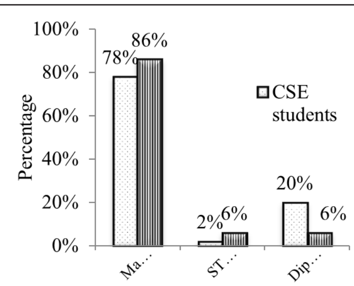


Figure 1b. Higher education.

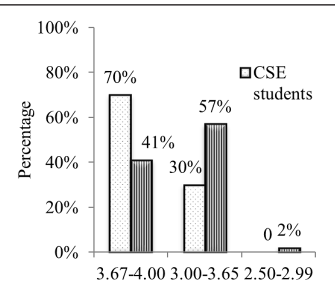


Figure 1c. Highest CGPA achievement.

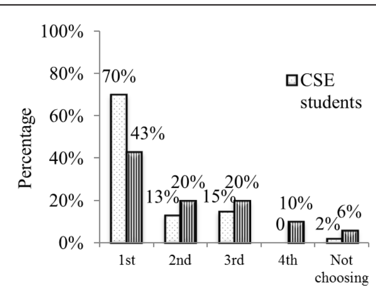


Figure 1d. Choice ranking.

Figure 1. Student demographics.

The first parameter of student demand can be measured directly by looking at the number who chose the CSE and CEE programmes as their first choice. The data show that hardly 50% of the CEE students chose CEE as their first choice.

There are several external and internal factors to explain these findings. Figure 2a and Figure 2b show that more than 63% of the CEE and CSE students chose their respective programmes based on personal interest related to the engineering field. The remaining 37% students listed other internal factors such as influence of parents, teachers and friends. As for the external factors, Figure 2b and 2d show that more than 80% of the students stated that they chose their programme based on the university's ranking and location. Other main external factors had to do with the main language used for course delivery and the attractive name of the programme. Several other factors were mentioned that did not play a significant role in the selection programme, accounting for only 20%.

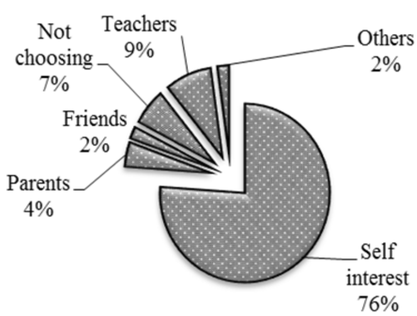


Figure 2a. CSE students – internal factors.

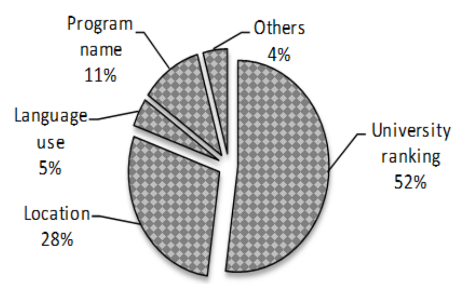


Figure 2b. CSE students – external factors.

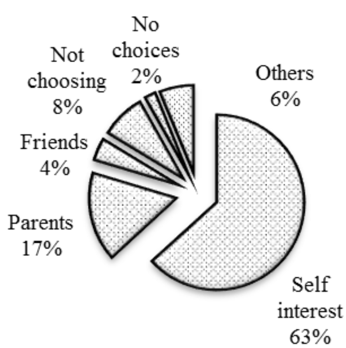


Figure 2c. CEE students – internal factors.

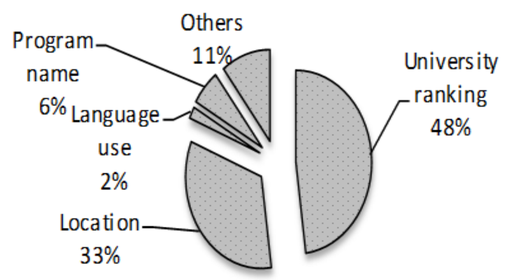


Figure 2d. CEE students – external factors.

Figure 2. Factors influencing the choice of programme by CSE and CEE students.

This offers the conclusion that the students chose CSE and CEE due to personal interest rather than coercion or persuasion of parents, friends, teachers and others. In addition to the factor of personal interest, the students also stated that they chose JKAS because of UKM's ranking as one of the top five research universities in Malaysia as well as its strategic location in Bandar Baru Bangi and its harmonious learning environment. Nevertheless, it should be noted that a percentage, although a small one, did select JKAS because they were attracted to the uniqueness of the names, CSE and CEE.

In terms of demand, CSE received a higher score compared to CEE, with the name of the programme being the only external factor. The percentage for this was smaller than for attraction due to the university's ranking status. As one of the top five research universities in Malaysia, UKM has indeed gained attention among new students as its research facilities are deemed an integral part of a reputable department, and therefore it is perceived as being able to cater for better education.

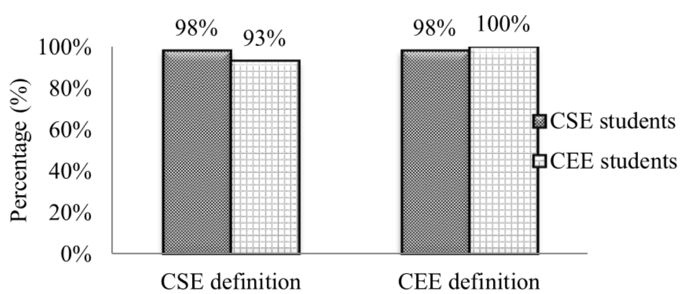
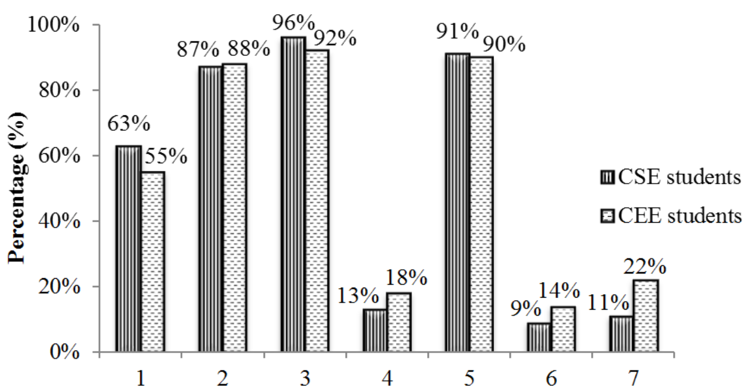


Figure 3. Number of students who stated the appropriate definition for each programme.

In this part, each respondent was required to give the definition of both programmes, CSE and CEE. Students from both programmes were able to provide a precise definition for both the CSE and CEE programmes, with over 90% of the students answering correctly as shown in Figure 3. The majority of the students stated that the CSE programme was a programme leading to structural design courses, while CEE was a programme that included the design of effluent and wastewater reactors as well as learning about factors involved in environmental impact assessment (EIA). Thus, the students showed a significant amount of awareness of what their programme of choice entailed. In addition, they could distinguish the fields of study for both programmes. Such findings indicated that there were really no issues regarding the name of the programme such as student confusion over the name.

The following section examines the students' ability to distinguish seven core courses for the CSE and CEE programmes. The students were expected to be able to state if the courses were either core courses for either the CSE or CEE programme or core courses for both the programmes. Figure 4 shows that the majority of the students answered correctly for the Structural Analysis, Bioreactor System, Steel and Timber Structural Design and Principle of Chemical Process courses. The results imply that the names of the courses were appropriate and represented the specialisation in the respective field of the programme. However, the students from both programmes were found to be confused with the following three course names, namely Integrated Design Project, Reinforced Concrete Design and Highway Engineering, with only 22% getting the correct answer. Lack of student skills caused difficulty in finding common ground to integrate these core courses and led to their inability to discern and to understand the relevance of the three courses offered. In JKAS adaptation, great effort is made by the lecturers to distinguish clearly the difference in each of the project-orientated problem-based learning for the three courses named above to make sure that each student is able to solve the problems related to their specialisation i.e. either structural or environmental engineering.



Course names:
1. Structural Analysis
2. Bioreactor System
3. Steel and Timber Structural Design
4. Integrated Design Project
5. Principle of Chemical Process
6. Reinforced Concrete Design
7. Highway Engineering

Figure 4. Percentage of correct student answers to question related to distinguishing the core courses of the programme.

In brief, the students formed a preconceived perception that only environmental-based courses were offered in the CEE programme, while the CSE programme taught the more heavy-duty core civil engineering-related courses.

This could be a result of having taken the programme name literally, focussing on the programme's keywords, 'environmental' and 'structural'.

DISCUSSION

This study can be considered a descriptive perception survey and the sample is limited to new-intake civil engineering students. Data collection was done during their orientation week. Overall, the study found that there was high demand for the CSE programme compared to the CEE programme. The high demand came from the students' own will and personal interest rather than from coercion of any individuals such as parents, friends or teachers. The selection of the programme was heavily influenced by external factors, namely UKM's ranking as one of the top five research universities in Malaysia (Liu & Chang, 2014). Being a research university (RU) gave JKAS extra pulling power in attracting new students both local and international as this reputation was a promise of good research facilities and lecturers recognised globally for their research expertise. In addition, there was also the preconceived notion that they would get good exposure to latest technology and the industry. It is interesting to note that the uniqueness of the programme name contributed to only a small fraction of the external factors i.e. less than 12%. Thus, the name of the programme did not play an important role in programme selection. It could also be ascertained based on the statistical data that the students were mature enough and had a reasonable overview of their programme choices in terms of programme definition and the role and the scope of work. Confusion did arise on some of the course titles offered and to which programme they belonged. This did not come as a surprise, knowing the fact that the respondents had just entered university and they had just begun their orientation week. It is hoped that their confusion will be dispelled by the time they commence their studies, especially with help from committed lecturers, mentors and seniors.

CONCLUSION

Based on the data obtained and from student demand, the idea of the programme mergers was in concurrence with this study, without neglecting the interests and needs of environmental and sustainability awareness. Hence, this should overcome the issue of confusion in selecting a civil engineering programme in UKM. With a series of reviews and a detailed new programme structure complete with course titles that are specific to the field that is represented, a new comprehensive civil engineering programme is expected to be produced by UKM. It is hoped that the findings of this study can pave the way for the administrators and the department lecturers to chart JKAS' future direction. Further study needs to be done with a greater number of respondents and respondents should include other stakeholders who are necessary to obtain more accurate results.

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Plagiarism among First Year University Students Using AutoCad Assignments

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ABSTRACT

Student honesty when completing assignments is a major indication to lecturers that students have acquired and know how to apply knowledge shared in the lecture hall. However, the problem of plagiarism among students in writing assignments has become a major problem in education. Plagiarism works as an indicator that students do not practise or apply or know how to apply knowledge that has been covered in class. The continued practice of plagiarism can only produce incompetent graduates who have no integrity. This study focusses on plagiarism as a whole; plagiarism occurs when students submit work that was actually completed by someone else but claims it as their own effort. A total of 73 students of Engineering Graphics participated in this study. A graphic drawing assignment using the AutoCad software was given to each student every week for four weeks. Plagiarism checking was carried out only after all assignments for the four weeks were received. Results of the study found that at least 25% of the students had committed plagiarism in every assignment. The largest group plagiarism was as high as 34 out of 73 (47%) students, all of whom shared the same file for one assignment. The results of this study will give better insight into temptation faced by students to commit plagiarism as a result of no action being taken by the course lecturer.

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INTRODUCTION

Plagiarism has become ingrained culture among university students around the world (Ashworth et al., 1997; Sheard et al., 2002).

Plagiarism refers to presenting a certain work as one's own, without giving credit to the original owner, within or without the knowledge of the originator (Walker, 1998; Park, 2003; Martins et al., 2014). Plagiarism is also regarded as fraud and showing lack of integrity in the offender (Park, 2003). There are many forms of plagiarism, such as copying directly without quoting the source; acknowledging the source but not doing any paraphrasing; copying former students' reports as one's own or 'recycling' reports and many more (Walker, 1998). All these problems have been identified as common and practised by many students in universities around the world.

In the academic context, plagiarism should not be taken lightly, and students who commit this offence should be penalised for being unethical and having no integrity. Moreover, plagiarism often crops up not only in written assignments, but also in assignments that require the use of software. When plagiarism is committed, lecturers will not be able to evaluate students' abilities accurately. While it is imperative for lecturers to be able to detect plagiarism, it cannot be denied that this can be an onerous task especially when the class has a large number of students.

Plagiarism in writing can be identified using various methods, among which are: 1) Conducting a search on the suspected sentence on the Internet; and 2) using plagiarism software such as Turnitin. On the other hand, plagiarism in the use of software is quite difficult to detect. Many studies have attempted to propose an effective method to detect plagiarism in the use of software. For example, Martins et al. (2014) created a plagiarism detection software to detect plagiarism source codes. They found that there were several types of complex plagiarism, such as changing statements, variable types, comments and identifiers' names, in order to make the source code different and unlikely to be detected as plagiarism code. Furthermore, they also had difficulty distinguishing between intended plagiarism and coincidence states.

Walker (1998) suggested that the academic staff create tools or steps in order to detect plagiarism and eventually stop the unethical activity. These steps may require students to submit multi-draft reports with the source materials; submit the work with a declaration of the report being their own work; and varying topics of assignments every semester or year. He also stated that the most important tool for a lecturer is to be able to detect plagiarism when it prevails.

Similarly, detection of plagiarism in graphic assignments using software is also quite difficult, as most students choose to take another student's soft copy of the assignment file and submit as their own. Therefore, it is very important for a lecturer to check whether plagiarism has taken place, even if the students try to hide it in several ways, namely: 1) Changing the name of the file;

2) changing the colour of the drawing or font properties in the files; and 3) adding or reducing some details in the file. This type of full plagiarism is undoubtedly the worst in the academic context as the plagiarising student does absolutely no work of his or her own. At the same time, many lecturers are not well versed in recognising or evaluating plagiarised work and simply believes that students have done their assignment themselves, and their duty as lecturer is completed when the students submit their assignment on time.

There are several ways to check plagiarism of work done using graphic software. One of them is to use the log file submitted by the students along with the project file ("Finding Cheaters", 2004). However, this process does not allow lecturers to conduct the plagiarism check without students being aware of the checking process. Another method is to use the 'time' command in an AutoCad file. This can be done after the students have submitted their graphic files. This method takes less time and can be done without the students' knowledge. This method will be discussed in detail in the section on Methodology below.

Plagiarism is an issue faced by the Department of Civil and Structural Engineering, Universiti Kebangsaan Malaysia involving its first-year students. Although warnings are given to the students before assignments are released, plagiarism among students is still rife. The high number of students who commit plagiarism in their assignments is the main reason that this study was carried out. The objective of this study was to focus specifically on the rate of plagiarism in graphic assignments using AutoCad software among first-year students pursuing a Graphic Engineering course. This study was carried out using the time-tracking method that exists automatically in each AutoCad file. This method can produce strong evidence of plagiarism, and once detected, it cannot be denied by the offenders.

METHODOLOGY

A total of 73 first-year students of the Engineering Graphics course, Session of 2013/2014, in the Department of Civil and Structural Engineering, Universiti Kebangsaan Malaysia were chosen as the research subject. Every week, the students were given a task that required them to draw graphically using the AutoCad software. The study period was four weeks. The tasks were labelled Tasks A, B, C and D, referring to the sequence of the assignment over the four weeks. The timeline for Tasks A, B and C was one day while Task D was required to be completed within two hours and submitted at the end of the class. Apart from that, the students were required to submit their assignments online to the course lecturer. All files submitted had to be named with the students' matric number followed by the assignment title.

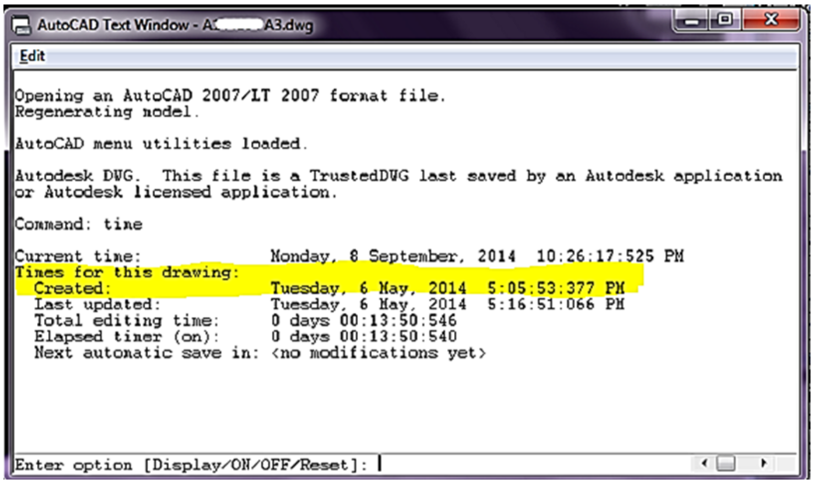


Figure 1. Created time form of graphic files that can be viewed using the 'time' command in AutoCad.

Figure 1 shows a time record automatically generated by AutoCad when a file is created. The time when the file was created and when it was last updated are automatically recorded by the software. The time format is in milliseconds. This study assumes that it is impossible for more than one student to create a new file at the same time where time is being measured in milliseconds. All the cases of plagiarism reported here have been verified by the offenders themselves, who admitted to the offence when confronted with the evidence. Therefore, all data used in this study is valid.

After all the AutoCad drawing assignments by the students over the four weeks were accepted, plagiarism analysis for each file was carried out. Every AutoCad drawing file was identified by the 'created time' recorded by AutoCad. The existence of a file is not changed even if the file is changed, cut or copied. The file remains as is and may be found using the instruction 'Time' in AutoCad.

RESULTS AND DISCUSSION

Total Number of Plagiarism Cases

The analysis of the four tasks for 73 first-year students is shown in Figure 2. The number of students refers to the students involved in committing the offence of plagiarism, and does not take into account the original owner of the file or the offenders. A high number of students committing plagiarism was marked, with at least 25% (18 students) for each task, signalling a very worrying trend. Assignment C shows us the highest number of plagiarism with 59 students, compared to only 18 students who committed plagiarism in completing Assignment A. The number of plagiarism cases increased dramatically every week with each new assignment given. This suggests that the students became more audacious in resorting to plagiarism over time when it was seen that the course lecturer seemed to be taking no action.

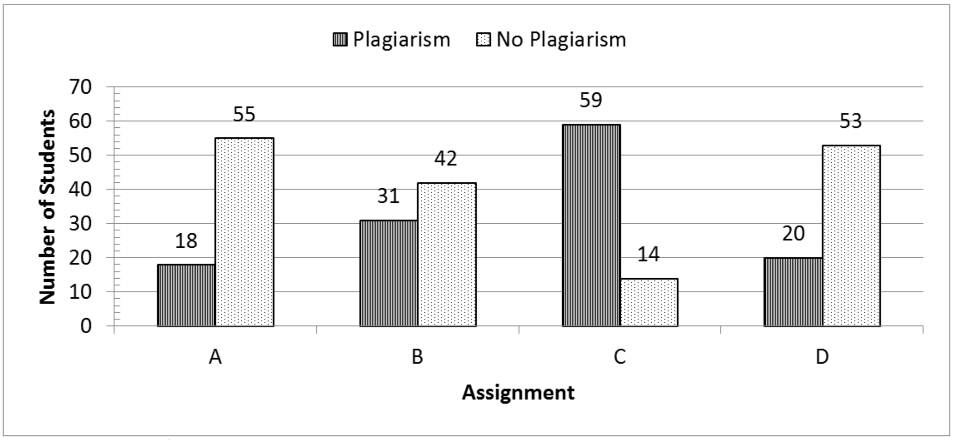


Figure 2. Number of students who committed plagiarism in assignments A, B, C and D.

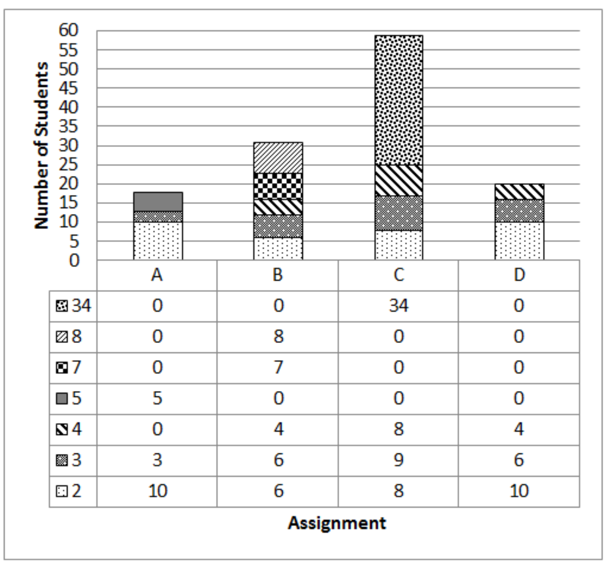
The number of students who committed plagiarism increased dramatically, from 43% in completing Assignment B to 81% in completing Assignment C, signalling a significant decrease in overall student integrity. The sharp decline in plagiarism from 59 in completing Assignment C to 20 in completing Assignment D (a reduction of about 53%) was probably due to the shortened timeline given for completing Assignment D, which had to be submitted before the class ended, making it difficult for students to openly copy files as they were all in class. The hypothesis offered for the decrease in plagiarism is that the shortened timeline and having to work in class together with other students and in the presence of the lecturer prevented students from copying; and furthermore, that a substantial increase in plagiarism on Assignment D would have taken place if a longer deadline for completion of the assignment had been given.

Group Plagiarism

Figure 3 shows the number of files that were copied and sent by students working in groups. A total of 18 students committed plagiarism on Assignment A, of whom a total of 10 students committed plagiarism in groups of two students each, while three and five students had shared the same file. For Assignment B, file sharing was rife in larger groups of seven and eight students. There were also plagiarism cases in a group of two, three and four students involving a total of 16 students.

The incidence of plagiarism was more prevalent on Assignment C, for which 34 students submitted the same file. This was probably due to lack of monitoring by the course lecturer on the previous two assignments, namely Assignments A and B, thus signalling to the students that cheating was tolerated. This means that consistent and frequent monitoring by lecturers is crucial in preventing students from committing plagiarism. The students were also found to have made minor changes to their copied files such as to the colour of the drawing lines and file name, or by adding fonts in the drawing as well as other alterations in an attempt to hide evidence of plagiarism. A total of 25 students plagiarised on Assignment C in a group of two, three or four students.

For Assignment D, students were given a warning before starting with respect to plagiarism, to the effect that they would be awarded a zero mark if found plagiarising or to have plagiarised. However, the warning was ignored as students who had plagiarised on the previous three tasks were unable to complete Assignment D. The decrease in the number of plagiarism cases on Assignment D could also be due to the warning given beforehand about the penalty for plagiarism, indicating that monitoring by the course lecturer in class can reduce plagiarism even if it does not eliminate it altogether. Plagiarism was evident at this stage, committed by 20 students, although it occurred only in small groups of two, three or four students. Ten students had shared the same files in a group of two; six students in a group of three; and four students who worked in the same group.



	A	B	C	D
34	0	0	34	0
8	0	8	0	0
7	0	7	0	0
5	5	0	0	0
4	0	4	8	4
3	3	6	9	6
2	10	6	8	10

Figure 3. Number of cases of plagiarism committed by students working in groups.

Frequency of Plagiarism by Each Student

Figure 4 presents the frequency of every student who committed plagiarism on their assignments. Only 12 students did not resort to plagiarism on any of the four assignments. About 16% of the first-year students were honest in completing their work. About 30% of the students plagiarised once, 22% plagiarised twice, 25% thrice and 7% did not do all their assignments by themselves.

In assignment A, 55 students did their assignment themselves (honest students), but 16 of them committed plagiarism on Assignment B. This group of students might have realised that the other students who had plagiarised had not been found out or penalised by the course lecturer. The number of honest students decreased further on Assignment C, as only 13 students submitted their own work, making this assignment the one with the highest number of plagiarism cases compared to other assignments. On Assignment D, only one student from the 'honest students' group had submitted plagiarised work although a warning had been given regarding plagiarism to the students. For the 59 students who had committed plagiarism on Assignment C, only 19 had persisted in committing this offence on Assignment D, while the other previous offenders seemed to have decided not to commit any misconduct after a warning was given. Only six students committed plagiarism consistently on all four assignments despite the given warning.

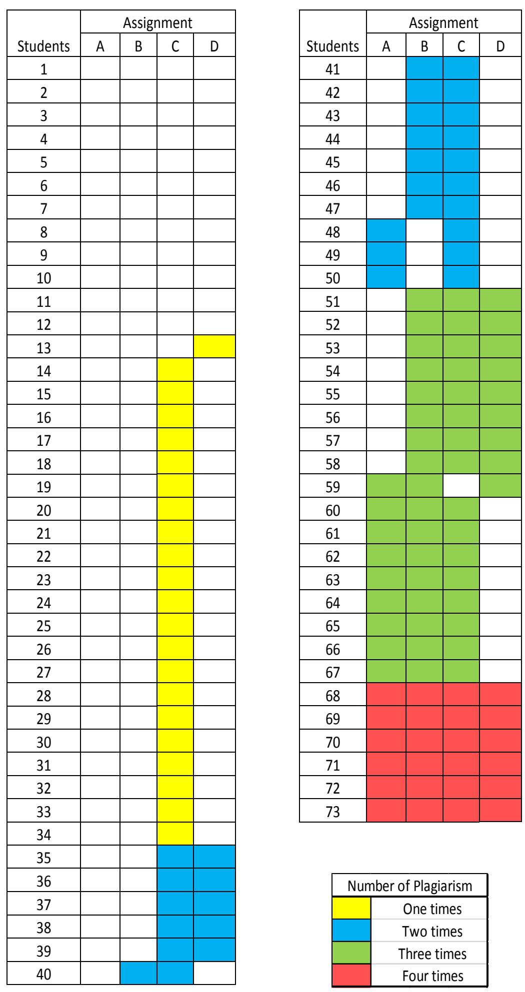


Figure 4. Number of plagiarism cases by each student on assignments A, B, C and D.

When and Where Did the Plagiarism Occur?

Many questions were raised on when and where the plagiarism occurred. For instance, how did the students submit plagiarised Assignment D files, as the files had to be submitted at the end of the class. One possibility is that since the file had to be sent through the course online system with the support of the Internet, the students could still exchange files with one another through email. They could also copy files and exchange them using an external drive. This brings up the issue of the ease of plagiarising through use of the Internet as a contributing factor in the trend of excessive plagiarism today, as the Internet makes it easy and convenient for any files to be dispatched in seconds. The time constraint imposed for completion of Assignment D might have caused the reduction in the plagiarism cases. With extra time allowed to complete the previous three assignments, they had had the opportunity to plagiarise while making alterations to prevent easy detection of plagiarism through editing, changing properties of the drawing and other details.

CONCLUSION

Plagiarism is a very serious problem and it can grow to alarming heights if no measure is taken by the course lecturer to curb or prevent it altogether. Plagiarism involving a group of 34 students shows that the rate of plagiarism is increasing and is likely to continue to increase if no monitoring is done by lecturers. Although the monitoring was done only before the final assignment was handed out, and a warning was also issued, a total of 20 students had not been deterred from committing the crime again, allowing for only a reduction in plagiarism of about 53%. This shows that plagiarism can be reduced, but can persist even when the course lecturer is monitoring its incidence. This study has shown that the temptation besetting students to commit plagiarism was higher when no action was taken by the course lecturer to correct their behaviour. Further study can be done to compare the plagiarism rate when students are monitored on every task and action is taken by the course lecturer to correct wrong conduct.

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Sustainable Education Model through Recycling and Ekorelawan Volunteering Activities

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ABSTRACT

The sustainable education model with the combination of UKM's recycling centre (PKSUKM) is an educational innovation in UKM's waste management system. Volunteering activities through environmental education and recycling activities are important components in this model. This study aims to establish *ekorelawan* service among the students of the Faculty of Engineering and Built Environment (FKAB) through their involvement in recycling activities on campus and within the larger community beyond campus. Therefore, surveys were conducted to determine the acceptance and willingness of students to engage in *ekorelawan* activities. A pilot study was done with the involvement of second-year students (73 students) of the Department of Civil & Structural Engineering in three programmes that were carried out during their first semester of the academic session 2014/2015. The programmes were Mengasihi Alam Anugerah Maha Pencipta (MAMA); recycling activities with students from a school in Bandar Baru Bangi; and an event to create awareness of the need for the conservation of Alur Ilmu UKM. Two surveys were conducted before (the start of the semester) and after the three programmes were run (the final semester). Only 23 students (32%) were interested in pursuing these voluntary activities. Time was the main constraint that prevented students from participating in *ekorelawan* programmes. The results of this pilot study are important in order to improve the programme and at the same time to devise strategies to attract more students of FKAB to participate in *ekorelawan's* programmes in the future.

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INTRODUCTION

The processes and outcomes of teaching are more easily and more systematically studied through the use of a model. A model is a conceptual framework that clearly captures relevant components of the concept and shows how the components relate in order for the concept to work effectively. The sustainable education model that is discussed in this paper is part of the research related to the operation of UKM's recycling centre. This model presents a concept of how UKM's recycling centre can be used as the basis for the teaching and learning process in accordance with the prescribed learning outcomes through a combination of research, education, sustainability and entrepreneurship. This triggers learning and teaching innovation for the overall good of the students and the entire UKM community. Md Zain et al. (2012), Md Zain et al. (2013) and Md Zain et al. (2014) discussed the implementation stage for whole-model development based on a problem that occurred in the operation of UKM's recycling centre that can be improved with student involvement in order to increase UKM's recycling rate. The discussion was concerned with the whole education model with analysis from a related survey on students' acceptance towards recycling; the relevant thinking style that aids the solving of problems; students' acceptance of activities that encourage them to think in a creative, innovative and critical way. A positive outcome would be students' acceptance of volunteering activities. The aim of this study in using a model was to complete the whole education model using UKM's recycling centre as the context.

Education through volunteer activities can be beneficial to students (Ouma & Dimaras, 2013). Volunteering means participating in an activity willingly or sincerely without expecting material reward. The act of volunteering is increasingly diminishing among individuals because of self-interest that drives people to think of and seek remuneration for any work done. Azizan (2014), in discussing the social problems of youth, emphasised involvement in community work as a means of addressing this problem. Community work requires volunteers who can help make a difference for the betterment of the community, the environment and their own moral development. Thus, it is important to study a model to see how it can be used in order to produce engineering graduates who do not only act as engineers but who are aware of their moral duty to society as well as their accountability to present and future generations. In an effort to produce professional engineers, the Faculty of Engineering and Built Environment (FKAB) has established six objectives and 12 outcomes of the programme (PO) to be achieved by each department. One of the programme outcomes relates to sustainable development and the environment, and states, "Having understanding of social, cultural, global and environmental responsibilities and ethics of a professional engineer and the need for sustainable development" (PO7, EAC, 2012).

According to Palmer and Neal (1994), the three areas that are closely related to environmental education is education about the environment, education for the environment and education through the environment. This is related to the care and positive attitude and actions towards the environment with a sense of responsibility to nature. The *ekorelawan* programme conducted in this study included all three components. Severe environmental deterioration in recent years has prompted educators to incorporate green engineering concepts and sustainability in their undergraduate syllabi (Bauer et al., 2012). Environmental sustainability education in the form of volunteer work will add value to this by developing awareness in students to be more responsible towards protection of the environment.

Sustainable education relates to the environment as the main focus. There are many definitions related to education and sustainability, both of which have the same relationship with the environment. Generally, education for sustainability is a process for the development of apprehension, ability, attitude and other values that can enhance student involvement in sustainable development at local, national and international levels as well as enable them to work in a sustainable future. Sustainable education enables students to integrate environmental considerations in making decisions more sparingly (Bauer et al., 2012). Environmental education and education for sustainable development have seen the importance of equality in the application environment through education. This has also been discussed by Cieges and Gineitiene (2006), who also established the similarities and differences between the two concepts. Higher learning institutions are responsible for developing students who possess awareness, knowledge, skills and other values to enhance sustainability.

The Sustainable Education Innovation Model through Recycling

Conventional education allows for the teaching and learning process to unfold only in the lecture hall but with innovations in educational methods, opportunity is given to students to think outside the box and apply what they learn in real-life settings. Students have to think critically, actively, gain experience and learn to solve problems, all of which work together to bring them to awareness. When innovative education is conveyed with passion, it can trigger the eagerness of students to understand concepts deeply and to learn to make decisions through proper critical thinking. The sustainable education innovation model is built upon these considerations.

The sustainable education innovation model shown in Figure 1 was developed based on research into and the operational experience of UKM's recycling centre. Innovation and sustainability were made the main components of the model, acting as the 'roof' of a house that protects and holds up the standards of innovation and sustainability while education is the base that provides strength to the whole structure, supporting its six crucial components, namely, research, entrepreneurship, users, management, policy and finances. Each component is connected to the others. Research can identify weaknesses in a model and can provide an answer to the problem statement, while also adding value to the model. Entrepreneurship as a component of this model provides opportunities in terms of business that can generate profit from UKM's recycling centre. Users come from different backgrounds and include students, the UKM community and the Bandar Baru Bangi community who are invited to bring recyclables to the centre for small sums of money. This makes it imperative for UKM's recycling centre to find an effective management system, develop effective recycling policies and source for adequate financial resources for its operation and ongoing research.

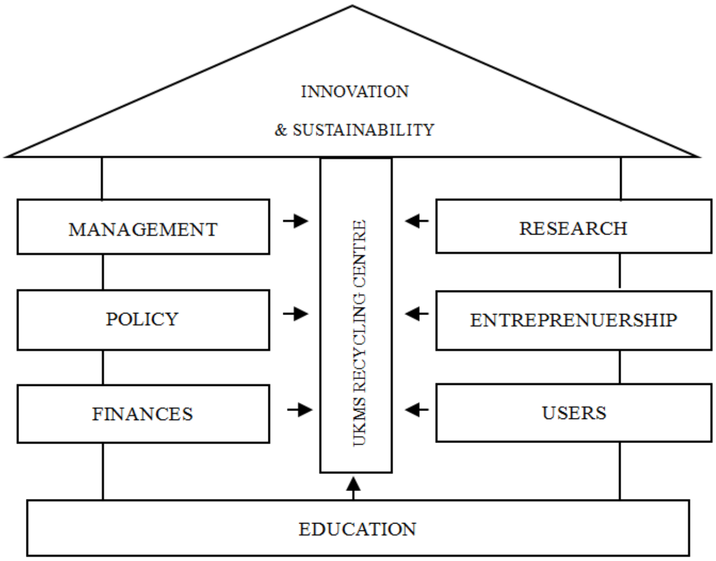

Figure 1. Sustainable education innovation model based on operation of UKM's recycling centre (Shahrom et al., 2013).

This model was developed from ongoing action research that was first started in 2010; this research has contributed much to students and the overall UKM community. Osman et al. (2010) discussed education in action research that can improve practices, understanding and situations through examples from other research action models that use both research and action elements. Thus, both research and action are used to enhance the teaching and learning process in order to prioritise creativity, innovation, critical thinking and volunteering activities. Education refers to the teaching and learning process that covers all courses offered by different faculties. The initial phase for this action research was student involvement, which came from the Self Development course (ZT1052 & ZT1062) and the Users' Behaviour course (EPPM3113) with a total of 70 students. The test results of the questionnaire showed that students received the teaching and learning process through involvement in recycling activities and they were encouraged to think using creativity, innovation and critical thinking (Md Zain et al., 2013; Md Zain et al., 2014). Md Zain et al. (2012), Md Zain et al. (2013) and Md Zain et al. (2014) discussed the implementation of the model development. Table 1 shows the involvement of undergraduate students in the operation of UKM's recycling centre from 2011 to 2015. This study discusses the volunteering activities related to sustainable education and recycling activities by analyzing the survey on the student's acceptance and willingness to engage in *ekorelawan* activities in CITRA courses (HHHC9101, HHHC9201, HHHC9301, HHHC9401, HHHC9501 & HHHC9601). The study considers the sustainability and innovation education model based on the operation of UKM's recycling centre.

Table 1
Involvement of Undergraduate Students in the Operation of UKM's Recycling Centre (2011-2015)

Courses	Faculty
ZT1052 Self Development I & ZT1062 Self Development II	Centre for General Studies
EPPM3113 Users' Behaviour	Faculty of Economics & Management
KW4014 Solid-Waste Management	Faculty of Engineering & Built Environment
KH2184 Environmental Engineering Studies	Faculty of Engineering & Built Environment
KW4102 Research Project I & KW4206 Research Project II	Faculty of Engineering & Built Environment
CITRA: HHHC9101 Social & Accountability HHHC9201 Communication Skills HHHC9301 Information Management Skills and Lifelong Learning HHHC9401 Values, Attitudes and Professionalism HHHC9501 Critical Thinking, Problem Solving and Science Approach HHHC9601 Leadership Skills and Teamwork	Faculty of Engineering & Built Environment

METHODOLOGY

A pilot study was conducted with the involvement of second-year students (73 students) from the Department of Civil and Structural Engineering in the three programmes that were carried out during the first semester of the academic session 2014/2015, namely, '*Mengasihi Alam Anugerah Maha Pencipta*' (MAMA), 'Green Schools Programme' with students from a school in Bandar Baru Bangi and an awareness programme for the conservation of *Alur Ilmu* UKM. A survey administered in the early stage before the programme was launched was conducted to determine the students' understanding of the importance of volunteer activities and environmental stewardship and their willingness to engage in volunteer activities. A survey carried out after the activity sought the students' viewpoint on the three activities and also sought to monitor their inclination to continue participating in future *ekorelawan* activities.

RESULTS AND DISCUSSION

Respondent Background

This study involved the administration of a set of questionnaires before and after the activity. Students who answered the questionnaires were second-year students from the Department of Civil and Structural Engineering. The number of students who answered the questions before the activities were 27 while 45 answered the second questionnaire after the activities carried out. The total number of students involved in the programme was 73. Figure 2 shows the percentage of students by gender, while Figure 3 shows the percentage of students who answered the survey before and after the programme according to departmental programme. The number of female students may reflect Brzozowski's (2013) proposal that women with careers and higher education are more likely to participate in volunteer activities. Figure 3 shows that the percentage of students from the Civil and Structural Engineering programme (Structural) was greater than that from the Civil and Environmental Engineering programme (Environmental) before and after the event. The difference was not significant, that is by only 2% to 4%. This indicates that interest in the programme did not have a significant influence on interest in volunteer activities. Figure 4 shows the percentage of students by race comprising Malays, Chinese, Indians and others. The percentage of Malays is the highest followed by Chinese, Indians and others.

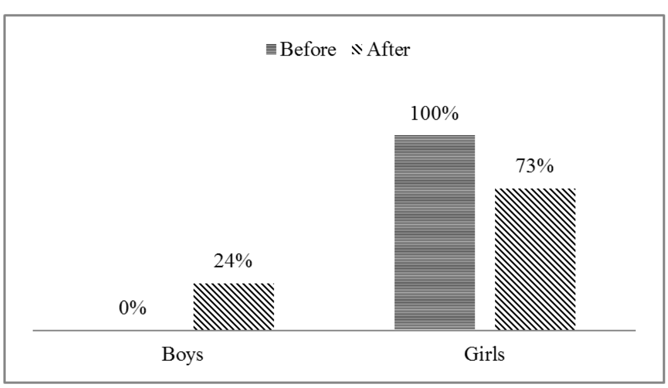

Figure 2. Percentage of students who answered the survey before and after the programme according to gender.

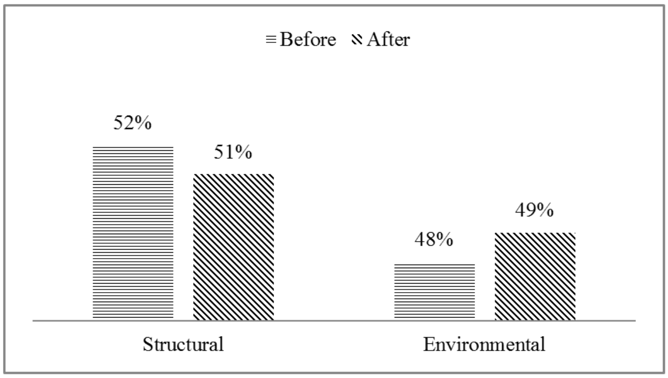

Figure 3. Percentage of students who answered the survey before and after the programme according to departmental programme.

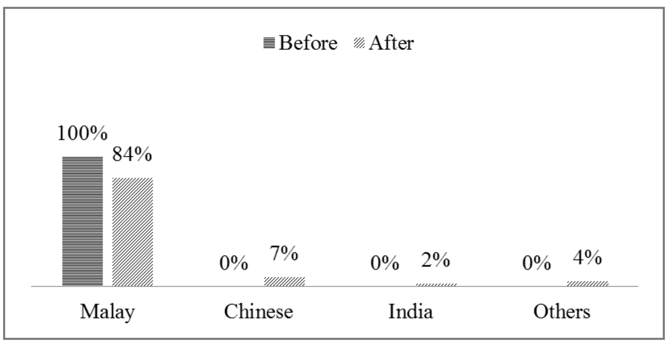

Figure 4. Percentage of students who answered the survey before and after the programme according to race.

The Importance of Volunteer Activities

Overall, the students agreed and strongly agreed that volunteer activities are important in preserving the environment. Students also agreed that it was important to be effective in volunteer activities, with 96% agreeing and strongly agreeing that they were aware of the establishment of *ekorelawan* UKM and its importance in preserving the environment. However, 67% said they would participate in volunteer activities if that could increase their CGPA or if they were given a financial reward to do so. This shows that the students understood and agreed with the importance of volunteering but they were not willing to carry out such activities in the absence of a reward. However, there were also students who were willing to participate in volunteer activities without receiving a reward (15%), as shown in Figure 5.

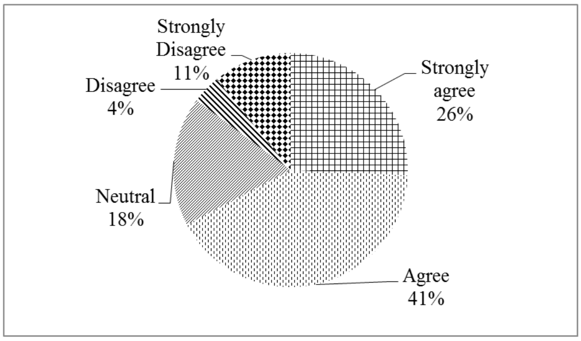

Figure 5. Percentage of students responding to the question about wanting a reward for doing volunteer activities.

The number of students who wanted a reward was high. These were students who had previously never volunteered their services before. Figure 6 shows that 67% of the students who had never participated in any volunteer activities previously were willing to gain new experience and wanted to understand the importance of volunteering. According to a study conducted by Che Nawi and Asmuni (2013), understanding is the second most important factor in an individual's involvement in volunteer activities. The experience of participating in volunteer activities leads to awareness of the deeper issues of life and can enhance the individual's self-motivation. There were also students who honestly declared that participation in the activities would help them with the CITRA course that was compulsory for every student in UKM. Some students participated in the events with the conscious intention of wanting to protect the environment while others simply wanted to broaden their network of contacts. Therefore, the reasons for student participation in these volunteer activities were varied. It should be noted that participation would indeed have been of more value if they had obtained a grade that could have helped in their studies.

About 75% of the students disagreed and strongly disagreed with the statement "Volunteer activities are suitable only for people who can afford them," while the rest were not sure, agreed and strongly agreed, as shown in Figure 7. This statement was addressed to the students to determine if they were aware of the cost to the individual of participating in volunteer activities. The survey provided writing space that allowed students to give suggestions and comments regarding volunteer activities organised by the university. Almost all of the students proposed to have more interesting activities that took them on visits outside the university; involved non-governmental agencies and other organisations related to the activities; and added more practical or hands-on knowledge. In addition, the students proposed that promotion of volunteer activities or *ekorelawan* be extended.

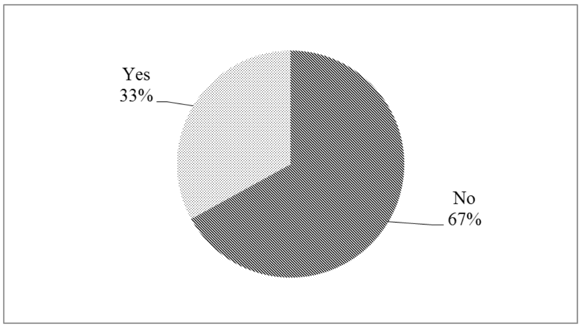

Figure 6. Response to the question on gaining experience from participation in volunteer activities.

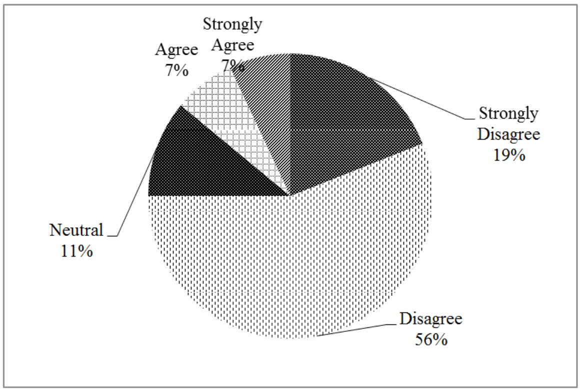

Figure 7. Response to the statement, "Volunteer activities are suitable only for people who can afford them."

After Exposure to Environmental Volunteer Activities

The students accepted their participation in the three activities as being beneficial, stating that their understanding of volunteerism had been enhanced and they were more aware of the importance of protecting the environment. The activities had also helped the students with their extra-curricular and academic work. Sixty per cent of the students agreed that volunteer activities can help them build self-confidence. However, 53% of the students agreed and strongly agreed that volunteer activities are a waste of time (Figure 8). This may give the perception that students are materialistic but according to Yahaya and Yahaya (2013), in order to encourage and maintain the spirit of volunteerism, gifts in the form of recognition are necessary to a degree.

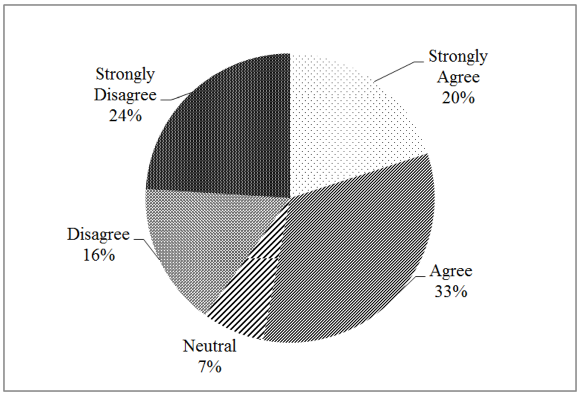

Figure 8. Response to the statement, "Volunteer activities are activities that waste time."

Positive response to participation in the MAMA programme showed that the students were aware of the link between environmental care and gratitude to nature as created by the Creator, with 91% agreeing and strongly agreeing with the statement, "This brings me closer to my Creator." Therefore, exposure to the relationship between the Creator and the environment can help students see an added relevance of protecting the environment. In this study, the students were exposed to the importance of environmental protection as vicegerents on Earth; this was to foster a sense of responsibility among them as they developed the awareness that environmental protection not only benefitted the environment but also fulfilled a religious requirement (Figure 9). Apart from activities in the university, the students were also involved in the Green Schools programme with students from a school in Bandar Baru Bangi. They were required to deliver environmental knowledge to the students about recycling. Figure 10 shows that 89% agreed and strongly agreed that uch community activities are good, and 85% said that they would like to engage in activities that promote social awareness.

Figure 9. Students involved in the MAMA programme being exposed to the relevance between religion and environmental protection.

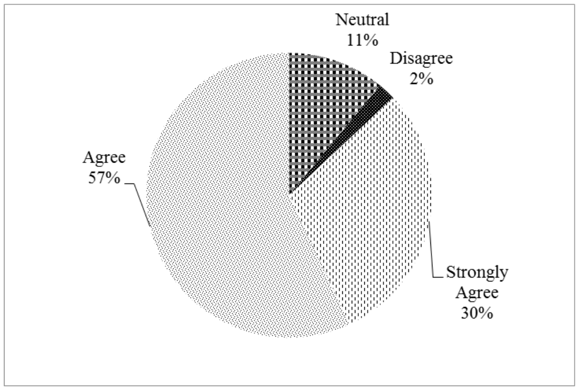

Figure 10. Response to the statement, "I want to be involved in awareness programmes and in serving the community."

Fifty-one per cent of the students agreed to continue participating in voluntary activities organised by the university. All the students who wished to continue their participation in volunteer activities were female students. The rest stated they were not interested in continuing with volunteer activities as they did not have the time to do so. Figure 11 shows the interaction of the students with pupils from the school in Bandar Baru Bangi, who ranged in age from 7 to 12 years. Activities that benefitted the community also involved activities that supported the university community; these students required the students to share the knowledge and experience they had obtained about the importance of the 3Rs (reduce, reuse, recycle) and its impact on *Alur Ilmu* UKM, as shown in Figure 12. These activities helped to enhance the students' confidence and communication skills, thus increasing their marketability upon graduation.

Figure 11. Ekorelawan in schools interacting with the pupils of a school in Bandar Baru Bangi under the Green School programme on recycling activities.

Figure 12. Students distributing pamphlets around UKM about the awareness programme and recycling activities for the conservation of *Alur Ilmu* UKM.

Education from home and its environment are the factors that can affect human behaviour concerning the environment. In an earlier study (Md Zain et al., 2014), students were asked to answer the question, "If you do not recycle, are you ever going to do it, and when are you going to do it?" (Table 2). In their response, they attested that they would recycle, and they would do so after they had learnt more about recycling, after exposure to recycling and after being involved in activities held by UKM's Recycling Centre. This indicates that their involvement in recycling activities in the process of teaching and learning as conducted in this study had provided knowledge, developed awareness of the importance of recycling activities and encouraged willingness to engage in future recycling activities. The activities had led to development of interest in and willingness to put in effort into recycling-related activities in the teaching and learning process. The students had been able to increase knowledge, understanding and awareness to practise environmental protection and more importantly, to act more responsibly towards the environment.

Table 2
Response to the Question, "If You Do Not Recycle, Are You Ever Going to Do It and When Are You Going to Do It?"

No	Comments
1	Yes, now
2	**Yes, when there is a chance.**
3	Yes, this week.
4	Yes, when there are items and nearest places to do recycling.
5	Yes, if there is time.
6	Yes, not sure.
7	Yes, after segregating items according to their types.
8	**Yes, when I know more facts about recycling.**
9	**Yes, after being exposed to recycling.**
10	Yes, maybe next time.
11	Yes, if there are items and places to segregate and recycle.
12	Yes, when there are recycle bins in dormitories.
13	**Yes, after involved in PKS.**

CONCLUSION

The educational model of sustainability combined with research, through involvement in PKSUKM gives priority to education regarding the environment and its preservation through creative problem-solving, innovation and critical thinking. Awareness of the importance of volunteer activities is still low among students. Factors such as the granting of rewards in the form of credit scoring and also recognition from the university can go a long way in encouraging students to participate in volunteer activities. An added benefit is that this allows them to explore and appreciate knowledge of nature while sharing that knowledge with the wider community. *Ekorelawan*, who are students of the Faculty of Engineering and Built Environment, provide service to the community and at the same time build morale and motivation, thus becoming better prepared to face life after graduation. *Ekorelawan* volunteer activities are also undeniably important in supporting and sustaining the operational and awareness programmes run by PKSUKM.

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Effectiveness of Pre-Test in Determining Students' Achievement in Department Fundamental Courses

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ABSTRACT

Students' understanding of foundational concepts in fundamental courses is important as it is a pre-requirement for proceeding to any advanced and specific courses in any degree programme. Despite high passing rates in most universities, students actually do not really have a good understanding of the course content, especially in fundamental courses. This paper aims to discuss how the pre-test of basic knowledge in mathematics and physics learnt during pre-university or matriculation level can be used to determine and predict student achievement in the fundamental courses of the two subjects. The pre-test questions were distributed to the first-year students at the beginning of semester one (1) of their study at the Department of Civil and Structural Engineering, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia. In this study, two fundamental courses were selected from first- and second-year programmes, namely, Static & Dynamic (KH 1044) and Fluid Mechanics (KH 2134), respectively. A total of 35 students from the test sample of 43 students successfully obtained the pre-test scores of over 40%, while only one student scored more than 80%. However, students who did well in the pre-test did not necessarily obtain good results in the final examination of both fundamental courses and vice versa. Therefore, necessary action or improvement to the teaching and learning process of the identified courses need to be taken to ensure that students have deep understanding of the subjects before they proceed to the advanced courses.

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INTRODUCTION

In line with rapid economic growth, whether in manufacturing or industry, the need for professionals and highly skilled employees becomes crucial. To meet the needs and requirements of the country, the Ministry of Education, Malaysia has formulated a strategic plan to nurture world class knowledgeable, innovative and first-class human capital by 2020 (Nuraini Khatimin et al., 2012). The plan emphasises the importance of improving the quality of the national education curriculum and enhancing teaching and learning experience.

Institutions of Higher Learning (IHL), which are the primary agents for generating and producing skilled manpower in response to the government's requirement, have to ensure the quality of these graduates. Thus, the Engineering Accreditation Council (EAC) was established to monitor engineering programmes offered at public universities to ensure that they are appropriate and meet the accreditation standards (Azrilah et al., 2012). Various methods are used to monitor the quality of graduates and the curriculum. The main measurement is student achievement of course outcomes (CO) as established in Outcome-Based Education (OBE). Based on the OBE curriculum, student performance throughout the year is consistently evaluated, which is an exercise that is crucial in continuous improvement policy (EAC, 2008). Therefore, students have to excel in their studies consistently every semester; to do this, they will need a good understanding and strong basic knowledge of fundamental courses.

Deep understanding of mathematics and science courses is a necessity for any student wishing to pursue education in the field of engineering. The application of science and mathematics plays an important role in developing latest technology, especially in the engineering field. According to Pyle (2001), engineering as a career requires an understanding of mathematics, science and technology. Although mathematics and science would have been learnt from primary school up to matriculation level (pre-university), students' understanding in fundamental courses at university level remains a concern. In fact, according to a study by Zulkifli et al. (2013), student understanding in mathematics in pre-university does not help or guarantee that they will understand the course better. Students always experience difficulty in studying mathematics as they have to understand theories and memorise formulae (Yushau, 2006). Understanding concepts comprehensively rather than remembering formulae blindly is a better strategy for students in solving mathematical problems (Wong et al., 2001). In engineering, mathematics is a key component subject and acts as a medium for expressing physical, chemical and engineering laws (Sazhin, 1998). This is the same for science education, which is not only closely linked with the development of science, but also with society's demands for science, technology, engineering and mathematics (STEM) education. It can be used much more practically, especially in industry, agriculture, crafts and military applications (Trna & Tronova, 2015). According to Sagakumar (2012), science is a prime course in technology and both courses are the key to development and community building.

Therefore, this study aimed to assess the level of student understanding in year one before they start their studies in engineering at the university. As mathematics and science courses are a necessity in the study of engineering, a pre-test should be administered to gauge students' understanding and prior knowledge at the beginning of the semester of their study. The pre-test questions that were prepared focussed on mathematics and physics as these two fields were foundational in fundamental courses taught at the Department of Civil and Structural Engineering, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia. Good understanding and background in mathematics and physics would help students to excel in the fundamental courses and simultaneously, allow them to use basic knowledge that they have learnt to solve engineering problems in advanced courses or specific courses in the department. Results reported by Devlin et al. (2013) suggest that although the rate of students who pass the examination at the university is quite high, most students do not understand the course content at great depth. The majority of students simply memorise the syllabus content merely to pass the examination. However, students with strong basic knowledge in fundamental courses can easily solve any engineering problems given to them compared to those who simply memorise course content for examination purposes (Osman et al., 2012).

METHOD

In order to evaluate whether the pre-test questions could be used to assess students' level of understanding and knowledge in mathematics and physics to predict student performance on basic courses at the department, three stages of assessment were carried out. In the first stage of assessment, pre-test examination was administered to first-year students at the beginning of Semester 1 of their study. In this study, 47 students (admission for year 2012/2013) at the Department of Civil & Structural Engineering, Faculty of Engineering and Built Environment (JKAS), UKM were chosen. Pre-exam questions were prepared to investigate whether the students could use their basic understanding and knowledge acquired in pre-university or matriculation level for continuing their studies in fundamental courses in year one and year two at the university. Six questions were designed that were mainly focussed on mathematics and physics as shown in Table 1.

Table 1
Pre-Test Questions

Question	Field
1	Mathematics (Logarithmic)
2	Mathematics (Trigonometry)
3	Mathematics (Matrix)
4	Mathematics (Differential)
5	Physics (Linear Motion)
6	Physics (Forces)

Every question in each field was prepared to test the students' understanding of a certain topic among those most relevant to the civil engineering syllabus. The validity and reliability of the question were also checked using the Rasch Measurement Model. The Rasch model provides item (question) difficulty as well as ability of the student (Nuraini Khatimin et al., 2012). The Rasch analysis found that the questions were appropriate for measuring student ability and the researcher's need. Detailed findings of the validity and reliability of the questions are discussed in Siti Aminah et al. (2015). For the purpose of this study, two courses, which were Static & Dynamics (KH1044) and Fluid Mechanics (KH2134), were selected to represent the important fundamental courses offered in year one and year two, respectively. Both courses were selected because they are compulsory courses for students who are registered in the Civil and Structural Programme and Civil and Environmental programme offered by the department.

The second stage of assessment involved collecting marks from the final examination of the Static & Dynamics (KH1044) course for the target group of students. The course content was divided into two parts, with 50% of the questions focussed on Static and the other 50% on Dynamics. Throughout the semester, students were required to carry out laboratory experiments, complete assignments and sit examinations. Thus, the overall marks were divided into 10% from laboratory work, 15% from assignments, 25% from the mid-semester examination and 50% from the final examination. The final examination for the course took place at the end of the semester of the first year of their study.

In the third stage of assessment, the Fluid Mechanics (KH 2134) course was selected and the same students were evaluated throughout the semester, which was in year two of their study. The overall marks for the course consisted of 10% from quizzes, 15% from laboratory work, 30% from the mid-semester examination and 45% from the final examination. For the purposes of this study, the marks from the final exam for the course were recorded. A period of approximately two years was taken to compile all the required marks simultaneously in completing the entire study. Further analysis of pre-test marks with Static & Dynamic (KH1044) and Fluid Mechanics (KH2134) courses was carried out to determine the correlation between the results of the pre-test and those of the fundamental courses of year one and two.

RESULTS AND DISCUSSION

The marks for the pre-test, Static & Dynamics (KH1044) and Fluid Mechanics (KH2134) courses for 47 students are plotted in Figure 1. From the whole class of 47 students, only four students did not sit the pre-test examination. The plotted pre-test marks shown in Figure 1 are arranged in ascending order where the lowest is 12% and the highest is 88%. A total of eight students obtained pre-test marks of 40% and below, 20 students had marks from 41% to 60%, 14 students obtained 61% to 80% and only one student scored 81% and above. This shows that the students did not have impressive pre-test results, with more than half of them obtaining marks of 60% and below. The marks given for these two courses, as shown in Figure 1, are the overall marks obtained by each student. It shows that all the students successfully passed both courses with more than 40% marks, with the highest score being 96%. The relationship between the pre-test and final examination marks for both courses is shown in Figure 2. There is no direct relationship that can be made between the pre-test and the final examination marks for both courses. Generally only eight students obtained final exam marks lower than 50% for Fluid Mechanics compared to 13 students for the final exam of the Static & Dynamics course.

Further analysis and discussion focussed only on the 43 students who underwent the pre-test examination. Figure 3 shows the distribution of the pre-test and the final examination marks for the Static & Dynamics (KH1044) and Fluid Mechanics (KH2134) course for these students. The highest score in the final examination for the Static and Dynamic course was 79% (student number 23) while for Fluid Mechanics it was 93% (student number 18). Figure 4 shows the distribution of the difference in marks between the pre-test and the final examination for both courses against the number of students. In Figure 4, the left axis refers to the percentage of pre-test marks arranged in ascending order and it is shown by a curve, while the right axis refers to the difference in course marks compared with the pre-test scores. Positive values indicate higher marks for the course compared to the pre-test scores, while the negative values indicate lower marks for the course compared to the pre-test scores. The results indicate that 49% of the total number of students (21 students) scored higher for both courses than they had done on the pre-test marks. The range of the difference in marks between the pre-test and both courses varies from 0 to 46%. On the other hand, 11 students (25.5%) scored lower for both courses than they had done on the pre-test; here, the difference in marks ranged from -4 to -9%. Eleven students (25.5%) obtained course marks that were inconsistent with the pre-test marks. This finding illustrates that students with higher pre-test marks are not guaranteed of obtaining higher marks for both courses and vice versa. For example, student number 42 and 43 had pre-test marks above 70%, but their final exam scores were not satisfactory. This is in contrast to almost half of the class who had low pre-test marks, but still scored higher for both courses. These results also show that the process of learning and teaching at the university as implemented for both courses during the semester was capable of helping students succeed and achieve high marks.

Figure 5 also shows left skewedness for pre-test marks 60% and below, where 19 out of 28 students managed to raise their marks in both courses compared to their previous low marks on the pre-test and right skewedness for pre-test marks 61% and above, where only two of the 15 students managed to raise their marks in both courses. Figure 5 shows the correlation between the pre-test marks and the final examination marks for Static & Dynamics and Fluid Mechanics. It shows that the correlation between Statics & Dynamics and the pre-test marks is 0.085 while that of Fluid Mechanics and the pre-test marks is 0.050. These results prove that the pre-test marks did not correlate with the basic course marks. High pre-test marks did not guarantee high marks in the basic courses. Therefore, it may be concluded that the pre-test given to the students cannot be used accurately to predict student achievement in basic courses.

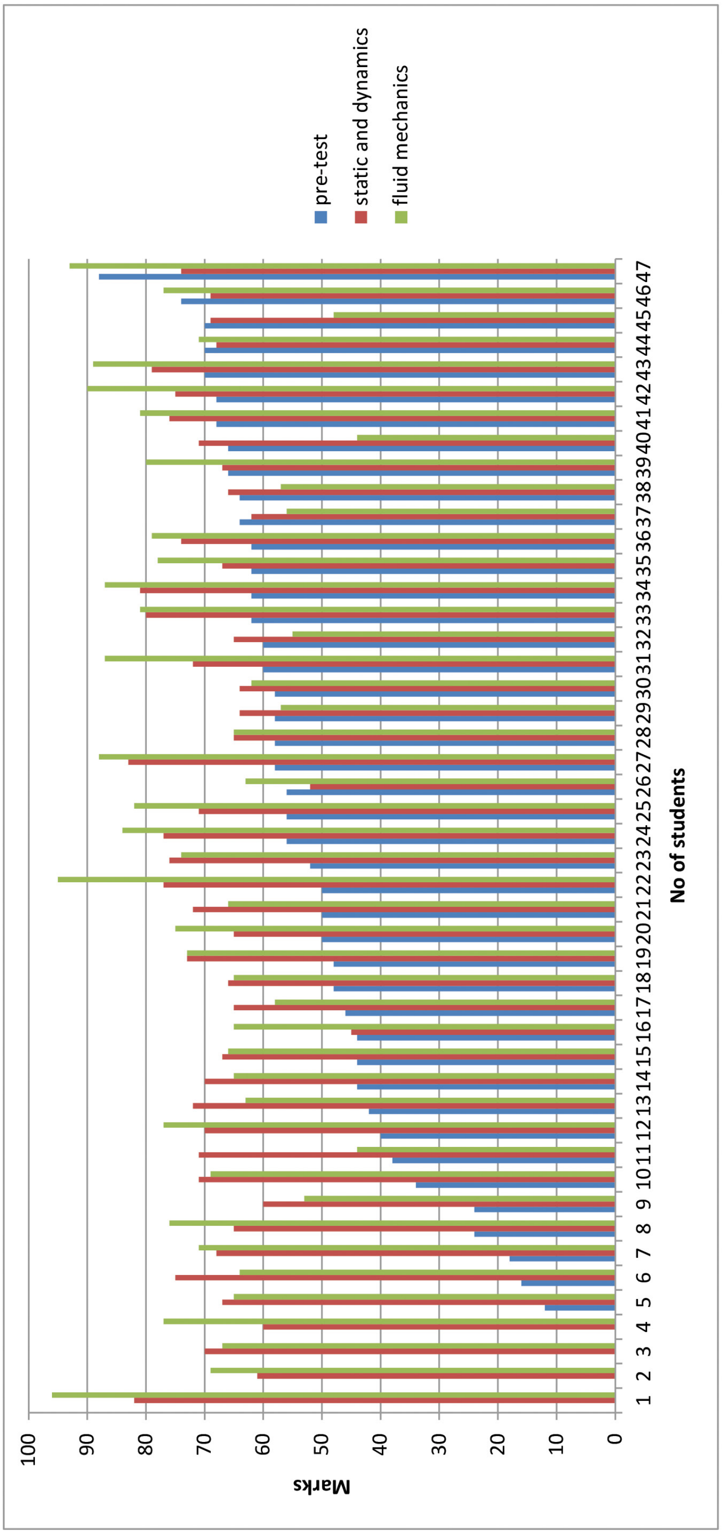


Figure 1. Pre-test and total course marks for Static & Dynamics and Fluid Mechanics courses for each student.

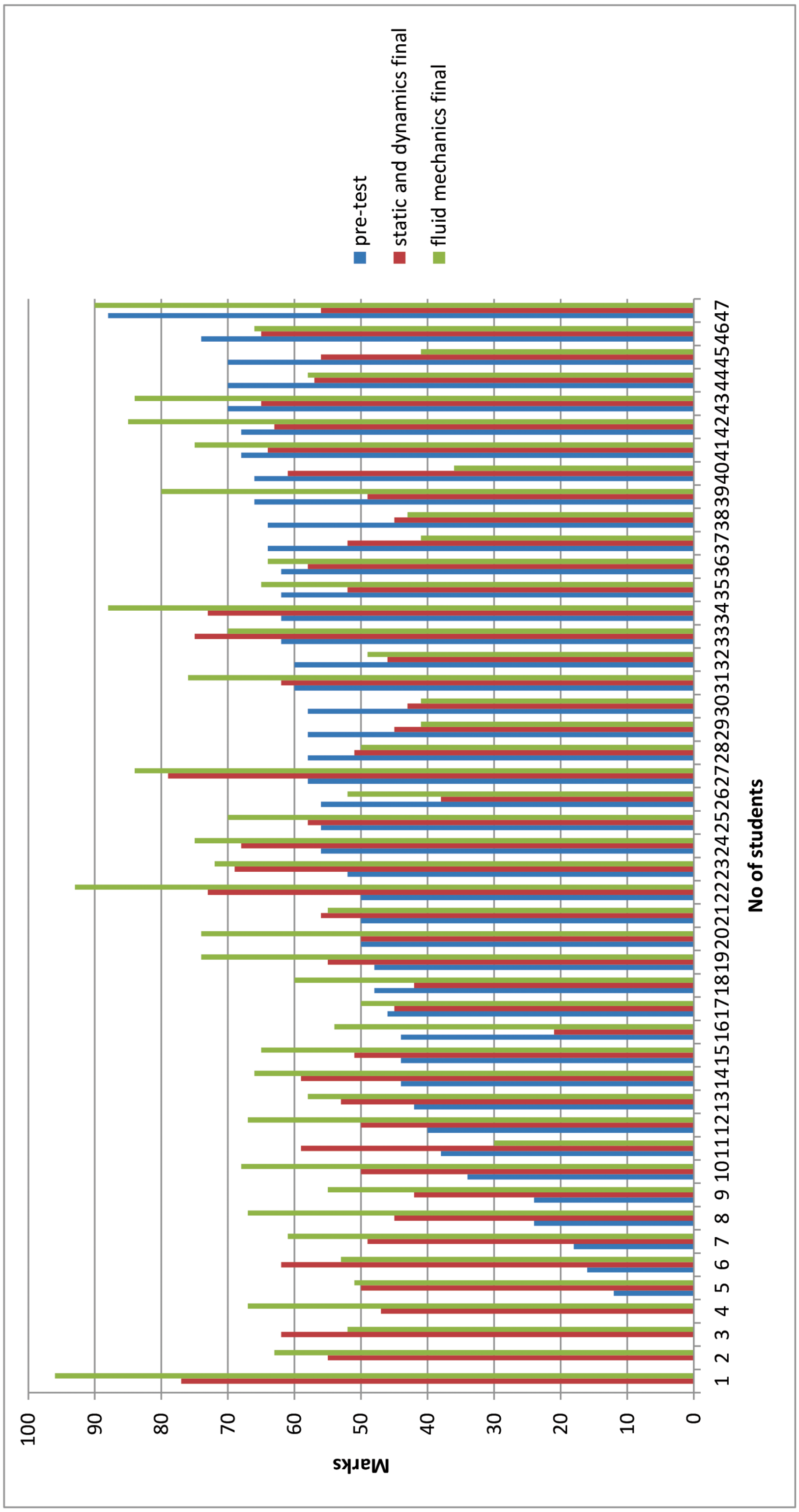
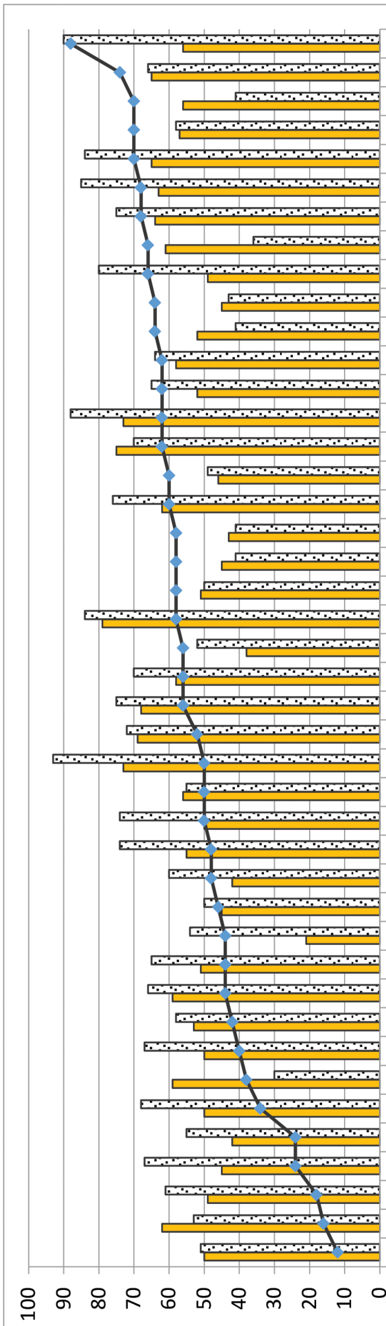


Figure 2. Pre-test and final examination marks for Static & Dynamics and Fluid Mechanics courses for each student.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
Static & Dynamics	50	62	49	45	42	50	59	50	53	59	51	21	45	42	55	50	56	73	69	68	58	38	79	51	45	43	62	46	75	73	52	58	52	45	49	61	64	63	65	57	56	65	56
Fluid Mechanics	51	53	61	67	55	68	30	67	58	66	65	54	50	60	74	74	55	93	72	75	70	52	84	50	41	41	76	49	70	88	65	64	41	43	80	36	75	85	84	58	41	66	90
Pre-Test	12	16	18	24	24	34	38	40	42	44	44	44	46	48	48	50	50	50	52	56	56	56	58	58	58	58	60	60	62	62	62	62	64	64	66	66	68	68	70	70	70	74	88

Figure 3. Pre-test marks with final examination marks of Static & Dynamics and Fluid Mechanics courses for each student.

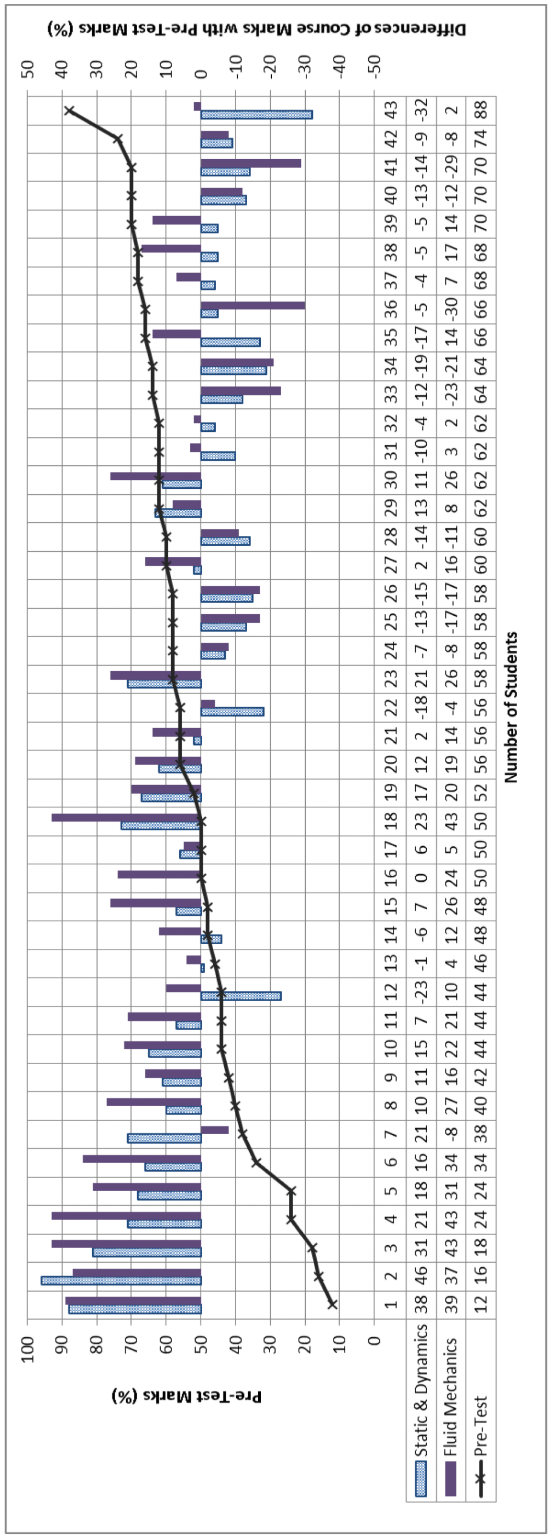


Figure 4. Pre-test marks and differences in course marks compared to pre-test marks for each student.

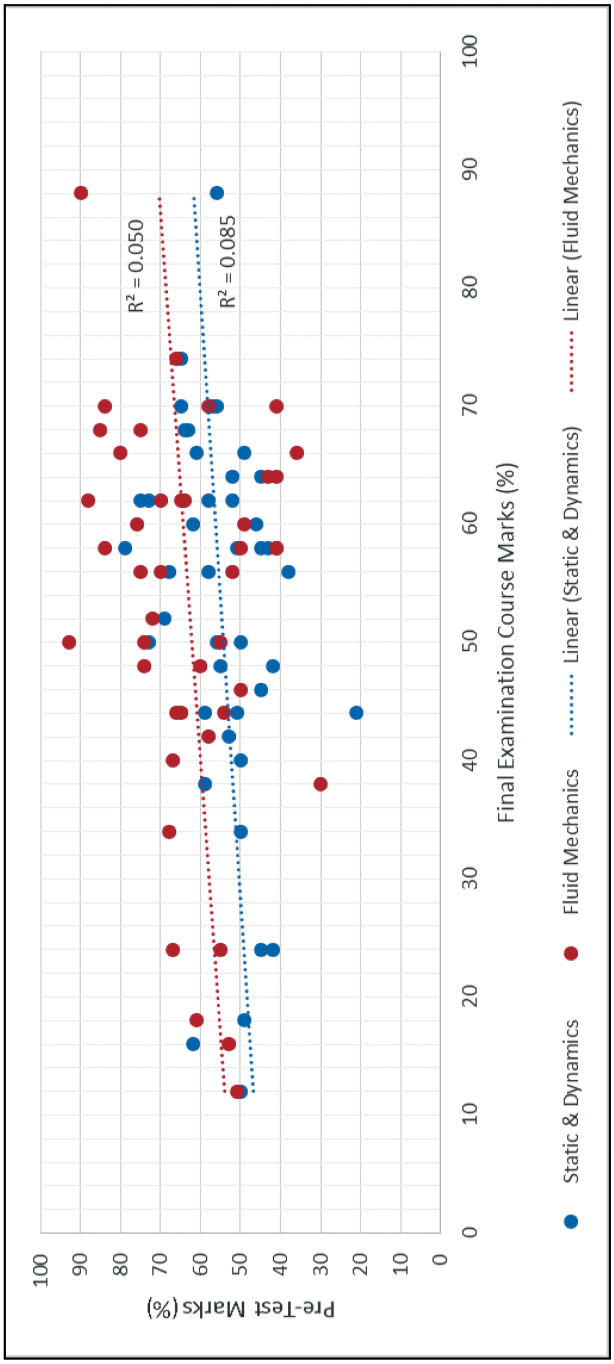


Figure 5. Correlation between pre-test marks and final examination course marks for all students.

CONCLUSION

The results of the pre-test examination given to a group of 43 students from year one in the Department of Civil and Structural Engineering, Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia were analysed. The aim of administering the pre-test questions was to assess the level of understanding and knowledge of the students in mathematics and physics as well as to find out the correlation between the results of the pre-test and two of the department's fundamental courses. Statistical analysis found that there was no direct correlation between performance on the courses and the pre-test. Students who had a high level of understanding in mathematics and physics courses were not guaranteed of excelling in the courses. Nineteen students did not obtain high marks in the pre-test but still managed to pass and excel in both courses, suggesting that the learning process had indirectly helped them to succeed. Validity and reliability of the questions outlined in the pre-test was investigated using the Rasch Measurement Model to ensure the suitability of the pre-test as a model to determine students' level of understanding in the early stages of their study.

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Effectiveness of Teaching and Learning Method in Concrete Laboratory Works

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ABSTRACT

The rising awareness of the importance of professional skills for engineering students has led to increased attention given by engineering schools to developing the critical thinking skills of students. Thus, this study discusses proposed methods implemented in the teaching and learning process in concrete laboratory experiments. A combination of problem-based and open-ended techniques of teaching and learning is used. The method is supported by creative lab demonstration using an IT tool to conduct flipped laboratory demonstration. Finally, an overall assessment, which consisted of cognitive and psychomotor domains, was conducted. Student feedback and performance in a Materials Technology course are evaluated in the context of the implementation of the proposed method. Student feedback generally indicated that the method was accepted as satisfactory and that it successfully improved the teaching and learning process where the three basic domains from Bloom's Taxonomy were applied.

Keywords: Critical thinking, open-ended, problem-based, flipped laboratory demonstration, student feedback

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INTRODUCTION

One of the required criteria for accrediting engineering programmes is to improve engineering education (Engineering Accreditation Commission, 2012). Engineering students need to graduate with positive attributes to become competent engineers. Therefore, in engineering education, laboratory experiments or practical work can be integrated into the curriculum to provide students with engineering experience and practice prior to graduation. Laboratory experiments can provide students with knowledge and practical skills and expose them to relevant issues in engineering (Salim et al., 2012). To improve the teaching and learning process, three basic domains from Bloom's Taxonomy must be applied. The domains of learning described in Bloom's Taxonomy are the development of cognitive, affective and psychomotor skills (Hamid & Baharom, 2013). Most of the cognitive mental skills (knowledge) are developed through classroom instruction. The affective skill component, which involves feelings or emotional areas (attitude), is developed through activities such as structured leadership of group design projects (capstone), career development activities and events (co-curricular activities), competitions and cornerstone and final-year project presentations. Psychomotor skills, which are commonly referred to as manual or physical skills (skills), are normally developed in the laboratory setting.

Among important skills that engineering students need to develop are technical skills. These skills are essential to ensure that engineering students have a successful professional career after they graduate. However, these skills can be only applied outside the classroom, in the laboratory and in assignments. Laboratory work is a very important component for engineering students. The ability to perform and conduct experiments without supervision is among the key skills that students in engineering schools need to acquire and develop. A proper methodology and form of assessment must be planned and performed adequately to ensure that students experience a beneficial and rewarding educational experience in the laboratory. Baharom et al. (2015) proposed an assessment method to relate psychomotor and cognitive performance using quadrant analysis. Students were divided into four categories, namely, exam-based, technical-based, well balanced and poor.

However, the spoon-feeding learning pattern governed most of the traditional laboratory work conducted. Students were given laboratory manuals and they had to follow the lab demonstrator's instructions during lab sessions. Therefore, students were not required to exercise a great deal of effort before the commencement of their laboratory exercises. Problem-based learning (PBL) and open-ended learning (OEL) techniques are good options to be integrated in laboratory work. Implementing PBL and OEL in concrete technology laboratory work will reduce problems, such as free riders and lack of understanding of the relationship between individual experiments and problem to be solved. Berg et al. (2003) revealed that the open-ended experiments showed the most positive outcomes regarding learning outcome, preparation time, time spent in the laboratory as well as student perception of the experiment. However, some students with poor attitude needed more support during experiments to meet the challenge of an open-ended experiment. The implementation of PBL in the concrete laboratory at the Department of Civil Engineering of UKM was started in the 2005-2006 session. Since then, improvement of delivery methods of class instruction and laboratory work has been carried out for continuous quality improvement (Hamid et al., 2008; Hamid & Mohammed, 2010; Hamid et al. 2011; Baharom et al. 2012).

Domin (1999) outlined four different styles in conducting laboratory, namely, traditional, open-ended, discovery and problem-based. These styles are differentiated based on outcome, approach and procedure. McComas (1997) described four levels of laboratory openness that can be differentiated by three descriptors, which are problem, ways and means and answers. A level-0 activity is traditional laboratory where all descriptors are given, while a level-3 activity is an open-ended laboratory where all descriptors are not given. Colburn (1997) suggested making small changes progressively in the laboratory activities from traditional to open-ended styles over the course of weeks or months. This method allows for the transition from traditional laboratory methods to open-ended style to avoid chaos in laboratory activities.

Thus, the purpose of this study was to describe the current implementation of the innovative technique of combining the problem-based and open-ended method in conducting concrete laboratory works followed by student feedback on the implementation of this method for continuous quality improvement.

METHODOLOGY

Teaching Delivery and Lab Work Operations

Construction Materials Technology is a compulsory subject for year-two students in the Civil and Structural Departments of the Faculty of Engineering and Built Environment, National University of Malaysia. This course introduces construction materials, manufacturing processes involved and characteristics and properties. The course implements lectures, projects and laboratory work on concrete mixing and testing. Figure 1 shows the learning process flow in concrete laboratory work as part of the Material Technology class, which covers three parts, namely, delivery, operations and assessments.

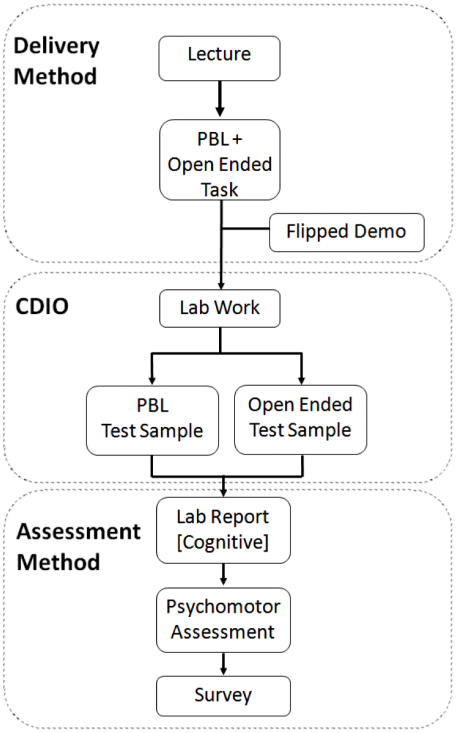


Figure 1. Learning process flow in concrete laboratory work.

At the beginning of this course, a conventional lecture was presented to the students. The purpose of this lecture was to make sure that the students had sufficient knowledge and information about the course (cognitive development). Students were given a specific task, where the first task was PBL and the second task was OEL. PBL and OEL are methods of student learning that focus on a complex problem that does not necessarily have a single correct answer (Hmelo-Silver, 2004). These methods are embedded in the process of Conceive–Design–Implement–Operate (CDIO).

In the first task, each group was assigned to design a concrete mix that would be appropriate to a specific structural element in a particular construction project. One of the examples was to design mixed concrete for the construction project in a nearby coastal area. To find solutions, students had to prepare and organise laboratory information before they carried out their lab work. They were required to decide on the suitable grade of concrete required, water-cement ratio, slump and wet density of the concrete. They had to prepare their own mix as well. In the second task, students were given an OEL problem. Students were asked to come up with a creative solution to produce floating concrete using waste material as additional material in their concrete-mix design. Then, they had to test whether the concrete grade was equal to the grade in the design and if the concrete they had made could float. Tasks 1 and 2 were run parallel to one another, requiring that the same concrete-mix was used to complete the second task.

To fulfil this task, students worked in collaborative groups to identify what they needed to learn to solve the problems. They were divided into several groups and various different situations or problems were assigned to them. This kind of group work requires critical thinking by each individual to solve the problem. The implementation of psychomotor skills in laboratory work was executed using PBL and OEL methods. Students needed to plan, organise and sequence the series of laboratory work as well as decide the time and method to acquire information and seek feedback and help from their mentor. Monitoring strategies can be key to better learning performance, and better monitoring strategies may provide the mechanism for developing more effective knowledge construction i.e. information seeking and information structuring strategies (Biswas et al., 2013).

To help students with the laboratory work exercise, flip demonstrations (flip demos) were introduced. The flip demo was provided to students along with the laboratory manual. Students were required to study the manual and video before they started the lab work. Hence, they could read and view the steps they needed to do later in the lab work. These videos were uploaded on *YouTube* to allow the students to watch the process at any time. Sample-still shots from the uploaded video are shown in Figure 2.

(a) Lab safety. (b) Moisture content of aggregate.

Figure 2 (a) and (b). Flipped demonstration using the YouTube platform.

Assessments

Both direct and indirect forms of assessment can be used to evaluate students. Direct assessment uses direct evidence of student performance, either for individual students or for representative samples of students. These methods make possible the collection of evidence of student learning or achievement directly from students. Indirect assessment uses indirect evidence of student achievement including student ability, knowledge and values. In this case, assessment was conducted by means of a survey. Evaluation is important for both types of assessment to measure student performance and to obtain appropriate responses from students. The quality of student performance needs to be determined to confirm the effectiveness of this method. Students are required to be comfortable with this approach and not feel burdened by them. Assessment either indirectly or directly to check results is known as triangulation.

A survey of the proposed method implementation was conducted to obtain feedback from students and an evaluation of the implementation of PBL. Each student was requested to answer a closed-ended survey, which used a 5-point Likert Scale (Garvey, 2011). Three other types of student assessment were also conducted, namely, reports, examinations and a psychometric assessment test. The examinations and reports were required to evaluate their cognitive development and the psychometric assessment test was designed to evaluate their psychomotor levels. A specific rubric was used to assess the student reports and the psychometric assessment test. This approach enabled the judges (lecturers who evaluated student marks) to assess student performance in PBL constructively and reliably. The use of a rubric reflects authenticity in assessment.

A psychometric assessment test aims to evaluate student ability to conduct concrete test experiments. In this study, the assessment test was conducted as a mock test because of the characteristic constraints of concrete. The concrete tests consisted of tests for slump, flow table and compaction. The students could select the tests randomly. The psychometric assessment test was conducted by inviting the judges for a live evaluation at the lab. The rubric was given to the judges and the evaluation ran smoothly.

Two types of assessment were developed to evaluate student performance. Psychomotor assessment rubric and a survey were developed for direct and indirect assessment. Both assessments used the Likert Scale for evaluation purposes. Direct assessment involved the creation of a rubric to evaluate student performance for a few psychometric criteria and the form of indirect assessment that was used was a survey designed to produce a response from the students on the implementation of the method. However, only indirect assessment results are reported in the next part of this paper.

RESULTS AND DISCUSSION

Indirect assessment uses indirect evidence of student achievement that includes student ability, knowledge and values. In this case, assessment was conducted using a survey. Evaluation is important for both types of assessment to measure student performance and to obtain responses from the student. The quality of student performance needs to confirm the effectiveness of this method. Students should be comfortable with this approach and not find the approach burdensome. The assessment of indirect and direct data is known as triangulation. However, only indirect assessment results are presented in this study.

For indirect assessment, a survey was conducted on 47 respondents. The aim of the survey was to obtain student feedback from the PBL-OEL activities conducted. The two parts of the survey were Part A, which included demographic content, such as gender and Cumulative Grade Point Average (CGPA) and Part B, which was the PBL-OEL implementation. Part B was divided into four categories, namely, (i) learning style of PBL-OEL, (ii) physical environment, (iii) demonstrator or facilitator and technician, and (iv) overall implementation. The questionnaire used a 5-point Likert Scale approach (1=strongly disagree to 5=strongly agree). The participants included 21 male and 26 female students. The results were analysed by calculating the mean score of each item from the survey. The maximum mean score was "5," which reflects the maximum Likert Scale value (5) and indicates that students strongly agreed with those items.

Figure 3 shows feedback from students for the implementation of PBL-OEL in laboratory work. The most agreeable item in this category was "PBL-OEL encouraged the students' participation in the discussion and interaction skills in the group." The students agreed that PBL-OEL implementation was interesting and allowed for deep understanding of topics. Further, the students were able to express the ideas, participate in analysing the problem as well as understand principles and the rationale for using PBL-OEL and the PBL-OEL process. Therefore, the students agreed with the implementation of the PBL-OEL in this course. The average mean value for the category PBL-OEL implementation style was 3.8 out of 5. PBL-OEL implementation will indeed affect student performance by increasing independent learning, critical thinking, problem-solving and communication skills (Morales-Mann & Kaitell, 2001).

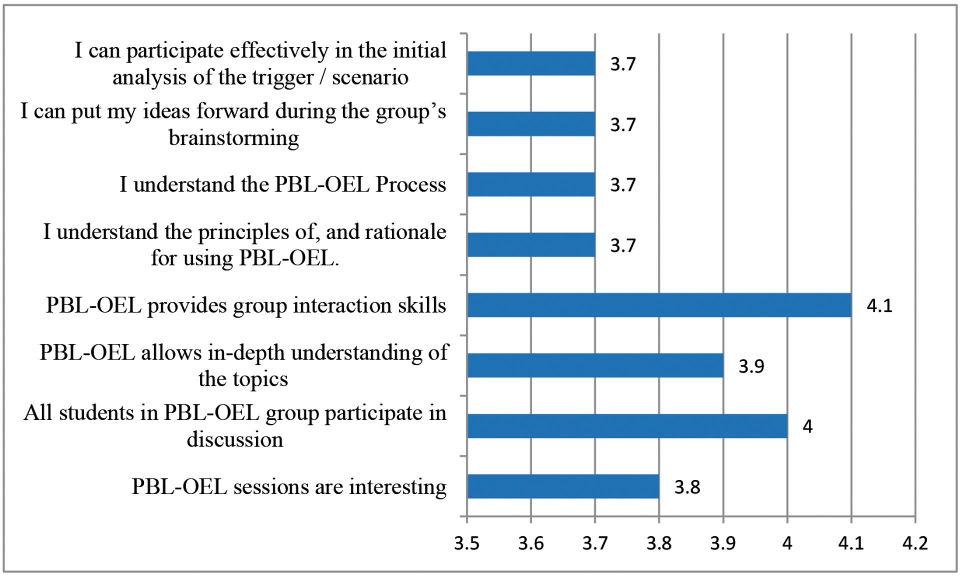


Figure 3. Students' feedback on the learning process.

Figure 4 shows the physical environment for PBL-OEL implementation responses from students. The physical environment category also played a role in PBL-OEL implementation. A good facility will help students perform better in educational activities. The result shows that the physical environment provided to the respondents was in good condition. The mean value of 3.6 indicated that the students agreed that the physical environment provided was suitable for PBL-OEL and the equipment for the experiment was sufficient and in good condition for PBL-OEL exercises. The percentage of students who did not agree with items in this category might have resulted from the limited number of available instruments, and thus, theymight have had to share tools to conduct the experiment. The sharing of instruments causes delays because of wait time, and this leads to time wasting. Thus, we recommend that the department should increase the number of laboratory equipment.

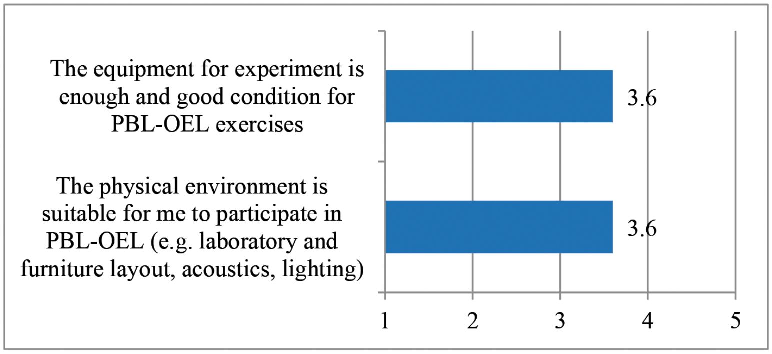


Figure 4. Students' feedback on physical environment for PBL-OEL process.

The next category of the survey was cooperation from the demonstrator and technician (Figure 5). This category measured the helpfulness of the demonstrator as instructor and technician as support personnel and the period for the PBL-OEL implementation. Most of the students agreed that the demonstrator and technician effectively facilitated the PBL-OEL sessions and the students agreed that the time allotted for each of the PBL-OEL sessions was sufficient.

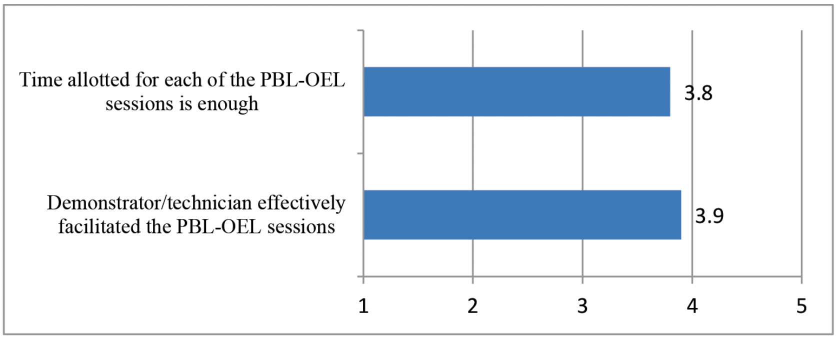


Figure 5. Students' feedback on cooperation from the demonstrator and technician.

The final category was overall implementation. Figure 6 indicates the effectiveness of PBL-OEL implementation from a student perspective. Students agreed (with a mean value of 3.9) that the PBL-OEL implementation was beneficial in helping them achieve the learning objectives. They also agreed (with a mean value of 3.9) that they were confident (with a mean value of 3.8) that PBL-OEL prepared them for this course. Further, the students were confident that PBL would prepare them for professional life. Therefore, the students agreed with the implementation of PBL for this subject and that they could apply knowledge and psychomotor skills via the PBL-OEL method. For that reason, the comparison of student performance needs to be conducted to measure the effectiveness of PBL-OEL implementation.

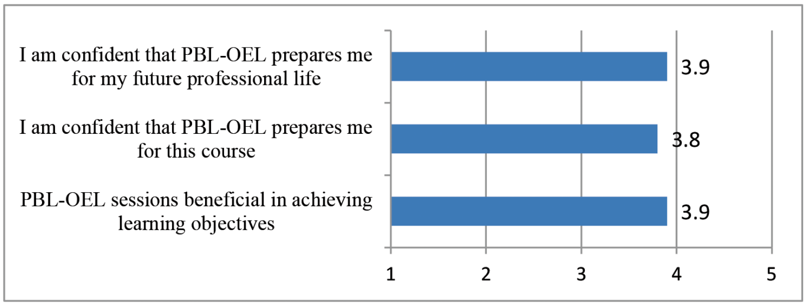
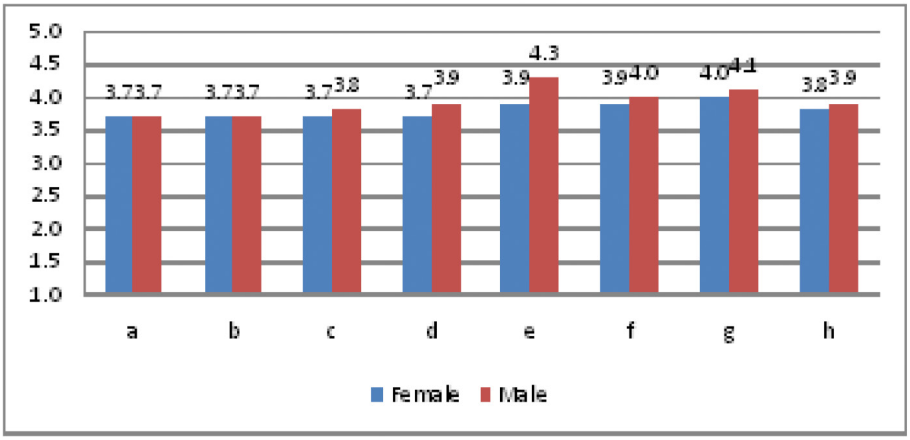


Figure 6. Students' feedback on the overall process of PBL-OEL.

The survey results were also analysed based on gender differences. Only survey questions from Part B, category (i), learning style of PBL-OEL were analysed. Figure 7 shows that, overall, not much difference was seen in giving feedback between genders. However, the male average scores agree to most of the statements, and are higher than the female responses. The clear difference in response was seen for question (e), where the male and female mean values are 4.3 and 3.9, respectively. Thus, more males than females agreed that PBL-OEL provided group interaction skills.



Notes:
a - I can participate effectively in the initial analysis of the trigger / scenario
b - I can put my ideas forward during the group's brainstorming
c - I understand the PBL-OEL Process
d - I understand the principles of and rationale for using PBL-OEL
e - PBL-OEL provides group interaction skills
f - PBL-OEL allows in-depth understanding of topics
g - All students in PBL-OEL group participate in discussion
h - PBL-OEL sessions are interesting

Figure 7. Gender difference in answering Part B: Category (i) learning style of PBL-OEL survey.

Finally, the analysis of the survey was conducted based on student academic performance, where respondents were grouped based on their CGPA. Students were grouped in four CGPA classes where first class includes a CGPA of 3.60 and above, second class was between 3.00 and 3.59, third class was between 2.50 and 2.99 and fourth class was below 2.50. Only the results of three questions from the first category (learning style of PBL-OEL) are presented in this study, as they show clear differences. As shown in Figure 8, most of the fourth-class students (67%) strongly agreed that the PBL-OEL sessions were interesting compared to first-class students (25%). The results showed that students who belonged to the lower class liked the way PBL-OEL sessions were conducted. The sessions involved several hands-on laboratory activities, which made the work more interesting. In PBL-OEL laboratory sessions, students need to develop technical skills, which are essential for all engineering students to ensure they have a successful professional career.

As shown in Figure 9 and Figure 10, about 25% of the first-class student showed full understanding of the principles of and rationale for using PBL-OEL and they understood the PBL-OEL process. The percentage of neutral feeling increased from second-class to fourth-class students, with none of the first-class students opting for neutral for the statements. Even though most of the fourth-class students liked the PBL-OEL session, they seemed not to understand fully the principles, rationale and the process of PBL-OEL itself. The limitation of their cognitive achievements could be one of the reasons for this result.

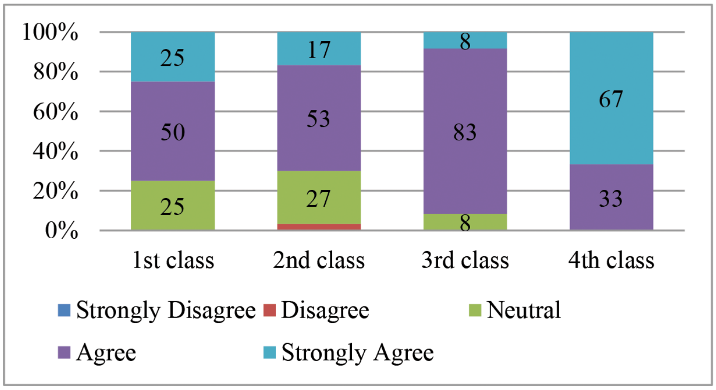


Figure 8. Feedback on "PBL-OEL sessions are interesting" based on level of students' academic performance.

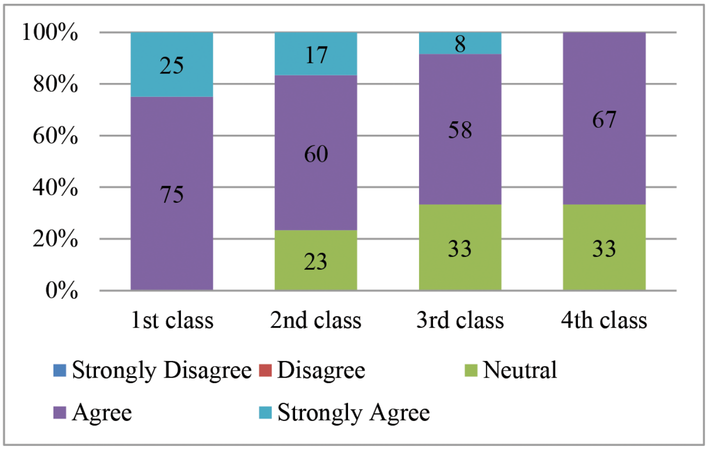


Figure 9. Feedback on "I understand the principles of, and rationale for using PBL-OEL" based on level of students' academic performance.

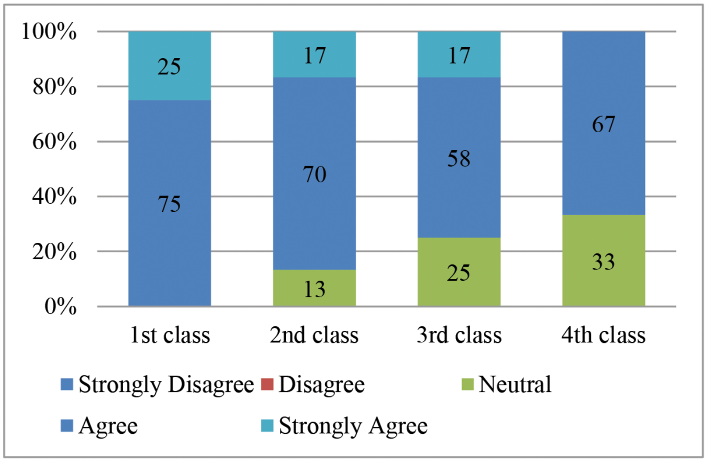


Figure 10. Feedback on "I understand the PBL-OEL Process" based on level of students' academic performance.

CONCLUSION

Overall, the results revealed positive outcome and responses towards the implementation of the proposed method. Student feedback generally indicated that the method was accepted as satisfactory and had successfully improved the teaching and learning process as all of them agreed with the statement given in the survey. In addition, based on gender, more male respondents agreed with the learning style of PBL-OEL compared to the female respondents. The results also showed that more third-class and fourth-class students (CGPA, 2.00-2.99) seemed not to be attracted to the PBL-OEL learning style compared to first-class and second-class students (CGPA, 3.00-4.00).

Finally, the results also revealed that a few key areas need to be improved, such as facilities provided and understanding of the importance of PBL-OEL process. Therefore, additional effort by the student, lecturer and technicians must be made to ensure effectiveness of the implementation of this teaching-learning method.

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Self-Regulated Learning in UKM

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ABSTRACT

Education has always been a significant contribution to the development of human capital in terms of social and economic growth. Hence, it should be able to inspire students to foster creativity and innovation and provide them with the skills needed to compete in the modern labour market. Furthermore, education provides talented human capital and is the key driver of economic growth for developing countries. University students are, therefore, required to acquire high-level thinking skills besides being able to regulate their own learning because the self-measurement method has proven to be effective in improving students' academic achievement and learning behaviour. This paper analyses the data collected using the instrument designed by Pintrich and Zusho (2002) to assess motivation and strategies of students and to what extent these factors regulate student learning. The population used in this study were 78 students from the Circuit Theory course for the 2013/2014 session. Scores used were based on their self-regulated learning (SRL) characteristics and their impact on student learning strategies. The study found that the majority of the students still practised the traditional method of learning, namely, learning for higher grades and at the eleventh hour, just before the exam. They did not put more effort into understanding the course content and attempted only the simple assignments given. In order for these findings to be more conclusive, further study is necessary to assess the impact of interventions of SRL through teaching and learning strategies practised in the Faculty of Engineering and Built Environment, UKM such as cooperative learning and problem-based learning, among others.

Keywords: Learning motivation, self-regulated learning, teaching and learning strategies

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INTRODUCTION

The blueprint for the New Economic Model, Economic Transformation Plan and the Government Transformation Plan contain some of the measures taken by the government of Malaysia to drive the nation to the mainstream of developed nation status. One of the challenges that need to be addressed is the human capital generated through the education system so that graduates can compete in an ever competitive global economy. It is fundamental to the development of the country and will help to meet the high aspirations and needs of the nation using systematic transformation to improve student achievement in total. This can be done by understanding and improving the dynamic process of teaching and learning as discussed in Malaysia's Education Action Plan 2013-2025 (Ministry of Education, 2000).

Various reports on student achievement in science and technology learning have stated that lack of interest and a decrease in the ability to master the concepts of science (Lee, 1989; Kong, 1993; Ministry of Education, 2000) have raised concerns among policy-makers in the education system. The same trend can also be seen in the process of learning mathematics. This is a very challenging and serious problem as science and mathematics are the core of the other applied sciences and are also the foundation for the economic growth of a nation. When students were asked why they were not interested to pursue their studies in the science and technology field, their main reason was that they found science and mathematics to be very difficult to understand and that these subjects required higher effort to pass the programmes. This is the same problem among students of the Faculty of Engineering and Built Environment, UKM. Engineering programmes are among the more demanding and strenuous programmes. Unfortunately, through years of experience and observation, most of the students usually attend lectures and participate passively and do not take the initiative to do any prior preparation. They are found to be more inclined towards rote-learning than to understanding and comprehending concepts because that takes too much effort.

The ability of students to self-regulate their learning is crucial because it forms the basic training for self-advancement in university and progress in the workplace. Many individuals have successfully adopted the technique of self-regulation in learning and their careers. For example, Benjamin Franklin wrote in his autobiography about how he improved his writing by selecting models of the best writing and trying to emulate them. He had set his learning objectives and recorded his progress with every achievement from stage to stage (Zimmerman, 2008).

The research question in this study was focussed on whether the students in the Department of Electrical, Electronics and Systems Engineering (JKEES) in UKM were able to:

1. Plan, monitor and regulate learning

2. Manage time and learning environment
3. Regulate effort and attention to learning
4. Get help from friends or instructors when faced with learning difficulties

Self-Regulated Learning (SRL)

Self-regulated learning or SRL provides students with an idea of how one should assess his or her ability in learning on a course and how to handle the problems associated with the learning environment. This is very important in the learning process (Zimmerman, 2008; Jarvela & Jarvenoja, 2011). Those who self-regulate their studies are aware of what they know and what they do not know. Unlike their counterparts who are very passive, these students find information proactively and take the steps necessary to master a concept. When they encounter an obstacle such as a misinforming instructor, a non-conducive learning environment or less informative college textbooks and notes, they will find a way to solve it (Zimmerman, 2000). SRL students view the acquisition of knowledge as a systematic process that can be controlled, and feel accountable for the results of their learning (Zimmerman, 2000). Most importantly, SRL creates better learning habits and strengthens students' learning skills (Wolters, 2011).

Self-Regulated Phase

The process of self-regulation occurs when student actions lead to the accumulation and mastery of information and skills. Most SRL models are divided into three phases: the initial thinking and planning stage; performance monitoring stage; and reflection on achievement stage (Zimmerman, 2000; Pintrich & Zusho, 2002). These phases are further illustrated in Figure 1.

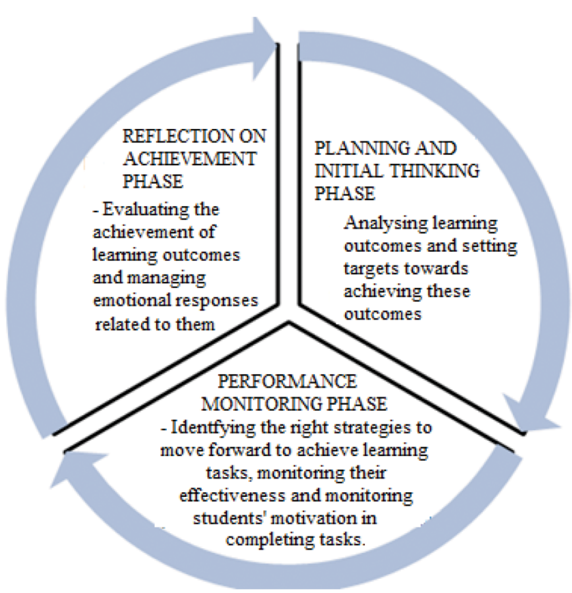

Figure 1. SRL phases.

Target setting, planning, selections of strategy, performance monitoring, management of emotional and evaluation of academic achievement progress are processes that require expert guidance (Bruin et. al., 2001; Harris et. al., 2005). Therefore, it is necessary for instructors to be able to recognise the factors that could affect a student's ability and identify strategies that they can use to promote SLR in the class.

METHODOLOGY

This study employs quantitative methods to determine the level of student motivation to learning through self-regulating strategies such as the metacognitive component, time-management, regulated effort and getting assistance in learning. The questionnaire on Motivational Strategies for Learning (Pintrich & DeGroot, 1990) was used to collect the data. It consisted of 81 statements designed to measure student motivation orientation and the use of different learning strategies in or outside the classroom. Respondents should provide answers ranging from 1 to 7 (1 = 'very untrue about me' to 7 = 'very true about me'). For negative questions (as marked * in the Appendix), the value of the rank given by the students was subtracted from 7 (example, if the student ranked the question as 5, then the actual answer would be 2). In this model, analysis was formulated on the four components as listed:

i. Metacognitive self-regulation
   - It refers to the three general processes that construct metacognitive self-regulatory activities, namely, planning, monitoring and regulating. Planning of activities, such as setting goals and tasks helps in analysis and understanding of information more easily. Monitoring of activities includes detecting someone's attention when he or she reads, examines and asks questions; this helps students to understand the material and integrate it with prior knowledge. Regulating refers to continuous adjustment of one's learning, where the learner needs to improve performance by correcting any misleading and misinformed conceptions.

ii. Time-management strategies
   - Students should be able to manage and regulate time and their learning environment. They not only need to know how to set the appropriate learning time, they also need to know how to use time effectively and set realistic goals.

iii. Regulated-effort strategies
   - Students should have the ability to regulate effort and attention when they are distracted by other things or bad assignments. It reflects the commitment of students to complete a task, even if the task is difficult or they are diverted by other more interesting preoccupations.

iv. Strategies to acquire assistance
   - Another aspect of regulating the environment is the need for students to manage learning aids and supports.

> Good students are able to realise when they lack knowledge or understanding of a subject or topic and can identify those who can help them.

Only the responses to questions that were related to each component were selected based on the recommendations by Pintrich and DeGroot (1990).

DISCUSSION

Table 1 (a) to (d) shows the descriptive statistical analysis conducted on students' responses to statements that were based on the four components. In this case the significant statements were based on scores above 3.5. For the metacognitive component, Table 1 (a) indicates that the responses to statements 33 and 57 were low, with a mean of <3.5 and a median of <4. The students stated that they always missed important information because they were always preoccupied with other things. They admitted that even if they read the notes and books, they still did not understand what was being read. However, it should be noted that 33 and 57 are negative questions. On the contrary, the responses to other statements, such as if they were confused about certain concepts, they revise the material in order to figure out the concept or when studying for the course they would try to ascertain concepts they did not understand well, showed means that were quite high, and more than 85% rated themselves 3.5 and above.

For time-management strategies, Table 1 (b) shows that the responses to questions 52 and 77 indicate the lowest achievement and again, these are negative questions. Students acknowledged that they were not maintaining their studying schedule and moreover, they did not devote all their time to the course due to being involved in other activities. On the other hand, about 85% of the students claimed that they attended class regularly, with the highest mean of 5.6 for their responses to statement 73.

Along with the findings above, in terms of regulated effort, Table 1 (c) shows that even when the mean value for the students' responses were slightly higher than 3.5, the responses for the two statements, namely 37 and 60, were still low. Responses to these statements provide evidence that almost 50% of the students did not put in effort or became uninterested and often did not commit to what had been planned. Sadly, when learning became more difficult, these students would give up or just complete the easy tasks. However, again, more than 80% claimed that they put in a lot of effort into learning, as indicated from their responses to questions 48 and 74.

Interestingly, Table 1 (d), which analyses the strategies to acquire assistance in learning, shows that more than 90% of the students stated that although they had problems related to the course content and the material taught in class, they tried to complete the task without the help of friends or the instructors.

Table 1
Statistical Parameters for the Four Components

(a) Metacognitive self-regulation

Statements	33	36	41	44	54	55	56	57	61	76	78	79
Mean	3.01	4.18	5.33	4.69	4.05	4.55	5.09	2.96	4.45	5.23	4.78	4.59
Standard Err.	0.15	0.18	0.13	0.15	0.19	0.15	0.15	0.18	0.16	0.14	0.15	0.16
Median	3	4	5	5	4	5	5	3	5	5	5	5
Mode	3	3	5	5	4	5	5	2	5	5	4	5
Standard Dev.	1.32	1.62	1.15	1.35	1.66	1.34	1.34	1.63	1.42	1.22	1.34	1.37
Sample Variance	1.75	2.62	1.32	1.83	2.75	1.81	1.80	2.66	2.02	1.48	1.78	1.88

(b) Time-management strategies

Statements	35	43	52	65	70	73	77	80
Mean	5.346	4.115	2.718	4.346	4.179	5.603	3.269	4.538
Standard Err.	0.167	0.148	0.180	0.198	0.152	0.162	0.191	0.180
Median	6	4	2	4	4	6	3	5
Mode	6	4	1	4	4	7	2	5
Standard Dev.	1.476	1.309	1.586	1.749	1.346	1.426	1.688	1.593
Sample Variance	2.177	1.714	2.517	3.060	1.812	2.035	2.849	2.537

(c) Regulated-effort strategies

Statements	37	48	60	74
Mean	3.949	5.077	3.769	4.974
Standard Err.	0.167	0.168	0.201	0.167
Median	4	5	4	5
Mode	3	6	4	5
Standard Dev.	1.476	1.484	1.780	1.477
Sample Variance	2.179	2.202	3.167	2.181

(d) Strategies to acquire assistance

Statements	40	58	68	75
Mean	3.436	4.910	5.756	5.782
Standard Err.	0.178	0.188	0.142	0.136
Median	3	5	6	6
Mode	3	5	7	7
Standard Dev.	1.576	1.661	1.250	1.202
Sample Variance	2.483	2.758	1.563	1.445

Table 2 indicates the performance of the students in their Circuit Theory course. Consistent with the policy in the faculty, the students who obtained C-, D+, D- and E were considered to have failed the course. From the table, about 19% of the students failed and interestingly, this shows that their learning strategies and motivations somehow correlated to their performance.

Table 2
Students' Grade in Circuit Theory Course

Grade	Percentage	Status
A and A-	17.2%	Pass
B, B+ and B-	36.6%	Pass
C and C+	27.2%	Pass
C-	9%	Fail
D and D+	7.3%	Fail
E	2.7%	Fail

CONCLUSION

This study analysed the motivation and strategies of students and to what extent they regulated their learning using the measurement instrument designed by Pintrich and Zusho (2002). About 80% of the students enrolled in the KL1124 Circuit Theory course claimed and rated themselves more than 3.5 in most of the questions asked. However, there were a few negative questions (defined by Pintrich & DeGroot, 1990) that were not applicable. These findings somehow correlated with the performance of the students based on their grades in the course. Based on the research question, as a whole, motivation and attitude in regulating learning still needs to be improved. Teaching and learning strategies implemented should consider appropriate measures for this purpose. The suggestions include providing the students with assistance in identifying specific and feasible learning goals, guiding them to choose appropriate learning strategies, helping them learn to accurately self-monitor the learning process and promoting positive attitudes towards learning outcomes.

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APPENDIX

The Motivated Strategies for Learning Questionnaire in this study was used to assess the students' attitude towards learning. It is based on the general cognitive view of motivation and learning strategies. The four components that were given focus in this study were metacognitive self-regulation, time-management strategies, regulated-effort strategies and strategies to acquire assistance. The statements were extracted from the 81 questionnaire statements and selected based on the recommendation by Pintrich (2002).

Time-management strategies

The statements assess student ability to manage and regulate time and study environment. In this case, time management involved scheduling, planning and managing time. In addition, study environment management indicated the setting in which students studied.

No.	Statement
35	*I usually study in a place where I can concentrate on my course work.*
43	*I make good use of my study time for this course.*
52*	*I find it hard to stick to a study schedule.*
65	*I have a regular place set for studying.*
70	*I make sure I keep up with the weekly readings and assignments for this course.*
73	*I attend class regularly.*
77*	*I often find that I don't spend very much time on this course because of other activities.*
80	*I rarely find time to review my notes or readings before an exam.*

Metacognitive self-regulation

The statements reflect awareness, knowledge and control of cognition. Goal setting and task analysis were made part of the planning activities as they were expected to assist in organising and understanding the content material better.

No.	Statement
33*	*During class time I often miss important points because I'm thinking of other things.*
36	*When reading for this course, I make up questions to help focus my reading.*
41	*When I become confused about something I'm reading for this class, I go back and try to figure it out.*
44	*If course materials are difficult to understand, I change the way I read the material.*
54	*Before I study new course material thoroughly, I often skim through it to see how it is organised.*
55	*I ask myself questions to make sure I understand the material I have been studying in this class.*
56	*I try to change the way I study in order to fit the course requirements and instructor's teaching style.*
57*	*I often find that I have been reading for class but I don't know what it was all about.*
61	*I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying.*

76	*When studying for this course I try to determine which concepts I don't understand well.*
78	*When I study for this class, I set goals for myself in order to direct my activities in each study period.*
79	*If I get confused taking notes in class, I make sure I sort it out afterwards.*

Regulated-effort strategies

The statements selected include the students' ability to control their effort and attention when facing distractions and uninteresting tasks.

No.	Statement
37*	*I often feel so lazy or bored when I study for this class that I quit before I finish what I planned to do.*
48	*I work hard to do well in this class even if I don't like what we are doing.*
60*	*When course work is difficult, I give up or only study the easy parts.*
74	*Even when course materials are dull and uninteresting, I manage to keep working until I finish.*

Strategies to acquire assistance

The statements measures whether the students were able to manage to get support from peers and instructors. The students should be able to tell when they do not understand some concepts or theories and are able to identify someone to provide them with assistance.

No.	Statement
40*	*Even if I have trouble learning the material in this class, I try to do the work on my own, without help from anyone.*
58	*I ask the instructor to clarify the concepts I don't understand well.*
68	*When I can't understand the material in this course, I ask another student in this class for help.*
75	*I try to identify students in this class whom I can ask for help from if necessary.*

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Correlation Study of Student Achievement at Pre-University Level and Their Corresponding Achievement in the Year-One Undergraduate Course of Circuit Theory at UKM

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ABSTRACT

Circuit Theory 1 (KKKL1114) and Circuit Theory 2 (KKKL1124) are two core courses undertaken by students of the Electrical and Electronics Engineering undergraduate study programme. The courses KKKL1114 and KKKL1124 are offered in the first and second semesters for all students in Year One for the undergraduate degree programme in the Department of Electrical, Electronics and Systems Engineering (JKEES), Faculty of Engineering and Built Environment (FKAB), Universiti Kebangsaan Malaysia (UKM, 2013). The moderate achievement of students on these courses in the previous semesters triggered the authors, who taught the courses, to examine the factors that influence student performance. Early intervention measures can be taken to help these students to succeed in their studies. Continuing from a previous study, which analysed the students' academic background, this study was carried out to analyse the students' performance in a pre-test conducted at the beginning of the semester and correlated with their performance in the final examination in Circuit Theory 1 and Circuit Theory 2. The study population was students of the intake session 2012-2013 (Group One). Comparisons with the students' achievement for students of intake session 2013-2014 (Group Two) were also carried out. Furthermore, an analysis on ranking effect on the students based on their final marks for KKKL1114 on Group Two students was done by subdividing them into three subgroups of tutorial sessions. The groups were the low performance group, intermediate performance group

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and high performance group. The analysis of the results of the Cumulative Grade Point Average (CGPA) indicate that the achievement of both groups of these pre-university students is comparable, indicating no significant difference in their pre-university CGPA. However, comparing student performance within the same group shows different performance for KKKL1114 and KKKL1124 as shown by the final marks for the two groups. For all students, only significant correlation between final examination marks for KKKL1114 and the pre-test is observed (R^2 = 0.47). For overall student performance, there was no significant correlation between their pre-university CGPA and their achievement for both KKKL1114 and KKKL1124. Student ranking into three tutorial subgroups based on the students' CGPA during pre-university showed a significant finding ($p < 0.05$) of consistent results in their final marks for KL1114. This shows that the students' final marks for KKKL1114 were linked and reflected to their pre-university CGPA. Ranking the students in this way can ease teaching and learning and allow for necessary interventions especially in the case of weak students to improve their study performance.

Keywords: Circuit theory achievement, pre-test, pre-university CGPA, tutorial session

INTRODCUTION

The Circuit Theory 1 (KKKL1114) and Circuit Theory 2 (KKKL1124) courses are first-year compulsory courses in the undergraduate engineering programme offered by the Department of Electrical, Electronics & Systems Engineering (JKEES) of the Faculty of Engineering & Built Environment, at Universiti Kebangsaan Malaysia (UKM). These courses are also implemented to meet the requirements of programme accreditation by the Engineering Accreditation Council Malaysia (EAC), as stipulated in the 2012 EAC Accreditation Manual. These foundational courses are aimed at equipping the students with the ability to analyse and design electrical circuits. Course content includes fundamental laws; Thevenin and Norton analysis; RLC and magnetic circuits; passive filters and frequency response; AC power analysis; 3-phase power systems; 2-port networks; as well as Laplace and Fourier transforms. In addition, students are also introduced to the electronic design software PSpice via assignments and projects (JKEES, 2014a & 2014b). To ensure standardisation, the implementation of both courses is benchmarked against equivalent courses offered at the University of Malaya, Malaysia and Chulalongkorn University, Thailand (Department of EESE, 2013).

Despite meeting relatively competitive entry requirements into the programme, student achievement in both of these first-year courses, as measured in their final grades, are less than sterling. This triggered the authors to undertake a study to determine possible root causes. Of particular interest pertaining to the study was to quantitatively determine if there was a statistically significant relationship between the students' pre-university academic achievements (matriculation, HSC, A-level, college diploma) and their final grades in the KKKL1114 and KKKL1124 courses. Bais et al. (2013) recommended that if a strong correlation existed, certain early intervention measures could be put into place to identify potentially problematic students and provide them with focussed and supplementary tutoring.

However, the investigation into such relationship is not straight-forward because there are multiple entry routes, each having different entry requirements into the electrical engineering programmes at UKM. While the majority of the students enrol straight out of matriculation programmes run by the Ministry of Education, a small number of students are also enrolled via the relatively more extensive Malaysian Higher School Certificate (HSC), A-levels and diploma programmes, each with its own, different syllabus and assessment methods. Using a systematic approach of population sampling, competency assessments under a controlled environment and statistical data analysis, this study sought to determine the statistical correlation between students' achievement at pre-university level and their corresponding achievement in the Circuit Theory courses at UKM.

METHODOLOGY

In this section, subject population, data gathering method and statistical data analysis procedure are explained and elaborated on.

Subject Population

The study evaluated the data for the student intake session of 2012-2013 (Group One) and the intake session of 2013-2014 (Group Two). For the intake session of 2012-2013, the total student admission was 50 while for the intake session of 2013-2014, the total student admission increased to 103. However, only 48 students participated in answering the pre-test for the 2012-2013 session and 90 students for the 2013-2014 session.

Data Gathering Method

For intake session 2012-2013 (Group One), the students' pre-university CGPA scores were collected and used to serve as the students' academic background. Students' pre-university CGPA scores were extracted from the data for all the students in the Undergraduate Affairs Unit, FKAB. Apart from the students' pre-university CGPA, data were also collected from the students' pre-test achievement results. Questions in the pre-test were designed to evaluate students' knowledge in the field of science and mathematics, in general and the principle of physics and electricity, in particular. More information about the pre-test can be referred to in Bais et al. (2013). For this intake, the pre-test was conducted during the first week of the academic session without prior notice to the students. Therefore, students needed to answer the pre-test questions based on what they could recall from what they had learnt during their pre-university. Apart from the students' pre-university CGPA and pre-test scores, data were also collected from the final examination marks from Circuit Theory 1 (KKKL1114) taken in Semester 1 and Circuit Theory 2 (KKKL1124) taken in Semester 2 of the academic session. As for tutorials, these students were grouped at random.

For intake session of 2013-2014 (Group Two), data collected were from the same four parameters as for the intake session of 2012-2013 (Group One). The same pre-test questions were given. However, a pre-test was conducted in the second week of the academic session and students were informed in advance about the pre-test. This was to enable the students to make necessary preparations before taking the pre-test. This was to see whether the preparations done by the students prior to the pre-test would be able to help them to answer questions in the pre-test. Students for this intake were also grouped for their tutorial classes based on their CGPA during pre-university to investigate whether the strategy could help them improve their study performance.

Statistical Data Analysis

Data analysis was performed using SPSS Statistical Package for the Social Sciences (SPSS) to get the average and standard deviation, and a *t*-test was performed to test significant differences ($p < 0.05$) between the two groups. In addition, R^2 correlation tests were conducted to obtain the correlation between the two parameters studied. Connections between the students' achievement in the pre-university and the students' achievement in year one in JKEES were seen through the strength of the correlation, while the differences or similarities were seen from the results of the *t*-test. Comparisons were made between Group One of the 2012-2013 intake session and Group Two of the 2013-2014 intake session, in the same group and also among all the students.

RESULTS AND DISCUSSION

The study included students who took only science subjects, including physics in their secondary school final exam known as the Malaysian Certificate of Examination (SPM), which is equivalent to the O-level examination. The examination is considered the marker for their pre-university achievement. By including students who had taken physics, the study took into account that the analysis was done only on students of similar background who already had basic knowledge of electricity, which was introduced in physics class at pre-university level. Statistics of the study groups and t-test results of both student groups are shown in Table 1.

Table 1
Statistics and t-test Results for Group One and Group Two Represented as Mean (M) ± Standard Deviation (SD)

	CGPA pre-university M ± SD	Pre-test marks M ± SD (%)	Final marks KKKL1114 M ± SD (%)	Final marks KKKL1124 M ± SD (%)	*t*-test KKKL1114 vs KKKL1124
Group 1 (N=48)	3.57 ± 0.55	17.1 ± 5.3	34.7 ± 18.8	52.4 ± 18.6	$p < 0.01$
Group 2 (N=90)	3.58 ± 0.28	46.6 ± 14.6	60.7 ± 13.5	59.2 ± 11.1	$p = 0.89$*
t-test Group 1 vs Group 2	$p = 0.96$*	$p < 0.01$	$p < 0.01$	$p = 0.03$	

Analysis between Groups

The statistical results show that student background as seen through the achievement of the pre-university CGPA scores of Group One and Group Two showed no difference ($p > 0.05$) between the two groups (Figure 1a). Comparing the scores on the pre-test prior to taking the course KKKL1114 for both groups of students showed that the pre-test scores for Group One were significantly lower compared to that of Group Two, which was 17.1 ± 5.3 versus 46.6 ± 14.6 (Figure 1b). Obviously, the pre-test scores for students of Group Two were higher than the pre-test scores for Group One students. This finding is most likely due to prior notice having been given that there would be a test; this obviously triggered the students of Group Two to do the necessary revision before taking the pre-test. Group One students, on the other hand, had not been notified of the coming pre-test; consequently, they were unprepared and obtained poor scores on the pre-test. The final marks for both KKKL1114 and KKKL1124 are also significantly lower for both Group One (34.7 + 18.8) versus Group Two (60.7 + 13.5) (Figure 1c) and Group One (52.4 + 18.6) versus Group Two (59.2 + 11.1) (Figure 1d).

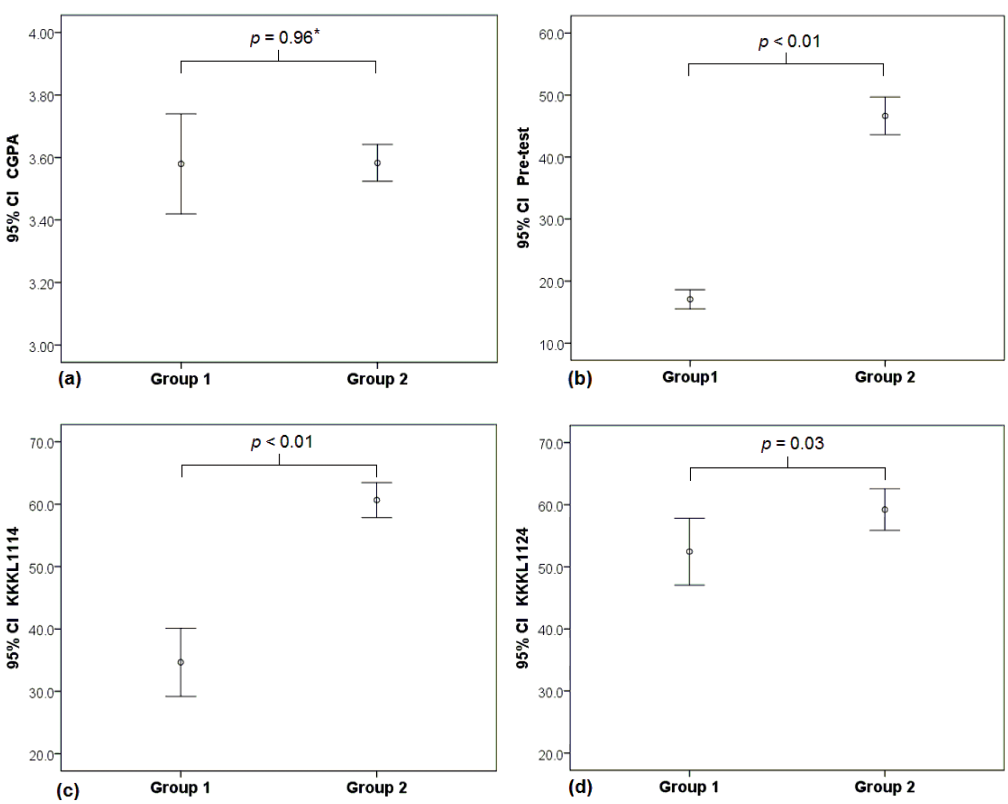

Figure 1. Comparison between group one and group two for (a) CGPA of pre-university, (b) pre-test, (c) final marks for KKKL1114 and (d) final marks for KKKL1124.

Analysis within Groups

The results of the analysis within the same group are shown in Figure 2. Obviously, the final marks for KKKL1124 were significantly higher than the final marks for KKKL1114 for Group One (52.4 ± 18.6 versus 34.7 ± 18.8). However, the final marks for KKKL1124 and KKKL1114 for Group Two were not significantly different (59.2 ± 11.1 versus 60.7 ± 13.5).

The analysis of the final marks for KKKL1114 for Group Two, who were segregated into three groups of tutorial classes based on the students' pre-university CGPA, namely, high performance, intermediate performance and low performance is shown in Table 2. All three categories of tutorial groups achieved significantly different final marks for KKKL1114 (as shown in Figure 3). Nevertheless, the students of Group One were divided into tutorial class groups randomly and not based on their pre-university CGPA. Thus, similar analysis of tutorial groups based on their pre-university CGPA against their finals marks for KKKL1114 could not be done.

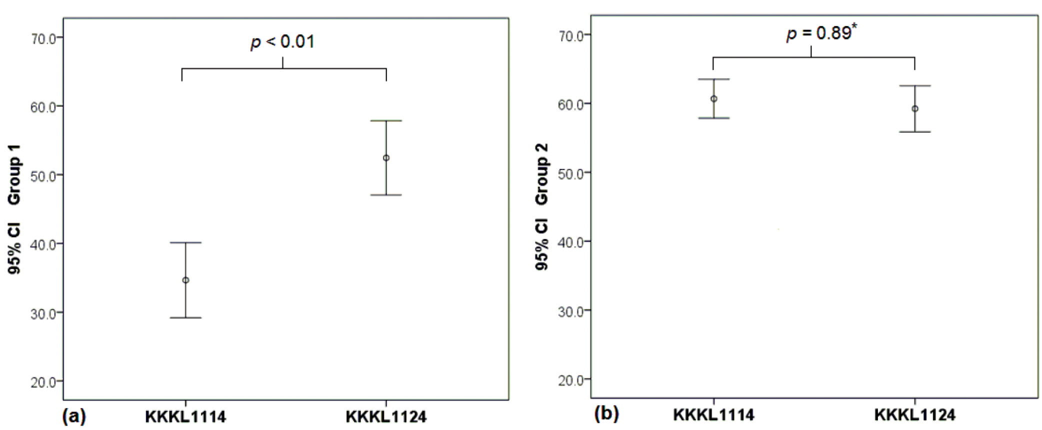

Figure 2. Final marks for KKKL1114 and KKKL1124 for (a) Group One and (b) Group Two.

Table 2
Analysis of CGPA Pre-University and Final Marks for KKKL1114 in Group Two (2013-2014) Between Three Tutorial Groups Using ANOVA. Data Represent Mean ± Standard Deviation

Total N = 90	CGPA pre-university M ± SD	Final marks KKKL1114 M ± SD
High performance group (n = 13)	3.91 ± 0.13	69.7± 9.9
Intermediate performance group (n = 67)	3.57 ± 0.22	59.7 ± 13.8

TABLE 2 (continue)

Total N = 90	CGPA pre-university M ± SD	Final marks KKKL1114 M ± SD
Low performance group (n = 10)	3.13 ± 0.09	55.4 ± 8.3
ANOVA	p < 0.01	p = 0.02

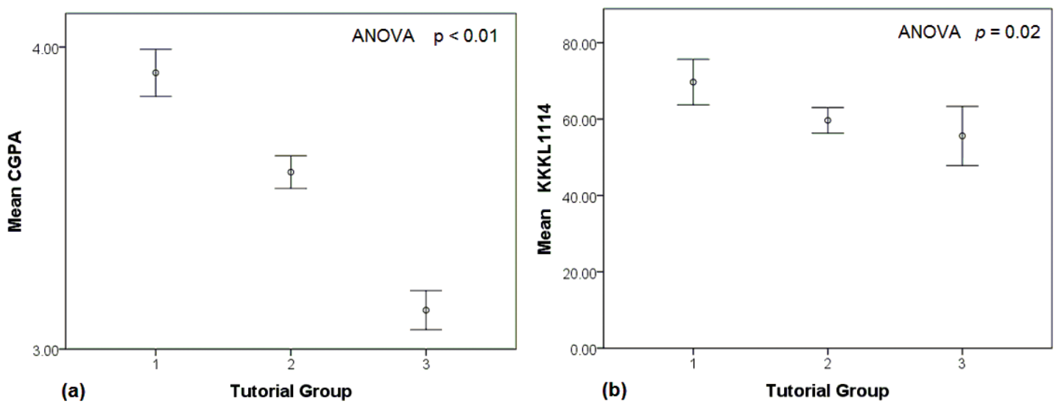

Figure 3. Students' tutorial group (a) CGPA scores in pre-university and (b) final marks for KKKL1114 for Group Two, where Group 1 = high performance, Group 2 = intermediate performance and Group 3 = low performance.

Analysis on Total Study Population

The results of analysis to find the correlation between two parameters for the whole group of students regardless of which group they belonged to, Group One or Group Two, with a simple Pearson correlation test for R^2 are shown in Figure 4. The results show that only a moderate association is observed between the final marks of KKKL1114 and the pre-test score with a correlation $R^2 = 0.47$ (Figure 4a), whereas a very weak correlation can be seen between the final marks of KKKL1124 and the pre-test scores (Figure 4b), the final marks of KKKL1114 and the CGPA scores (Figure 4c) and the final marks for KKKL1124 and the CGPA scores (Figure 4d). The pre-test scores and the CGPA scores of students in pre-university does not reflect the level of their basic understanding in KKKL1124. Therefore, the pre-test scores and pre-university CGPA scores do not serve as predictors for the students' achievement in KKKL1124 but could be a predictor for KKKL1114.

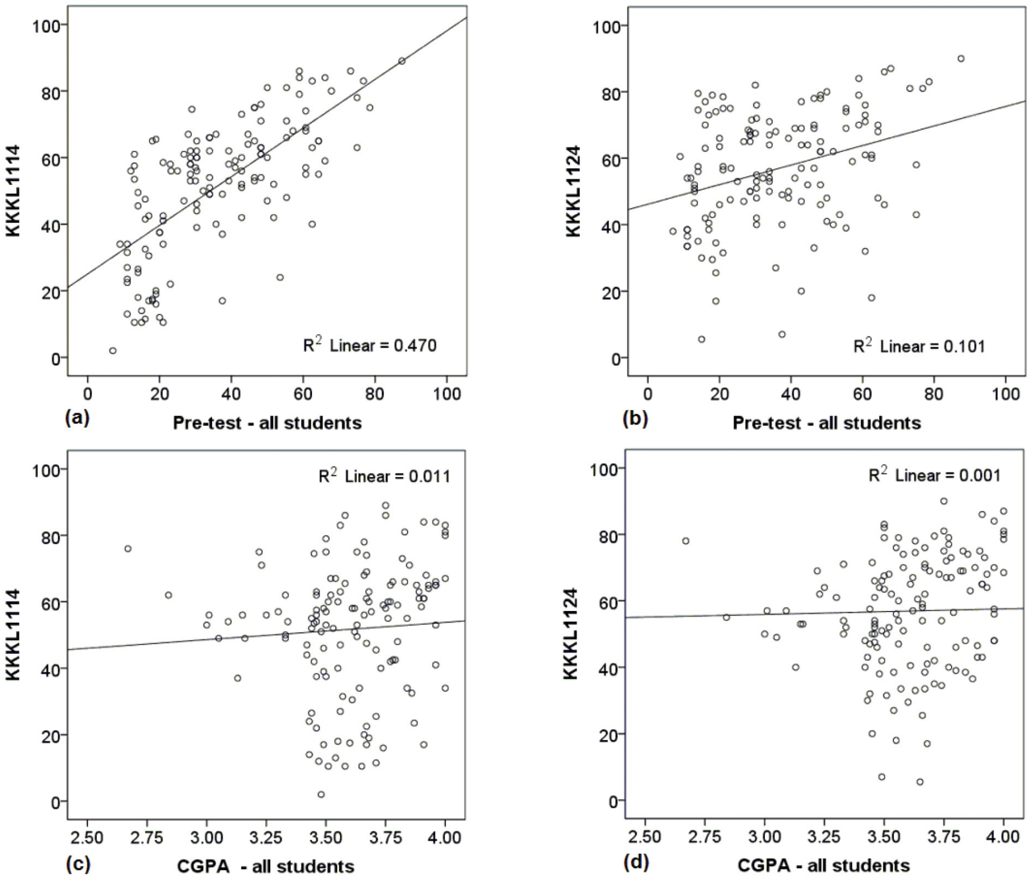

Figure 4. The correlation between two parameters among all students (a) KL1114 and the pre-test, (b) KKKL1124 and the pre-test, (c) KKKL1124 and CGPA and (d) KKKL1124 and CGPA.

Finding the correlation between student achievement in pre-university and their achievement in Circuit Theory courses taken in their first year at university is indeed only the first step in finding the root cause of the problem. The findings of this study are important for us to help students improve their academic performance especially that of weak students as early intervention can be better planned for them in the future. Early intervention measures can be taken to help these students to succeed in their studies during the remaining years at university. Overall, we discovered that there was almost no correlation between pre-university CGPA and Circuit Theory courses, as shown in Figure 4. However, grouping the students based on their pre-university CGPA scores for Circuit Theory I (KKKL1114) produced significantly segregated final marks for Circuit Theory I (KKKL1114) that were connected to their pre-university CGPA scores. In other words, the students' pre-university CGPA scores were coherent with their final marks for Circuit Theory I (KKKL1114). Theoretically, tutorial sessions can be conducted to help students learn and pick up knowledge that they could not grasp during lectures. This theory has been proven true in a study conducted by Sharma et al. (2005), where tutorial sessions conducted for students highly encouraged them to solve physics problems and structured worksheets with exercises based on first-year university level questions. The results proved that the students who attended the tutorial sessions regularly were able to improve their examination marks noticeably. Another study discovered that an important factor such as active learning, which was not investigated in our study, also played a crucial role in improving students' academic performance (Freeman et al., 2014). In the future, we will investigate specific aspects of teaching approaches to access the factors that influence student performance in Circuit Theory courses.

CONCLUSION

The findings of this study showed that student achievement in the subjects KKKL1114 and KKKL1124 had no significant correlation with their pre-university CGPA scores, which suggested that students with good grades in pre-university would not necessarily do well in the subjects KKKL1114 and KKKL1124 and vice versa. Furthermore, the students' pre-university CGPA scores were obtained from the total score of various subjects undertaken during pre-university. Thus, in future work it would be more relevant to use the marks from subjects such as mathematics and physics, which are more directly related to the courses KKKL1114 and KKKL1124. In addition, it was also found that the formation of tutorial groupings based on pre-university CGPA scores contributed to the significant improvement in student performance in their final marks, as observed in Group Two of 2013-2014. This is because teaching and learning can be conducted during tutorial sessions to cater for each student's capabilities.

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The Correlation Between Electrical Engineering Course Performance and Mathematics and Prerequisite Course Achievement

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ABSTRACT

Malaysia requires human capital with critical thinking and ability to solve problems to drive the country. These attributes are also required by the Engineering Accreditation Council (EAC), which stipulates that engineering students must have the ability to solve complex problems. Many electrical and electronics engineering courses require good understanding in mathematics to solve complex problems. In addition, some engineering courses have prerequisite courses, which students must complete before they can enrol in those courses in later semesters. Normally, prerequisite courses are fundamental courses and they play important roles in helping students understand the content of the course that requires the prerequisite. In this study, the relationship between student performance in electrical and electronics engineering courses and mathematics and prerequisite course achievement is identified. One mathematics and three engineering courses are used in this study, namely Calculus Vector (KQ1124), Circuit Theory 2 (KL1124), Electromagnetic Fields and Waves (KL2134) and Signal and System (KL2124). The Pearson correlation test using SPSS was used to identify the relationship between electrical and electronics engineering course performance with mathematics and prerequisite courses achievement. The results show that there is a strong positive relationship between engineering courses and previous mathematics achievement. A strong positive relationship also exists between performance in an engineering course and its prerequisite course.

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INTRODUCTION

Mathematical courses are important in the study of electrical and electronics engineering. Many electrical and electronics engineering courses such as Circuit Theory, Electromagnetic Fields and Waves, Signal and System and Digital Signal Processing require good understanding in mathematical courses such as Calculus Vector and Differential Equations. Furthermore, the Engineering Accreditation Council (EAC) has recently required engineering students to have the ability of solving complex problems, since most complex engineering problems require mathematics for their solution. Hence, mastery in mathematical courses is important for engineering students to achieve good grades in engineering programmes. Several studies have shown mathematics is important in engineering courses (Karen & Gergan, 2004; Uysal, 2012; Hsu, 2013). Aside from engineering, mathematical skills also impact student performance in other courses. Donovan and Wheland (2009) have shown that there is a relationship between mathematical ability and success and retention in chemistry courses. Mathematics is also important for solving physics problems (Wenno, 2015), and it is a predictor to physics students' performance (Awodun et al., 2013). Therefore, poor performance in mathematics may affect students' performance in engineering courses (Asshaari et al., 2011; Soheila et al., 2012).

Recently, students of the Department of Electrical, Electronics and Systems Engineering (DEES) in the Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia (UKM) have shown a decline in their performance (Husain et al., 2011). This is not a situation that should occur because students who enrolled in this department obtained excellent results in their pre-university education. Additionally, the student selection scheme set by the university requires students who are highly qualified, not only in the academic field but also in co-curricular activities. Poor academic performance among university graduates is a serious issue because the community expects that these students will be knowledgeable individuals able to handle current development issues in society. Several studies have been done in an effort to improve students' performance. One of the efforts is the identification of possibly weak students at the early stage of their study by introducing an early test (Kamal et al., 2012). The early test questions cover basic mathematics and engineering knowledge. Students have to take the test in the first or second week of their study. Based on the test marks, possibly weak students (students with very low marks) can be identified. Hence, these possibly weak students can be closely monitored from the beginning of their study by their mentors, who are also lecturers of the department.

There may also be other reasons for the students' weak performance. One of these may be related to their weakness in mathematics. A recent study shows that engineering students at the Faculty of Engineering & Built Environment, UKM are weak in mathematics (Ismail et al., 2011). The results show the overall mathematics performance of the whole faculty, which includes four different departments. Hence, no specific information on the mathematics performance of DEES students is available. Moreover, the study does not explore the relationship between mathematical achievement and performance in engineering courses. Therefore, the first aim of this study was to identify the relationship between electrical and electronics engineering performance with mathematical achievement. In this study, DEES students' performance in Calculus Vector (KQ1124), which is a mathematics course, was first compared with two engineering courses, Circuit Theory 2 (KL1124) and Electromagnetic Fields and Waves (KL2134) to find a relationship between them. Then, the relationship between Calculus Vector (KQ1124) and a third course, Signal and System (KL2124), was also tested. These three engineering courses were selected because the content of the courses requires Calculus Vector for analysis and problem solving.

Besides a good understanding in mathematics, some electrical and electronics engineering courses also require good understanding in fundamental courses, which are normally taught in the early semesters. Normally, the fundamental courses become prerequisite courses, which the students have to take before they can enrol in certain courses in later semesters. In order to understand the advance courses, students have to have mastery of fundamental knowledge. Therefore, mastery of prerequisite courses is important for the students to be able to achieve good grades in the advance courses. Previous studies showed that prerequisite courses have a relationship with students' performance in economics (Faridul et al., 2008; Peng, 2013) and nursing programmes (Alicia et al., 2003). Easter (2010) studied 10 contributing factors that affected students' chemistry grades, and the result showed that performance in prerequisite courses was the main factor. The same result was also evident for the management course, where the prerequisite affected performance in the Organisational Behavior course (Capehart & Bello, 2008). The same relationship may also exist in electrical and electronics engineering programmes. Therefore, the second aim of this study was to identify the relationship between performance in electrical and electronics engineering courses and the prerequisite course achievement. In this study, DEES students' performance in Circuit Theory 2 (KL1124) and Signal and System (KL2124) were compared to identify the relationship between them. Circuit Theory 2 (KL1124) is a prerequisite course for Signal and System (KL2124).

MATERIALS AND METHODS

This study was divided into two sections. The first section was to identify, if any, the relationship between students' performance in mathematics and electrical and electronics engineering courses, while the second section was to identify the relationship between performance in an engineering course and its prerequisite course achievement. For the first section, final exam marks from one mathematics course, Calculus Vector (KQ1124), and two engineering courses, Circuit Theory 2 (KL1124) and Electromagnetic Fields and Waves (KL2134) were used. Calculus Vector was offered in Semester 1, Circuit Theory 2 in Semester 2 and Electromagnetic Fields and Waves in Semester 3. These three courses were chosen because Calculus Vector is required in solving complex problems in Circuit Theory 2 and Electromagnetic Fields and Waves. For the second section, the relationship between Circuit Theory 2 and Signal and System (KL2124) final marks were determined, where Circuit Theory 2 is the prerequisite course for Signal and System. As stated before, Circuit Theory 2 is offered in Semester 2, while Signal and System is offered in Semester 4.

For this study, only final exam marks were considered. This is because final exam questions cover the whole syllabus of the course. In addition, the final examination is an individual assessment where no group work is included in the evaluation. It is important in this study to use individual student assessment to compare the students' performance in each course. Furthermore, final exams are carried out in controlled environments, where students are seated at a certain distance from each other and have to answer all questions in a fixed period of time.

Student performance was rated based on the grades shown in Table 1. As discussed earlier, this study was only focussed on the final examination. For analysis, the grades are divided into six categories, namely Excellent, Good, Medium, Weak, Very Weak and Fail, as depicted in Table 1.

Table 1
Grades and Categories Based on Students' Marks

Grade	Marks	Category
A	80 - 100	Excellent
A-	75 – 79.9	Good
B+	70 – 74.9	
B	65 – 69.9	Medium
B-	60 – 64.9	
C+	55 – 59.9	Weak
C	50 – 54.9	
C-	45 – 49.9	Very weak
D+	40 – 44.9	
D	30 – 39.9	
E	0 – 29.9	Fail

The data analysis in this study used the Statistical Package for the Social Sciences (SPSS) software. In order to identify the relationship between students' performance in mathematics and engineering courses, and an engineering course and its prerequisite, the Pearson correlation test was used.

Participants

The participants of this study were students from the Department of Electrical, Electronics & Systems Engineering, Faculty of Engineering and Built Environment, UKM. A total of 114 students from two batches participated in this study, of which the 2011 batch consisted of 56 students and the 2012 batch consisted of 58 students. Of the 2011 batch, 56.9% of the participants were male and 43.1% female, while the 2012 batch had an equal number of male and female participants. Tables 2 and 3 summarise the information on the gender of the participants involved in this study for both batches.

Table 2
Gender of the 2011 Batch

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Male	31	56.9	56.9	56.9
	Female	25	43.1	43.1	100.0
	Total	56	100.0	100.0	

Table 3
Gender of the 2012 Batch

		Frequency	Percentage	Valid Percentage	Cumulative Percentage
Valid	Male	29	50.0	50.0	50.0
	Female	29	50.0	50.0	100.0
	Total	58	100.0	100.0	

RESULTS AND DISCUSSION

The correlation between students' performance in mathematics and electrical and electronics engineering courses and the correlation between students' performance in an electrical and electronics engineering course and its prerequisite course are discussed separately in the following sub-sections.

Correlation between Performance in Mathematics and Engineering Courses

In order to identify the relationship between student performance in mathematics and engineering courses, the final marks from one mathematics subject, Calculus Vector (KQ1124) and two engineering courses, Circuit Theory 2 (KL1124) and Electromagnetic Fields and Waves (KL2134) were used as variables. The correlation tests were done separately, with null hypothesis for each test as follows:

H^{01}: There is no relationship between students' performance in Calculus Vector and Circuit Theory 2.

H^{02}: There is no relationship between students' performance in Calculus Vector and Electromagnetic Fields and Waves.

Tables 4 and 5 show the relationship between students' performance in Calculus Vector with Circuit Theory 2, and between Calculus Vector with Electromagnetic Fields and Waves for the 2011 and 2012 batches, respectively. As shown in Tables 4(a) and 4(b), the Pearson correlation coefficient values (*r*-values) of Calculus Vector and Circuit Theory 2 were 0.714 and 0.628, for the 2011 and 2012 batches, respectively. The *r*-values indicate that Calculus Vector and Circuit Theory 2 had a very strong positive relation. Therefore, students with good performance in Calculus Vector also gave good performance in Circuit Theory 2, while students with poor results in Calculus Vector performed poorly in Circuit Theory 2. The same relationship also appears true for Calculus Vector and Electromagnetic Fields and Waves, where the *r*-values for these courses were 0.662 and 0.575 for the 2011 and 2012 batches, respectively. Students with good performance in Calculus Vector also showed good performance in Electromagnetic Fields and Waves, while students with poor result in Calculus Vector also performed poorly in Electromagnetic Fields and Waves.

Another important parameter shown in Tables 4 and 5 is the significant value (*p*-value). The *p*-value for all variables in Tables 4 and 5 were zero, which indicates that both null hypotheses, *H01* and *H02* were rejected. Therefore, relationship exists between students' performance in Calculus Vector with Circuit Theory 2 and between Calculus Vector with Electromagnetic Fields and Waves.

The relationship between variables are also presented in scatter plots as shown in Figures 1 and 2. Figure 1 shows the scatter plots for correlation between students' performance in Calculus Vector and Circuit Theory 2 for the 2011 and 2012 batches. The correlation between students' performance in Calculus Vector and Electromagnetic Fields and Waves for both batches is shown in Figure 2. For each scatter plot, a best-fit line is drawn to see the relationship direction between the variables. All best-fit lines in Figures 1 and 2 show a positive direction, indicating that there was positive correlation between the variables.

Table 4
Correlation between Students' Performance in Calculus Vector (KQ1124) with Circuit Theory 2 (KL1124) for the (a) 2011 Batch and (b) 2012 Batch

		KL1124	KQ1124
KL1124	Pearson Correlation	1	.714**
	Sig. (2-tailed)		.000
	N	56	56
KQ1124	Pearson Correlation	.714**	1
	Sig. (2-tailed)	.000	
	N	56	56

**. Correlation is significant at the 0.01 level

(a) 2011 Batch

TABLE 4 (continue)

		KQ1124	KL1124
KQ1124	Pearson Correlation	1	.628**
	Sig. (2-tailed)		.000
	N	58	58
KL1124	Pearson Correlation	.628**	1
	Sig. (2-tailed)	.000	
	N	58	58

**. Correlation is significant at the 0.01 level

(b) 2012 Batch

Table 5

Correlation between Students' Performance in Calculus Vector (KQ1124) and Electromagnetic Fields and Waves (KL2134) for the (a) 2011 Batch and (b) 2012 Batch

		KQ1124	KL2134
KQ1124	Pearson Correlation	1	.662**
	Sig. (2-tailed)		.000
	N	56	56
KL2134	Pearson Correlation	.662**	1
	Sig. (2-tailed)	.000	
	N	56	56

**. Correlation is significant at the 0.01 level

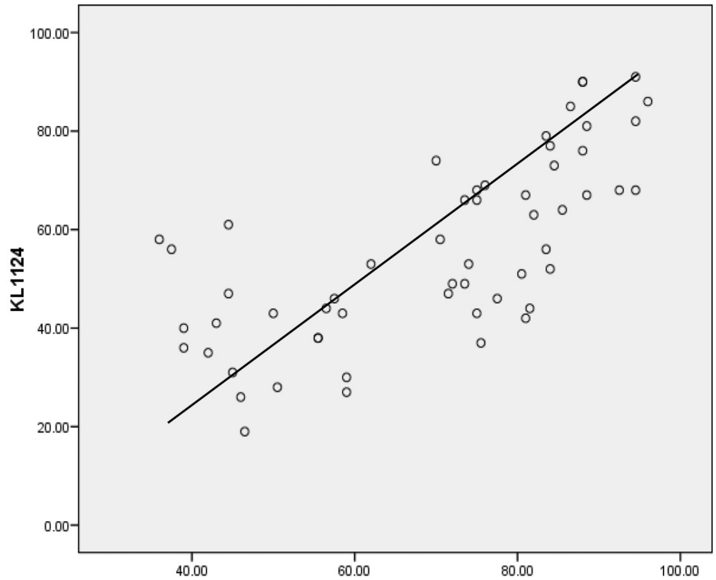
2011 Batch

		KQ1124	KL2134
KQ1124	Pearson Correlation	1	.575**
	Sig. (2-tailed)		.000
	N	58	58
KL2134	Pearson Correlation	.575**	1
	Sig. (2-tailed)	.000	
	N	58	58

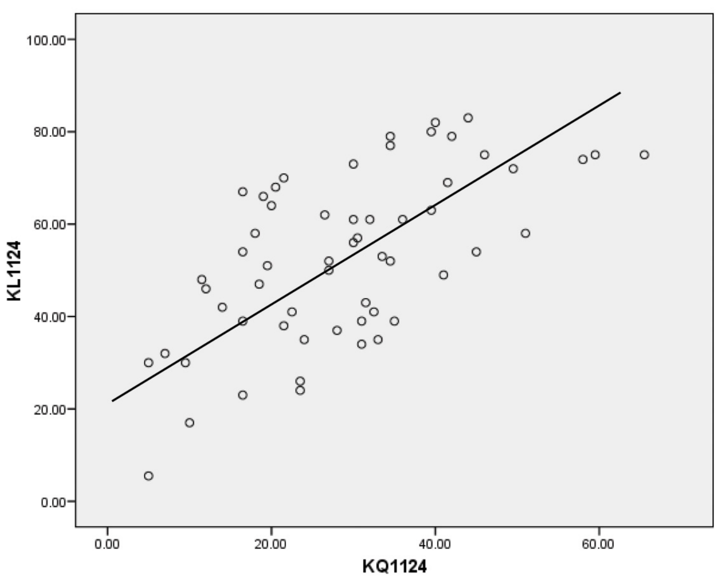
**. Correlation is significant at the 0.01 level

2012 Batch

A strong positive correlation between students' performance in Circuit Theory 2 and Electromagnetic Fields and Waves and Calculus Vector indicates strong relationship between mathematical achievement and student performance in electrical and electronics engineering courses. This is because problem solving in engineering courses requires good understanding of mathematics. Therefore, a strong foundation in mathematics is required in order to achieve good grades in electrical and electronics engineering courses.

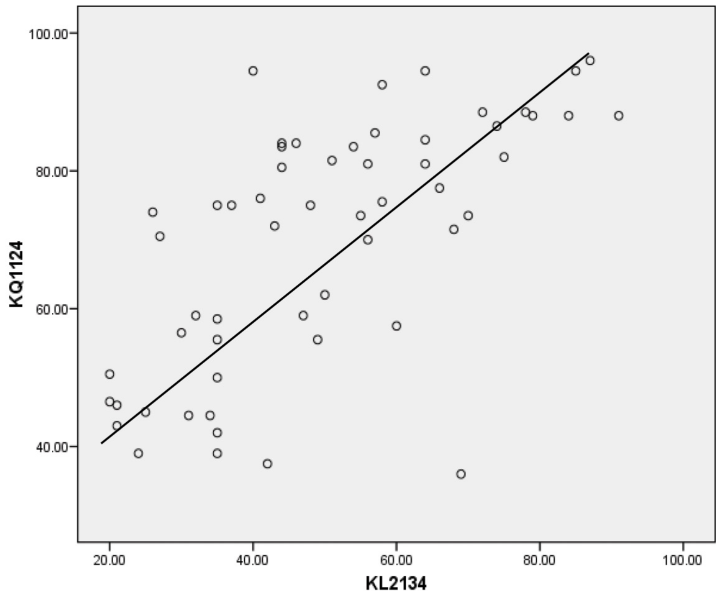


(a) 2011 batch

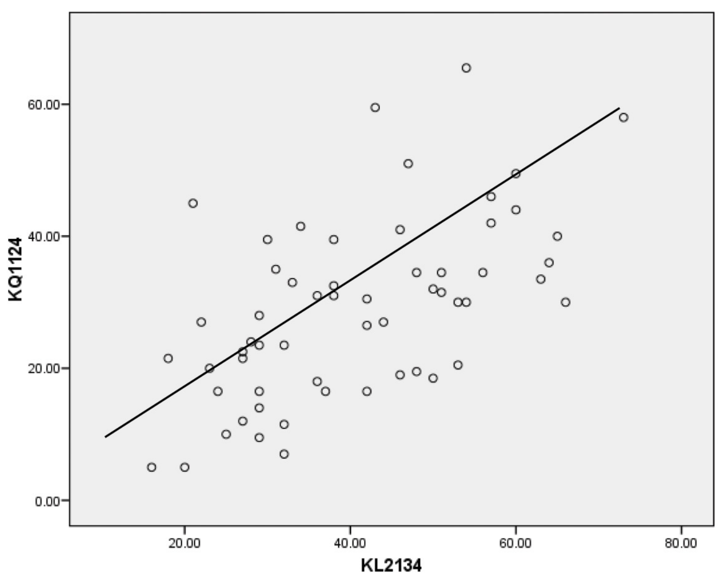


(b) 2012 batch

Figure 1. Scatter plots for the correlation between students' performance in Calculus Vector (KQ1124) and Circuit Theory 2 (KL1124) for the (a) 2011 batch and (b) 2012 batch.



(a) 2011 batch



(b) 2012 batch

Figure 2. Scatter plots for the correlation between Calculus Vector (KQ1124) and Electromagnetic Fields and Waves (KL2134) for the (a) 2011 batch and (b) 2012 batch.

For further analysis, the percentage of students' performance in Circuit Theory 2 and Electromagnetic Fields and Waves based on their Calculus Vector achievement was tabulated as shown in Table 6 and Table 7, respectively. The data are grouped into categories based on Table 1. The results showed that 50% of Excellent students in Calculus Vector achieved Excellent and Good grades in Circuit Theory 2. However, only 7.7% students with a Good grade in Calculus Vector achieved the Good grade in Circuit Theory 2. Meanwhile, 60.8% of students who failed Calculus Vector received Very weak or Fail on their Circuit Theory 2 tests.

Table 6
Percentage of Students' Performance in Circuit Theory 2 (KL1124) Based on Their Calculus Vector (KQ1124) Achievement

Category	KQ1124 (No. of students)	KL1124 (Percentage)					
		Excellent	Good	Medium	Weak	Very weak	Fail
Excellent	22	31.8%	18.2%	27.3%	13.6%	9.1%	0%
Good	13	0%	7.7%	30.8%	15.4%	46.2%	0%
Medium	2	0%	50.0%	0%	50.0%	0%	0%
Weak	12	0%	16.7%	0%	8.3%	58.3%	16.7%
Very weak	37	5.4%	18.9%	16.2%	18.9%	35.1%	5.4%
Fail	28	0%	3.6%	17.9%	17.9%	42.9%	17.9%

As shown in Table 7, 40.9% of Excellent students in Calculus Vector obtained Excellent and Good grades in the Electromagnetic Fields and Waves course. However, only 7.7% of the Good grade students in Calculus Vector also achieved the Good grade in Electromagnetic Fields and Waves. Meanwhile, 92.8% of students who failed Calculus Vector got Very weak or Fail grades in Electromagnetic Fields and Waves.

Table 7
Percentage of Students' Performance in Electromagnetic Fields and Waves (KL2134) Based on Their Calculus Vector (KQ1124) Achievement

Category	KQ1124 (No. of students)	KL2134 (Percentage)					
		Excellent	Good	Medium	Weak	Very weak	Fail
Excellent	22	18.2%	22.7%	13.6%	22.7%	22.7%	0%
Good	13	0%	7.7%	15.4%	23.1%	38.5%	15.4%
Medium	2	0%	0%	0%	100%	0%	0%
Weak	12	0%	8.3%	8.3%	0%	75.0%	8.3%
Very weak	37	0%	0%	18.9%	21.6%	40.5%	18.9%
Fail	28	0%	0%	0%	7.1%	35.7%	57.1%

The results in Table 6 and Table 7 suggest that students must score an A grade in Calculus Vector in order to obtain a Good grade in Circuit Theory 2 and Electromagnetic Fields and Waves. A fail in Calculus Vector results in the high possibility of students failing or obtaining a very weak grade in both Calculus Vector and Electromagnetic Fields and Waves.

Correlation between Performance in an Engineering Course and Its Prerequisite Course

In addition to the relationship between the mathematics and engineering courses, this study also looked at the relationship between students' performance in the electrical and electronics engineering course and its prerequisite course. For this study, Signal and System (KL2124) and its prerequisite course Circuit Theory 2 (KL1124) were chosen as the variables. In addition, the mathematics course Calculus Vector (KQ1124) was also included in the correlation test because both engineering courses require mathematics in solving complex problems. Table 8 shows the Pearson correlation test result for these three courses.

As shown in Table 8, the *r*-values for Circuit Theory II and Signal and System were 0.762 and 0.733 for the 2011 and 2012 batches, respectively. The results showed a strong positive correlation between the engineering course and its prerequisite course. In addition, the table also shows a strong positive correlation between Signal and System and Calculus Vector, where the *r*-values were 0.729 and 0.598 for the 2011 and 2012 batches, respectively. This also supports the results in the earlier section, where students' performance in engineering courses was related to their achievement in mathematics.

Table 8
Correlation Between Students' Performance in Calculus Vector (KQ1124), Circuit Theory 2 (KL1124) and Signal and System (KL2124) for the (a) 2011 Batch and (b) 2012 Batch

		KQ1124	KL1124	KL2124
KQ1124	Pearson Correlation	1	.714**	.729**
	Sig. (2-tailed)		.000	.000
	N	56	56	56
KL1124	Pearson Correlation	.714**	1	.762**
	Sig. (2-tailed)	.000		.000
	N	56	56	56
KL2124	Pearson Correlation	.729**	.762**	1
	Sig. (2-tailed)	.000	.000	
	N	56	56	56

**. Correlation is significant at the 0.01 level (2-tailed)

(a) 2011 Batch

TABLE 8 (continue)

		KQ1124	KL1124	KL2124
KQ1124	Pearson Correlation	1	.628**	.598**
	Sig. (2-tailed)		.000	.000
	N	58	58	58
KL1124	Pearson Correlation	.628**	1	.733**
	Sig. (2-tailed)	.000		.000
	N	58	58	58
KL2124	Pearson Correlation	.598**	.733**	1
	Sig. (2-tailed)	.000	.000	
	N	58	58	58

**. Correlation is significant at the 0.01 level (2-tailed)

(b) 2012 Batch

Table 9 shows the percentage of students' performance in Signal and System based on their prerequisite course achievement, which is Circuit Theory 2 for both the 2011 and 2012 batches. The performance is again grouped into categories based on Table 1. About 88.8% of students with Excellent grade in the prerequisite course achieved Good and Excellent grades in Signal and System. Meanwhile, 50% of students with Good grade in Circuit Theory 2 attained Good and Excellent grades in Signal and System. These results showed that students with Excellent and Good grades in the prerequisite course had a very good chance of obtaining the Good grade in the course that needed the prerequisite. This result suggested that the students should score at least 70 marks or grade B+ in Circuit Theory 2 in order to get a Good grade in Signal and System.

On the other hand, 62.5% of Very weak students in Circuit Theory 2 got Weak and Very weak grades in Signal and System, and 25% of them failed the course. About 44.4% of Fail students in the prerequisite course also failed in Signal and System, and 22.2% of them achieve the Very weak grade. Therefore, students who failed the prerequisite course had a very high possibility of failing or getting a very weak grade in the course that needs the prerequisite.

Table 9

Percentage of Students' Performance in Signal and System (KL2124) Based on Their Prerequisite Course Achievement

Category	KL1124 (No. of students)	KL2124 (Percentage)					
		Excellent	Good	Medium	Weak	Very weak	Fail
Excellent	9	44.4%	44.4%	11.1%	0%	0%	0%
Good	16	25.0%	25.0%	31.3%	18.8%	0%	0%
Medium	21	14.3%	9.5%	28.6%	19.0%	23.8%	4.8%
Weak	19	5.3%	10.5%	36.8%	31.6%	15.8%	0%
Very weak	40	0%	0%	12.5%	22.5%	40.0%	25.0%
Fail	9	0%	0%	0%	33.3%	22.2%	44.4%

CONCLUSION

This study presents a relationship between students' performance in mathematics with electrical and electronics engineering courses and between an electrical and electronics engineering course and its prerequisite courses. One mathematics and three electrical and electronics engineering courses were chosen as variables in this study. They are Calculus Vector (KQ1124), Circuit Theory 2 (KL1124), Electromagnetic Fields and Waves (KL2134) and Signal and System (KL2124). The SPSS Pearson correlation test was used to get the relationship between the variables. The results showed that there was a strong positive relationship between students' achievement in mathematics and their performance in engineering courses. A strong positive relationship also existed between students' performance in an engineering course and its prerequisite course. Therefore, in order to obtain good grades in engineering courses, students must achieve good results in mathematics and fundamental engineering courses, which become prerequisites to other courses. Improvement to teaching and learning is essential for the mathematics and fundamental engineering courses to help students achieve good results in these courses, and subsequently perform well in all the other engineering courses. These students achieved good grades in their pre-university education, implying that they had the ability to succeed in their engineering studies.

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Implementation of Evidence-Based Learning in the Course, Power Electronics

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ABSTRACT

The evidence-based learning approach was introduced and implemented in a course on power electronics in this study. In order to implement the evidence-based learning approach, the power electronic course run by the Department of Electrical, Electronics and System, Faculty of Engineering and Built Environment, UKM was divided into three complementary phases. The first phase begins with learning the theories of power electronics topics such as rectifier circuit etc. in the classroom; the second phase is learning to design, model and simulate the rectifier circuit using a dedicated software tool; and the last phase is learning to develop the rectifier circuit hardware and to investigate the circuit's characteristics in the laboratory. As a result, students understood the lesson on rectifier circuit better than if they had only been introduced to theory alone or a combination of both theory and computer simulation lessons as they have undertaken all specified phases step by step. Moreover, the proposed learning concept also increased the students' confidence in handling the rectifier circuit experiment. Hence, evidence-based learning should be considered a preferred and alternative learning approach for the power electronics course.

Keywords: Evidence, experiment, rectifier circuit, simulation, theory

INTRODUCTION

Evidence-based education is an approach in education where the approach is based on significant and reliable evidence derived from experiments; the idea that education should be or become an evidence-based practice has recently come to prominence

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in several countries (Biesta, 2007; George, 2009). Evidence-based education operates at two levels. The first level utilises existing evidence from worldwide research and literature on education and its associated subjects. The second level is to establish concrete and appropriate evidence, when existing evidence is lacking, questionable, uncertain or weak in nature (Davies, 1999). Cranney and McDonald (2012) define evidence-based learning as a class of approaches that have been empirically demonstrated to produce learning outcomes. Bruniges (2011) reports that evidence-based teaching and learning has been implemented in Australian schools. Thus, evidence-based learning offers a lot of advantages and benefits, other than close correlation with engineering education that needs to be investigated.

Learning is a compulsory task undertaken by students to meet the requirements of their enrolment in a formal educational institution. In the context of higher educational institution, students are learners; lecturers are professionals who facilitate students' learning in the form of teaching, supervising, guiding and advising students. Usually, teaching and learning in higher educational institutions are based on delivering knowledge by theory or practical example from a lecturer to students literally or by the aid of teaching assisted tools (Carlson & Sullivan, 1999). However, do students really understand? In the context of electrical engineering it is very hard for students in the first place to imagine current flow in a circuit, for example. They need to strive hard and seriously study in order to understand to what has been delivered in the classroom (Lynch & Russel, 2005). For the lecturer, it is common to evaluate students' understanding through a written examination. If students perform well in the examination, they get excellent results, meaning that they understand the subject matter in depth. However, this is not the case in the context of the course, Power Electronics.

In general, the application of power electronics is to process and control the flow of electric energy in a form that is optimally suited for user loads (Mi, Shen, & Ceccarelli, 2005). Torrey (2004) stated that Power Electronics as a course can be considered application-orientated and a multi-discipline course in which students' understanding and confidence in mastering the subject matter are less than expected if teaching is based merely on theory. Based on these arguments, new methods of teaching and learning need to be introduced and implemented in this course. Evidence-based learning for arbitrary new findings in power electronics applications has long being practised. Almost all publications related to power electronics research must provide real results, which can be obtained via hardware-based experimental work verification or validation method. In this case, real result means a voltage or current waveform response or measurement value for a specific power converter circuit. Without real evidence, a real situation cannot be validated because theory and computer simulation are impractical and cannot be validated (Yusof, Za'im, & Shareef, 2015). In order to employ the proposed approach, the traditional learning approach needs to be restructured. In this study, three phases of a different learning approach were introduced. The three phases related to and complemented one another. The first phase was building the learning foundation, which was introducing theory; the second phase was learning based on computer-assisted tools, such as modelling and simulation; and the third phase was real application-orientated learning i.e. experimental work. The different approach using three learning phases seeks to cater for students' level of understanding. Not every student understands clearly topics taught in the classroom, thus computer simulation was believed to be able to help them. If a few students still found it difficult to catch up with the lessons being taught, it was expected that experimental work would greatly them grasp the learning points. Nevertheless, evidence-based learning is not a new learning approach, as it has been implemented in teaching and learning in medicine and nursing (Johnson et al., 2011).

In the Department of Electrical, Electronics and System Engineering (JKEES), Faculty of Engineering and Built Environment, UKM, Power Electronics is a compulsory course for fourth-year students who enrol in the electrical and electronics engineering programme. The faculty handbook for students prepared by FKAB (2013) states that Power Electronics has four course outcomes (CO). The evidence-based learning fulfils three out of the four course outcomes, which are: ability to understand Power Electronics and its applications (CO1); ability to design, analyse and operate power converter circuits (CO2); and ability to model, simulate and analyse power converter circuits using computer tool (CO3). The fourth course outcome is ability to understand the operation of a motor (CO4). Evidence-based learning is therefore is an effective method to strengthen and improve knowledge delivery of this course.

Evidence-based learning was expected to achieve the objective related to experimental work in the laboratory for this course. Experiments provide a concrete basis for abstract and formal concepts in electrical engineering education (Groccia & Buskist, 2011). Furthermore, laboratory experiments provide hands-on experience and practical training opportunity in power electronics application (Jimenez-Martinez, Soto, de Jodar, Villarejo, & Roca-Dorda, 2005). Nevertheless, the guided experiment conducted by the instructor is a simplified practical approach for many students. However, for the fourth-year student, this approach of doing an experiment needs to be changed. It is proposed that experiments be conducted by students without first watching a demonstration by the instructor. The objective of having such unguided experiments is to encourage the students to be independent and to work seriously and with great effort without relying on a manual or the instructor in carrying out the experiment. While an instruction manual for such experiments is not required, the objectives of the experiments must be clearly stated. The instruction manual for the unguided approach will contain only the learning objectives, equipment used and brief instructions. However, assistance from the instructor is still required, but must be kept to the minimum in order to ensure that students achieve the lesson outcomes. This will nurture students' self-confidence and sense of independence in carrying out laboratory work. This study focusses on the topic of the single-phase rectifier circuit operation. A summary of the differences between the traditional method i.e. theory-based learning approach and evidence-based learning is listed in Table 1.

METHODOLOGY

Teaching and learning for the chosen topic, the single-phase rectifier circuit, was implemented in three phases; firstly, the concept or theory was delivered, followed by application of computer-based modelling and simulation, and finally, laboratory work was carried out. In total, 25 students enrolled in the Power Electronics course for the 2014-2015 academic session participated in this study. Details of the phases are discussed in the subsequent sections.

Table 1
Traditional Method Versus Evidence-Based Method

Traditional method	Evidence-based method
1. Teaching and learning in classroom • Theory • Revision • Tutorial • Examination	1. Teaching and learning in classroom • Theory • Revision • Tutorial • Examination 2. Computer software tool • Modelling • Simulation 3. Hardware experiment • Set-up and testing • Validation

Phase 1 – Theoretical Lesson

In this phase, the students were introduced to the theory and foundation of the rectifier circuit. The circuit operation, schematic circuit design, related mathematical equation, tutorial and analysis of the rectifier circuit were among the subtopics taught. After the theory class, a quiz was given to measure students' performance and comprehension. The single-phase bridge rectifier as illustrated in Figure 1 was chosen for this study.

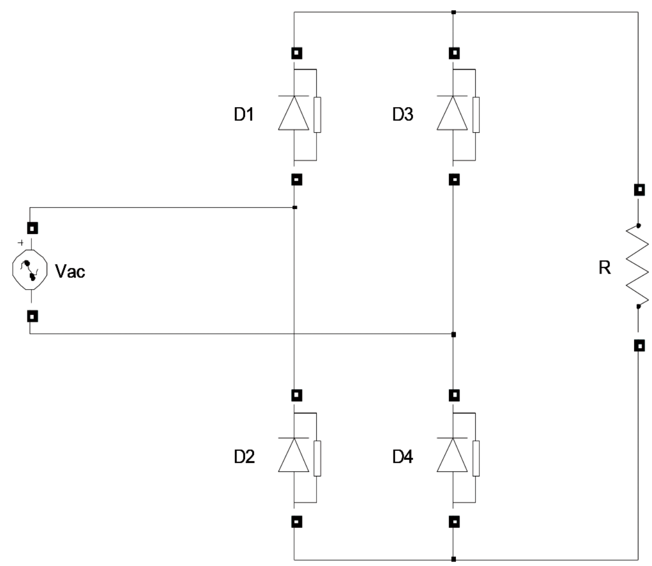

Figure 1. Single phase diode bridge rectifier circuit model.

Theoretically, alternative current (AC) supply voltage v_{ac} can be formulated as follows:

$$v_{ac} = V_m \sin \omega t \text{ V} \quad [1]$$

where V_m is the amplitude of v_{ac} with sinusoidal waveform at fundamental frequency f = 50Hz. According to voltage waveform, the input-output relationship of the rectifier circuit in mathematical representation is derived. Since the input is AC voltage, to transform it into DC voltage an integral method is applied in equation [1] for a half-cycle time duration, $T/2$. Hence, if rotating frequency $\omega = 2\pi f$ [rad/s] and phase angle, $\omega T/2 = \pi$ radian, then the average DC output voltage, V_o with resistive load can be calculated as follows:

$$V_o = \frac{1}{\pi}\int_0^{\pi} V_m \sin \omega t \, d(\omega t) = \frac{V_m}{\pi}[-\cos \omega t]_0^{\pi} = \frac{2V_m}{\pi} \text{ V} \quad [2]$$

Phase 2 – Computer Simulation Lesson

After being introduced to the theory, the students were exposed to computer-assisted modelling and simulation application using the MATLAB Simulink software tool (Yusof & Rahim, 2010). The MATLAB Simulink software tool was introduced to students in their first year of study in the department. Thus, the learning process was not time consuming because the students remembered how to use the software tool. By modelling the rectifier circuit in Figure 1, the particular waveforms could be obtained by means of simulation as depicted in Figure 2. The advantage of this method was that the theory and concept of the rectifier circuit learnt in the classroom could be realised virtually. This allowed students to better comprehend the topic than if they had been asked to just imagine and listen to a lecture. Furthermore, analysis of the rectifier circuit could be done and the characteristics of the circuit could be identified. Nevertheless, in doing so, some assumptions had to be taken into account, such as that the components were ideal, there were no environmental effects etc. Computer simulation can provide substantial knowledge regarding a rectifier circuit. However, real-life conditions were absent because of problems related to environmental and unpredicted factors such as humidity, temperature, power disturbances and reduction of component effectiveness due to the ageing process, among others. These problems are usually not considered in computer modelling and simulation (Tattje & Vos, 1995).

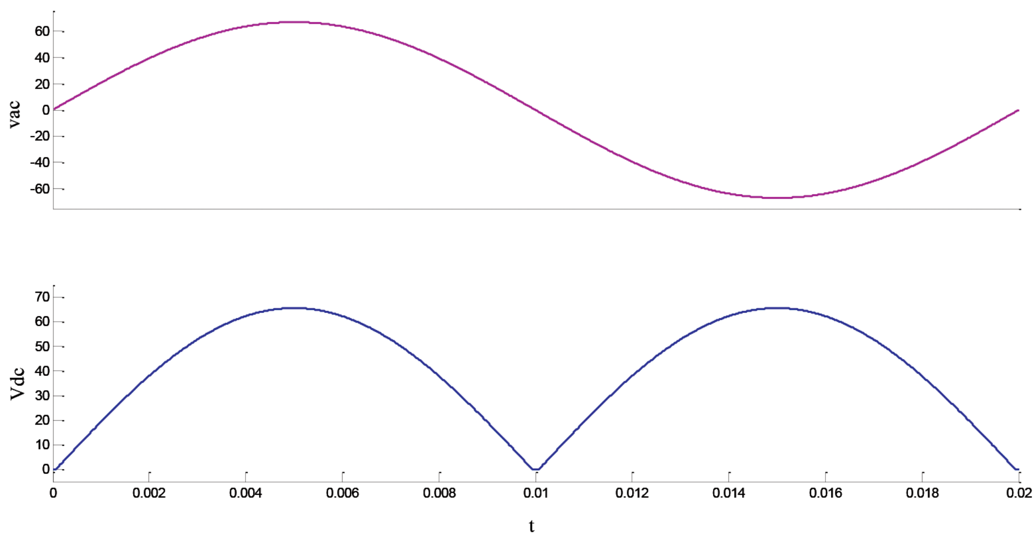

Figure 2. Simulation results of v_{ac} (upper trace) and V_{dc} (lower trace).

Phase 3 – Experimental Work

The rectifier circuit experiment was conducted to prove and validate the aforementioned two phases. Without real data or in this case, the waveform of average DC output voltage for a single-phase diode rectifier circuit, validation of the theory that was delivered and the computer simulation results could not be made. To run the experiment, the required equipment and components were: 1 unit of AC supply voltage; 4 units of power diode; 1 unit of resistor bank (100 Ω); 1 unit of oscilloscope and 2 units of differential probes. The computer simulation assignment was performed by a group of two. The group that completed and passed their computer simulation assignment was allowed to undertake the diode rectifier circuit experiment while groups that did not complete the experiment within the time allocated or whose results were flawed had to repeat the task. All the students managed to complete their computer simulation assignment on time. Each group was required to construct a single-phase diode rectifier in bridge configuration, similar to the schematic model design shown in Figure 1. The instruction manual was simple and objective. The flow chart of the single-phase diode rectifier circuit experiment is depicted in Figure 3. Since the students already understood what they had to do, the instructor was required to check the circuit connection before the students started their experiment. Two differential probes were used to measure the input AC voltage and the average DC output voltage of the rectifier circuit. As expected, the oscilloscope displayed the waveforms of both measured voltages shown in Figure 4 and Figure 5, respectively. These results were real evidence, and were expected to be identical to the computer simulation results. Hence, the experiment results verified the theory that had been taught about the rectifier circuit.

RESULTS AND DISCUSSION

As depicted in Figure 2, the simulated waveform was a sinusoidal AC source voltage v_{ac} with peak value 67 V, which can be translated into an effective value of 47.4 V$_{rms}$ $\left(=67/\sqrt{2}\right)$. Figure 2 also shows the average DC output voltage V_{dc} measured at 42.6 V. Here, the minimum value was 0, while the maximum value was V_m, which equals to 67 V. According to equation [2], the average value was a constant DC voltage. Moreover, the DC pulse frequency was 100 Hz because two pulses appeared within a full cycle of 50 Hz. Hence, the DC pulse frequency was obtained from a calculation of 50 Hz times two pulses per full cycle. To verify the calculated average DC voltage of 46.2 V in equation [2], the result as given in Figure 4 was used as reference. Based on the plots in Figure 4 and Figure 5, as expected, both waveforms of v_{ac} and V_{dc}, were similar to the simulated waveforms indicated in Figure 2. Table 2 indicates the values of v_{ac} and V_{dc} for each phase of the learning approach. For measured v_{ac} and V_{dc}, the respective values were 47.7 V$_{rms}$ and 43 V. Comparing the three values resulted in discrepancies, but they were neglected as the error values were very small and could be tolerated. This implies that the values obtained from the respective theoretical calculation, simulation result and measured experiment were considered identical. In consequence, the results obtained from the experimental investigation indicated a very close agreement with the theoretical results and the computer-based simulation results. In this case, it was already understood that the evidence could be obtained through experimental work. Without real evidence such as the measured v_{ac} and V_{dc} of the rectifier circuit, the theoretical aspect could not be validated, which could create uncertainty or cast doubt on the students' understanding of the rectifier circuit. In other words, validation via experimental work can strengthen and further enhance students' confidence and comprehension.

Table 2
Comparison Between Respective Theoretical, Simulation and Experiment Values

	Theoretical [V]	Simulation [V]	Experiment [V]
$V_{ac,\,rms}$	47.4	47.4	47.7
V_{dc}	42.7	42.7	43

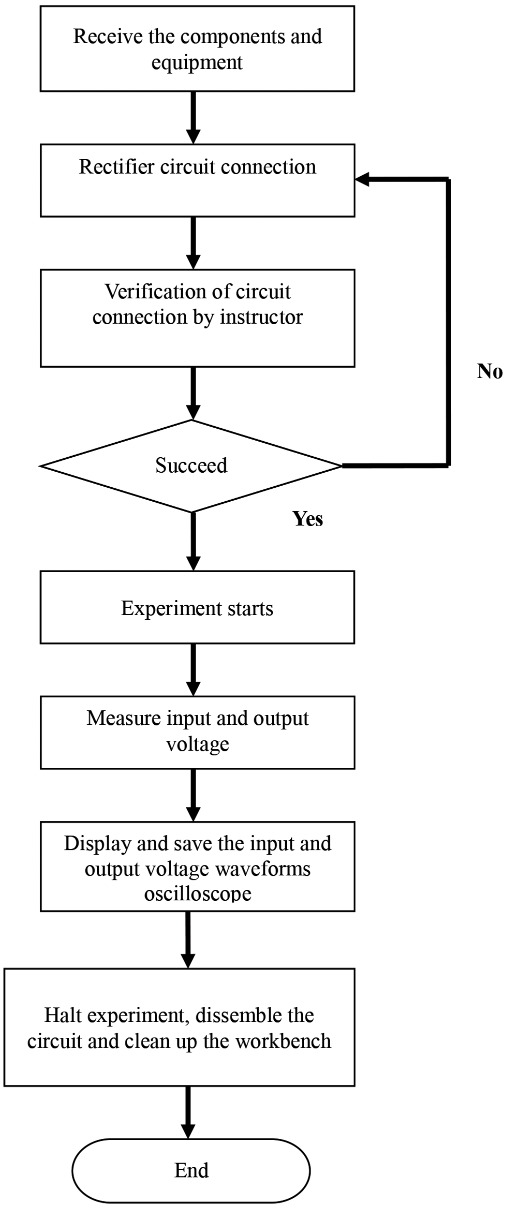

Figure 3. Flow chart of single-phase diode rectifier circuit experiment.

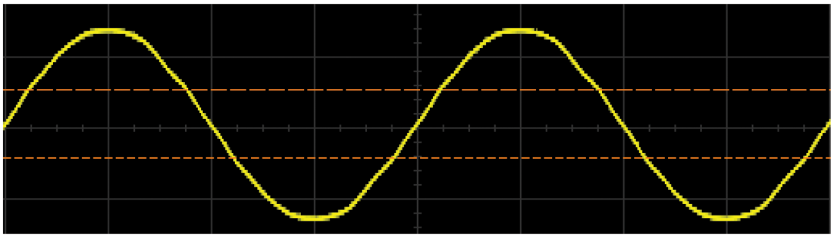

Figure 4. Measured AC source voltage, v_{ac} (scale: 50 V/div).

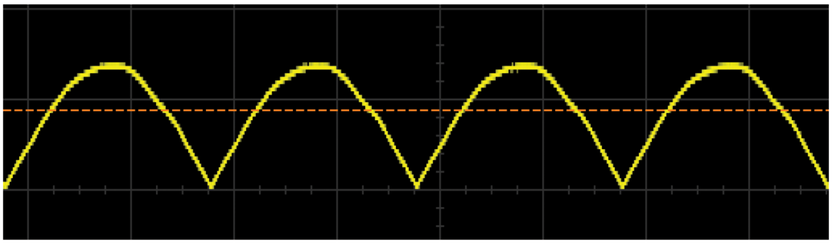

Figure 5. Measured average DC output voltage, V_o (scale: 50 V/div).

CONCLUSION

This paper discussed the implementation of evidence-based learning of a topic in the Power Electronics course in the Department of Electrical, Electronics & System, UKM. Each implemented learning phase was well received and students performed well in them according to the proposal. After the students completed the final phase of learning, they were satisfied with the level of knowledge and understanding they had acquired. Nevertheless, evidence-based learning cannot be successful only by doing experimental work alone; theory and computer-based simulation together contribute to bringing about this achievement. In terms of students' effort in learning, only the first phase indicated less effort than the lecturer's as the students only listened to the lecturer. On the other hand, the second and the third phases required huge effort from the students in order for them to accomplish the proposed learning objectives. With respect to real application, external disturbances could affect the performance of the rectifier circuit. Normally such effect is not taken into account for theoretical and computer-simulation-based learning. Furthermore, the proposed evidence-based learning approach did not contradict the previous approaches in many aspects; instead, it enhanced the students' understanding and improved their hands-on skills. On top of that, the students' confidence was observed to have increased as very few unnecessary questions were asked by them and the laboratory experiment was completed before the allocated time. As required by Power Electronics common practice, when any new circuit topology design is proposed, validation of the design is required to be done by experts in order to assess if it operates properly according to basic principles. The evidence-based learning implemented in the Power Electronics course at the Department of Electrical, Electronics & System, UKM was in line with common practice in the study of Power Electronics. This evidence-based learning should be introduced in the Power Electronics course in other universities as well.

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Linking Course Outcomes and Grade Achievement for Students Undertaking a Laboratory Course

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ABSTRACT

The Chemical Engineering Laboratory 2 (KKKR2412) course offered by Universiti Kebangsaan Malaysia's Department of Chemical and Process Engineering, Faculty of Engineering and Built Environment, to students of Chemical Engineering in their second year of study is aimed at training them to handle basic experiments in chemical engineering. In this course, students are taught how to conduct practical training, data collection, results analysis, conclusion making and subsequently, how to write technical reports. Clear assessment is also conducted throughout the course to measure students' understanding via concise and comprehensive report writing, either individually or in a group, oral presentation and peer assessment with an appropriate grade given at the end of the course. However, so far no studies have been conducted on evaluating the relationship between the course outcomes of the subject and the students' grade achievement in order to see the effectiveness of the outcomes and assessment outlined. Therefore, in this paper, the relationship between the learning outcomes of the Chemical Engineering Laboratory 2 course for Year Two students and their grade point obtained for two academic sessions (i) 2012/2013 and (ii) 2013/2014 were linked and investigated by means of a survey form that was distributed to students at the end of the laboratory course. This study shows that mastering the practical content of the course is the most important factor in determining student grades, followed by communication and group work that was carried out throughout the course.

Keywords: Grades, group work, laboratory, learning outcomes, practical work

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INTRODUCTION

KKKR2412, a laboratory course, is a compulsory course offered to students of Chemical Engineering in the Department of Chemical and Process Engineering during the second year of study. Through this course, practical training is given to the students on how to apply the lecture-based learning courses such as Organic and Physical Chemistry, Chemical Reactors, Fluid Mechanics and Heat and Mass Transfer, which they have learnt throughout their studies (FKAB, 2012). Practical exposure is needed to develop students' skills in applying the knowledge of mathematics, science and engineering, communication ability, engineering problem solving ability, leadership and managing group members (Yuhana & Kofli, 2012). Practical work undertaken is designed to train students in conducting experiments, analysing data, producing a technical report from the experimental results obtained, and finally, presenting the findings orally. Through this course, students are exposed to the work experiments in a chemical engineering laboratory, laboratory safety, experimental techniques and teamwork. Besides that, the most important element is report writing, which is emphasised because all the results obtained from the experimental work can only be understood and shared to all through good reports.

It is very important to measure the learning outcomes of this course in order to evaluate the performance of students at the end of the course. It is also important for educators to master learning outcomes in order to design and use various learning methods and effective teaching tools to better help students (Rahman & Kofli, 2013). According to Hamid (2004), learning outcomes are defined as the expectation on students' ability of knowing how to implement the executed programme after completing their course of study. This is the basis of Outcome-Based Education (OBE), which is now being applied in institutions of higher learning in Malaysia. Student achievement is typically measured by grade point and is used to directly measure student learning outcomes (Arshad et al., 2011) as well as it contributes to students' cumulative grade. It is debatable whether or not learning outcomes are the same as or different from grading; it depends on several factors (Unknown, 2015). Grading mostly covers aspects such as attendance, improvement, effort, participation etc., which are not considered in the learning outcomes of a course. However, some educators do consider these criteria in their grading and learning outcomes thus it is possible to identify the relationships between the two. The common ways to measure learning outcomes are via different assessment schemes (i) summative (examination), (ii) formative (on-going) and (iii) indirect (survey) (Walvoord, 2010). Since the course studied in this paper involved practical work, the formative and indirect assessments were judged to be the best way to measure its learning outcomes.

The aim of this research was to study the relationship between the achievement of learning outcomes in a course involving laboratory work and student grade results measured through formative assessment. The course selected was Chemical Engineering Laboratory 2, which is undertaken by Year Two Chemical Engineering Bachelor Degree students in Universiti Kebangsaan Malaysia. The cohorts studied were from the two consecutive academic sessions of 2012/2013 and 2013/2014. The learning outcomes and grading for this course were prepared and measured based on the same criteria (practical content, communication, group work).

METHODOLOGY

This study was conducted partly through a survey in the form of a 5-point Likert test distributed to two different batches of chemical engineering students at the end of the KKKR2412 course in order to measure the attainment of learning outcomes. The survey was given to 31 students from the academic session of 2012/2013 and 24 students from the session of 2013/2014. The survey was divided into four major sections, namely: (I) Student General Information, (II) Practical Content, (III) Communication and (IV) Group Work. Part II to IV from the survey were evaluated by the level of agreement with statements using a Likert scale of 1 to 5 from 'strongly disagree' to 'strongly agree' (Abdullah et al., 2011). Table 1- 3 present the given statements.

The final part of the study discussed the students' marks, grade and achievement from direct assessment. The distribution of marks is presented in Figure 1 and was assessed through a short report (individual), a long report (group) oral presentation and group work. The short and long reports, which accounted for 85% marks, were also indirectly measured in the learning outcome survey from Part II (Practical Content) while the oral presentation (10%) and group work (5 %) were measured indirectly from Part III (Communication) and IV (Group Work) of the survey, respectively. Oral presentation was assessed by a team of at least two lab coordinators (course lecturers) based on a specific presentation rubric formally used for the assessment. Meanwhile, group work was assessed through a peer assessment survey that was given to the students at the end of the semester for each student to assess group members' performance individually throughout the semester. The grade obtained at the end of the course was compared with the attainment of the learning outcomes as evaluated through the survey. Grades were given from A, A-, B+, B and so on in the marks range of 100-80%, 79-75%, 74-70%, 69- 65% and so on, respectively.

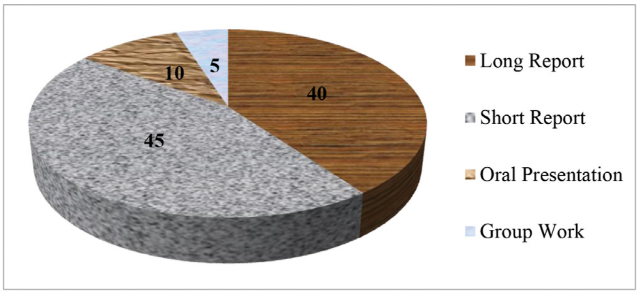

Figure 1. Distribution of the student's marks from direct assessment in percentage.

DISCUSSION

Part 1: Student General Information

Figure 2 (a) shows the percentage of students in Year Two enrolled in the Chemical Engineering programme who were involved in the survey. There were 31 and 24 respondents who responded to the survey for the respective academic session of 2012/2013 and 2013/2014.

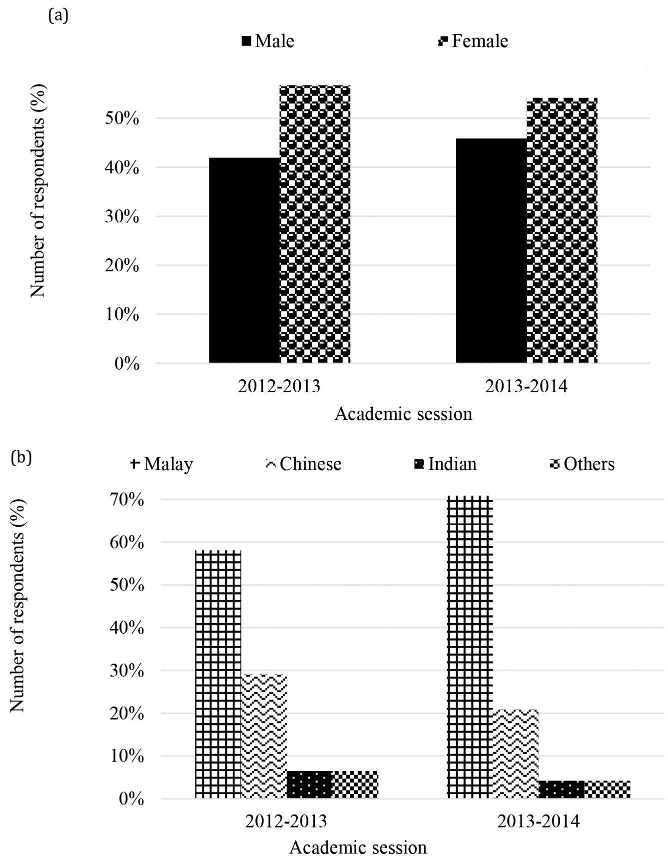

Figure 2. Distribution of respondents for the academic session of 2012/2013 and 2013/2014 by (a) gender (b) race.

A relatively uniform percentage of male and female respondents took part in the survey for both sessions. Figure 2 (b) shows the distribution of students who responded. Malay respondents totalled the highest percentage for both sessions (around 60 - 70%) followed by Chinese (about 30%). The number of Indian and respondents from other races was the lowest.

Part II: Practical Content

The practical content of the laboratory courses are outlined in Table 1. There are seven (7) statements on the course content that were answered by the respondents from the two academic sessions (2012/2013 and 2013/2014). The statements were on the laboratory courses, the topics given, the benefit of the lab work, knowledge application from the courses, necessary readings and references, data analysis and finally, the quizzes that could benefit lab planning/preparation. Figure 3 shows the respondent's agreement with the practical content in Table 1.

Table 1
Practical Content

Number	Content
S1	I understand the purpose of laboratory courses held.
S2	Practical topics are appropriate to the courses offered.
S3	I benefit from the implementation of practical work undertaken.
S4	I can use the knowledge base of courses in conducting experiments.
S5	I need to make appropriate references in understanding the practical topics that I do.
S6	I was able to obtain and analyse data.
S7	Quiz questions help me to make arrangements about who will do the practical.

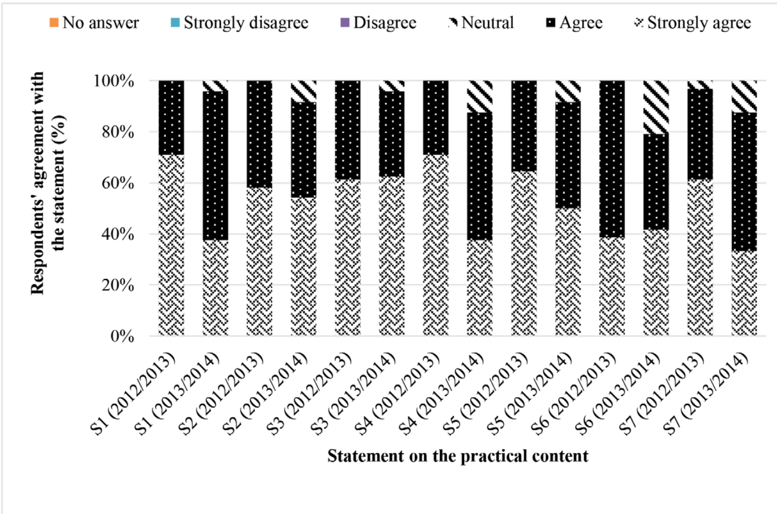

Figure 3. Respondents' agreement on practical content.

It was found that the percentage of respondents for the 2012/2013 session who 'strongly agreed' with all the statements, was higher compared to the group that 'agreed' only on almost all statements. Meanwhile, the percentage of respondents in the 2013/2014 session who 'strongly agreed' with all the statements, was found to have decreased between 5 and 35% compared to the 2012/2013 session. Around 5 to 20% of the respondents in the 2013/2014 session were 'neutral' on all statements especially statements number S6, S4 and S7 (refer to Table 1). The decline in the percentage of students in the 2013/2014 session who 'strongly agreed' with almost all the statements (S1-S7) compared to the respondents in the 2012/2013 session is an early indication that their understanding of the practical content was possibly not as good as that of the respondents from the previous session. Essentially, statements S4 to S6 represent different cognitive levels of Bloom's Taxonomy on the analysis and application of the courses learnt (Bloom, 1956). Thus it can be seen that the percentage of those who 'strongly agree' and also those who 'agree' fell compared to the other statements measured, and the results were more significant for the later academic session. These results are later linked with the grade achievement of the respondents (refer later section), considering that the practical content (Part II) contributed to the highest percentage for marks (up to 85%) and thus highly influenced the grade obtained.

Part III: Communication

There are two types of communication assessed through the course, which were vocal (via oral presentation) and written (via report writing). The communication content in the form of statements measured from the respondents is presented in Table 2, while the respondents' percentage of agreement with the statements are shown in Figure 4.

Table 2
Communication

No.	Content
S1	I was given the opportunity to make a presentation in the course.
S2	I loved the presentation.
S3	I prepared for the presentation.
S4	I can write a report using the appropriate procedure (UKM Style).

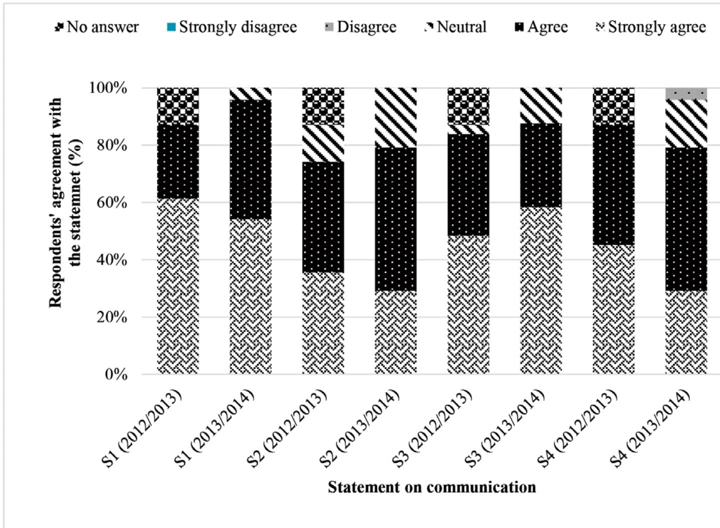

Figure 4. Respondents' agreement on communication during practical courses.

It was found that approximately 50-60% of the students were 'strongly agreed' on the communication opportunities given, either through oral presentation or written practical reports. Only about 30-40% of the respondents were 'strongly agreed' that they loved to do presentations (S2) and they could write a report using the UKM style (S4). The rest of the respondents were either 'agree' only with each of the statements or being 'neutral'. There are also some students who 'disagree' with statement S4 on writing using the UKM style. The disagreement could be possibly due to several factors such as that the respondents had less exposure and/or awareness about the importance of writing using the UKM style. Students are supposed to be aware from the beginning of their programme that writing reports in the UKM style is important because they will be using the same writing style especially for integrated projects, design projects and final-year projects later on, until they completed their degree programme. Therefore it is beneficial for students to get used to the style for writing technical reports as it would make things easier for them as the programme unfolded. One way to effectively implement this is either to guide students through a workshop on writing in the UKM style or to supply the students with a book on Guidelines for Thesis Writing using the UKM Style (*Pusat Pengurusan Siswazah*, 2010), which is available at the university bookstore. Effective communication skills (oral and written) are essential for students as for all aspects of their life ranging from the professional to the social. According to a survey by the National Association of Colleges and Employers (NACE) (2015), communication skills are ranked the first among a job candidate's 'must-have' skills and qualities. Therefore, these skills must be developed and polished during their years of study if they are to be properly prepared for life after graduation.

Part IV: Group Work

The learning outcome for group work was measured either in active or passive statements, as shown in Table 3. S1, S4 and S5 were the active statements while statements S2 and S3 were presented in the passive. Referring to Table 3 and Figure 5 shows that more than 90% of the respondents 'agreed' and 'strongly agreed' with the active statements for S1 (share ideas), S4 (help members of the group) and S5 (do the practical work and reports together) connected with the laboratory courses. For passive statements, S2 (silent during the internship) and S3 (members of the group did not do any work), there were variations in the answers given by the respondents, from 'strongly disagree' to 'strongly agree'. On average, about 20-40% of the respondents 'agreed' and 'strongly agreed' with the statement S2 and S3 while the remaining (60-80%) 'disagreed' with these statements or did not give any answer. The respondents' agreement with statements S2 and S3 shows that there were many respondents who were reluctant to work in a group, and this may have caused problems for group members as they would have had to put in extra effort. This lack of teamwork is, of course, very unhealthy. Group work means students should work in a team, be cooperative, share and transfer knowledge and most importantly, be able to minimise error in laboratory results through discussion and shared planning and problem solving throughout the process (Kroft, 2014), without which, efficient team work will not be achieved. Thus, students should always be given the opportunity to work in a team as this too helps them develop and hone essential social skills for life in the real world.

Table 3
Group Work

No	Content
S1	I always came up with ideas during the experiment.
S2	I kept silent during practice runs.
S3	Some of the members in my group did not do any work.
S4	I was always willing to assist other members during practice.
S5	I did a lot of practical work and report writing.

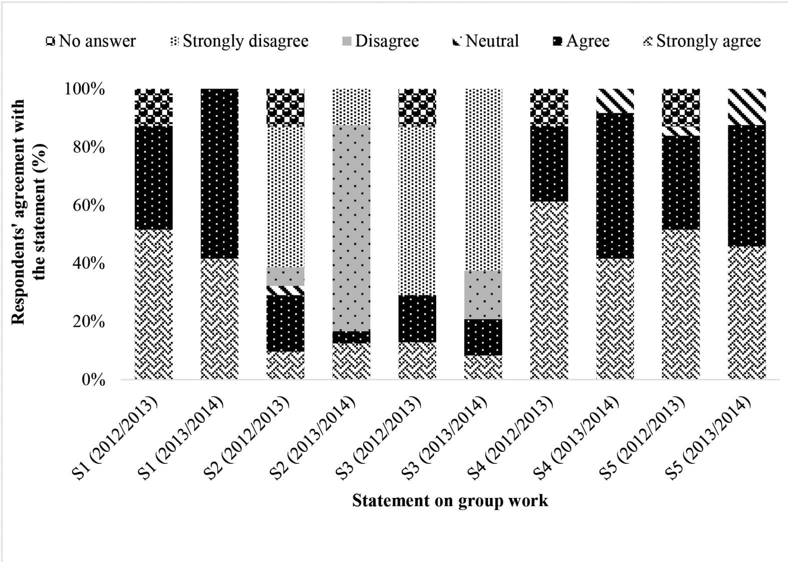

Figure 5. Respondents' agreement on group work.

Part V: Grade Achievement

In terms of student results, the percentage of students in session 2012/2013 who obtained a Grade A were more than double those who did so in session 2013/2014 (refer to Table 4). All the students in the 2012/2013 session received only Grades 'A' and 'A-', while students in the 2013/2014 session obtained a wider distribution of grades from 'A' to 'B' compared to the former session. The decrease in percentage of students receiving grades 'A' and 'A-' for session 2013/2014 was in line with the results of the survey on learning outcomes especially with regards to practical content (Part II). Survey results of the learning outcome for the KKKR 2412 laboratory course for students in session 2013/2014 taken from the percentage of their agreement to the given statement were lower than in the 2012/2013 session. This decreasing percentage from session 2012/2013 to 2013/2014 was significant especially for statements S1, S4, S5 and S7 (from Table 1) where almost half of the respondents 'strongly agreed' with them but the rest either 'agreed' or were 'neutral'.

The correlation of the respondents who 'strongly agreed' regarding the practical content (Part II) with their grades of 'A' and 'A-' in session 2012/2013 and 2013/2014 are presented in Figure 6. The figure shows that the decrease in the percentage of students who received Grade 'A' decreased from 78 to 33% and the percentage of those who received Grade 'A-' increased from 22 to 42% for session 2012/2013 and 2013/2014, respectively. The decrease in Grade 'A' correlated with the respondents' strong agreement with the statements in Part II, which dropped from 61 to 48% for session 2012/2013 to 2013/2014, respectively. In simple words, the decrease in the total of respondents who 'strongly agrees' with the statement resulted in a decrease in the number of respondents obtaining Grade 'A' and vice versa. This result suggests that the students' level of agreement with statements may indirectly indicate their performance in their grades especially for those who obtained Grade 'A'.

Table 4
Overall Student Achievement Grade

Session 2012/2013		Session 2013/2014	
Grade	Percentage of students (%)	Grade	Percentage of students (%)
A	78	A	33
A-	22	A-	42
B+	0	B+	17
B	0	B	8

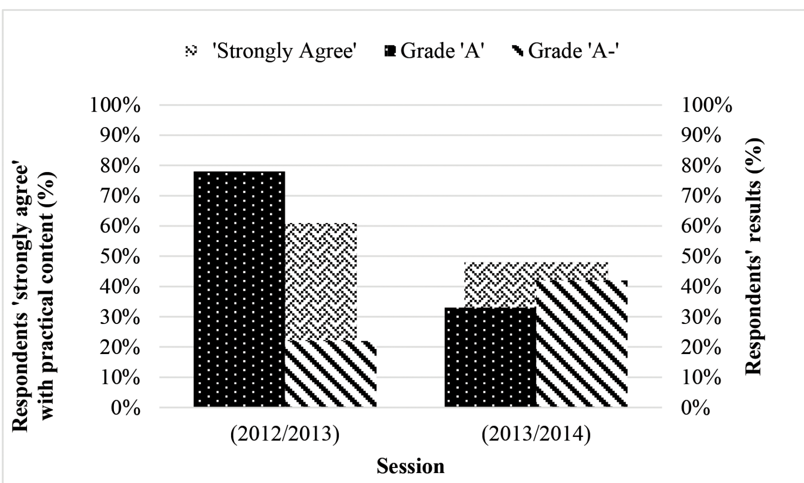

Figure 6. Correlation of respondents who 'strongly agree' on practical content with their grades in session 2012/2013 and 2013/2014.

CONCLUSION

The most important factor in determining student achievement grade for the laboratory course is the mastering of practical content as, in this study, this contributed to 85% of the total marks (Grade 'A' from 80%). The higher the respondents' agreement with statements outlined in the practical content (Part II), the better their results obtained i.e. students from session 2012/2013 who achieved better grades (A and A- only) had a higher agreement percentage (almost double) than those in the later session. Apart from that, other criteria such as communication and teamwork were also continuously assessed to determine the students' achievement in these areas due to the importance of both skills in a laboratory course. Therefore, it was necessary for students to understand the practical content of the course during the laboratory course in order for them to achieve good grades. This can be possibly improved in the near future through effective lectures, practical briefings, meetings/discussions with students and others.

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

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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.

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

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INTRODUCTION

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

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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 JKKP. 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 encompasssed 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.

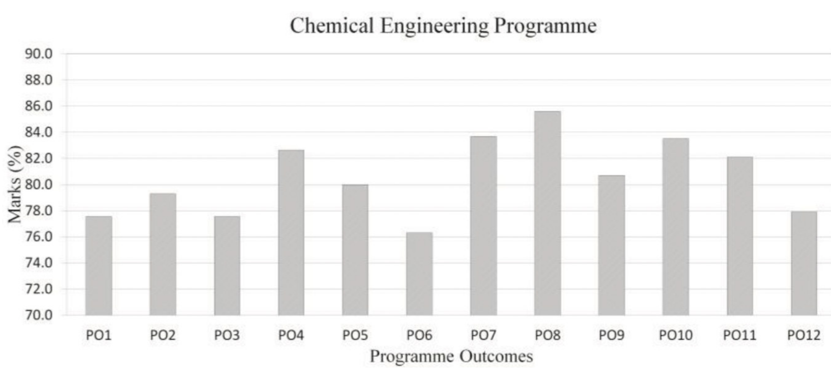

Figure 1. Percentage of respondents who noted achievement in the attainment of programme outcomes (PO) for Chemical Engineering.

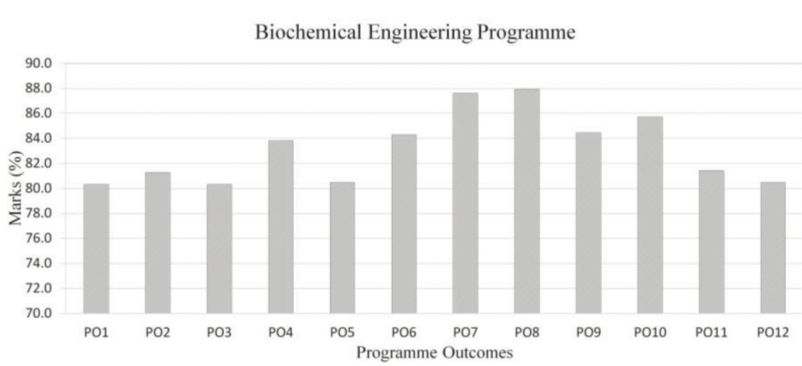

Figure 2. Percentage of respondents who noted achievement in the attainment of programme outcomes (PO) for Biochemical Engineering.

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.

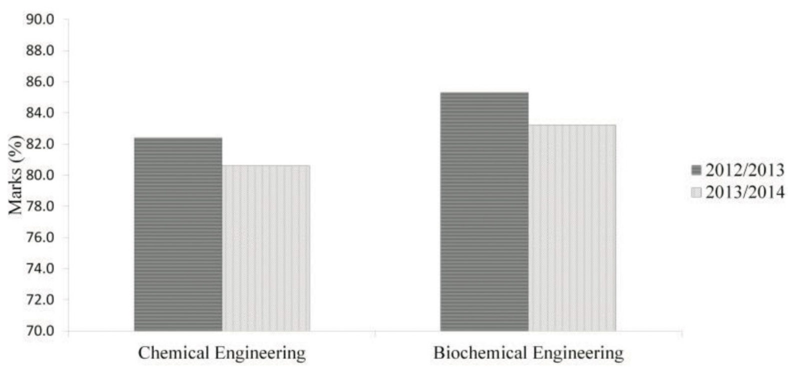

Figure 3. Comparison between the achievement of POs in the comprehensive Chemical Engineering and Biochemical Engineering programmes for 2012/2013 and 2013/2014.

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.

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ePortfolio as an Assessment Tool: The Development of Rubric Criteria

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ABSTRACT

The ePortfolio is a paradigm in constructivist e-learning. Apart from being an assessment tool, the ePortfolio is a platform to highlight the student's competency to the employer or to anybody who has an interest in the student's skills and ability. This virtual assessment tool can save employers time when it comes to shortlisting potential candidates before the face-to-face interview session. This paper discusses the ePortfolio as an assessment tool in higher education to assess students' competency. The methods used were intensive literature review and website survey on universities that have implemented the use of the ePortfolio in their learning programmes. Six American universities were chosen. The information gathered from this survey was then compared with information from the American universities. This research suggests a new basic assessment framework based on the comparison analysis. The framework listed nine abilities that must be acquired by students as the determinant factors in assessing student achievement. The abilities were artefacts, reflection/critique, use of multimedia/technology, organisation/navigation, layout and readability/contents, quality of writing and proofreading (originality/grammar/vocabulary/citation), written and oral communication, portfolio/documentation compilation and mechanic/quantitative method. To produce a complete, systematic and detail assessment framework, further research needs to be conducted.

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INTRODUCTION

ePortfolio has been used worldwide as an assessment tool in higher education. The increase in the use of the ePortfolio, supported by the rapid development of Information and Communication Technology (ICT), allows peoples to access information and communicate online. Nowadays, almost all people including old citizens have their own social networking site, for example, Facebook. In addition, many have created their own websites or pages to share their work and promote and sell their products online. Now, ICT has been integrated in education through the implementation of the ePortfolio as an assessment tool in universities. This paper seeks to review the implementation of the ePortfolio as an assessment tool and the importance of the ePortfolio in improving student knowledge and achievement. The literature review in this paper focusses on the theories and previous research on the implementation of the ePortfolio in universities around the world. The website survey of specific universities aimed at determining the assessment method of the ePortfolio. According to Shada et al. (2011), a portfolio contains a selection of a student's work compiled over a period of time and is used for assessing performance or progress. Most traditional portfolios are presented in hard copy as documents. The ePortfolio is a digitised collection of artefacts, including demonstration, resources and accomplishments that represent an individual, group, community, organisation or institution (Lorenzo & Ittelson, 2005). Furthermore, Ramirez (2011) described the ePortfolio as an eclectic, ultra-accessible theatrical area that enables students to create, rehearse and present themselves. In addition, Jarrot and Gambrel (2011) stated that the ePortfolio is a platform to demonstrate students' achievement. Thus, this research concludes that the ePortfolio is a platform which students may create, rehearse and present to demonstrate their achievement through a digital collection of their works. The collection can be uploaded on a website or other electronic medium that comprises text-based, graphic or multimedia elements (Lorenzo & Ittelson, 2005). The aims of this research were to determine the features of the ePortfolio as a virtual marketing tool and to analyse the criteria of the ePortfolio assessment method that is implemented in universities.

METHODOLOGY

The research methodology of this study involved two techniques, namely, the intensive literature review and a websites survey. An intensive literature review aimed to understand the concept of the ePortfolio and to collect all the theories related to the ePortfolio from previous research. The main sources for the literature review were from published journals, especially the International Journal of ePortfolio.

This survey was conducted on various universities' websites and focussed on universities in the United States of America (USA). However, there were limitations as many universities do not reveal information about assessment method on their websites. Only a few universities provided sufficient information on their assessment methods. Six universities were chosen to demonstrate the criteria of the ePortfolio assessment method. The universities were Clemson University, University of Wisconsin-Stout, Boston University-College of General Studies, Loyola University Chicago, San Francisco State University and Draka University. The data from the websites survey were analysed and compared. Then, the rubrics and scoring scale obtained from the survey were integrated to determine and develop the assessment method. A new assessment scale for student achievement was then suggested based on this survey.

DISCUSSION

The ePortfolio as a Virtual Assessment Tool

The ePortfolio needs to be assessed in order to support student learning (Jarrot & Gambrel, 2011). Thus, it is important to know the criteria of assessments to evaluate student ePortfolios. This assessment will encourage students to produce a good ePortfolio that will benefit them in their future working life. The information gathered from each university is explained below.

Clemson University. The information obtained from the survey of the Clemson University website (http://www.clemson.edu/) was related to the scoring system. A review of the ePortfolio scoring system adopted by Clemson University found that there were five scoring scales between 0 and 4 that indicate the levels of acceptance of the artefacts as evidence of student achievement. Table 1 shows the scoring scales and the rubric.

Table 1
ePortfolio Assessment Rubric of Clemson University

Criteria (Score)	0	1	2	3	4
Level of acceptance of the artefacts	Inappropriate artefact; must be replaced	The artefact doesn't meet the competency, but with some revision it may	The artefact is a good demonstration of the competency	The artefact is a very good demonstration of the competency	The artefact is an excellent demonstration of the competency.
TOTAL RATING					

In Table 1, the artefacts that scored '2' and above are considered acceptable while the artefacts that obtained a score of '0' and '1' must be replaced and revised, respectively. These scoring scales can be the benchmark for student achievement and competencies. However, detailed information on the assessment implemented in Clemson University is limited.

University of Wisconsin-Stout. The survey of the University of Wisconsin-Stout website (www.uwstout.edu) found the assessment rubric for students' ePortfolio. The rubric is based on seven assessment criteria with a certain weightage. The assessment criteria are Selection of Artefacts, Reflection/Critique, Use of Multimedia, Citations, Navigation, Layout and Readability and Quality of Writing and Proofreading. Table 2 shows the simplified ePortfolio assessment rubric adopted by the University of Wisconsin.

Table 2
ePortfolio Assessment Rubric of the University of Wisconsin

Criteria (Weightage)	Unsatisfactory – 0%	Limited – 80%	Proficient – 90%	Exemplary – 100%	Rating
Selection of Artefacts (40%)					
Reflection/Critique (30%)					
Use of Multimedia (10%)					
Citation (5%)					
Navigation (5%)					
Layout and Readability (5%)					
Quality of Writing and Proofreading (5%)					
TOTAL RATING					

This rubric provides weightage according to the importance of the criteria. For example, the most important criterion, 'Selection of Artefacts' is given the highest weightage (40%). Every criterion has its own rating for assessing students' competency level. The rating value for each criterion must be added to get the total rating for students' achievement. For every criterion, there are four levels of achievement such as unsatisfactory, limited, proficient and exemplary. However, there was limited information about how to assess student's achievement according to these levels.

Boston University (College of General Studies). The third survey was conducted on College of General Studies, Boston University. The information gathered from this survey completed the two previous surveys. The rubric had set seven abilities that were to be assessed. The following is a list of abilities set by the College of General Studies, Boston University:

i. Written and oral communication
ii. Gathering, analysing and documenting information
iii. Awareness of specific historical, literary and cultural contexts

iv. Rhetorical and aesthetic conventions
v. Critical thinking and perspective-taking
vi. Integrative and applied learning
vii. Quantitative methods

All these abilities are very important for producing quality students able to compete in the workplace. Therefore, these abilities should be evaluated in assessing students' competency and achievement.

Loyola University Chicago. The fourth survey conducted on Loyola University Chicago (www.luc.edu) found the assessment rubric for students' ePortfolio. This rubric is used to ensure that outcomes for engaged learning are being met through the development of work compiled in the student's ePortfolio. The rubric is based on three criteria, namely, synthesis through reflection, relate experience to development and connect engaged learning to Loyola University Chicago's mission. Table 3 shows the simplified ePortfolio assessment rubric adopted by Loyola University Chicago.

Table 3
ePortfolio Assessment Rubric of Loyola University Chicago

Criteria (Weightage)	Unsatisfactory – 0%	Limited – 80%	Proficient – 90%	Exemplary – 100%	Rating
Selection of Artefacts (40%)					
Reflection/Critique (30%)					
Use of Multimedia (10%)					
Citation (5%)					
Navigation (5%)					
Layout and Readability (5%)					
Quality of Writing and Proofreading (5%)					
TOTAL RATING					

This rubric provides the three important criteria for evaluating students' ePortfolio. Every criterion has its own rating for assessing students' competency level. The rating value for each criterion must be added to get the total rating for students' achievement. For every criterion, there are three levels of achievement such as 'does not meet/partially meets expectation', 'meets expectations' and 'exceeds expectations'. However, there is still limited information about how to assess student's achievement according to these levels.

San Francisco State University. The fifth survey, conducted on San Francisco State University (www.sfsu.edu), also found the assessment rubric for students' ePortfolio.

The rubric developed by this university is for assessing the use of the ePortfolio for assessing programme outcomes. There are two versions of the rubric used to evaluate students' ePortfolio in this university. The first version has five criteria, namely, portfolio requirement, creative use of technology, artefacts, organisation and writing and reflection. For every criterion, there are four levels of achievement: poor, fair, good and exceptional. Table 4 shows the first version of the ePortfolio assessment rubric adopted by San Francisco State University.

Table 4
ePortfolio Assessment Rubric of San Francisco State University (First Version)

Criteria	Poor	Fair	Good	Exceptional
Portfolio requirement				
Creative use of technology				
Artefacts				
Organisation and Writing				
Reflection				

The second version of the ePortfolio rubric assessment highlighted five criteria with points to evaluate students' ePortfolio. The criteria are in terms of technology use, personal reflection, portfolio construction and management, student product content choice and organisation or mechanics. Each criterion has four levels of achievement: beginning, acceptable, effective and exceptional. Table 5 shows the second version of the ePortfolio assessment rubric adopted by San Francisco State University.

Table 5
ePortfolio Assessment Rubric of San Francisco State University (Second Version)

Criteria	Beginning	Acceptable	Effective	Exceptional
Technology use (20 points)				
Personal reflection (20 points)				
Portfolio construction and management				
Student product content choice (20 points)				
Organisation or mechanics (20 points)				

The second version of the rubric provides the same weightage of points, that is, 20 points for each criterion. This means that all the criteria are equally important in assessing students' ePortfolio. However, there is still limited information in both versions of the rubric on how to assess students' achievement according to the stated levels.

Draka University. The sixth survey was conducted on Draka University. The information gathered from this survey completed the previous surveys. The rubric has five abilities for assessment. The abilities are content and vocabulary, grammatical accuracy, organisation, originality and mechanics. Table 6 shows the simplified ePortfolio assessment rubric adopted by Draka University.

Table 6
ePortfolio Assessment Rubric of Draka University

Criteria/Grade	A	B	C	D	Comment
Content and vocabulary (45 marks)					
Grammatical accuracy (20 marks)					
Organisation (15 marks)					
Originality (15 marks)					
Mechanics (5 marks)					
Total Marks					

This rubric provides weightage according to the importance of the criteria. For example, the most important criterion, 'content and vocabulary', is given the highest weightage (45 marks). Every criterion has its own rating by assessing students' competency level. The rating value for each criterion must be added to get the total rating of students' achievement. For every criterion, there are four levels of achievement such as Grade A, Grade B, Grade C and Grade D. However, there is still limited information on how to assess students' achievement according to these levels.

Integration of the Rubrics and Scoring Scales (Proposed Framework)

Based on the rubrics and scoring scales used by the six universities, this paper analyses the important criteria (based on comparison analysis) that need to be included in ePortfolio rubric criteria and the method of rubric assessment (refer to Table 7).

Table 7
Comparison Analysis of the Important Criteria in ePortfolio Rubric Assessment

No.	Selection of Criteria	Clemson University	University of Wisconsin-Stout	Boston University	Loyola University Chicago	San Francisco State University (1st ver.)	San Francisco State University (2nd ver.)	Draka University	TOTAL
1	Artefacts	/	/			/	/		4
2	Reflection/Critique		/		/	/	/		4
3	Use of Multimedia/Technology		/			/	/		3
4	Organisation/Navigation		/			/	/	/	4
5	Layout and readability (Content)		/				/	/	3
6	Quality of writing and proofreading (originality/grammar/vocabulary/citation)		/					/	2
7	Written and oral communication			/		/			2
8	Portfolio/Documentation compilation			/		/	/		3
9	Awareness of historical/literacy/cultural context			/					1
10	Rhetorical and aesthetic			/					1
11	Critical thinking			/					1
12	Integration and application			/					1
13	Mechanic/Quantitative method			/			/	/	3
14	Experience				/				1

The comparison analysis seen in Table 7 shows that there are nine important criteria that need to be included in ePortfolio assessment, namely:

a) Selection of artefacts
b) Reflection/Critique
c) Use of multimedia/technology
d) Organisation/Navigation
e) Layout and readability/Content
f) Quality of writing and proofreading (originality/grammar/vocabulary/citation)
g) Written and oral communication
h) Portfolio/documentation compilation
i) Mechanic/Quantitative method

The other criteria such as awareness of historical/literacy/cultural context, rhetorical and aesthetic, critical thinking, integration and application and experience are not important in ePortfolio assessment. Based on the analysis, these items only appear once. It can be concluded that the frequency of importance is low. There were four methods of rubric assessment that were identified from the surveys of the six universities. This is shown in Table 8.

Table 8
Integration of Rubric Assessment from the Six American Universities

<table>
<tr><td>No.</td><td>Method of Rubric Assessment</td><td colspan="10">Rubric Value/Descriptions</td></tr>
<tr><td>1</td><td>Percentage (%)</td><td>0 - 9</td><td>10 - 19</td><td>20 - 29</td><td>30 - 39</td><td>40 - 49</td><td>50 - 59</td><td>60 - 69</td><td>70 - 79</td><td>80 - 89</td><td>90 - 100</td></tr>
<tr><td>2</td><td>Scoring Scale</td><td>0</td><td colspan="2">1</td><td colspan="3">2</td><td colspan="2">3</td><td colspan="2">4</td></tr>
<tr><td>3</td><td>Grade</td><td colspan="5">D</td><td colspan="2">C</td><td>B</td><td colspan="2">A</td></tr>
<tr><td rowspan="4">4</td><td rowspan="4">Achievement</td><td colspan="4">Beginning</td><td colspan="3">Acceptable</td><td colspan="2">Effective</td><td>Exceptional</td></tr>
<tr><td colspan="4">Poor</td><td colspan="3">Fair</td><td colspan="2">Good</td><td>Exceptional</td></tr>
<tr><td colspan="4">Does Not Meet Expectation</td><td colspan="3">Meets Expectation</td><td colspan="3">Exceeds Expectations</td></tr>
<tr><td colspan="4">Does Not Meet Competency</td><td colspan="3">Good</td><td colspan="2">Excellent Demonstration</td><td>Very Good Demonstration</td></tr>
</table>

This research concluded that the integration of both rubrics and scoring scale is able to assess students' competency holistically. The rubric from University of Wisconsin, San Francisco University (version 2) and Draka University are very useful for determining students' competency as it has weightage to determine the most important criterion in the ePortfolio. At the same time, the nine abilities that were identified above should be determined, especially 'Selection of Artefacts', 'Reflection/Critique' and 'Organisation/Navigation'. The scoring scale would then classify students' achievement based on the rating obtained using the rubric (see Table 9).

Table 9
Scoring Scale Based on Rubric Rating (Suggestion)

	Total Rating (%) – From Rubric				
	0-50	51-70	71-80	81-90	91-100
Scoring Scale	0	1	2	3	4
Achievement	No mastery	Developing	Competent	Proficient	Excellent

Based on Table 9, an artefact is considered acceptable only when it obtains at least 71% of the rating (Scale=2). This meets the requirement set by Clemson University. This score indicates that students must really master what they have learnt and how to use what they have learnt. This compels students to improve their soft skills to obtain a particular rubric rating. This encourages student involvement in activities and enables them to improve in both academic and co-curricular activities. However, this is only a suggestion needs further research before it can be verified.

CONCLUSION

The implementation of the ePortfolio is very useful for improving the process of learning at the higher educational level. It is supported by the educational goal of producing 'balanced' students. The ePortfolio not only facilitates assessment of students holistically, it also encourages students to learn new skills that are not available in the classroom, especially those related to using Web 2.0 tools. These are skills that are usually acquired only through experience, that is, from engaging in activities that require the skills. To create a good ePortfolio and get a good grade, students must acquire all these skills. Therefore, the implementation of ePortfolio will produce proactive students that participate in various activities in their learning processes. From a survey of several websites, we found that the assessment of students' ePortfolio is a holistic approach for evaluating students' knowledge and skills. Thus, a systematic assessment method/framework must be developed. Findings from this survey revealed seven abilities that should be assessed and the assessment rubric and scoring scale for determining students' achievement. The integration of the assessment rubric and scoring scale with the abilities to derive the determinant factors for assessment of student achievement is our suggestion of a new assessment system.

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The Effectiveness of Health and Safety Topics in an Engineering Course Syllabus

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ABSTRACT

Adherence to Health and Safety (H&S) is one of the required programme outcomes (PO) in all engineering programmes offered at the Faculty of Engineering and Built Environment (FKAB), Universiti Kebangsaan Malaysia (UKM). The Course Outcome (CO) is measured in the mandatory course, Engineering Ethics and Technological Advancement. A two-stage survey of students' understanding of H&S matters was carried out at FKAB. Students' responses in the first and second stages suggest that they feel they possess satisfactory understanding of H&S; however, this is not so. While this survey analysis concurs with previous studies on universities and gaps in industry expectation, these finding have to be addressed appropriately before students can enter the job market and practise H&S in the workplace as trained to do in university. The study also shows that an improved teaching method significantly increases students' understanding of H&S issues. A new syllabus for a course that addresses H&S issues has been implemented, together with the faculty-wide programme revision activity.

Keywords: Health and Safety (H&S), Personal Protective Equipment (PPE), ethics

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INTRODUCTION

Accidents due to health and safety (H&S) issues occur all year long, especially in developing countries, where massive projects are completed in fast-tracked modes and at low cost. As a developing country, Malaysia has its share of H&S issues. One shocking example of such issues is the tragic accident that resulted in the deaths of three foreign general workers at the Mass Railway Transit (MRT) construction site in Kota Damansara, Kuala Lumpur in 2014. Accidents due to H&S issues also occur in developed countries, for example, Singapore. An operator of an excavator died when the machinery toppled to the first floor of a building at a construction site near Thomson Road, Singapore, in June 2013 (The Straits Times, 2013). In addition, the Health and Safety Executive (HSE), a non-departmental public body in the UK sponsored by the Department for Work and Pensions published 133 worker deaths over the working year of 2013/14; which is equivalent to 0.44 deaths per 100,000 workers (Health and Safety Executive, 2014). In general, H&S issues are major problems and they can occur in any country. All parties involving construction workers, their employers and the public are responsible for H&S incidents; it is the culture around it that can lead to H&S accidents (Hale et al., 2010). Health and Safety Organisations (HSO) or Committees (HSC) are pivotal in ensuring safety efforts and should therefore be the natural starting place for a change to safety-first culture. Results of studies indicate a marked improvement in HSO performance, interaction patterns concerning safety, safety culture indicators and a change in the trend of injury rates (Nielsen, 2014); however, the theoretical framework for safety culture is generally underdeveloped and the link to research on organisational culture has been weak or even non-existing (Choudhry et al., 2007).

Health and safety issues do not only cause injuries and fatalities, they can also incur big losses and impact. The fatal accident at the MRT site in Malaysia referred to earlier caused the issuance of a stop-work order. The Chief Executive Officer of MRT Corp, the contractor for the MRT line, voluntarily offered to resign (Lee and Hamudin, 2014). An initial investigation by the Department of Occupational Safety and Health (DOSH), a department under the Ministry of Human Resources overseeing H&S issues, revealed that there were no engineers at the site during the installation of the parapet wall of the Sungai Buloh-Kajang (SBK) line of the Mass Rapid Transit (MRT); this breach in standard operating procedure (SOP) led to non-compliant acts that resulted eventually in a 650-tonne span becoming dislodged and falling to the ground.

(a)

(b)

Figure 1(a) & (b). MRT accident site, Kota Damansara (Lee and Hamudin, 2014).

The longer term and much bigger impact of such an incident is the public's loss of confidence in MRT construction projects and the costly delay of multi-billion *ringgit* investments. A one-day site delay means a day's delay in overall completion. The scale of an MRT project is enormous, so such a delay causes not only a big loss to the company, sub-contractors and suppliers, but also to the country and the public. Figure 1(a) shows government officials cordoning off the site and Figure 1(b) provides an aerial view of the area in which the accident took place. Harun et al. (2013a) showed that when accidents occurred due to non-compliance of H&S regulations, not only did they cause the loss of lives and damage to property, they also diverted government focus from nation building.

There are many local construction companies bidding for works internationally in emerging economies such as Brazil, India, Turkey and Bangladesh (Chuing & Abdul-Rahman, 2011). These companies might carry negative traits even though they might not be involved in the construction of any MRT lines. The negative perception might cost them the chance of winning an international job. Malaysis might not achieve its vision of becoming a developed country by 2020 if similar issues keep occurring; the government will lose its focus on development as its attention is diverted towards unnecessary issues, as mentioned by Harun et al. (2013a). On the other hand, if companies manage to keep an excellent track record, such as highway concessionaire UEM, which completed the 116.8km Cikopo-Palimanan infrastructure in Indonesia, confidence in local companies builds up. For this reason, this paper sought to understand the effectiveness of H&S topics provided in a mandatory course offered in UKM, Engineering Ethics and Technological Advancement (course code KKKF3283), which is compulsory for all third-year undergraduate engineering students.

METHODOLOGY

A two-stage survey was conducted among students who were enrolled in the Engineering Ethics and Technological Advancement. The first stage was conducted before the respondents were taught H&S topics and the second stage after they had been exposed to the H&S elements in the lecture. Since the size of the student enrolment was large, an Internet-based questionnaire was distributed electronically as this was believed to be better able to cater for the large volume of questions and answers. The questionnaires were divided into four categories. In the first category, students were asked basic questions i.e. about their background. This was also to familiarise the students with the electronic system.

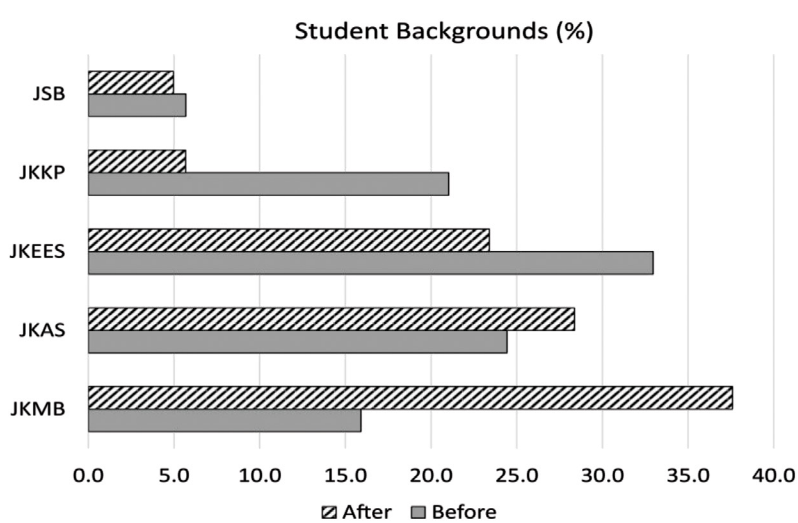

Figure 2. Percentage of student background by department showing figures before and after H&S topics were taught.

Figure 2 shows students from all four engineering departments as well as from the Department of Architecture (*Jabatan Seni Bina*, JSB) who participated in the survey. The patterned horizontal columns indicate the percentage (%) of student participation after H&S topics were taught according to department. The grey columns indicate student participation before the lectures. The Department of Electrical, Electronics and Computer System (*Jabatan Kejuruteraan Elektrik dan Elektronik*, JKEES) made up the most number of students i.e. 33.0% before the H&S lectures. This was followed by the Department of Civil and Structural Engineering (*Jabatan Kejuruteraan Awam dan Sivil*, JKAS) (24.4%), the Department of Chemical and Process Engineering (*Jabatan Kejuruteraan Kimia dan Proses*, JKKP) (21.0%), the Department of Mechanical and Materials Engineering (*Jabatan Kejuruteraan Mekanik dan Bahan*, JKMB) (15.9%) and the Department of Architecture (5.7%). Quite a large percentage of students participated in the first-stage survey i.e. 176 students out of totally 231 students, equivalent to 76.2%. About 61% of the students participated in the second-stage survey. The details of student involvement are shown in Table 1.

Table 1
Student Participation

	Before H&S Lectures	After H&S Lectures
Total number of students in KF3283 (persons)	231	231
Student participation in the survey (persons)	176	141
Percentage of participation (%)	76.2	61.0

There was a variety of student activities that were related to H&S issues. These activities were categorised into the following: (i) Perodua Eco-Challenge or PEC; (ii) Shell Eco-Marathon (SEM); (iii) Proton Green Mobility Challenge (PGMC); (iv) ChemECAR; and (v) concrete-mixing & site visit and several other activities. This information is summarised in Figure 3. Wearing Personal Protective Equipment (PPE) was required most of the time for all the activities. On the other hand, activities categorised under 'Others' did not necessarily require participants to wear any PPE. For example, in robotic and recycling programmes, the participants were not required to wear any PPE.

In Figure 3, for the first-stage survey, students who chose 'no involvement' made up 31.3% of respondents while students who participated in the Perodua Eco-Challenge or PEC made up 5.7% of the survey population; those who took part in the Shell Eco-Marathon (SEM), 11.4%; Proton Green Mobility Challenge (PGMC), 4%; ChemECAR, 13.1%; and concrete-mixing/site visit, 6.3%. Students who participated in other activities made up 28.4% of the sample. The ratio of students who were involved in activities against those who were not is approximately 2.1:1 (i.e. (100-31.3) / 31.3). This shows that the majority of the students were active in extra-curricular activities. A leap in student participation in SEM indicated that the start of this (SEM) project was some time between the two surveys.

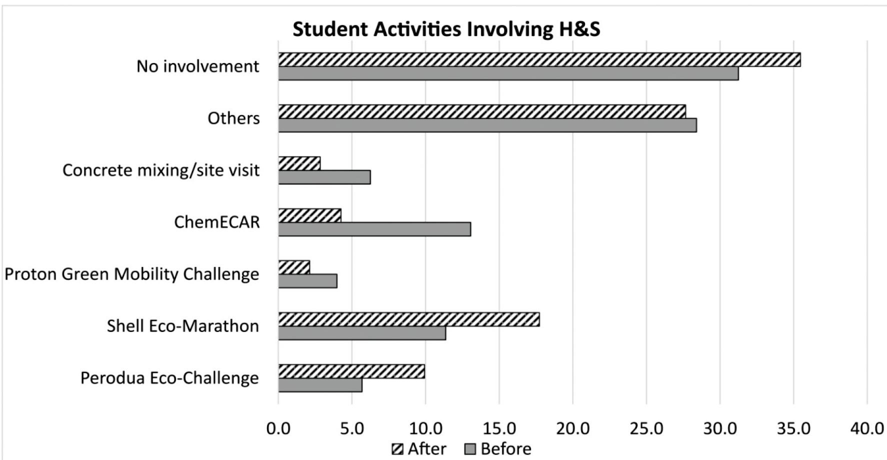

Figure 3. Students who participated in activities in which adherence to safety rules are important before and after H&S topics were taught.

The survey was conducted using an Internet-based programme. It is user friendly and took less than five minutes to complete. The invitations to complete the survey were sent by email and *iFolio*, a full-fledged student electronic e-learning system. The survey was conducted on voluntary basis. The sample was taken from the Engineering Ethics and Technological Advancement course. A five-point Likert scale was used for the questionnaires, in which 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree. Some of the questions asked regarding H&S were subjective in nature such as "understanding H&S issues…"; inference was required to measure beliefs related to common measurement techniques. Employing a Likert scale in this study might not have been the best approach. To reduce this lack of fit, a guideline for answering the questionnaires was considered (Glendon et. al., 2006).

RESULTS

The first response out of the four results to be discussed here is related to students' understanding of PPE.

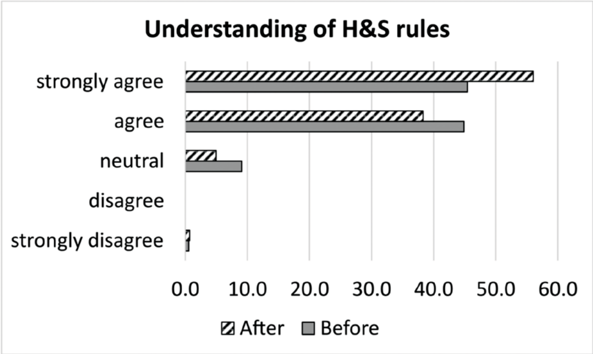

Figure 4. Understanding of health and safety rules before and after H&S topics were taught.

Figure 4 shows students' understanding of H&S rules. The total percentage of strongly agree and agree are 90.3% and 94.3%, respectively for before and after the H&S lectures were given.

Figure 5 shows the response to the question on influence of H&S rules in respondents' everyday lives. A whopping 96.6% and 97.9% of the students agreed that H&S aspects had an influence on their lives before and after they attended the H&S lectures, respectively. It is assumed that students do not only observe H&S rules in the laboratory or in workshops at university, but also practise similar rules at home. These could be, for example, when fixing their motorcycles (typical mode of transportation among students) etc. In UKM, laboratories practise strict H&S rules. Accidents related to H&S are rarely reported; therefore, the responses to this question was within expectation.

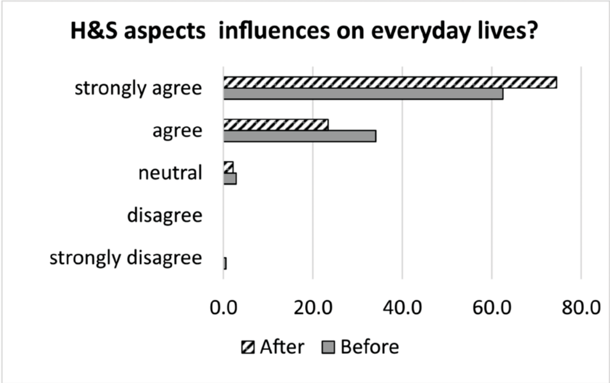

Figure 5. Response to the question relating health and safety aspects to everyday life practices before and after H&S topics were taught.

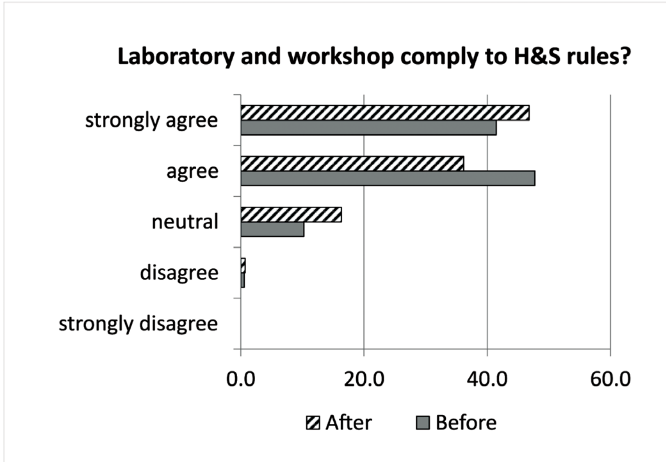

Figure 6. Response to the question on compliance with H&S rules in the laboratory and during workshops before and after H&S topics were taught.

Figure 6 shows the response to the question on compliance with H&S rules in the laboratory and during workshops before and after H&S topics were taught. About 89.2% and 83% responded positively, respectively, for before and after H&S lectures. Students who chose neutral for this question increased by 6% from 10.2% to 16.3%. It is interesting to note that the 6%, who originally agreed that laboratories and workshops observed H&S rules now felt unsure. There might be certain elements that the student had learnt during the lectures that might have influenced their perception and understanding of health and safety. The strong positive responses of 89.2% and 83% to the question on labarotory and workshop compliance seem to be on the high end as safety culture is generally underdeveloped in many places of work (Nielsen, 2014; Choudhry et al., 2007).

Figure 7 shows students' responses on their understanding of PPE. It is quite interesting to observe that, in general, there was a big jump from students who strongly agreed and agreed, 55.3% after the lecture against 30.7% before the lectures on H&S issues. This result means that close to one fourth (55.3% - 30.7% = 24.6%) of the participants thought that they knew about H&S issues, but in fact, they did not. The big numbers of those who did not understand PPE and those who were not sure (approximately one third of the students) signify that their positive responses recorded in Figure 4 to Figure 6 might have been compromised by some of the participants, whose knowledge was limited to H&S matters. PPE is a must-know item in H&S, and not knowing the meaning of it leads to total disregard for its use in the laboratory and workshop.

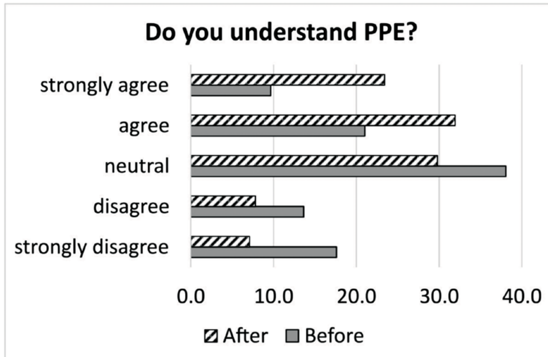

Figure 7. Students' understanding of PPE before and after H&S topics were taught.

That a large number of the students still did not know what PPE was after the lecture is worrisome for lecturers. About 7.1% strong disagreed and 7.8% disagreed. These students will enter the job market thinking that they understand H&S when in fact, they do not. Remedial action such as more elaborate explanation and more examples should be given in lectures. This study also agrees with previous findings that showed a gap between employer and university expectations (Zaharim et al., 2009) of students. Students and universities have the perception that certain important topics have been sufficiently covered in the programme, but the industry feels otherwise.

There is a great need to arrange for H&S special lecture sessions to address students' misunderstanding of H&S. As a matter of fact, this issue was realised at the start of the year, when the Engineering Accreditation Council (EAC) audited the Department of Mechanical and Materials (Harun et al., 2013b). It was found that the PO on H&S was not sufficiently measured in both engineering programmes offered. The authors also realised that quite a large ratio of students were active in curricular activities requiring sufficient knowledge of H&S i.e. 2.1:1 as shown in Figure 3, and therefore, immediate action was needed to avoid risk of accidents.

New curriculum syllabi for all engineering programmes in UKM for the 2015-2016 session have been developed starting from 2014. Information regarding student performance based on their grades, their Programme Outcome (PO) performance, industrial expectations through the industrial advisory panels (IAP) and ongoing quality improvement actions were gathered. The development and review for these engineering programmes was headed by the Deputy Dean (Undergraduates & Alumni). Generally, the structure for all revised programmes is based on Fig.8. While the structure shown is for the Mechanical Engineering programme, all other engineering programmes follow the same framework, especially for the 'Compulsory University and Citra Courses' and 'Mathematics Courses'. Note that the course KKKF3283, 'Engineering Ethics and Technological Advancement' where the PO for H&S is measured, and whose students were involved in these surveys, is in Semester 5 in the currently approved programmes. This course is written in red in Figure 8. This course is categorised in the university-compulsory course.

CATEGORY	YEAR 1		YEAR 2		YEAR 3		INTER-SESSION	YEAR 4	
	SEM 1	SEM 2	SEM 3	SEM 4	SEM 5	SEM 6	Industrial Training	SEM 7	SEM 8
Compulsory University and Citra Courses		**LMCW**	**LMCW**	**LMCW**	**KKKF3283** Eng. Ethics & Techn. Advancement			**LMCE** Speech Comm., Presn. Skills, Professional Written Comm.	
	LMCE Foundation English	**LMCE** Academic Communication I	**LMCK**	**KKKQ** Eng. Statistics	**LMCE** English for Eng. and Architecture			**KKKM** Eng. Economy	
	LMCE Academic Communication I				**LMCR** free flow				
	KKKM Engineering Graphic Designs								
Matematics courses		**KKKQ** Eng. Mathematics II	**KKKQ** Eng. Mathematics III						
Core Engineering Courses	**KKKQ** Eng. Mathematics I	**KKKM** Eng. Statics	**KKKM** Thermo. and Heat Transfers						
	KKKM Science and Mtrls. Eng.								
Culminating Course	**KKKM**	**KKKM**	**KKKM**	**KKKM**	**KKKM**	**KKKM**	**KKKM** Ind. Training	**KKKM**	
		KKKM	**KKKM**	**KKKM**		**KKKM**		**KKKM**	
			KKKM	**KKKM**		**KKKM**		**KKKM**	
				KKKM		**KKKM**			
Culminating Course					**KKKM** Integrated project	**KKKM** Fluid dynamics		**KKKM** Eng. Design Project I	**KKKM** Final Year Thesis
					KKKM Thermal Systems	**KKKM** Quality Management			**KKKM** Eng. Design Project II
					KKKM Mechanical component Anls.				
Elective Courses								**KKKM**	**KKKM**
									KKKM
									KKKM

Figure 8. Typical engineering programme curriculum structure.

There are a few other courses that measure H&S performance; however, this course depends on the respective programme requirements. Therefore, it is easier to discuss the course KKKF3283 only. The new curriculum structure allows students to get involved in extra-curricular activities that require knowledge of H&S matters as shown in Figure 3 and at the same time to enrol in KKKF3283. The extra-curricular activities usually involve year-three students. This way, students get the benefit of practising their in-class knowledge.

The course syllabus for KKKF3283 is improved in the faculty-wide engineering programmes revision. To improve the delivery of H&S requirements, one of the Course Outcomes (CO) is rewritten specifically i.e.:

Ability to make engineering decisions which take into consideration cultural differences, health and safety, technology transfer and infrastructure.

Below is the Course Outcome for which the Programme Outcome related to H&S is measured:

Ability to apply reasoning informed by contextual knowledge to assess societal, health safety, legal and cultural issues and the consequence responsibilities relevant to professional engineering practice.

The new syllabus contains detailed requirements for H&S, specific PPE requirements, consequences, local acts and two-way discussions in the lecture hall. There is no change to the measurement methods of this CO and consequently PO, which is through examination questions and final-report presentations. The improved understanding among students through their responses shown in Figure 4 to Figure 7 is used as the basis for syllabus change.

CONCLUSION

Health and safety aspects at university are important elements to ensure not only that there are no injuries and accidents, but also to promote a comfortable working environment for future engineers. The latter helps students achieve better results in their study or research. We have identified that students understood and practised H&S rules appropriately. This was evident from their highly positive scores in the questionnaires (in most cases, more than 80%). Despite a jump in the number of students who understood the word PPE, the relatively large number of students who did not understand the definition of PPE calls for immediate remedial action. For future planning, the Engineering Ethics and Technological Advancement course will add more elements of H&S to address this issue.

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Designing a Reliable Academic Quality Management System in Nurturing Future Engineering Professionals – A Case Study

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ABSTRACT

Engineering quality system among local universities has undergone stiff competition in reflecting the outcomes of education. The capability of each university of maintaining their academic structures must be given attention in order for it to stay competitive. The purpose of this paper is to develop a reliable academic quality management system for accreditation of engineering education based on EAC and MQA requirements. The main structure includes the institutional engineering curriculum, co-curriculum, governance and a systematic documentation system. The stakeholder inputs are used as elements in responding to industry and government needs. Reviewing inputs, self-assessment reports (SAR), different best practices and additional inputs helped in supporting and strengthening this academic quality management system. Three main planning elements were involved namely, establishment, assessment and continuous improvement stages. With the development of reliable academic quality management, engineering knowledge, skills and attitudes can be further enhanced to improve the quality of our graduates. The model can significantly become a platform for maintaining accreditation as well as sharing some best practices for other institutions offering similar programmes. As such, engineering education is set to reach greater heights in producing right human capital assets in nurturing future engineers.

Keywords: Accreditation, academic quality management system, Programme Educational Objectives (PEO), Programme Outcomes (PO), graduate attributes, quality assurance, Continuous Quality Improvement (CQI), Institute of higher learning (IHL)

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INTRODUCTION

Optimising human and intellectual capital in engineering education is a continuous process and requires new inputs for improvement. This issue needs to be addressed and studied in detail. It requires a large sum of money, time and effort to come up with a systematic approach of engagement in any accreditation system. The additional workload and the burden of juggling between teaching-learning and administrative work could affect the productivity of academicians. There has always been a quality trade between teaching profession and the administrative tasks. From academicians' point of view, the focus should be on educating and producing qualified graduates for their future careers as demanded by the stakeholders. On the part of industry, management has the responsibility of supporting the delivery and assessment of engineering education. To maintain accreditation status is not easy. Motivational factors such as understanding the principles of engineering and its long-term benefits for organisation need to be documented and practised. Some of the benefits may include improvement in quality of graduates produced, raising university ranking and improving academic documentation, procedures and working instructions. The most important contribution is generating a perfect environment for work and clearly adopting the system guided by the vision and mission of the institution. With these moves, negative perception and de-motivation among members of the institution can be minimised, leading to a win-win situation among students, academicians and management teams. Several well-known engineering frameworks used for the higher education quality management system include ABET, CDIO, TQM, STEM and ISO.

Total Quality Management (TQM) is perhaps one of the well-known Japanese management process-approach philosophies applied in industry through mechanisms for continuous improvement of products and services. The philosophy fuels action to improve the outcomes of any customer's requirements, in this case, the quality of graduates. The idea of continuous improvement is the same approach for developing an academic quality management model. CDIO (Conceiving, Designing, Implementing and Operating) is another engineering education framework model focusing on a technical and knowledge-based approach. The main cycles involve Conceive-Design-Implement-Operate with continuous improvement to the work of producing quality and competent engineering graduates.

The Accreditation Board for Engineering Education and Technology (ABET) requires an outcome-based approach driven by a continuous assessment system for institutions of higher learning in their effort to produce quality graduates. This is also required for engineering programmes. A more recent approach, STEM education, focusses on graduates with innovative and a wider scope of knowledge in areas of physical science, technology, engineering and mathematics. The academic management system is driven by multitasking, and therefore, tends to produce graduates with additional skills and capabilities. At worldwide level, the International Organisation for Standardisation (ISO) is a worldwide standard provider that offers quality management system for industry, technology, computing and communications. All of these management system approaches can serve as models for local, regional and foreign institutions of higher learning. A reliable academic management system will ensure that the requirements of both the Engineering Accreditation Council (EAC) and Malaysian Qualification Agency (MQA) are achieved. In time, a more stable and reliable academic quality management system model can be established.

LITERATURE REVIEW

The recent trend shows that the standard of engineering education falls short of expectation in achieving its learning objectives and outcomes. This has led to identifying three 'domains' of learning ability with the aim of achieving educational goals. The domains are the domains of cognitive, affective and psychomotor (Bettina Lankard, 1998) ability. One study classified student behaviour in terms of the intended outcomes of education (Krathwohl et al., 1964). Each domain contributes to specific areas of intelligence such as knowledge, skills and attributes. These outcomes are strong initiatives in overcoming the current shortage of qualified human capital, which has made the need for generating human and intelligent capital among engineering professionals essential (Rashid, 2012). MQA and EAC require all institutions of higher learning (IHL) to have an effective quality assurance system with an appropriate set of procedures (EAC, 2012). The MQA framework is benchmarked against that of developed countries such as England, Wales, North Ireland, Australia and New Zealand as well as certain countries in Europe. The emergence of Outcome-Based Education (OBE) is widely accepted as a replacement for result-based education for a more innovative and dynamic education system. Quality Assurance in higher learning currently places emphasis on output, that is, the quality of graduates in terms of academic results (learning) and employability or workplace recruitment is now the focus (Gray et al., 2009). This is a positive step as IHLs will be producing graduates who can meet stakeholders' demands. The shift from input-based to output-based education is expected to increase graduates' readiness and self-confidence to enter the engineering profession. This is how current engineering programmes are bringing progress to IHLs and their students (OBE Committee, 2012).

Each programme requires defined outcomes in producing graduates with certain skills and abilities to meet the needs of stakeholders (UNESCO, 2007).

The framework may include nurturing confidence and trust among stakeholders in maintaining quality and in meeting the criteria set for each engineering programme from certificate to doctorate level. The EAC manual promotes outcome-based education by incorporating the university engineering accreditation process with its vision and mission. Prime movers in the project will be the link between industry, IHLs, the government, the Education Ministry and recognised engineering standardisation bodies such as the Dublin Accord, Sydney Accord and European Accredited Engineer Project (Memon et al., 2009). Based on current demand, it is clear that engineering education needs to be reviewed and continuously upgraded from time to time. Results achieved can be evaluated to suit the requirements of IHLs. The success factors, according to the Washington Accord (WA), depend on planning, evaluation and improvement, and rely on a well-structured framework according to the latest global consortium for an accredited engineering degree programme (IEA, 2013). The accreditation agency for setting up the criteria in the United States is the Accreditation Board of Engineering and Technology, which is referred to on all matters related to engineering education (ABET, 2013). A holistic approach covering all processes in engineering education can help graduates excel and meet stakeholders' expectations (Kahveci et al., 2012).

The following are some views with regards to the advantages of implementing the right academic management model. Academic quality management system based on the ISO 9001:2008 can provide a foundation for total quality management and academic accreditation capable of meeting stakeholders' requirements (El-Morsy et al., 2014). There is evidence that students' satisfaction with academic performance was enhanced due to the implementation of the TQM model at the departmental level (Kosmidis et al., 2010). Applying CDIO, which stands for conceiving, designing, implementing and operating, has been proven to be effective in enhancing the engineering education model (Zhang & Liu, 2009). As for STEM, the interactive systems nature of its educational processes is unlikely to prove effective in improving undergraduate education (Porter et al., 2006). After reviewing the models, lack of organisation and quality was identified as the major failing. If this is strengthened, the proposed academic quality management system will work efficiently.

OBJECTIVES

The main objective of this study was to build an academic quality management system based on MQA and EAC requirements in nurturing future engineering professionals. Local Malaysian graduates are expected to master eight (8) domains listed in the Malaysian Qualification Framework (MQF) of learning outcomes. This includes Knowledge of discipline areas; Practical skills; Social skills and responsibilities; Values, attitudes and professionalism;

Communication, Leadership and team skills; Problem solving and scientific skills; and Information management and lifelong learning skills. All the domains are listed under MQA's requirements (Ministry of Higher Education, 2011). The EAC Manual 2012 has added several more domains for engineering graduates, including environment sustainability, project management and finance.

In order to achieve these outcomes, each university needs to prepare a strategic quality plan with a proper documentation system. The plan should be a benchmark for future engineering graduates of Malaysian IHLs in accordance with the Washington Accord.

METHODOLOGY

This study used standard engineering methodology by reviewing modules and framework available in the literature. A search was made for input from industry, students, parents, alumni as well as the government agencies through inputs and guidelines governing governmental ministries. Data gathered were used to determine and support elements in the proposed academic quality management system. Comparison with other quality management models were made on current trends and needs. Common concepts such as planning, organising, controlling and monitoring as well as continuous review were. This basic concepts came from TQM, ISO, CDIO, ABET and other quality management models.

Several criteria were used in comparing the academic management system used in Malaysian institutions offering engineering programmes. The EAC Manual uses six accreditation criteria as guidelines, namely, Academic Curriculum, Students, Academic and Support staff, Facilities and Quality Management Systems for qualifying requirements. MQA, which overviews overall quality assurances of Malaysian IHLs based on its code of practice of institutional audit (MQA & Malaysian Qualifications Agency, 2009), has nine qualifying requirements. The criteria were Vision, Mission, Education Goals and Learning Outcomes, Curriculum Design and Delivery, Student Assessment, Student Selection and Support Aervices, Academic Ataff, Educational Resources, Programme Monitoring and Review, Leadership, Governance and Administration and finally, Continual Quality Improvement. With the combination of both criteria, the foundation of developing a designated academic management model was set. Besides the EAC and MQA references, information from a Self-Assessment Report (SAR) submitted to the Board of Engineers Malaysia (BEM) for the purpose of applying engineering accreditation was referred to. These materials are classified as confidential and are prepared solely for accreditation purpose by each institution. Outcome-Based Education (OBE) also uses the continuous cycle of Plan-Do-Check-Action (PDCA) concept. This process-approach ensures that the model can be further improved and enhanced throughout its process of improvement and that value-added activities are indeed beneficial.

Project Milestones

The project aimed to fully develop one reliable model of the academic quality management system. A few considerations were made to ensure the success of this academic quality management model:

- Evaluating the long-term and short-term goals of by alumni by assessing their PEO and PO
- Establishing and reviewing assessment processes by stakeholders
- Using reliable assessment tools in evaluating PEO and PO attainment
- Involving stakeholders and alumni in the teaching and learning process
- Promoting academic programme enhancement
- Motivating students and staff (academic and non-academic) in sustaining career development and academic programmes
- Monitoring the effectiveness of the current education system in teaching and learning (T&L) to produce competitive, competent and higher graduate employability
- Maintaining documentation and facilities such as safety, sufficiency and accuracy
- Planning a reliable academic Quality Management System and maintaining the institution quality standard

Planning

Planning is crucial to the process of developing an academic quality management model. Effective planning requires in-depth understanding and knowledge of engineering education requirements, which include basics such as criteria, core components, strategies and details of the project. Good understanding of guidelines, requirements and content for the accreditation is highly anticipated. Malaysian institutions offering engineering programmes need to meet all of the EAC and MQA's requirements. Some of the elements required for engineering accreditation can be applied, and many are compatible with quality management system standards. Below are three stages involved in developing the proposed academic quality management system:

(a) Establishment stage of reviewing the current system based on MQA/EAC requirements
(b) Assessment stage for system evaluation (PEO, PO, Academics, Student, Staff, QMS and OBE)
(c) Continuous Quality Improvement (CQI) stage to develop an academic Quality Management System

Establishment Stage

The establishment stage involves the formation of clear direction as to what were the objectives to be achieved by developing an academic quality management system model. The framework must comply with all the standards and legal requirements and assessment criteria needed for the programmess. This includes the standards set by the Ministry of Education (MoE), Malaysian Qualifications Agency (MQA), Board of Engineers Malaysia (BEM), Engineering Accreditation Council (EAC) and other accreditation bodies. Knowledge of ISO standards such as 9001:2008 Quality Management System (QMS) can be an added value to the system. Apart from this, input from industry, represented by the Industrial Advisory Panel (IAP), the government and other interested stakeholders will also help. The achievement and outcomes produced should be aligned with the vision and mission of each IHL to ensure that credibility and the quality assurance system for academic achievement are established for a strong structure of setting up a reliable academic management system.

Assessment Stage

Once the structure is established, the implementation and assessment are necessary see how well the system is working. One method of ensuring the structure is working effectively is to test that the academic quality assurance system is per accreditation requirements. Auditing the system requires preparation and the readiness of the complete academic framework infrastructure before actual assessment; this includes documentation, personnel (student and staff), facilities and infrastructure as well as the whole academic curriculum structure of the Programme Educational Objectives (PEO), Programme Outcomes (PO), and Course Outcomes (CO). The academic quality management system should be established and implemented accordingly. This is important to ensure that achievement can be measured during the assessment stage. Assessment must be reliable and must reflect the students' actual performance to meet educational objectives and expected outcomes. There should also be clear evidence of outcomes obtained in fulfilling the assessment stage.

Continuous Quality Improvement Stage

After the system is assessed by accreditation bodies, the next stage focusses on all highlighted continuous quality improvement (CQI). The inputs received from the evaluators can be considered as improvement activities to enhance the institution's standard. Some critical input comes from assessment results, either direct and indirect or formative and summative). Input also comes from internal and external stakeholders, alumni and quality auditors. Any non-compliance is noted as an area for improvement. This auditing exercise provides room for improvements to the system. Improvement can be carried out either continually or continuously as recommended and decided by each institution. The closing loop process of the system will add value to the present academic quality management system. In the long run, the system will mature and contribute to the development of the academic quality management system.

Figure 1. Stages of the process of the academic management system.

RESULTS

Academic Quality Management System Structure

In developing the overall academic structure, the requirement elements must be structurally formed in order to complete the model. The standard for both MQA and EAC requirements can be aligned together to form one solid structure for the academic quality management system. This suggested model consists of six divisional structures embedded within four core structures, namely the Documentation System, Curriculum Structure, Quality Culture and Organisational Structure. The suggested model is illustrated in Figure 2.

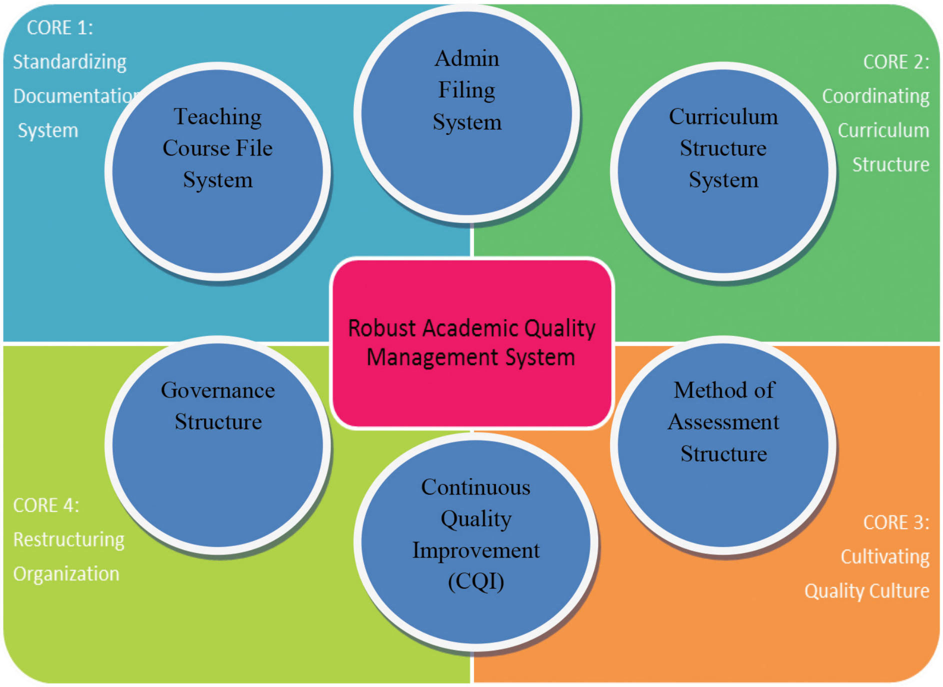

Figure 2. Formation of robust academic quality management system.

Documentation System Structure

A filing system for all the engineering programme courses needs to be developed and maintained from the beginning to the end of the evaluation period to monitor and evaluate the effectiveness of the teaching process. Each course file must be complete and the contents closely monitored by Quality Assurance Unit personnel. Files taken out must be returned to the filing cabinet each time to ensure availability to all. Lecturers must update the content of each file as this is considered an important document for auditing and accreditation purposes. Apart from the course file**,** laboratory files must also provide proper documentation as course supplement. These include documenting safety aspects in the laboratory and facilities infrastructure for supporting teaching and learning activities. On the larger documentation scale, such as for departmental and faculty level, a standardisation central documentation system is compulsory. Hundreds of documents need to be kept and properly segregated, indexed, categorised and arranged according to department.

The need to maintain a large number of official documents calls for a structured and well organised administrative filing system. One centrally controlled documentation unit headed by the Quality Assurance Unit can help to coordinate all the important documents for the whole faculty. The administration filing system can be colour-coded and arranged according to semester. This system will require good control and protection procedures to maintain content integrity of the whole academic quality management system.

Curriculum Structure

Curriculum structures deal with the formation of the engineering curriculum offered by the institution and the formation and establishment of an accredited engineering programme. The structure of the curriculum is a fundamental requirement for strengthening institutional reliability in producing graduates who meet the expectation of stakeholders. Curriculum structure must have objectives, direction and well-organised, correctly chosen programme education objectives (PEO). The structure is strengthened by linking the programme outcomes (PO) and executing the course outcomes (CO) through an efficient delivery process. For accreditational purposes, the new academic management system must include PEOs and POs that are developed based on the Washington Accord. A good educational objective utilises the SMART concept: systematic, measurable, achievable, reliable and timely. The PEO statement must be strongly connected with the mission and vision of the institution.

Method of assessment includes the process of evaluating and assessing the existing system. Indicators are used to measure either the results or outcomes to achieve objectives and targets set by the institution. Both PEOs and POs need to be measured to ensure that objectives and outcomes can be achieved as evidence of the strategic plan and to strengthen the programme and graduate attainment. Therefore, the results of graduate attainment should reflect actual performance and should continuous strengthen the pillar attributes. Various assessment methods and tools are used to measure the attainment and performance of graduates. The most common method of assessment is to use direct and indirect measurements. These measurements can significantly determine if the education objectives and outcomes are met and fulfil the expectation of stakeholders. Some of the activities include internal assessment of the system and getting feedback internally and from the industry, alumni, students and other stakeholders. Loops in the system can be rectified by the process of improvement.

Other assessment methods may include benchmarking visits to other institutions, an accreditation visit and also meeting with the Industry Advisory Panel (IAP). Curriculum structure is meant to strengthen the pillars of the PEOs and ensure that graduate attributes are achievable by students enrolled in the programme. This includes all the different stages including educational objectives, programme outcomes and course outcomes. Such an effective system of student assessment can ensure that the quality of graduates meets the international standard and fulfils stakeholder needs.

To further improve any deficiency in the system, continuous quality improvement (CQI) can be applied to existing input to close any loops and to strengthen the existing curriculum structure. The morale of staff should also improve under the new system. In UKM, staff morale has improved tremendously since CQI was applied in teaching and learning activities. The positive result obtained can be seen in the improvement of staff working standard and academic management documentation, which must be continually dynamic and updated. Overall curriculum structure improvement can be seen in the documentation of all courses, departments and faculties. This is important as there are many documents to account for, from teaching and learning points to student performance documents such as quizzes, exams, projects, skills competency, industrial training and final-year projects, among others.

Quality Culture Structure

Developing a good working culture among students, lecturers and administrators at the workplace is not an easy task. It takes years to instil cultural acceptance in any organization, whether government or in the private sector. The same is true for institutions of higher learning. Several motivational techniques can be used to attract participation of employees in cultivating quality culture. Preparing for accreditation requires solid teamwork from all faculty members especially those serving on working committees. The workload and documentation preparation for compliance requires good planning and coordination in order to achieve satisfactory results. Internal audit is another example of how departments work together to carry out audit activities among themselves as coordinated by the Quality Assurance Unit. In addition, laboratory audits are also carried out in compliance with the safety laboratory standard, including equipment testing and safe working procedures. Students are expected to follow laboratory guidelines and adhere to best practices in ensuring the laboratory is conducive and safe for use. Any non-compliance needs to be improved to ensure the laboratory meets all auditing requirements.

Self-assessment is another task carried out by the Faculty of Engineering and Built Environment (FEBE) every semester. The task can instil teamwork and quality culture among team members. The report reflects the enthusiasm among department members to carry out self-assessment for the betterment of documentation ownership. The culture of helping one another can produce best practices in a department. This activity also encourages team members to avoid any non-conformity while emphasising on quality awareness among members. In implementing such a system, the organisation must follow the department's standard operational procedure to avoid mistakes. Self-assessments prepare an institution for the actual audit exercise and provide confidence for the auditing committee through a self-assessment report prepared apart from the successful audit strategy. There are many other related activities that promote quality culture among workers, including providing research grants such as the Strategic Action Plan (PTS) funds and organising workshops and seminars to enhance the culture of conducting new, among others. To show the seriousness of embedded quality culture in UKM, an Engineering Quality Week was organised to disseminate information on accreditation to students and staff. Several Quality Awards were given away to best quality practitioners to honour their contributions to the faculty. Every year, UKM has organised *K-Novasi* for teaching and learning activities (T&L) to promote new techniques and innovation to enhance higher learning skills in education. There are many technical workshops being held throughout the year to cultivate quality culture in UKM.

Organisational Structure

Good structural organisation needs to have proper division with specific tasks and functions. An organisation must be driven by competent personnel within its organisational structure to ensure the goals of the institution can be achieved. Therefore, a solid governance structure is needed to ensure that the functions of the organisation can be smoothly ans systematically implemented, monitored, controlled and maintained for continuity of the structure. For efficient execution, selecting the correct administrative and management personnel, lecturers and support staff is important. They must be given suitable support to fulfil their tasks, duties and responsibilities. There should be clear expectations to ensure that the entire academic quality system works well. Structured governance allows an institution to be organised and improves the quality of work of staff. A clear and strong structure also helps to develop better standard operation procedures and staff have a better understanding of what to do and how to do it. This is a valuable asset that strengthens the institution's position in supporting organisational structure. It is the duty of those holding leadership positions in the organisation to ensure that organisational structure is supported by competent persons. For accreditation purposes, department representatives can join the steering committee to help manage given tasks. The structure illustrated in Figure 3 shows how the QA organisational structure is set up with representatives from the Faculty of Engineering and Built Environment. The Head of Quality Assurance is supported by Science Officers and a secretariat for day-to-day operation of the unit.

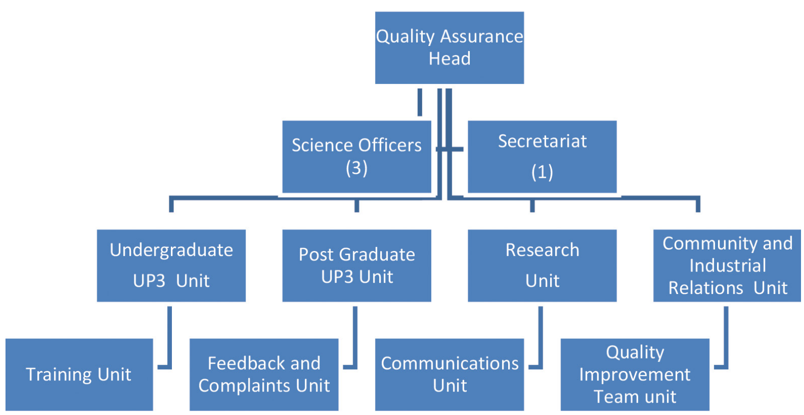

Figure 3. Organisational structure of a quality assurance unit.

The Quality Assurance Unit is restructured and expanded to cover all the tasks of the faculty. The governance structure is set up with a working committee with members from all the relevant departments. The working committee consists of four or five members led by a Department Representative, who is responsible for reporting the progress of the committee to the Quality Assurance Head. This consolidation group focusses on three main areas to achieve the UKM CITRA graduate attainment. The focus includes continuous quality improvement (CQI) and curriculum structure review based on PEO development and topics related to the improvement of quality services at faculty level. Focus on these areas brings greater impact to the overall curriculum with the establishment of comprehensive guidelines determining correct PEOs and POs. The Quality Management Committee structure representing the Faculty of Engineering and Built Environment (FEBE) is illustrated in Figure 4.

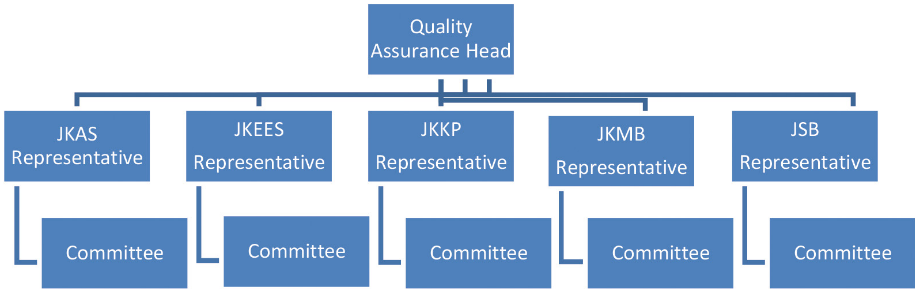

Figure 4. Quality management committee for FEBE accreditation task.

DISCUSSION

Research and Enhancement

The model presented was improved and contributed to some important engineering education feedback and valuable input. Self-healing and resolving CQI loop cycles can lead to changes that improve the level of engineering assessments and this is considered good practice. Lessons learnt from implementing this academic quality management system can be shared and can take the organisation to greater heights. The results correlate with and are reflected in the QS World University Ranking, the local university SETARA status and other higher educational evaluation and benchmarking. This helped to improve UKM's ranking among Malaysian universities as measured against University Malaya's (UM) ranking for engineering. This achievement can be used to help other universities. The quality of academic processes is continually being improved according to the needs of accreditation bodies as well as stakeholder requirements. UKM is distinguished as being a local IHL with accreditation status awarded by EAC for a full five years for its engineering programmes. Among others, Continuous Quality Improvement (CQI) is considered a very important element for an IHL to receive such an award as it makes the academic quality management system stronger and more reliable. Table 1 to Table 6 provide sample documents used by the Faculty of Engineering and Built Environment in UKM. These documents are prepared for supporting the faculty's academic quality management system. The strength of the system lies in the integration of all the six structures mentioned in this paper.

Table 1
Curriculum Structure Review Items

Structure Component	The important development
PEO	Correct method of PEO establishment
PO	Utilisation of standard attributes
Academic Curriculum	Mapping and actual assessment of formative and summative assessment
Student	Quality of graduate attainment /programme
Academic Staff	OBE implementation/motivation
Facilities	Sufficient and conducive environment
QMS	Develop, implement, monitor and improve

Table 2
Sample of Assessment Methods

Task	Related parties	Remark	Report
PEO assessment (Alumni and Employer)	Alumni Liaison Committee	Under Deputy Dean and P&A monitoring	PEO achievement report (alumni and employer)
PEO achievement analysis	Alumni Liaison Committee	Representative from each department	
PO assessment (Direct)	SP3P	PPA	Report analysis
PO achievement report (Direct)	UP3 Committee	Under Department Head and Deputy Dean P&A	PO achievement (Direct and Indirect)
PO assessment (Indirect)	SPPP	PJK	
PO achievement analysis (Indirect)	UP3 Committee	Under Department Head and Deputy Dean P&A monitoring	
Optimisation, PO mapping and determination of performance indicators	Programme Coordinator	Collaboration with UP3	External assessor report; Meeting with industrial panel; Benchmarking
Rubrics & formative assessment coordination	UP3 Committee	Members of UP3 Committee	
Summative assessment coordination	Chief Coordinator of Examination	Revised Bloom's Taxonomy	

Table 3
Sample of Continuous Quality Improvement (CQI)

Task	Activity	Frequency	Remarks
Review PEO and comprehensive programme and curriculum review	Input/Feedback from external assessors; Alumni survey; course review with industry; Benchmarking; Stakeholders' feedback	Every 3 to 5 years	Performance assessment and programme accreditation
PO assessment/ analysis of student attainment	Input from student exit and exam survey; Industrial Training/IAP	Yearly cycle	Reviewing programme/ student motivation
Course monitoring and assessment	Evaluate feedback from student/lecturer; Student assessment	Every semester, six-month cycle	Assessing delivery, teaching and facilities

Table 4
Sample of Administrative Filing System

No	File reference No.	File name
AUDIT - 13		
1.	ABC 1.18.4/13/x	Audit
POST GRADUATE - 105 (By Course)		
1.	ABC 1.18.4/105/x	Examination
2.	ABC 1.18.4/105/x	Examiner Committee Meeting (viva)
3.	ABC 1.18.4/105/x	Masters of Engineering Programme
COMMITTEE MEETING - 111		
1.	ABC 1.18.4/111/x	FKAB Curriculum Committee Meeting (Faculty Course Review Workshop; PEO & PO)
2.	ABC 1.18.4/111/x	Departmental Curriculum Committee Meeting (Curriculum Review Workshop)
3.	ABC 1.18.4/111/x	Accreditation Committee Meeting (Alumni Relations Committee; Benchmarking Committee; Curriculum Review Committee; Organising Committee with Industry Committee)
4.	ABC 1.18.4/111/x	Materials related to accreditation (Meeting with IAP, industry & alumni; External examiner report; Benchmarking report, etc.)
5.	ABC 1.18.4/111/x	Quality Assurance Division Committee Meeting (QAD)
6.	ABC 1.18.4/111/x	UP3 (Teaching, Improvement and Learning Units) (PO analysis achievement; PEO analysis achievement)
7.	ABC 1.18.4/111/x	CQI (Continuous quality improvement) (Course and programme improvement level, Form B1)

Table 5
Sample of Teaching File Management Label, Forms and Checklists

No.	Department	Filing label by colour
1	All Engineering Faculty	White (Semester 1) + Light purple (Semester 2)
2	Chemical/Process Engineering	Light green (Semester 1) + Dark green (Semester 2)
3	Electrical/Electronics and System Engineering	Yellow (Semester 1) + Orange (Semester 2)
4	Mechanical/Materials Engineering	Light blue (Semester 1) + Dark blue (Semester 2)
5	Civil/Environmental Engineering	Pink (Semester 1) + Red (Semester 2)
6	Built Environment	Light brown (Semester 1) + Dark brown (Semester 2)

TABLE 5 (continue)

Form & Checklists	Purpose
Teaching Folder Checklist (Under graduates course)	Undergraduate course assessment
Teaching Folder Checklist (Post graduates course)	Postgraduate course assessment
Follow Up Form Courses Teaching and Learning Improvement (B1)	Form used to receive feeedback for postgraduate programme
Feedback to Teaching and Supervision Evaluation System (*SPPP*)	Feedback and complaint on teaching courses (Improvement from previous semester)
Mark Distribution Form	Confirmation form between the performa and the achievement mark

Table 6
Quality Assurance Governance Structure

Key Personnel	Task/Function
1. Dean of Engineering Faculty	QA Decision maker
2. Head of Quality Assurance	Coordinate Faculty and QA activities
3. Secretariat / Science Officers Main division Unit UP3 Undergraduate Unit UP3 Post Graduates Unit Research Unit Community & Industry Relations Unit	Assisting QA Head in QA activities Sub-Units Training Unit Feedback and Complaints Unit Communication Unit QIT Unit
4. Departmental Representative(s) - Civil/Environmental Engineering Dept (JKAS) - Electrical/Electronics/System and Engineering Dept (JKEES) - Chemical/Process Engineering Dept (JKKP) - Mechanical/Materials Engineering Dept (JKBM) - Built Environment Dept (JSB)	Executing all QA function for Faculty of Engineering & Built Environment (FEBE)

CONCLUSION

On a wider scale, any engineering faculty can be managed more economically from an administrative point of view. This includes reducing unnecessary documentation and additional workload among lecturers. It would be beneficial for other IHLs to implement a similar system for evaluating the academic quality management system of their engineering programmes. Engineering education is a continuous process and there is no limit to outperforming others in terms of developing a better system. This new academic quality management system model allows for structured and manageable preparation for the accreditation process for engineering. The model can assist other IHLs in their own best practices. Perhaps one of the challenges faced by an institution would be how to make an academic quality management system part of their work culture. Strong and committed leadership can raise the level of engineering education and transform it into a holistic experience for students and at the same time, take it to international standards. In the coming years, engineering education is set to reach greater heights by producing intellectual capital adequately prepared to enter the job market, confident of meeting stakeholders' expectations. A proper academic quality management system (AQMS) allows more engineering graduates to be fully equipped for their future profession. This will in fact open the horizon for realising Malaysia's vision of becoming a fully developed nation with high income for citizens by 2020.

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Assessing Students' Performance on Material Technology Course through Direct and Indirect Methods

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ABSTRACT

Student performance of technical expertise at the end of the learning process is very important. The achievement of Course Outcomes (COs) must be tracked every semester and counteractive action must be carried out if the achievement does not meet the performance criteria that has been set. This paper will assess student performance for each CO for the course, Material Technology using direct and indirect assessment and triangulation as the result of continuous quality improvement (CQI). Direct assessment was measured using assignment, final examination, project presentation and laboratory report, while indirect assessment was measured using a pre-test and post-test survey. The item constructs of pre-test and post-test questionnaires were validated using the Rasch measurement model. The direct and indirect assessments were compared and the results revealed that differences exist between students' perception of their learning and their actual learning. The findings indicate that there is an inconsistency between students' perception of their learning (indirect assessment) and their attainment of knowledge and practical skills as rated by their lecturers (direct assessment). Thus, indirect measurement alone is not a valid measure of student learning achievement.

Keywords: Direct assessment, indirect assessment, Course Outcomes (CO), material technology course

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INTRODUCTION

Outcome-Based Education (OBE) has become a critical aspect of accreditation requirement by the Engineering Accreditation Council (EAC), which

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represents the Board of Engineers Malaysia (BEM). Outcome-Based Education (OBE) is an approach that focusses on behaviour change in the learning of students rather than on the learning process. It is designed to be an open system that complies with a set of predefined outcomes. It is also a student-centred learning process that focusses on measuring student achievement of the outcomes outlined in each course. At the Faculty of Engineering and Built Environment (FKAB), Universiti Kebangsaan Malaysia (UKM), every lecturer is required to discuss and establish Course Outcomes (COs) for every course teaching plan. Firstly, the COs are clearly defined, then the curriculum is designed to realise the outcomes. Curriculum and teaching depend on how best to facilitate the desired outcomes. This leads to a planning process that is different from traditional educational planning. Each course must address a specific and measureable set of COs. The COs define the goals of learning explicitly. Lecturers assist in the preparation of lectures while students concentrate on improving their performance, knowing the goals of the course that they are pursuing. Indirectly, the COs also spawn criteria that need to be measured (Lee et al., 2009). The introduction of the OBE system has led to a significant amount of work in the development and assessment of these outcomes in students.

Assessment of Learning Outcomes

Assessment is the systematic and ongoing process of collecting, interpreting and acting on information related to the goals and outcomes developed to support an institution's mission and purpose. Generally, the assessment process involves (1) studying activities (courses, co-curricular events like a lecture series, fieldwork etc.) that are designed to meet specific goals (in this case, COs); (2) determining if goals are being met; and (3) adapting activities/goals as appropriate if goals are not being met (Suskie, 2004). Students benefit from assessment because assessment feedback helps them understand their strengths and weaknesses. On the other hand, instructors and lecturers also acquire some benefit because assessment activities bring lecturers together to discuss important issues such as what is to be taught and why as well the standard and expectations for student learning.

Different methods of assessments are used by different institutions; however, most of them are based on direct and indirect assessment. Triangulation of results provides a better judgement of the achievement of COs. Direct assessment methods require learners to display or demonstrate their knowledge, behaviours and/or thought processes. In FKAB, the assessment tools that are always used are the tutorial, examination, laboratory exercise and presentation. Indirect measures are in contra-distinction to direct measures. Indirect assessment methods require learners to reflect upon their knowledge, attitude, behaviour and/or thought processes (Colosi & Dunifon, 2006). For the course, Material Technology, which is offered to second-year students of the Civil and Structural Engineering programme, indirect assessments contain a set of pre- and post-test questionnaires. This most common evaluation design is normally used to collect information on student perception bebefore and after course/programmes, that is at two time intervals, to accurately detect any changes in the participant. The participants are asked a series of questions both at the beginning (pre-test) and then again at the course/programme's completion (post-test) (DeMaio et al., 1998; Colosi & Dunifon, 2006).

Here, the purpose of using a pre- and post-test is to identify student perception before and after undergoing the process of learning on the course, Material Technology. The pre-test itself can assess the quality of the questionnaire and the research study. It can provide useful information regarding the quality of data that will be collected in real research (DeMaio et al., 1998). Conventional pre-tests also are based on the assumption that questionnaire problems will be signalled by the answer that the questions elicit (Presser et al., 2004). Good quality research data are dependent on good items in the questionnaire that are not misleading. However, the quality of pre-test questions is often overlooked and these items are not re-tested. Consequently, the findings of the study do not reflect the expected results (DeMaio et al., 1998; Azrilah et al., 2012).

The importance of item constructs should be emphasised. Construct validity defines how well a test measures up to its claim and it can be validated using the Rasch measurement model (Roszilah et al., 2011; Azrilah et al., 2013; Siti Aminah et al., 2015). The Rasch measurement model has been widely used today as an approach to improving the methods of teaching delivery and student assessment. This model was introduced by Georg Rasch, a mathematician from Denmark. Rasch's theory puts a person with high ability or excellent results at the top of the ranking in a positive logit scale and the person with weak ability at the bottom position in a negative logit scale. The mediocre person is located between the excellent and weak persons. This model is able to produce a reliable repeatable measurement instrument and can be used to construct an instrument with accuracy (Azrilah et al., 2013).

This paper attempts to assess CO assessments in Material Technology, the course, using direct and indirect assessment and triangulation from the result of continuous quality improvement (CQI). The Rasch measurement model analysis was used in this study to validate the instrument used in the indirect process.

Context of Study

Materials Technology (coded KKKH2164) is a first-semester, second-year course taught at the Department of Civil and Structural Engineering at Universiti Kebangsaan Malaysia (UKM). The course deals with the introduction of construction materials, their manufacturing processes, their characteristics and properties. This course consists of lectures, project work and laboratory work on concrete mixing and testing. The mix design method of concrete (the most widely used construction material) is emphasised (Roszilah et al., 2012).

Course Outcomes are statements of learning achievement that are expressed in terms of what the student is expected to know, understand and be able to do upon completion of a course. They may also include attitudes, behaviour, values and ethics. Clear articulation of COs serves as the foundation to evaluating the effectiveness of the teaching and learning process. COs must be specific and measureable. The main components to create a measurable CO are: (1) student learning behaviour, (2) appropriate assessment methods, and (3) specific student performance criteria/criteria for success. Specifying COs can provide specific, clear information for students on what is expected from them; thus, students may find it helpful if COs are discussed at the start and end of a course. COs are different from aims, in that they are concerned with the achievement of the learner, rather than the overall intentions of the tutor. Teaching and learning methods and assessment processes are aligned directly with the learning outcomes. COs for Material Technology are shown in Table 1.

Table 1
List of Course Outcomes for the Course, Material Technology

No.	CO Statements
CO1	Able to understand/explain/discuss the physical and engineering properties of Civil Engineering Materials
CO2	Able to understand/explain/discuss physical and engineering properties of concrete components (coarse and fine aggregates, cement, admixtures) and fresh and hardened concrete
CO3	Able to design concrete mix proportion using DoE or ACI method
CO4	Able to understand/explain/discuss testing of fresh and hardened concrete
CO5	Able to communicate verbally the physical and engineering properties of Civil Engineering materials; physical and engineering properties of concrete components (coarse and fine aggregates, cement, admixtures); physical and engineering properties of fresh and hardened concrete and testing of fresh and hardened concrete to members in class
CO6	Able to apply testing methods to determine the properties of fresh and hardened concrete under minimum supervision
CO7	Able to analyse the different types of concrete depending on intended application and requirement for strength and environment.

METHODOLOGY

Indirect Assessment

An indirect assessment is useful in that it can be used to measure certain implicit qualities of student learning, such as values, perception and attitudes from a variety of perspectives. For Material Technology, indirect measurements are done through questionnaires at the beginning (as pre-test) and final (as post-test) semester.

Pre- and post-tests generally are used in behavioural research to compare groups and/or measure change resulting from experimental treatments. In this case, pre- and post-tests are a measurement of the learning received during the class as a result of comparing what the student knew before in a pre-test and after the class experience in a post-test. It is used to quantify the knowledge attained in the class and indicate how the students are learning in the course. The reason for using a pre-test is to measure a starting point or the amount of pre-existing knowledge of the course outcomes and the reason for using a post-test is to measure learning as a result of the course experience. The set of questionnaires is the same for the pre- and post-test. This design is believed to measure changes in participant knowledge, attitudes or behaviour regarding the course content. In general, measurement is done at two time intervals to accurately detect any changes in the participants.

The test questions required the students to rank their knowledge and ability to understand/discuss and explain what the COs addressed. They were asked to rate their quality of learning experience using the following 5-point Likert scale: 1. Excellent, 2. Good, 3. Fair, 4. Poor, 5. Very poor. The results of the pre-test and post-test are presented in the form of the percentage of students are as shown in Figure 1 and 2.

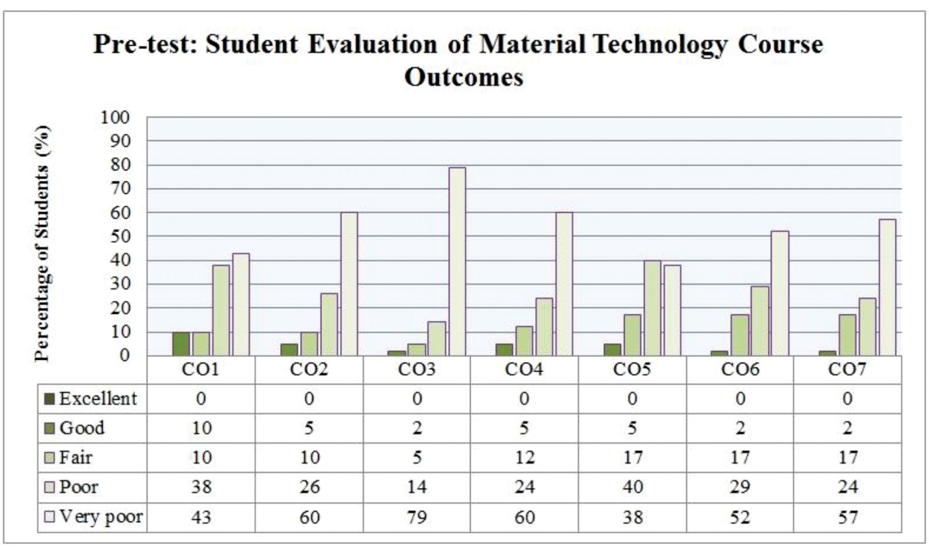

Figure 1. Results of pre-test: Student evaluation of Material Technology COs.

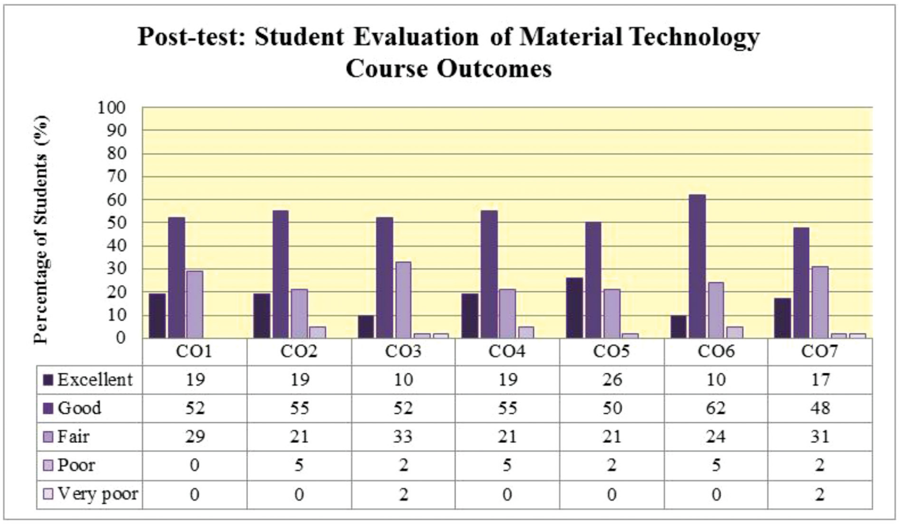

Figure 2. Results of post-test: Student evaluation of Material Technology COs.

To validate the item construct for the pre-test and post-test, the responses of 42 students who had filled answered the pre-test questions for the Material Technology course were tabulated in Excel*prn and run in WinStep®, a Rasch software to obtain logit values. The analysis output obtained from WinStep® was analysed to identify reliability and validity.

Direct Assessment

Lecturers are most familiar with direct assessment (measures). Direct assessment is the direct examination or observation of student knowledge or skills against measurable Course Outcomes. Lecturers conduct direct assessment of student learning throughout a course using different methods such as examination, assignment, project and laboratory work and reports. These techniques provide a real sampling of what students know and/or can do and provide strong evidence of student learning. Table 2 below shows how assessments for each CO are carried out through the semester.

Table 2
Course Outcomes Assessment Methods and Tools for Material Technology

CO	Assessment methods	Assessment Tools
1	Final exam	Marking scheme
2	Final exam, Laboratory report	Marking scheme, rubric
3	Final exam, Assignment, Laboratory report	Marking scheme, rubric
4	Final exam, Assignment	Marking scheme
5	Project presentation	Rubric
6	Laboratory work	Rubric
7	Laboratory report	Rubric

In the course, Material Technology, the measurement of CO achievement is the total marks obtained by the students from all the assessment methods that are specific to the respective COs as shown in Table 2. The calculation is done without applying any weightage. Steps for calculating CO achievement scores use the following equation:

$$\frac{\textit{total marks obtained by students}}{\textit{total marks allocated for all assessments}} \times 100\% = \textit{CO achievement} \qquad (1)$$

The mark obtained from each student is ranked into five levels of achievement. Table 3 shows the ranking for CO achievement by the student. The results of CO achievement through direct measurement are shown in Figure 3.

Table 3
Ranking of CO Achievement in Material Technology

COs Scores (%)	Description
81-100	Excellent
61-80	Good
41-60	Fair
21-40	Poor
0-20	Very poor

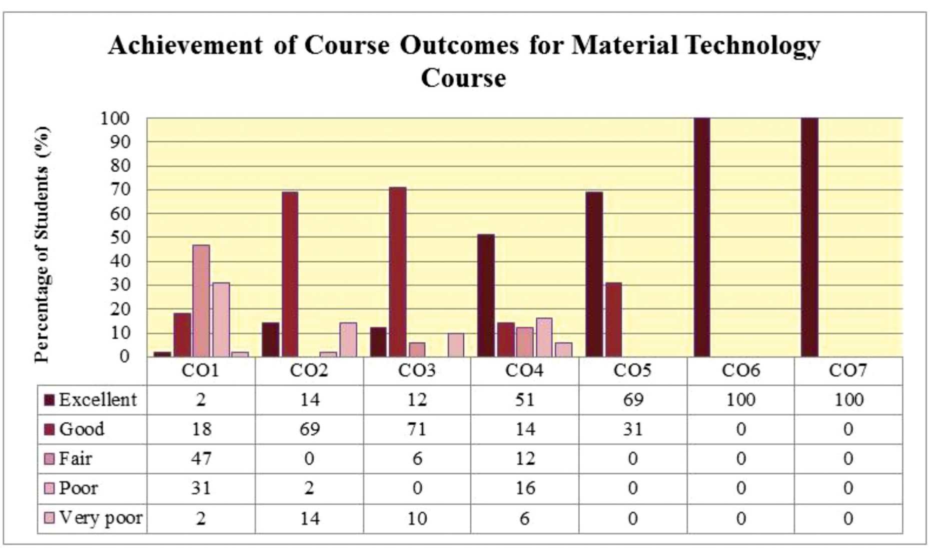

Figure 3. Achievement of Material Technology COs.

DISCUSSION

Instrument validation

From the output of WinStep®, summary statistics and the Item Measure Order were established. In WinStep® output, person represents the students while item represents the test questions. Table 4 shows the summary statistics of the pre-test and post-test. The summary statistics contained information on mean, standard deviation, minimum and maximum value, reliability and separation. For the pre-test, the summary statistics revealed that the consistency of the raw score was good, with a Cronbach Alpha value of 0.93. This validated the model as acceptable. The student reliability value was 0.80, indicating that there was a good spread of student ability within the sample that was used (Azrilah et al., 2013). The person ability spread between was maximum +26.0 logit and minimum +7.0 logit, while the mean person value was at +11.6 logit. The students could be grouped into approximately two groups (e.g. disagree, agree) based on the student separation value, G = 2.00, while the item could be grouped into two groups.

The purpose of the item measure table, as shown in Table 5 was to check the validity of the items which had three controls to be compared: point measure correlation, outfit MNSQ and outfit ZSTD. The range of acceptable criteria for each control was as follows: Point Measure = $0.4 < x < 0.8$; Outfit MNSQ = $0.5 < y < 1.5$; Outfit z-standard (ZSTD) = $-2 < z < 2$. Other than determining construct validity, analysis of the point measure correlation defined if the correlation was small. A small correlation meant that many students could not answer the question. If all three controls were not met, the question would be considered a misfit question. The results revealed that none of the questions was out of the range of the acceptable criteria. Therefore, all the questions were fit and valid; hence they could be used in the post-test.

Table 4
Summary Statistic for Indirect and Direct Assessment of Material Technology

Summary Statistics		Mean	SD	Max	Min	Cronbach Alpha	Reliability	Separation, G
Pre-test	Student	11.6	4.9	26.0	7.0	0.93	0.80	2.00
	Item	69.6	7.4	49.0	55.0		0.85	2.38
Post-test	Student	26.8	4.1	35.0	17.0	0.88	0.87	2.51
	Item	160.9	4.7	168.0	153.0		0.53	1.07

Table 5
Item Measure Order for Pre-test of Material Technology

ENTRY NUMBER	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT		OUTFIT		PT-MEASURE		EXACT	MATCH	Item
					MNSQ	ZSTD	MNSQ	ZSTD	CORR.	EXP.	OBS%	EXP%	
3	55	42	4.74	0.39	0.71	-0.9	0.45	-0.5	0.74	0.67	83.3	82.3	CO3_B
2	67	42	3.34	0.31	0.75	-1	0.52	-1.1	0.82	0.75	76.2	70.1	CO2_B
4	68	42	3.25	0.3	0.93	-0.2	0.86	-0.2	0.78	0.75	76.2	69.8	CO4_B
7	69	42	3.16	0.3	1	0.1	0.8	-0.4	0.77	0.75	76.2	69.5	CO7_B
6	71	42	2.99	0.29	1.24	1	1.87	1.9	0.69	0.76	73.8	67.8	CO6_B
1	78	42	2.44	0.27	1.05	0.3	1.09	0.4	0.77	0.77	69	64.3	CO1_B
5	79	42	2.36	0.27	0.77	-1.1	0.89	-0.3	0.79	0.77	69	63.6	CO5_B
MEAN	115.2	42	0	0.3	0.97	-0.1	0.99	0.1			71.3	68.6	
S.D.	46.1	0	3.24	0.03	0.16	0.7	0.32	0.7			6.1	4.4	

Back to Table 4, the summary statistics for the post-test showed that there were no big differences with the post-test results. The value of the Cronbach Alpha was 0.88, showing that the consistency of the raw score was good. The student reliability value was 0.87, also indicating that there was a good spread of student ability within the sample that was used. The persons' ability was spread between maximum +35.0 logit and minimum +17.0 logit while the mean person value was at +26.8 logit. Based on the student separation value, G = 2.59, there were approximately three groups of students while the item could be grouped into only one group separation (G=1.07).

Results of Direct and Indirect Assessments

The results of the two tests i.e. the pre- and post-test for indirect measurement both showed positive trends from the start to the end of the course. Referring to Figure 1, more than 80% of the students ranked their knowledge and ability to understand/ discuss and explain all the COs addressed in Material Technology as poor and very poor except for CO5. This was because CO5 addressed communication skills. Students had taken compulsory university courses in their first year that taught them how to improve their interpersonal skills. For the remaining six COs, however, they had an almost zero starting point of pre-existing knowledge about the course. However, by the end of the course, students perceived that they had understood and were knowledgeable in the seven COs. More than 60% of the students ranked their perception of the seven COs as excellent, good and fair.

On the other hand, direct measurement showed the real achievement of students. There was a difference between what students felt or expected and their actual knowledge and understanding as proven through marks scored on the examination and for coursework. Figure 3 shows that 100% of the students excelled in CO6 (Able to apply testing methods to determine the properties of fresh and hardened concrete under minimum supervision) and CO7 (Able to analyse the different types of concrete depending on intended application and requirement to strength and environment). Figure 3 also shows that 33% and 22% of the students had difficulty understanding the content of CO1 (Able to understand/explain/discuss the physical and engineering properties of Civil Engineering materials) and CO4 (Able to understand/explain/discuss testing of fresh and hardened concrete), respectively.

Analysis of students' final grades for the direct method and the results of student self-assessment questionnaires in the indirect method are compared and it was found that there was a definite difference. Students felt that they were knowledgeable in CO1 and CO4 but in reality, they could not really answer the questions on those respective COs in the examination and coursework. This shows that the students had overestimated their understanding of certain COs.

To make a clearer comparison, the number of students who had achieved the target set, which was fair and above for both assessments, were added up and compared. Table 6 and Figure 4 show the percentage of students who scored 'fair', 'good' and 'excellent' for both assessments. For the indirect assessment, the post-test was chosen because it was a reflection of student expectation of their knowledge at the end of the semester. The analysis showed that there were clearly a difference between the percentage of student achievement for CO1, CO2 and CO4 between the direct and indirect assessment method, which was 33%, 11% and 16%, respectively. Based on the results of direct assessment, the students seemed to find it difficult to understand or explain or discuss the basic Material Technology course. The gap difference was more than 10%; this was quite a big gap, showing that indirect assessment alone is not valid for determining student achievement. Lecturers need to know student expectations to develop a good continual quality improvement process. Meanwhile, for the rest of the Cos, which are CO3, CO5, CO6 and CO7, the gap difference was below 10%.

Table 6
Comparison of Student Achievement of COs from Indirect and Direct Assessment for Material Technology

Course Outcomes (COs)	Indirect Assessment (Post-test)	Direct Assessment	Difference
CO1	100	67	33%
CO2	95	84	11%
CO3	95	90	5%
CO4	95	78	17%
CO5	98	100	2%
CO6	95	100	5%
CO7	95	100	5%

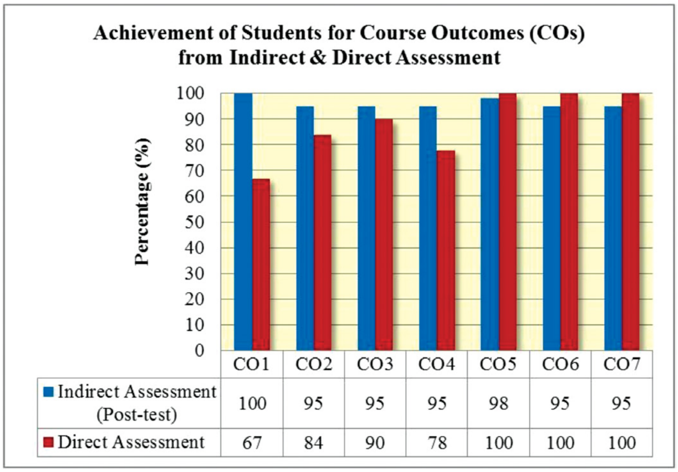

Figure 4. Achievement of students for course outcomes (COs) from indirect and direct assessment in Material Technology.

CONCLUSION

Direct and indirect assessment are both needed for attainment of Course Outcomes as seen from two different perspectives i.e. from lecturers and from students. The results of the analysis using both direct and indirect methods showed that three COs reflected extreme confidence on the part of students and another four COs reflected lack of confidence in students' perception. In addition, this study also stressed on the validity of the pre-test. The finding shows that the items that were used in the pre-test were good and acceptable and could be used in the post-test. It is important to consider that the post-test findings will be used to make a comparison between student perception and their real achievement. The Rasch Measurement Model was found to be an effective method to determine the test questions' construct validity and to identify misfit items.

In the continous quality improvement process, all stakeholders' opinions need to be considered. In this case, students are one of the stakeholders, and their expectations through indirect measurement is an important point to be noted. Combinations of the two assessments create a platform for holistic assessments. Holistic assessment is focussed on the whole process; the entire involved person is discussed as education is a two-way communication process that involves both students and lecturers.

This study provided a unique perspective of the assessment of learning comparing results from direct and indirect measures in Material Technology. The findings suggest that student perception of learning is not essentially reflective of knowledge content and practical laboratory skills mastery. Perception of learning seems to be a distinct construct from actual learning, and it may reflect student satisfaction with their experiences in the course, rather than their achievement of content and skills. Thus, student satisfaction with their educational experience deserves the attention of lecturers and administrators who are interested in improving programme quality.

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Study on the Impact of Team Teaching Using the Rasch Measurement Model: Perception of Students and Lecturers

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ABSTRACT

This article reports the results of team teaching practice at the Department of Electrical, Electronic and Systems Engineering (JKEES), Universiti Kebangsaan Malaysia (UKM). Two sets of questionnaires were used for lecturers and students to explore their perception of team teaching. A total of 21 lecturers and 253 students were chosen as survey respondents. The Rasch Measurement Model was employed to measure the reliability and validity of the survey instrument developed to evaluate the team teaching practice. Data were then analysed to identify the effectiveness of the team teaching method employed, and to measure its impact on students and lecturers. Results showed that the survey questions were developed with good individual and item reliability. Most of the respondents gave good feedback to the team teaching practice. Thus, students and lecturers perceive that team teaching as a method is effective and has positive impact on teaching and learning.

Keywords: Team teaching, Rasch Measurement Model, learning and teaching process

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INTRODUCTION

Team teaching is a complex activity that is conducted to actively support the teaching process towards the escalation of quality teaching and learning processes. This is evidenced by many reports by researches regarding team teaching (Fuller et al., 2001; Rowland, 2003; Mullin et al., 2006). Team teaching is an integrated process that involves many aspects to support the system. This is especially true for lecturers and students who are involved in the teaching and learning process. Members in team teaching must purposefully, regularly and cooperatively work as a group in setting the goals (Williams, 1997).

The team teaching approach is known as a part of nurturing the teaching and learning process among students and lecturers. However, it is the responsibility of the lecturers to conduct the appropriate approach in terms of promoting an inclusive education environment to students. Students also need to develop the skill to work in a group where interaction is needed to support the implementation of team teaching (Bergen, 1994).

In the Department of Electrical Electronics and Systems Engineering (JKEES), team teaching is defined as a group of two or more lecturers teaching a course to the same group of students. Team teaching in JKEES was implemented in 2009 but the effectiveness of its implementation has yet to be evaluated. Therefore, a survey instrument was developed to measure the effectiveness of team teaching as a teaching-and-learning method. The survey was targeted at two groups, namely, lecturers and students.

For subject evaluation, the Rasch Measurement Model was widely used to perceive the impact on undergraduate students who were pursuing subjects such as Microelectronic subject (Abdullah et al., 2012) and Space Science Education (Abdullah et al., 2013). Team teaching, as a supporting system that was arranged cooperatively, revealed the effectiveness of the teaching and study process towards student achievement.

In this study, the Rasch Measurement Model was used to measure the reliability and validity of the survey instruments that were developed. The Rasch Measurement Model offers many advantages in measuring reliability and the validity because the end results can be understood and they provide estimates of personal parameters. The Rasch Measurement Model can be used as a good tool assessment of a person's ability because this measurement software provides quantitative analysis as well as predictive and qualitative analysis (Ayob et al., 2011). The purpose of using the Rasch Measurement Model is to obtain data size category reaction. Basically, these data categories do not just use mathematical operations. Consequently, these data justify the conclusion using the mode and median in the process of scheduling data. Therefore, the results obtained can be used to measure the validity and the reliability of the instruments in measuring the impact of team teaching methods as perceived by lecturers and students.

METHODOLOGY

Two sets of questionnaires were designed, one for lecturers and another for students. The questionnaire for lecturers was divided into two parts: (i) information on the background and experience of the lecturers in a team-teaching environment and (ii) a total of 17 questions about the perception of the teaching team. The questionnaire to the students was also divided into two parts: (i) information about the students' background and experience of students in a team-teaching environment and (ii) a total of 23 questions about their perception of the teaching team. The questionnaires used the Likert scale from "strongly disagree" (1) to "strongly agree" (5). Responses to the survey questions were received from 21 lecturers and 253 students. This study used a descriptive statistical analysis and the Rasch Measurement Model to see how team teaching impacted the perception of the students and lecturers. According to (Kubinger, 2009), the Rasch Measurement Model can be used to measure the perception of the effectiveness of the teaching team.

RESULTS AND DISCUSSION

The summary of statistical and individual item categories for each lecturer is shown in Tables 1 and 2, respectively. Table 1 shows that the perception of lecturers who participated in team teaching showed a significant response, with an individual test score of 0.71 for the Cronbach alpha. This shows the satisfaction of the lecturers with team teaching. According to the instrument scale criteria rating, this value indicates a good score (Fisher, 2007).

Table 1
Summary Statistics of Measured Person (Lecturer)

SUMMARY OF 21 MEASURED Person

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	73.7	22.0	.73	.29	1.00	.0	.99	-.1
S.D.	6.6	.0	.54	.01	.35	1.1	.38	1.1
MAX.	84.0	22.0	1.62	.31	2.10	2.9	2.23	3.1
MIN.	59.0	22.0	-.42	.27	.55	-1.7	.59	-1.5

REAL RMSE .31 TRUE SD .45 SEPARATION 1.46 Person RELIABILITY .68
MODEL RMSE .29 TRUE SD .46 SEPARATION 1.59 Person RELIABILITY .72
S.E. OF Person MEAN = .12

Person RAW SCORE-TO-MEASURE CORRELATION = 1.00
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .71

Table 2
Summary Statistics of Measured Item (Lecturer)

SUMMARY OF 21 MEASURED Item

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	72.7	21.0	.00	.29	1.00	-.2	.99	-.3
S.D.	17.9	.0	1.41	.04	.53	1.9	.50	1.8
MAX.	94.0	21.0	4.07	.44	2.03	2.8	2.09	3.0
MIN.	28.0	21.0	-1.80	.25	.23	-4.0	.24	-3.7

REAL RMSE .33 TRUE SD 1.37 SEPARATION 4.20 Item RELIABILITY .95
MODEL RMSE .30 TRUE SD 1.38 SEPARATION 4.64 Item RELIABILITY .96
S.E. OF Item MEAN = .32

The summary statistics shown in Table 1 and 2 show that the measured items represent 21 questions from the questionnaire that revealed a very good answer of 0.95 among the lecturers. This is an excellent spread for the items in the questionnaire.

Table 3 shows the summary statistics for individual categories while Table 4 presents a summary of the item statistics for students. In Table 3, the tabulated measured person data of students indicated good consistency with the raw score given by Cronbach's alpha of 0.80. In the summary of statistics, the measured item maximum reliability value is 1.00. This provides an interpretation of the results for satisfaction with team teaching that can be shown on a measurement ruler. The maximum item on the logit ruler used is 3.20 and the minimum is -1.43.

Table 3
Summary Statistics of Measured Person (Student)

SUMMARY OF 253 MEASURED Person

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	108.0	35.0	.13	.24	1.00	-.3	.99	-.3
S.D.	9.5	.0	.54	.01	.55	2.0	.54	2.0
MAX.	140.0	35.0	2.10	.27	3.85	7.2	3.93	7.4
MIN.	69.0	35.0	-2.01	.23	.20	-5.0	.19	-5.3

REAL RMSE .26 TRUE SD .47 SEPARATION 1.81 Person RELIABILITY .77
MODEL RMSE .24 TRUE SD .48 SEPARATION 2.03 Person RELIABILITY .80
S.E. OF Person MEAN = .03

Person RAW SCORE-TO-MEASURE CORRELATION = 1.00
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .80

Table 4
Summary Statistics of Measured Item (Student)

SUMMARY OF 34 MEASURED Item

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	796.1	253.0	.00	.09	.97	-1.0	.99	-.8
S.D.	211.1	.0	1.46	.01	.44	4.4	.45	4.4
MAX.	997.0	253.0	3.20	.11	2.56	9.9	2.58	9.9
MIN.	356.0	253.0	-1.43	.08	.43	-9.0	.44	-8.7

REAL RMSE .09 TRUE SD 1.45 SEPARATION 15.47 Item RELIABILITY 1.00
MODEL RMSE .09 TRUE SD 1.45 SEPARATION 16.48 Item RELIABILITY 1.00
S.E. OF Item MEAN = .25

MAXIMUM EXTREME SCORE: 1 Item
UMEAN=.0000 USCALE=1.0000

The mean person measure in the summary statistics for lecturers as shown in Table 1 is 0.73 compared to 0.8 for students' (Table 3). This indicates that in general, both lecturers and students are satisfied with the expected output of the team teaching programme.

Table 5 shows the maximum measure of items (questions for students) where the value of the item reliability is 1.00. This is a high value of reliability and showed great consistency. In question number 4, the students were asked to give their opinion on whether team teaching leads to better student performance. Almost all the students agreed with the question because according to them, team teaching led to better performance and created a good environment for learning. As a result, the students were able to achieve the course objectives in every semester.

Table 5
Item Measured Table (Student)

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PT-MEASURE CORR.	PT-MEASURE EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%	Item
4	253	253	9.35	1.82	MAXIMUM MEASURE				.00	.00	100.0	100.0	Q4
5	356	253	3.20	.11	.82	-1.9	.95	-.5	.06	.30	60.5	63.6	Q5Q
9	375	253	2.98	.11	.76	-2.7	.82	-1.9	.10	.31	51.4	58.5	Q9
8	379	253	2.93	.10	.64	-4.3	.68	-3.6	.29	.32	58.1	57.3	Q8
7	397	253	2.75	.10	.73	-3.3	.75	-2.9	.04	.33	51.4	53.6	Q7
3	421	253	2.52	.09	1.34	3.5	1.46	4.6	-.12	.34	39.5	49.9	Q3
6	426	253	2.48	.09	.64	-4.8	.67	-4.2	-.04	.34	56.1	49.4	Q6
1	570	253	1.41	.08	1.93	9.0	1.94	9.1	.09	.38	28.1	46.9	Q1
11	594	253	1.26	.08	.51	-7.4	.52	-7.2	.36	.39	60.1	46.3	Q11
10	727	253	.44	.08	.43	-9.0	.44	-8.7	-.06	.39	72.3	45.4	Q10
2	763	253	.21	.08	2.56	9.9	2.58	9.9	.13	.39	12.6	45.8	Q2
26	764	253	.21	.08	1.43	4.6	1.43	4.6	.43	.39	34.8	45.8	Q26
34	830	253	-.21	.08	1.20	2.3	1.24	2.6	.23	.38	50.6	46.2	Q34
25	845	253	-.31	.08	1.05	.6	1.06	.7	.25	.38	51.4	46.8	Q25
32	846	253	-.32	.08	1.24	2.6	1.27	2.9	.18	.38	46.2	46.8	Q32
35	861	253	-.42	.08	1.84	7.9	1.89	8.2	.16	.38	39.9	47.1	I0035
27	892	253	-.63	.08	1.05	.6	1.05	.6	.46	.37	54.2	48.5	Q27
30	902	253	-.70	.08	.67	-4.1	.68	-4.1	.55	.37	58.5	49.0	Q30
28	906	253	-.73	.08	1.35	3.6	1.37	3.8	.22	.37	45.1	49.1	Q28
31	907	253	-.74	.08	1.03	.4	1.02	.3	.54	.37	50.2	49.6	Q31
24	913	253	-.78	.09	.87	-1.6	.87	-1.5	.57	.36	54.2	49.8	Q24
23	934	253	-.94	.09	.60	-5.2	.61	-5.1	.60	.36	62.8	51.6	Q23
33	934	253	-.94	.09	.80	-2.4	.80	-2.3	.54	.36	56.9	51.6	Q33
15	935	253	-.94	.09	.78	-2.6	.78	-2.6	.64	.36	57.7	51.7	Q15
22	936	253	-.95	.09	.67	-4.2	.68	-4.1	.62	.36	59.3	51.7	Q22
21	946	253	-1.03	.09	.76	-2.8	.76	-2.9	.63	.36	60.5	52.5	Q21
12	957	253	-1.11	.09	.84	-1.8	.84	-1.9	.53	.35	63.2	53.1	Q12
17	958	253	-1.12	.09	.61	-5.0	.62	-4.9	.58	.35	64.0	53.2	Q17
14	960	253	-1.13	.09	1.21	2.3	1.20	2.1	.45	.35	49.8	53.3	Q14
19	966	253	-1.18	.09	.72	-3.5	.71	-3.5	.64	.35	62.5	53.7	Q19
20	966	253	-1.18	.09	.67	-4.2	.67	-4.1	.65	.35	61.3	53.7	Q20
29	966	253	-1.18	.09	1.04	.5	1.05	.6	.32	.35	53.8	53.7	Q29
13	968	253	-1.20	.09	.72	-3.4	.71	-3.5	.42	.35	63.6	53.8	Q13
18	970	253	-1.21	.09	.73	-3.3	.74	-3.2	.61	.35	57.7	53.9	Q18
16	997	253	-1.43	.09	.71	-3.5	.71	-3.6	.61	.34	63.2	55.2	Q16
MEAN	780.6	253.0	.27	.14	.97	-1.0	.99	-.8			53.3	51.1	
S.D.	226.8	.0	2.12	.29	.44	4.4	.45	4.4			11.5	4.0	

Table 6 shows the maximum measure of items (questions for lecturers). Table 6 shows that question item number one had the high value of 1.00. It had a significant correlation with the question given to the students. Question number one stated that team teaching meant organising lecturers into groups to enhance teaching and learning. All the lecturers agreed with the statement in the questionnaire and gave a high score for the item measurement.

Table 6
Item Measured Table (Lecturers)

Item STATISTICS: MEASURE ORDER

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PT-MEASURE CORR.	PT-MEASURE EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%	Item
1	21	21	7.56	1.83	MAXIMUM MEASURE				.00	.00	100.0	100.0	Q1
3	28	21	4.07	.44	.89	-.2	.93	-.1	.17	.25	61.9	67.8	Q3
5	42	21	2.23	.31	.31	-2.8	.32	-2.8	.49	.34	81.0	55.5	Q5
15	47	21	1.78	.29	1.60	1.7	1.54	1.6	.46	.37	47.6	51.1	Q15
20	55	21	1.17	.26	2.01	2.8	2.09	3.0	.14	.40	19.0	43.0	Q20
2	59	21	.90	.26	.24	-4.0	.27	-3.7	.43	.42	81.0	41.7	Q2
21	61	21	.77	.26	1.50	1.7	1.55	1.8	-.14	.42	19.0	42.0	Q21
4	62	21	.71	.25	.86	-.5	.87	-.4	.24	.42	57.1	40.3	Q4
7	66	21	.45	.25	1.23	.9	1.27	1.0	.47	.43	33.3	39.8	Q7
12	77	21	-.28	.26	.55	-1.8	.58	-1.6	.54	.42	47.6	45.9	Q12
8	79	21	-.42	.27	.82	-.5	.77	-.7	.64	.41	61.9	46.0	Q8
11	80	21	-.49	.27	.23	-3.9	.24	-3.7	.78	.41	81.0	45.8	Q11
18	80	21	-.49	.27	.68	-1.1	.69	-1.1	.56	.41	52.4	45.8	Q18
10	83	21	-.72	.28	.83	-.5	.83	-.5	.27	.39	57.1	47.4	Q10
19	83	21	-.72	.28	1.68	2.0	1.70	2.0	.39	.39	19.0	47.4	Q19
13	86	21	-.97	.30	1.17	.6	1.11	.5	.54	.38	47.6	47.9	Q13
16	86	21	-.97	.30	.73	-.8	.75	-.8	.37	.38	52.4	47.9	Q16
9	87	21	-1.06	.30	.46	-2.0	.48	-2.0	.44	.37	71.4	48.5	Q9
14	90	21	-1.35	.32	1.48	1.4	1.32	1.0	.48	.35	47.6	50.8	Q14
22	90	21	-1.35	.32	2.03	2.6	1.73	2.0	.36	.35	52.4	50.8	Q22
6	91	21	-1.45	.33	.95	-.1	.86	-.3	.60	.35	52.4	51.7	Q6
17	94	21	-1.80	.36	.81	-.5	.83	-.4	.30	.32	57.1	56.8	Q17
MEAN	70.3	21.0	.34	.36	1.00	-.2	.99	-.3			52.4	48.3	
S.D.	20.5	.0	2.09	.32	.53	1.9	.50	1.8			18.1	6.2	

The result of the Rasch analysis is highlighted in Figure 1. Of notice is question Q17, which asked lecturers whether a team-teaching group should have different areas of expertise. The majority of the answers were neutral to this question. According to the lecturers, different expertise was not the key to success in encouraging a proper teaching and learning process among students; rather, team teaching required shared understanding and cooperation as a team.

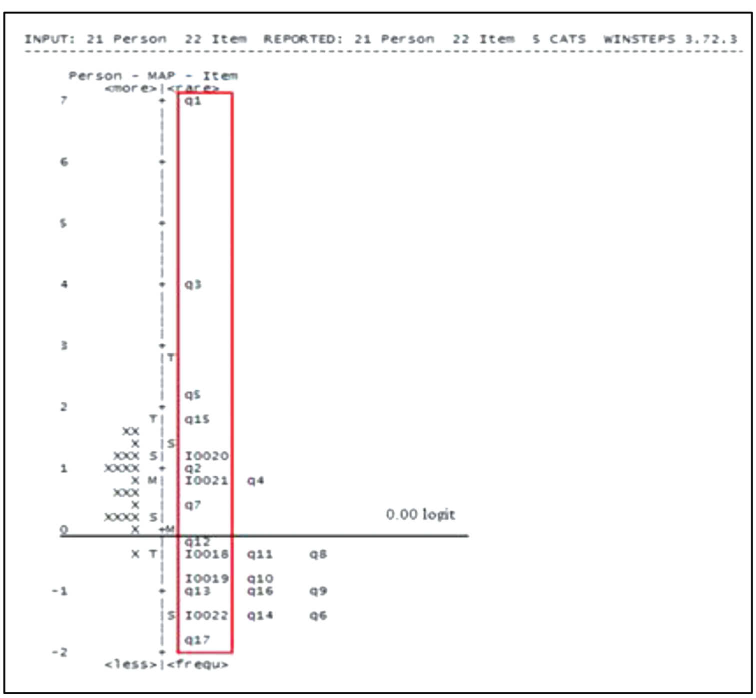

Figure 1. PIDM for team teaching analysis (lecturer).

The Rasch Measurement Model is a unique software that was able to give a quick summary of students' interest and involvement in team teaching. This is shown in the Person-Item Distribution Map (PIDM) of Figure 2. The students were involved in team teaching in the current and previous semesters. The aim of the questions was to confirm how many students were actively involved in team teaching method for different subjects. As can be seen from Figure 2, almost all the students agreed that team teaching was effective, as they were actively involved lessons that used team teaching as a method.

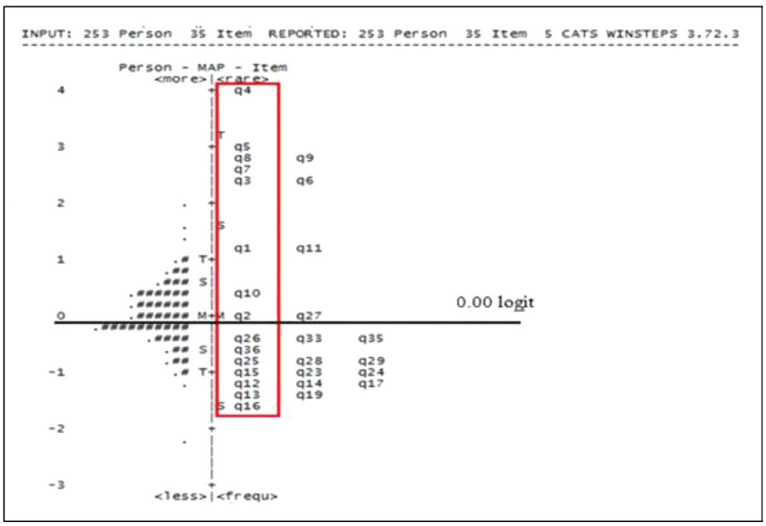

Figure 2. PIDM for team teaching analysis (student).

CONCLUSION

The Rasch Measurement Model was an appropriate model to analyse persons and items in this study. It is observed that the majority of the respondents gave positive feedback in the questionnaire to the method of team teaching to deliver teaching and learning. In the Rasch Measurement Model, the use of the logit ruler was useful in measuring specific outcomes such as the perception of lecturers and students of the team teaching method. It was observed that team teaching was well-tolerated and can be used to improve the teaching and learning process in JKEES, UKM.

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Customer Focus Practice Among Skills Training Institutions in Malaysia and the Performance of Organisations

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ABSTRACT

Customer focus is essential in ensuring the performance of an organisation including education and training organisations. Customers in the education and training sectors consist of a variety of groups including students, parents, industry, civil society and the relevant authorities. Other than that, the faculty and staff are also internal customers whose needs and expectation need to be satisfied. Students are the main customers, and they receive training and support services at institutions. Instructors and staff are prime movers in training and services in an institution. However, research and literature on customer focus practices in the education and training sectors are still limited, particularly in the skills training sector in Malaysia. This study is carried out so that the gap can be reduced. This study aimed to examine the extent to which customer focus is practised by skills training institutions in Malaysia and to evaluate the extent of the impact of this focus on the performance of institutions that offer such training. A questionnaire survey was used as the research instrument. Questionnaires were distributed to the managers of 500 training institutions throughout the country. A total of 218 completed and eligible questionnaires for analysis were received, representing a response rate of 43.6%. Data were analysed using descriptive and inferential statistical techniques. The results show that student, instructor and staff focus practice are is at a moderate level, which is at about five of seven points on the Likert scale. The regression analysis shows that the student focus and the instructor and staff focus significantly affect the performance of the

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institutions. These findings demonstrate that customer focus greatly influences the performance of the organisation, and therefore, management of these institutions should increase efforts to ensure customer satisfaction.

Keywords: Customer focus, organisation's performance, skills training

INTRODUCTION

Customer focus refers to the level an organisation meets the needs and expectations of the customer on an on-going basis (Zhang, 2000). Customer focus is one of the main pillars of the Total Quality Management (TQM) (Hackman & Wagemen, 1995). In a highly competitive business environment, one of the most intense pressures for the management of the organisation is to focus on the customers' needs (Piercy, 1995). The key to quality management is maintaining close contact with customers so that the customers' needs can be completely understood and the requirements can be fulfilled and further accepted by the client (Zhang, 2000). Information about the needs, wishes, complaints and customer satisfaction should be collected and analysed (Zhang, 2000; Lagrosen et al., 2004; Phusavat et al., 2009). Only organisations that meet the requirements and needs of the customers will be able to continue to operate and compete effectively in the present business market. Organisations need to be aware of the need to keep the customer as the main focus in the decision-making process and practise a customer-centred culture.

The same is true for the education and training sectors. Moreover, the education and training sectors need to manage various groups of customers, both internal and external. However, the research and literature on customer focus practices in the education and training sectors are still limited, in particular, concerning the skills training sector in Malaysia. Thus, this study was carried out so that the gap can be reduced. This study aimed to identify the extent to which customer focus is practised among the skills training institutions in Malaysia and to evaluate the extent of the impact of this focus on the performance of the institutions.

LITERATURE REVIEW

Customers are individuals who receive or have the effect of a product or service (Juran, 1988). Training and educational institutions need to meet the needs and expectations of the different customer groups and stakeholders including students, alumni, parents, employers and government (Mahapatra & Khan, 2007). According to Frazier (1997) there are two types of customer in the education sector, namely internal and external customers. Internal customers are those individuals or groups who directly produce and consume the product or service. They include the instructors, supporting staff, students, administrators etc. while the external customers are those individuals or groups who have an interest in the product or services but do not produce or consume it directly. They include employers, parents, tax payers and the government.

The training institution is responsible for providing the best possible services to ensure that they are viewed positively by customers. Quality of services provided is fundamental to the training institution if it wishes to succeed in the competition for resources, instructors and students and the increasing demands and expectations of stakeholders in terms of quality and accountability (Shelnutt & Buch, 1996). It is necessary to measure customer feedback so that service quality can be efficiently managed. Customer feedback is very useful for evaluation and improvement (Abili et al., 2011).

Feedback from the students as the main customer allows the training institution to evaluate its service quality. Students are the customer group that should be given priority because they are the direct recipients of training and use most of the services provided. The students' relationship with service providers is different from the relationship between the main customer and service providers from other sectors because in the education sector, instructors and students must work together to achieve effective learning. The absence of cooperation between the two parties leads to ineffective training delivery.

The implementation of good quality management will affect the students. Sakthivel et al. (2005) has developed a model of total quality management (TQM) for academic excellence and empirically tested the relationship between TQM implementation and student satisfaction in terms of academic performance. The study found a significant relationship between student satisfaction with academic performance with five constructs of TQM, namely, the commitment of top management, course delivery, campus facilities, friendly service and customer feedback and improvement.

Jalali et al. (2011) also identified the factors that affect student satisfaction in higher education institutions in Malaysia. They found that academic activities are more important than non-academic activities. However, academic activities are not limited only to activities in the classroom but include aspects that can develop good values, attitudes, behaviour and personality of the students. Douglas et al. (2006) in their study to measure student satisfaction in a university in the United Kingdom also found that the most important aspect in determining student satisfaction relates to teaching and learning.

However, Douglas et al.'s (2006) findings that the relevant aspects of physical facilities are less important in influencing student satisfaction are contrary to findings by Sapri et al. (2009), who found that the facilities provided by the institution are the most important aspect. They stated that physical facilities are the pull factor that will influence the student to register. When the student has enrolled, then teaching and learning becomes more important than the physical facilities. However, this study involved only one university in the United Kingdom that was equipped with the latest facilities and equipment, so this aspect was not an issue for the students. A study by Sapri et al. (2009) involving universities in Malaysia found that factors such as libraries, laboratories and campus environment were important from the perspective of the students.

Petruzzellis et al. (2006) conducted case studies at a university in Italy regarding student satisfaction and service quality. The findings showed that universities should focus their efforts on improving the quality of both teaching and non-teaching aspects to ensure that they could react to and handle the request and the good economic environment well.

Besides focussing on providing quality service to the students, the instructor factor is also noteworthy. One important factor in determining the quality of education and the training programmes is the quality of the teaching staff. The instructors are responsible for trainees, employers in the industry, community and the government. The skills and efficiency of the instructors are the important factors in determining the success of the teaching process. One of the efforts that can be implemented to improve the quality of the instructors is to raise their level of education and qualifications. According to Jovanova- Mitkovska (2010), the development of instructors is really important nowadays in order to develop trainees in order to:

- Create an environment of lifelong learning for all;
- Provide opportunities for the improvement of specific and general knowledge, expertise, professional and academic progress;
- Enhance knowledge and information to increase performance;
- Improve and innovate in training delivery;
- Provide impact on teamwork and collaboration among instructors; and
- Transform strategies and methods of teaching.

Instructor development is a process of long-term sustainable development starting from the beginning to the end of an instructor's career. The development process consists of various methods including training in new knowledge, skills, strategies in specific areas and the use of technology. Training institutions should create an environment that encourages teaching staff to improve their professionalism, knowledge and skills and to develop their career.

It can be concluded then that the satisfaction of internal and external customers is important in determining the consistency of training and educational institutions. Failure of the institution to meet these requirements will affect the well-being and resilience of the organisation.

METHODOLOGY

The questionnaire was used in this study to measure the performance of customer focus practices among training institutions in Malaysia and its' influence on the performance of the institution. The respondents were made up of managers of the training institutions, who provided feedback on the extent to which the institution is orientated towards internal and external customers. The survey questionnaire is a popular method for collecting data because the information is readily available and the answer is easy to encode (Sekaran, 2003). Content validity of the measurement instruments is considered acceptable as all the items in the questionnaire were identified through a thorough literature review and consultation with experts in academic and skills training.

The survey covered three main parts. Part one contained a statement of research objectives and questions relating to the background of the training institutions. The second part measured the implementation of TQM principles and performance of the institutions using a 7-point Likert scale. The final section contained demographic information including information on gender, age, position, work experience and scope of work. Questionnaires were sent via e-mail and mailed to 500 respondents based on their convenience. The respondents were officers at the managerial level and above from 500 training institutions nationwide. The survey was conducted over three months starting in August 2013 and ending in November 2013. A total of 218 respondents (43.6%) returned the completed questionnaires. Data were recorded and analysed using descriptive and inferential statistical techniques.

Two hypotheses were developed to focus on customer-related practices and their impact on the performance of the institution.

i. Student focus practice has a positive effect on the performance of the institution.
ii. Instructor and staff focus has a positive impact on the performance of the institution.

Instructor and staff represent two groups of internal customers who need to be focussed on by top management. These two groups are equally important in ensuring service quality in training institutions.

RESULTS

Demographic Information of the Respondents

Table 1 shows the demographic information of the respondents. Of the 218 respondents, 52.3% were male and 47.7% were female. The majority of the respondents were aged between 31 and 40 years (48.6%), followed by those aged 21 to 30 years (29.4%) followed by those aged 41 to 50 years (13.8%). Most of them (78%) were from public training institutions and the rest were from private training institutions. More than two thirds of the respondents (71.6%) had less than 10 years' working experience.

Table 1
Demographics of Respondents

Item	Number	%
Gender		
Male	114	52.3
Female	104	47.7
Age (years)		
21 to 30	64	29.4
31 to 40	106	48.6
41 to 50	30	13.8
more than 50	18	8.2
Working Experience (years)		
Below 5	81	37.2
5 to 10	75	34.4
11 to 20	44	20.2
More than 20	18	8.2
Type of Institution		
Public	170	78.0
Private	48	22.0

Instrument's Reliability

The internal consistency of the scale of measurement was estimated using the Cronbach Alpha Reliability Coefficient. Cronbach Alpha values for the three constructs were between 0.930 and 0.947 as shown in Table 2. Cronbach Alpha values beyond 0.70 show that the scale of measurement was consistent and reliable. Therefore, the measurement instruments can be considered to have a degree of acceptable internal consistency reliability.

Table 2
Cronbach Alpha Value

Construct	No. of Items	Cronbach Alpha
1. Student focus	11	0.943
2. Instructor and staff focus	11	0.930
3. Institution performance	10	0.947

Level of Customer Focus Practice

Table 3 shows the mean scores for items related to the students' focus practice in the skills training institutions. Mean scores ranged from 5.16 to 5.49 on a scale of 7 where there was still room for improvement. Improvement can be done particularly in both core functions and supportive functions of the training institutions. Mahapatra and Khan (2007) indicated that students are generally assumed to be the principal customers and that they take on different roles within the institution. They are also the product of the process, the internal customers for many campus facilities and training delivery.

Table 3
Mean Score Values of Student Focus Practice

No.	Item	Mean	St. Dev.
1.	We have an established mechanism for identifying student needs and expectations.	5.16	.981
2.	We provide a conducive learning environment.	5.35	.915
3.	We have an effective employment service unit/student placement.	5.35	.879
4.	Our training programmes are dynamic and change as the market changes.	5.45	.853
5.	We use feedback from stakeholders to evaluate the programmes offered.	5.33	.892
6.	We take into account changes in training and service delivery methods.	5.38	.852
7.	Global and international needs are taken into account in designing our programmes.	5.34	.944
8.	We build active and ongoing relationships with students.	5.49	.907
9.	We have a mechanism to allow students to submit complaints about our programmes and services.	5.41	.887
10.	We create effective mechanisms to determine student satisfaction or dissatisfaction.	5.38	.873
11.	We use the information on student satisfaction and dissatisfaction to improve our training programmes and services.	5.43	.914
	Student Focus Mean	**5.37**	**.717**

The overall mean of student-focussed practice is 5.37. Student-focussed practice includes the identification of customer needs and expectations, providing an atmosphere and facilities that are conducive to learning, support services, relevant training programmes, good rapport with students and student feedback management. These things need to be improved on an on-going basis to ensure lasting student satisfaction with their training institutions.

Student satisfaction is influenced by various factors including factors related to the core and supportive functions of a training institution. Core functions are aspects that are related to teaching and other learning activities such as the competency of the instructor, curriculum, training delivery and training equipment. On the other hand, supportive functions are elements such as physical facilities, support services, library, and campus environment that affect the quality of students' daily lives. A thorough evaluation of these factors would help administrators in improving the quality of their training services and student satisfaction (Stukalina, 2012).

Instructor and staff focus involves matters such as communication systems, opportunities for lifelong learning, performance management, reward and recognition, human resource management and career advancement (see Table 4). The overall mean score of instructor and staff focus practice was 5.34, where the mean for each item was between 5.11 and 5.51 on the scale of 7 points.

To ensure that instructors are competent in facilitating knowledge and skills, the institutions need to invest in instructor development through training and industrial attachment. Competency in both theory and practice of instructors is a key asset to the effectiveness of the learning experience of students.

Table 4
The Mean Score Value of Instructor and Staff Focus

No.	Item	Mean	St. Deviation
1.	We have an effective communication system across departments and functions.	5.36	1.021
2.	We ensure continuous education and training is provided to staff and instructors.	5.51	.897
3.	Our performance management system includes feedback to instructors and staff.	5.46	.911
4.	Our reward and recognition system is based on the students' evaluation of the instructors' performance in the classroom and workshop.	5.28	1.048
5.	Our reward and recognition systems include rewarding the achievement of best performance.	5.26	.940
6.	We have an effective method for managing the recruitment of instructors and staff.	5.22	.914
7.	We have an effective method to retain instructors and staff.	5.11	.968
8.	We ensure that instructors and staff show a variety of ideas and suggestions.	5.33	.989
9.	We manage an effective career development for all staff, administration and instructors.	5.26	.926
10.	We encourage the use of new knowledge and skills acquired by instructors and staff in the workplace.	5.48	.942
11.	We provide many opportunities for the development of skills and professionalism of the instructors and staff.	5.43	.894
	Instructor and Staff Focus Mean	**5.34**	**.739**

The overall mean score for the performance of the institutions is 5.33, where the mean for each item is between 5.11 and 5.56 (see Table 5).

Table 5
Mean Score Value of Institution Performance

No.	Item	Mean	St. Dev.
1.	Overall students' achievement	5.45	.750
2.	The effectiveness of our training programme	5.56	.779
3.	Increased student intake	5.28	.932
4.	Positive feedback from students and stakeholders	5.44	.830
5.	View/evaluation of students and stakeholders of the organisation	5.36	.803
6.	Institutional relationships with former students (alumni loyalty)	5.11	.966
7.	Feedback from students and stakeholders based on their assessment of our training activities	5.28	.827
8.	Satisfaction levels of instructors and supporting staff	5.23	.927
9.	Experiencing an increase in the quality of service delivery regarding training and support service	5.34	.801
10.	An increase in short-term training and consultancy services to the industry	5.30	.869
	Institute Performance Mean	**5.33**	**.699**

The performance of institutions involves the students' achievement, programme effectiveness, student recruitment, customer feedback, relationships with alumni, customer satisfaction and service quality improvement.

Sapri et al. (2009) found that students' learning experience is influenced by three major factors, namely, lecturer's performance; service or process that is involved in delivery of the service; and facilities that support the core process. This is in line with Hill et al. (2003), who found in their study on student perception of quality experience in higher education that the quality of the lecturer and the student support system is the most influential factor. The quality of the lecturer's service includes delivery in the classroom, feedback to students and relationship with students.

The Relationship between Customer Focus and Performance Practices of the Institution

The correlation analysis was conducted to identify the relationship between the customer focus variables and performance of the institution. The results are shown in Table 6. The correlation analysis results showed that the relationship between customer focus practices and organisational performance was strong and positive, where the correlation coefficient (R) was 0.739 and 0.764, respectively for student focus and instructor and staff focus. In conclusion, customer focus practice has a significant relationship with the performance of the institution.

Table 6
The correlation Between Customer Focus and Performance of the Institution

Factor	Correlation coefficients (R)
Student Focus	.739**
Instructor and Staff Focus	.764**

Further, the multiple regression analysis was conducted to explore how customer focus practices affect the performance of the institution. The Stepwise Linear Regression method was used because it is more time-saving. Only significant predictor variables were included in the regression model (Piaw, 2006). The analysis results showed that both variables, that is, student focus and instructor and staff focus, significantly affected the performance of the institute. The coefficient of determination R2 was 0.633, indicating that changes in the variance of student focus and instructor and staff focus resulted in a change of 63.3% of the variance in performance of the institution. Table 7 shows the results of the regression analysis.

Table 7
Results of the Regression Analysis

Model	Unstandardised Coefficient		Standardised Coefficient	t	Sig.
	B	Std. Error	Beta		
(Constant)	1.005	.226		4.447	.000
Instructor and Staff Focus	.453	.062	.479	7.294	.000
Student Focus	.356	.064	.365	5.563	.000

Discussion

Overall, customer focus practice among the training institutions in Malaysia are moderate in view of all the items that did not reach the minimum score value exceeding 6 of the 7 Likert-scale points. The results of the regression analysis showed that the student, instructor and staff focus practice affected performance of the organisation, illustrating that customer focus practice should be a priority for all training institutions. The needs and expectations of the students should be given priority in terms of training and implementation and support services. This finding is consistent with the findings of Sultan and Wong (2013), who found that the three aspects that determine the quality of service in institutions of higher learning are the academic, administrative and facilities aspects.

An organisation that is focussing on customer management inevitably needs to also focus on its employees as an internal customer. Organisations can only provide satisfaction to customers if their employees are deriving work satisfaction (Chen et al., 2006). Instructors are the main source in the process of training delivery. Instructors should be viewed as internal customers of the training institution. An effective communication system should be established in an organisation to ensure effective information sharing. This would improve employee satisfaction, thereby improving job performance and further affecting the improvement of organisational performance. In an era of rapid technological changes in the industrial market, knowledge and skills of the instructors should always be improved through training and continuous education. In order to maintain the performance of instructors, performance management and reward systems must also be well managed. Career advancement should be addressed to ensure employees' loyalty and to motivate employees to improve business results. The findings of this study support the findings of Dobre (2013), which showed that if recognition for employees is increased, employee motivation will also increase and further improve the quality of work and organisational performance.

CONCLUSION

Overall, this study showed that the practice of customer focus by skills training institutions in Malaysia still needs to be improved. Satisfaction of the customer is crucial to the survival of training institutions. The factors that influence customer satisfaction are made up of factors associated with teaching and non-teaching aspects. Therefore, both aspects need to be taken into consideration in the quality improvement initiative. Customer focus practice has a strong relationship with the institution's performance, which means that the increase in customer focus practice will improve the overall performance of the institution. Customer focus practice is the human dimension of quality management; the education and training sector involve many dimensions of humanity, whether at the input, process or output stage.

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Relationship between the Critical Factors for Success in Training Service Quality in UKM

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ABSTRACT

Quality is something that should be given emphasis in all work and every activity undertaken. If quality becomes the priority, results will have an impact. Therefore, quality should be emphasised. Keeping this in view, the leading objective of this study is to identify the relationship between critical factors for success in training services that will influence student satisfaction by organising training in Universiti Kebangsaan Malaysia (UKM). The factors involved are the object quality, process quality, quality of the infrastructure, the quality of interaction and environmental quality. A questionnaire was developed and distributed to the students who had participated in the training organised by UKM. Frequency analysis and correlation analysis were used to analyse the data collected. Model validation is carried out to obtain the validity and sustainability of the model developed. The overall results of the analysis revealed that the highest Pearson value, which approximates the value of 1, is between the interaction quality and the environmental quality, which is 0.84. This high correlation indicates a strong relationship between the interaction quality and the environmental quality. The relationship of the object quality and the quality of infrastructure gives the lowest Pearson value of 0.651. There are proposals to improve the quality of training in the future, such as extending the period of training, diversifying activities and training content to be more attractive and using the online registration approach to simplify work processes and save time. The evaluation of this study should be taken into account to ensure

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that the defect can be overcome and to strengthen the training service management at the university.

Keywords: Customer satisfaction, correlation, quality, quality of service, training, students

INTRODUCTION

For the last two to three decades, quality has been considered as one of the leading requirements of work. The Malcolm Baldrige National Quality Award (MBNQA) was developed in the late 1980s to provide a standard of excellence in quality for manufacturing and service companies in the United States (Rungtusanatham, Forza, Koka, Salvador, & Nie, 2005). This initiative and many other award programmes aimed at encouraging quality in work around the world, such as the European Quality Award, have caught the attention of senior executives. Top management are now aware that customers and internal suppliers or employees play a role in the effort to improve the quality of an organisation (Stanley & Wisner, 2001).

The importance of quality in meeting customer demand is that quality gains the customer's loyalty. The importance of maintaining customer loyalty is lies in its ability to retain customers so that there is less need to search for new ones. The longer a relationship can be maintained with customers, the higher the profit, as loyal customers will invest in suppliers who can meet their needs every time. This will also lead to their bringing in new customers for the supplier when these loyal customers share with others their experience of good service (Oakland, 2004). Deng, Lu, Wei and Zhang (2010) studied the determinants of customer satisfaction and identified one of them as being loyalty. Beliefs, perceived service quality, perceived customer value, the functional and emotional values contribute to the increase of customer satisfaction. Meanwhile, trust, customer satisfaction and cost conversion directly affect customer loyalty. This study proves that the relationship between quality and customer loyalty brings long-term interest to an enterprise and organisation.

Training is always important to enhance the knowledge of individuals in each and every aspect of life. However, it has been observed that quality is also attached to training, and in order for successful training, the problems hindering compatible relationship among the factors that bring success need to be resolved. Keeping this in view, a study was conducted to identify the critical factors for success in achieving quality improvement in the delivery of training. Each of these factors plays a role in determining the final services process, namely, customer satisfaction. Customer satisfaction can be evaluated by developing the measurement model. The measurement model is developed based on the 5Q quality model developed by Zineldin (2000). Figure 1 shows the conceptual model used in determining customer satisfaction and quality of training services delivered.

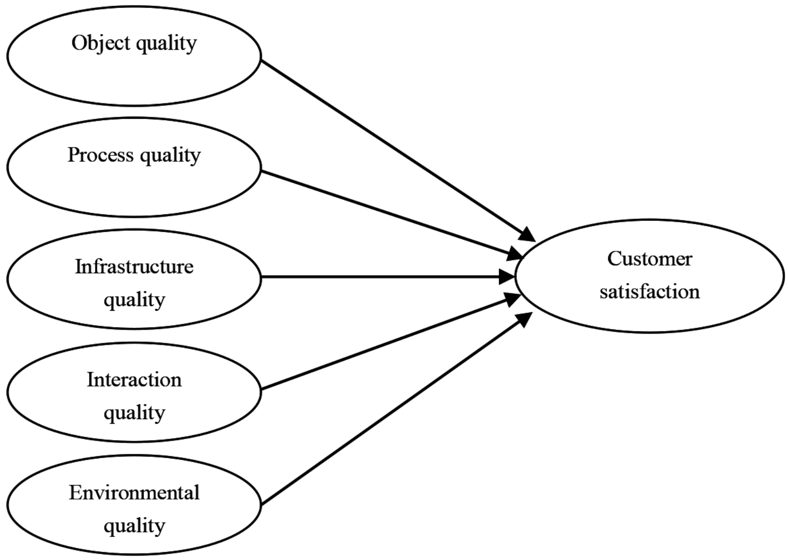

Figure 1. Customer satisfaction conceptual model (Zineldin, 2000).

The five dimensions of quality are described as follows (Zineldin, 2006):

1. Object quality – These qualities relate to the basic thrust of the training and is the main objective of the procedure, a course or programme focused on the technical aspects. It measures the organisation of the training itself, providing the main reason for "why students participated in the training." From the psychological point of view, meeting the core objective of the training is one of the main factors affecting the level of satisfaction.
2. Process quality – Quality involves the delivery of an object and how students view the training situation. It measures the effectiveness of the training delivered. Process indicators should be given more attention in training. These factors include the nature of the effectiveness and empathy during training, how the staff control the students' complaints and their willingness to provide training as expected. Satisfaction or the lack of satisfaction is a decision on the quality of the process.
3. Infrastructure quality – Infrastructure of the training venue is the major factor that affects the welfare of consumers and their overall satisfaction. This quality relates to skills, competencies, attitudes, technology and how activities are managed, controlled and coordinated. This indicator is considered important because the lack of these factors reflects low training quality. When it comes to academic institutions and the quality of the service they render, according to Price, Matzdorf, Smith and Agahi (2003),

their physical facilities affect their students' sense of satisfaction with them.

4. Interaction quality – This quality measures the quality of the exchange of information between organisers and trainers. This quality also measures how universities coordinate the service process to provide high quality education. Satisfaction is influenced when adequate explanations are given before, during and after the training. One of the important issues in this dimension is that organisers must be able to inspire and stimulate critical thinking.
5. Environmental quality – The relationship and interaction processes between customers and suppliers are affected by the quality of the environment. The lack of a friendly environment may reflect poor quality and lack of trust.

METHODOLOGY

The respondents for this study were UKM students. A total of 150 questionnaires were distributed and 131 were returned. The survey was developed from Zineldin's survey. There were two parts to the survey. The first part was on the background of the respondents, while the second was on the aspects contained in each critical factor of success. Each statement was measured on a 7-point Likert scale with 1 indicating 'strongly disagree' and 7, 'strongly agree'. Questionnaires were distributed to the students in the faculty, library and student centre facilities. The forms were collected after the respondents had filled in the relevant information. The questionnaire was also distributed through social media such as Facebook, Twitter and gmail.

The Statistical Package for the Social Sciences (SPSS) version 19.0 was used to analyse the data collected. Frequency analysis was carried out to collect the demographics of the respondents. The correlation analysis was performed to examine the relationship between the variables and the response (Zikmund, 2003). The correlation measurement used was the Pearson correlation. This correlation reflects the degree of linear relationship between the two variables. The correlation value is between +1 and -1. A value of +1 indicated a perfect linear relationship in a positive manner, where the increase in one variable can affect the increase in another variable. Conversely, if the correlation is -1, the linear relationship between the two variables is negative, where the increase of one variable affects another variable decrease. If the correlation value is 0, it means that there is no linear relationship between the two variables. Seldom are the correlation values 0, -1 or 1. The hypotheses determined in this analysis were:

- H_0: *Correlation between the two variables is not significant if the p value is the same and less than 0.01*
- H_1: *Correlation between the two variables is significant if the p value is the same and less than 0.01*

Model Validation

The validation process is usually used to see if there are similarities between the outputs of the model that have been developed and the real system (Hvala, Strmcnik, Sel, Milanic, & Banko, 2005). The main purpose of performing this model validation is to determine whether the model is acceptable for the intended use or otherwise. The validation and detection model can be an effective way to assess and monitor the performance of the model (Huang & Tamayo, 2000). To verify the output obtained, the expert review method was used. This method can determine the accuracy of the qualitative results through a final report or specific evidence from the participants and determine whether or not they feel what they are going through is accurate (Creswell, 2003). The validation of this study data can be achieved by interviewing the organiser's staff and students involved in the initial study.

In this qualitative study, the structured interview was used. The structured interview was to obtain accurate information such as sociodemographic, position held, length of service and so on (Merriam, 1998). Staff of the training organiser were selected to participate as respondents because they are the most relevant to this study as they have in-depth knowledge on the organisation of the training (Stevens & Palfreyman, 2012).

The validation was done by providing two different sets of questions based on the results obtained. The first set of questions was developed for the organisers' staff and the second was specifically for the students. The content of the first set of questions adduced statements and sought the views of the organisers on the results of the analysis obtained and the measurement model developed. Three questions were posed to the respondents.

The content of the questions for the students consisted of two subjective questions. Statements or questions asked were about the positive comments and their views on the improvement of all aspects of the quality of training services for the future. The answers and comments given supported the results of the measurement model developed.

RESULTS

Two analyses were made on the data obtained, namely frequency analysis and correlation analysis. Model validation was carried out to obtain the validity of the model developed to support the output received.

Frequency Analysis

The study respondents consisted of 131 students who had participated in the training organised by UKM. The frequency analysis results showed that the majority of the respondents were female (77.1%). In terms of age, the majority of the respondents were in the age range of 20-24 years (93.9%). Malay students recorded the highest percentage (84%) compared to other races and most of the respondents were pursuing a Master's degree (73.3%).

Correlation Analysis

The Pearson correlation analysis results can be seen in Table 1. From the results obtained, it can be concluded that there was a strong relationship between the two variables. This means that changes in a variable are closely related with changes in the second variable. The highest Pearson value that was proportionate to 1 was between Q4 and Q5 i.e. 0.84. This high correlation indicated a strong relationship between the quality of interaction and environmental quality. If the quality of interaction changed, environmental quality would be affected, and vice versa. The relationship between Q1 and Q3 provided the lowest Pearson value i.e.0.651.

All of the Pearson correlation values in Table 1 show positive values. This means that the relationship between the two variables was proportionately positive. When the value of the variable increases, the two variables will also increase in value. Likewise, when the first variable decreases, the second variable will also decrease.

Table 1

Correlation Between Variables

Variables		Object quality (Q1)	Process quality (Q2)	Infrastructure quality (Q3)	Interaction quality (Q4)	Environmental quality (Q5)
Object quality (Q1)	r	1				
	p					
Process quality (Q2)	r	0.807**	1			
	p	0.000				
Infrastructure quality (Q3)	r	0.651**	0.741**	1		
	p	0.000	0.000			
Interaction quality (Q4)	r	0.690**	0.831**	0.789**	1	
	p	0.000	0.000	0.000		
Environmental quality (Q5)	r	0.710**	0.752**	0.772**	0.840**	1
	p	0.000	0.000	0.000	0.000	

r: Pearson quality value p: significant (2 - end)
** Correlation is significant at level 0.01(2 - end)

Table 1 clearly indicates that since all the p valuea were below 0.05, each pair of variables was significant. This means that an increase or decrease in one variable was significantly associated with the increase or decrease in the second variable. Thus, H_0 (the correlation between the two variables was not significant if the p value was the same and less than 0.01) was proven valid.

Ramaloo (2011) reported that the relationship between the overall quality of services provided by the Graduate School (PPS), UKM and the level of student satisfaction was strong. The quality of service provided was excellent and fulfilled the students' expectations in terms of satisfaction.

Model Validation

The model validation was done using the interview technique. Structured interviews with the organisers and students were conducted to obtain support on the quality model developed. Table 2 shows a list of personnel interviewed. Five persons were the staff selected from different departments representing the training organiser in UKM.

Table 2
List of Staff for Model Validation

No.	Name	Position	Department	Length of Service (Number of Years)
1	Nor Asiah Mohamad	Librarian	Tun Sri Lanang Library	13
2	Najwa Ahmad Zawawi	Pricipal Asistant Registrar	Student Managemnt Department	12
3	Suhaimi Sulaiman	Youth and Sports Officer	Sports Centre	5
4	Siti Salwa Ahmad Zur	Assistant Registrar	Graduate Study Centre	5
5	Noor Faliza Hanim Roslan	Culture Officer	Cultural Centre	5

The staff were employees who hold key positions in the quality management and training organisations. Length of service was an advantage because it added to their experience in organising and managing the delivery of training to students. Model validation was done using the interview technique. The structured interviews with the organisers and students were conducted to obtain the support of the quality model developed. The interview sessions took about two weeks to complete.

DISCUSSION

Five of the respondents agreed that the five aspects of quality were adequate and included trainers, learning methods, learning locations and training duration. The qualities were compatible with the employee's job duties and led to delivery effectiveness and satisfaction among the students. The views of all the officers on the quality of interaction, which had the highest mean values, coincided because interaction can facilitate work process.

Process quality and infrastructure quality recorded a low mean value because these qualities were beyond their control. According to Mrs Najwa (JPPel), infrastructure was difficult to control because it depended on department usage and the cost to improve the ergonomics value to customers and to maintain the system was high. Although process quality could be controlled, a lot depended on the system, and the process needed to adapt to the system facilities. Puan Nor Asiah (PTSL) stated that the training process involving trainers was unpredictable and the subject of their lives could not be designated as a technical tool.

The five respondents also agreed that there was a strong relationship between the quality of interaction and the quality of atmosphere. Mrs Najwa (JPPel) mentioned that the quality of interaction between students and organisers would create a conducive and comfortable environment for all involved. This statement was supported by Mr Suhaimi (Sports Centre), who stated that quality facilitated understanding among the participants. Friendly interaction was necessary for the students to communicate and ask questions. Therefore, personnel or training instructors must know the background of the trainees so that it is easy to provide explanations and guidance.

The final question posed to the organisers was about the appropriateness of the measurement model to guide the continuous improvement of the delivery system and skills training to the students. In conclusion, all agreed that it was appropriate to use the measurement model to evaluate detailed effectiveness of teaching and the level of acceptance of the information provided.

In addition to the interview with the training instructors in UKM, student interviews were also conducted to gain support for and to check the validity of the model developed. A total of 50 students were selected for the model validation. The respondents were the same who were involved in the earlier studies of student satisfaction with the quality of training delivery. They were selected via email as stated in the questionnaire. Appointments were made according to the respondents' availability. The interview with the students took a month during the month of July in 2013.

In the interviews, the students were asked to provide feedback on the results of the descriptive statistics listed as critical factors of success. A total of 93.5% of the respondents supported quality of interaction as being very important in delivering effective training to students. Among the positive comments about this quality was that the relationship between the students, trainers and management had affected them so greatly that they remained in touch even after completing the training (third respondent). Another comment was that the information shared would be received by all the participants of the training (39th respondent).

The percentage of respondents who did not agree that quality was the most important interaction was very small, at 6.45%. The fourth respondent was of the opinion that the organisers were not committed to carrying out their tasks and were less concerned about the needs of the participants.

The sixth respondent said that the problem of interaction occurred because the students' own commitment to the student-run programme was not satisfactory. The lowest mean value recorded for infrastructure quality was concurred on by the students. Respondents 11, 13, 14, 24 and 49 were of the opinion that this was due to the incomplete existing equipment, which needed repair. Respondents 15, 18, 25, 34, 36, 45 and 47 were of the opinion that the quality did not meet the required level of satisfaction as the Internet facilities provided were not satisfactory and slowed down work, affecting the participants emotionally.

Based on the views expressed by both parties, it can be concluded that the results obtained were agreeable to them. This validation supports the findings, and this should encourage the university to apply this model in their training delivery system.

CONCLUSION

Factors affecting the success of training delivery were the main results of this study. The relationship between these factors affected customer satisfaction and was interdependent. The results-based Pearson values clearly indicated that the leading success factors were interaction quality and environmental quality; indeed, a strong relation between them was observed. However, there was a very weak relationship between object quality and infrastructure quality. Furthermore, the factor of interaction quality factor was considered to be the most important factor as good interaction between trainers and students is very helpful when it comes to discussion and asking questions. Moreover, knowing the success factors can provide guidance to stakeholders in formulating new policies to improve the quality of skills training implementation. The measurement model developed was not only used in the organisation of training but also to achieve customer satisfaction.

This study can also be used as an implementation effort in conducting training excellence that is beneficial to both parties involved, namely the organisers as providers and students as customers. This study can also be used as a guide for other organisations, learning centres and public or private institutions of higher learning to improve their implementation, management and training services.

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Examination Achievement of Engineering Students from UKM and UDE : A Comparison

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ABSTRACT

Under the double-degree programme offered by Universiti Kebangsaan Malaysia (UKM), a number of Universitat Duisburg-Essen (UDE) students are required to study in UKM for one semester each year. They are free to choose any courses offered in the programme for that particular semester. In Semester 1 of the 2014/2015 session, the Department of Mechanical and Materials Engineering ran four courses that were enrolled in by students from both universities. Given the different background, ways of thinking and academic competencies, it was expected that the students would perform differently and it was predicted that the German students would demonstrate better achievement compared to UKM's mostly Malaysian students. The objective of this study was to discover if there was a difference in terms of performance between the international students and the host students who took the same courses. This paper consists of three main sections. First, after a general introduction of the study, the methodology is explained. Second, a comparison of examination-based achievement in four selected courses between the two groups of students is presented in summary. Finally, some possible reasons as well as explanations for the difference or similarity in the performance of the two groups is considered. The findings suggest that in general, students from UDE showed better performance than the host students. In the long term, this study is intended to be useful in improving the quality of teaching and learning in UKM, specifically when dealing with students from UDE as well as home students.

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INTRODUCTION

Since 2000, Universiti Kebangsaan Malaysia (UKM) and Universitat Duisburg-Essen (UDE) have been collaborating on a double-degree programme, which enables students from various engineering fields to complete their degree at both universities. UKM students who are interested must have excellent academic results of at least 3.0 CGPA in their third year. Those selected will have to take up German language classes for at least 300 hours before leaving for Duisburg, Germany (Nasir, 2013). Additionally, each year, students from UDE will study in UKM for one semester, taking any offered courses in the programme. Upon completion, students will graduate with two degree certificates from both partner universities.

Since the launch of the double-degree programme, both partners have committed themselves to intensive and growing cooperation in the field of research and education. In every academic session, students from UDE are free to choose the courses they wish to enrol in. If they pass these courses, they are exempted from similar courses in UDE as the credit is transferable. Since UKM hosts UDE students for only one semester, the courses taken in UKM are based on the fundamental knowledge they gained from their previous semesters in UDE.

Courses Involved

Four courses were selected randomly for this study: Thermodynamics 1 (KM2114), Control System (KP3254), Planning and Production Control (KP4334) and Manufacturing Strategy Management (KP4373). In Semester 2 of the academic session of 2014/2015, these courses were offered and taken by both groups of students. The number of students for each course is tabulated in Table 1.

Table 1
Number of Students in Each Course

Courses	UKM	UDE
Thermodynamics (KM2114)	48	16
Control System (KP3254)	15	23
Planning and Production Control (KP4334)	21	3
Manufacturing Strategy Management (KP4373)	13	6

For each course, the students were assessed through projects, laboratory work and examinations. The number of UDE students varied as they were free to choose their courses. Four courses were chosen; general information on each course is presented below:

1) Thermodynamics 1 (KM2114) – This course provides exposure, knowledge, understanding and synthesis of

the main characteristics of the first law of thermodynamics and its basic properties, properties of pure substances, control volume analysis, the second law of thermodynamics and entropy analysis. Students will be exposed to experimental and calibration work on the measurement of temperature and pressure. In the first semester of the 2014/2015 academic session, 48 UKM students and 16 UDE students registered for Thermodynamics 1.

2) Control System (KP3254) – This course aims to introduce the methods of analysis and design for feedback control systems. It includes modelling of mechanical, electrical and electromechanical systems, analysis of feedback control systems using time domain techniques (Routh-Hurwitz stability criterion and root locus) as well as frequency domain techniques and design of control systems using PID and lead-lag compensation methods. Fifteen UKM students and 23 UDE students enrolled for this course.

3) Production Planning and Control (KP4334) – The objective of this course is to convey knowledge, understanding and synthesis in the area of production planning and control. It covers production management problems in manufacturing systems including theories and practical knowledge of qualitative and quantitative planning. Therefore, it is strongly relevant to academic and industry application. Only three students from UDE signed up for this course, while from UKM, there were 21 students.

4) Manufacturing Strategy Management (KP4373) – This course provides exposure to organisations and systems as well as knowledge, understanding and synthesis. It also applies the system concept in the organisation, mission, objective, goal, work and strategy. This includes the process of modelling organisation strategy, unity of function units, corporate strategy and internal and external analysis and value chain analysis to identify the internal and external strength of an organisation as a corporate strategy shaper. Students are also exposed to the unity of corporate strategy and the implication of strategies in manufacturing, particularly in manufacturing process selection, human resources strategy, which is human resource management, the effect of changes to organisational structure and the effect of technology on an organisation. Thirteen UKM students and six UDE students took this course.

Assessment

During the 14 weeks of the course, lectures were conducted for an average of 3 hours per week. In general, after seven weeks of lecture, students will sit a mid-semester examination that covered all the topics taught in the first half of the semester. By the end of the semester, students would sit a final examination aimed at evaluating their understanding of the course. These examinations represent 20-30% and 50-60% of the overall assessment for the course, respectively. Examination questions are designed based on the lectures; the questions are put through a moderation process at the departmental level in order to ensure all examination questions are up to the expected high standard and quality compliance required by UKM.

Additionally, during the 14 weeks of the integrated project, laboratory work must be done according to schedule. For open-ended laboratory assignment, students are free to design the experiment based on the topic and problem statements provided. The assessment for this part consists of a proposal presentation, final presentation and a written technical report. However, the project assessment is done in groups, which means that every group member gets the same score as each member is assumed to have contributed fairly in conducting the experiment. Other than academic assessment, students are also assessed for generic skills to fulfil all the outcomes set in Outcome-Based Education (Tahir et al., 2013).

Research Problem

Sharing the same culture and educational background has led to a degree of lack of enthusiasm in being competitive among local students. It was expected that the presence of new classmates from a different country could increase the desire and will to compete among local students in order to better their grades. Therefore, as a quantitative measurement, individual achievement in terms of examination was believed to be an effective tool to use for comparison.

The major aim of this study was to identify the difference between international and local students by comparing their individual achievement based on examinations in various courses. It was expected that the comparison would yield input for re-evaluation of teaching and learning for future improvement.

Nevertheless, this study limited the comparison to only individual performance so that only two main examinations were taken into account. The comparison was made by evaluating only the average achievement of a set of students rather than to focus on every student individually.

METHODOLOGY

The methodology used in this study was straight to the point. Data were gathered from the marks of multiple courses taken by the UDE students. By the end of the semester, after completing all the assessments, the marks were recorded in the provided template. For each course, students were divided into two groups, UKM and UDE, and then, by focussing only on the examination results, their achievement was compared.

Analysis of data was done using Microsoft Excel as the analysis was limited to only a simple statistical analysis. Based on the raw data collected, bar charts representing the average achievement values were plotted for the mid- and final examinations for the four selected courses. Other than the average score, standard deviation was calculated and presented in a separate table as the average value alone may not have been sufficient to represent the score.

Comparison Analysis

From the data analysis depicted in Figure 1 and Table 2, it can be clearly seen that the group from UDE scored higher than the UKM students on all the selected courses. For KP3254, 46% of differences between the two groups of students was obvious; however, the standard deviation showed a high value, revealing the fact that in the same group of students itself, the scores were scattered. KP4334 also showed obvious differences, but notably, there were only three students from UDE who took this course. Thus, the low value of the standard deviation might have been caused by the small number of students. Nevertheless, the comparison of standard deviation for each course in general proved that students from UDE presented comparable performance among themselves.

Data analysis for the final examination results showed that UDE students scored slightly higher than UKM students only in two courses, KM2114 and KP3254, while the other two courses showed different results. In Table 3, the highest standard deviation for KP4334 proved that a small number of UKM students in the group are in the excellent category while the rest are in the average category.

Table 2
Mid-Semester Examination Analysis

Course	UKM		UDE	
	Average	Standard Deviation	Average	Standard Deviation
KM2114	68.90	12.72	84.20	8.63
KP3254	27.73	20.67	73.83	7.48
KP4334	68.67	9.56	96.67	3.06
KP4373	60.15	15.48	66.67	11.57

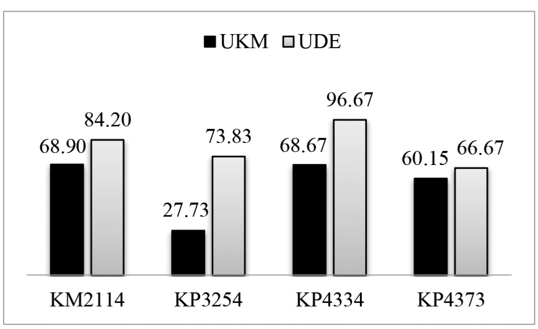

Figure 1. Average score for mid-semester examination.

Table 3
Final Examination Analysis

Course	UKM		UDE	
	Average	Standard Deviation	Average	Standard Deviation
KM2114	56.48	14.63	65.06	13.52
KP3254	45.60	13.11	58.35	10.26
KP4334	64.90	18.01	56.67	8.14
KP4373	82.46	13.36	80.83	6.21

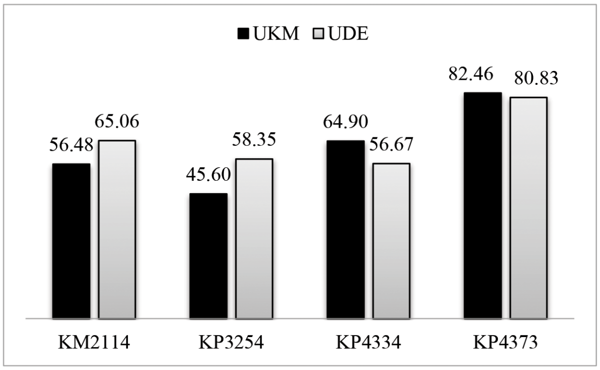

Figure 2. Average score for final examination.

Assumptions and Inferences

The comparison analysis of average achievement showed that there were noticeable differences between the two groups of students in the mid-semester examination although the gap became narrower in the final examination. In any examination, all the students are tested on knowledge gained from the same lectures and through the same learning process. This fact supported the idea that students from UDE have put more effort into self-learning than did the home students. Self-learning outside the classroom might have contributed as the main factor for this result as the students from different backgrounds would choose different study approaches (Husain et al., 2013).The difference might be caused by different learning methods adopted by the students. According to a study conducted by Tawil et al. (2012), there are various learning approaches, for instance traditional learning, e-learning, individual and group study.

The assimilation process can prepare students to adapt to and even do well in a new environment (Zepke & Leach, 2005) and it seems that students can successfully integrate and adapt to new, challenging institutional settings. Being away from their homeland and out of their comfort zone might have helped the German students to perform better in UKM. A study conducted among Malaysian students studying abroad and students enrolled in the same programme in UDE showed that their personality changed with respect to the changes in environment and culture (Muchtar et al., 2010). It is believed that a similar occurrence happened with the UDE students in this study.

Despite these general assumptions, research findings on the effects of studying abroad cannot be generalised across programmes (Ecke, 2014). Nevertheless, the relevance of this point must be clearly supported by future studies on a specific cohort of students. Mastor et al. (2011) in their study focussed on the UKM-UDE double-degree programme and found that in order to adapt to the challenge of cultural distance, exchange students showed noticeable changes in their attitude, personal characteristics and lifestyle.

For the international students, joining the double-degree programme should motivate them to score high grades on all courses taken in Malaysia as failing to do so would require them to repeat the same course in Germany, which was what they had wanted to avoid by coming to Malaysia in the first place. Only excellent students, selected from informal interviews, are offered the opportunity to join the double-degree programme. Apart from the academic requirement of showing excellent grades, they also found that making the decision to study abroad was also challenging, despite the increasing number of students joining the programme each year since it was launched in 2003. The option to further study abroad is not a one-time choice but the outcome of different long-term processes (Carlson, 2013). Therefore, other than the opportunity for extensive social interaction, the foreign students were aware why they were in UKM. This was probably the main reason why this group of students struggled very hard to achieve good results.

Although there was no direct evidence nor explicit study conducted on fundamental knowledge of the two groups of students, it was presumed that the fundamental knowledge gained possessed by the UDE students from their study in the University of Duisburg-Essen was strong and sufficient for them to understand the course, answer the examination questions and finally attain better results. Obviously, all four courses taken in UKM had not been offered to these students in UDE. There are some courses that must be taken prior to these four courses. Regardless of where and how they learnt the basic knowledge, possession of strong fundamentals would have enabled them to understand the courses better.

The fact that both countries use a different educational system should not be overlooked. The Malaysian educational system is more examination-orientated compared to Germany's. Despite readiness to adapt, students from UDE faced a form of cultural shock as assessments were weighed too high. In addition, the systematic way of conducting examinations in UKM led them to perceive that to succeed in their studies in UKM, they had to perform best in the examinations.

CONCLUSION

The achievement of the two groups of students in four selected courses were compared. Overall, for the mid-semester examination, students from UDE showed better performance in all four courses compared to the UKM students. However, the difference in performance was less obvious in the final examination and, surprisingly, there were some courses in which UKM students scored slightly better. It was found that the significant difference in performance between the international and the host students might have been due to personality changes in order to adapt to a new culture, new environment, and most importantly, new educational system among the UDE students. Another significant finding that emerged from this study was that the fundamental knowledge that the students possessed from their previous study in Germany might have been a vital contribution for them to excel in UKM. This research has triggered many questions and performance in the double-degree programme certainly needs further investigation. Future studies should be expanded in terms of the quantitative or qualitative approach to identify concrete reasons for the gap between the two groups of students. However, in the near future, it is recommended that if this study is embarked on, the survey should be conducted early because the international students tend to leave UKM as soon as their final examination is over.

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Online Early Monitoring of Students' Level of Mathematical Ability in Engineering Mathematics Subjects

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ABSTRACT

Proper mastery of engineering mathematics is one of the key success factors for students in the field of engineering. Delays in identifying students who are weak in mathematics can result in their having difficulties in learning subsequent mathematics courses. Therefore, a method of monitoring students' ability in the Faculty of Engineering and Built Environment, Universiti Kebangsaan Malaysia (UKM) in the subject of mathematics was developed in the form of an online system, namely, TCExam. TCExam contains a maths readiness test for the subjects of Vector Calculus and Linear Algebra. A total of 60 questions in the form of multi-objective questions are prepared based on important topics needed to be mastered by students. Also included in the TCExam are survey questions on factors among students in selecting a university. The TCExam is implemented for students during the first week of the semester. This system will provide maths readiness test results directly to the lecturers and the data will then be analysed using the Rasch Measurement Model to obtain a reliability value as well as test quality and students' level of ability. The high value of Item Reliability of 0.98 explains that the level of reliability of the readiness test questions is very high. Results from the Rasch analysis also reflect that students' level of mathematical ability is poor, indicating that the maths readiness test is needed at the early stage of their enrolment into university to identify weak students much earlier so that specific monitoring measures can be made to help these students.

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INTRODUCTION

Mathematics is an important subject and a prerequisite for almost all undergraduate courses at universities, especially for engineering courses. Mathematics serves as a necessary foundation in nurturing future engineers. This is important, given that engineering plays an important role today in the development of activities related to technology, energy, computers, electronic devices and manufacturing processes (Alves et al., 2012). Engineering courses require students to have a strong foundation in basic mathematical concepts. The ability to master mathematical theories is important for solving practical problems. According to Sazhin (1998), the objective of teaching mathematics to engineering students is to ensure that students are able to balance between the practical applications of mathematical concepts and their understanding. It is thus important to balance between theory and practical applications in engineering courses.

However, engineering students' achievement is now showing a deteriorating trend, and this concerns lecturers as well as local and international universities. In 1995, a study conducted by the Engineering Council revealed that engineering students had relatively weak mathematical ability in the subject at undergraduate level (Sutherland & Pozzi, 1995). This group of students had problems in achieving good grades, especially in mathematics. This also led to difficulties in selecting engineering students at the undergraduate level, given the declining level of mathematical ability among students at the pre-university stage. The declining quality of students will have a direct impact on the field of engineering in the future if the problem persists and if it is not properly addressed by the authorities. Research findings with regards to engineering students' achievement in the Faculty of Engineering and Built Environment (FKAB), Universiti Kebangsaan Malaysia also showed a decrease in mathematical ability among engineering students (Zainuri et al., 2009; Haliza et al., 2010; Aziz et al., 2013; Fuaad et al., 2014; Othman et al., 2015).

In an effort to improve student achievement in FKAB, UKM, particularly in the subject of engineering mathematics, provides a maths readiness test for first-year engineering students upon admission. The test is prepared for the first-year engineering mathematics courses, Linear Algebra and Vector Calculus. Previously, the maths readiness test was conducted manually on paper, making it a time-consuming task as answer scripts and data entry needed to be done manually. This problem, in turn, slowed down the process of analysing new students' results, which then made it difficult for lecturers to identify problematic students at the beginning of the semester. In addition, paper wastage was also an issue when the maths readiness test was carried out, given the large number of first-year engineering students. Thus, the main objective of this study was to develop a method of monitoring students' ability in the subject of mathematics in the form of an online system, namely TCExam. The results of this study will facilitate lecturers in expediting efforts to identify the level of students' ability. This study uses the Rasch Measurement Model in the process of question analysis and indetermining students' level of ability in the Linear Algebra readiness test. Unlike previous years, the proposed test is to be conducted online, which will directly reduce operational and materials costs.

The Rasch Measurement Model is a measurement method that uses data from student test results, modifying that data in a 'logit' scale, allowing for a comparison between students' level of ability and item difficulty level to be carried out in the same interval (Rozeha et al., 2007). The analysis of students' results reflects whether or not the questions administered in the readiness are appropriate for students' level of ability. This in turn will assist lecturers to take appropriate action on improving teaching and learning methods to help students who have problems with their foundation in engineering mathematics (Rozeha et al., 2007).

METHODOLOGY

Research Sample and Data Collection

This study involved a total of 355 first-year students from FKAB, UKM, which consists of students from four departments, namely, the Department of Civil and Structural Engineering (JKAS), the Department of Chemical and Process Engineering (JKKP), the Department of Mechanical and Materials Engineering (JKMB) and the Department of Electrical, Electronics and Systems Engineering (JKEES) for the 2014/2015 session. A total of 13 testing sessions were conducted in two computer laboratories at the faculty, which can accommodate between 20 and 35 students at a time. The readiness test was conducted for three to four sessions a day in each department and it took four days to be completed.

Research Instrument (Mathematical Readiness Test)

This study used the readiness test questions as a means of measuring the level of mathematical ability among students at the beginning of the semester, which could assist lecturers in identifying students who have difficulties at an early stage of the course, during admission. The research instrument was a set of mathematical readiness tests that was validated using the Rasch Measurement Method. The questions were uploaded in the TCExam online system. A total of 60 multi-objective questions were given based on important topics that needed to be mastered by engineering students. Students had to answer two sets of mathematical readiness tests: Vector Calculus (30 questions) and Linear Algebra (30 questions) and one online questionnaire regarding university selection. The sttudents were given one hour to complete each set of questions. Data on the student results were then downloaded from the TCExam system and analysed using the Rasch Measurement Model to determine the level of their mathematical ability. For this research, the data of test results that were obtained from the mathematical readiness test (Linear Algebra 2014/2015 session) were analysed using the the Rasch Measurement Model. The reliability of the mathematical readiness test (Linear Algebra) was measured from the value of the Item Reliability and Cronbach Alpha.

TCExam

TCExam is an open-source system for electronic tests, also known as Computer-Based Assessment (CBA), Computer-Based Testing (CBT) or e-examination, and it enables lecturers to digitalise and distribute tests, quizzes, examinations as well as questionnaires to target groups in an easier and faster manner. The system, developed in 2004 and translated into 24 languages, is widely used around the world by universities, schools and government and private companies.

The TCExam coordinates all phases of evaluation: authoring, scheduling, delivery and reporting automatically. It is easy to use as users can access the TCExam system using the Internet web through engines such as Mozilla Firefox or Internet Explorer. The advantage of the TCExam compared to the traditionally written examination system is that the system will speed up the administration and the scoring process will be more efficiently done compared to traditional methods that require lecturers to check students' answers and enter their data manually one by one into Excel. The system further reduces 'human error' in the data entry process. The TCExam simplifies the process of assessment, reduces cost and improves the quality and reliability of the test.

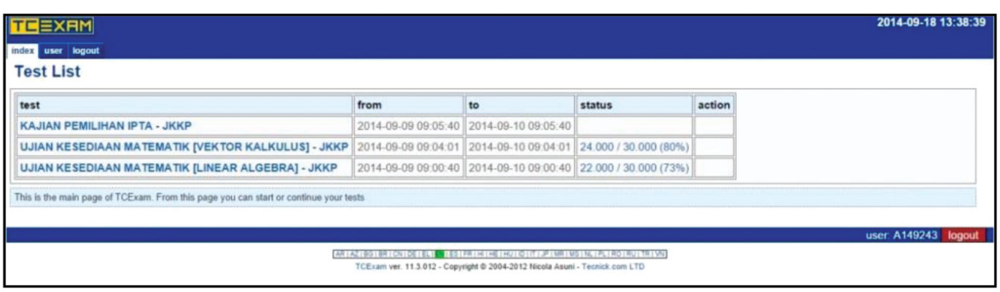


Figure 1. Interface showing the list of tests for students.

In this study, three sets of questions were uploaded into the TCExam system, namely IPTA Selection Study, Mathematical Readiness Test (Vector Calculus) and Mathematical Readiness Test (Linear Algebra). Figure 1 shows the interface when students logged in using their respective IDs and passwords. The ID and password were given prior to the exam in the computer laboratory. This was to prevent students from other departments/ sessions from accessing the questions from outside the computer lab. For this study, the three sets of questionnaires were segregated according to department in order to avoid confusion and question leaks as all four departments involved were taking the test at different times. The results of the exam were revealed immediately after the session.

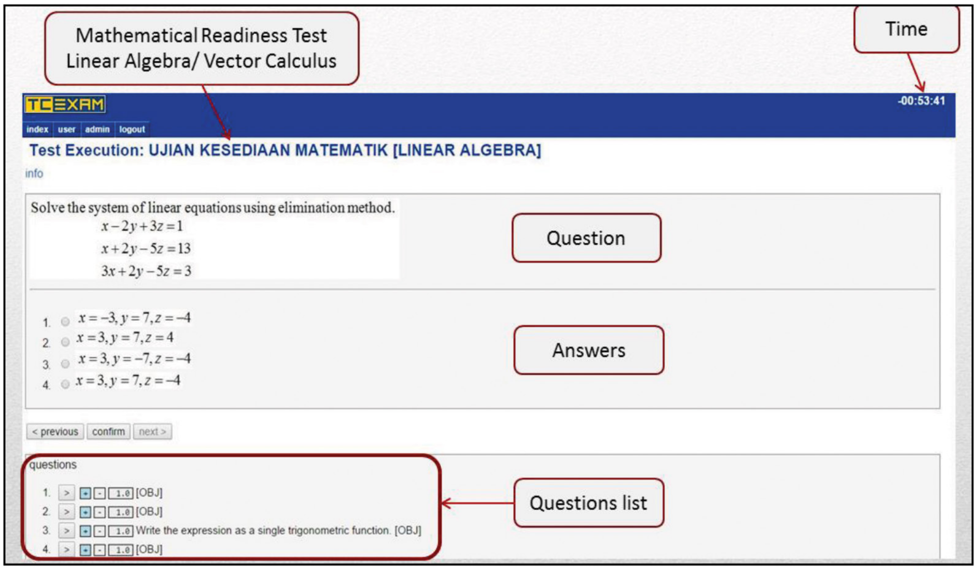
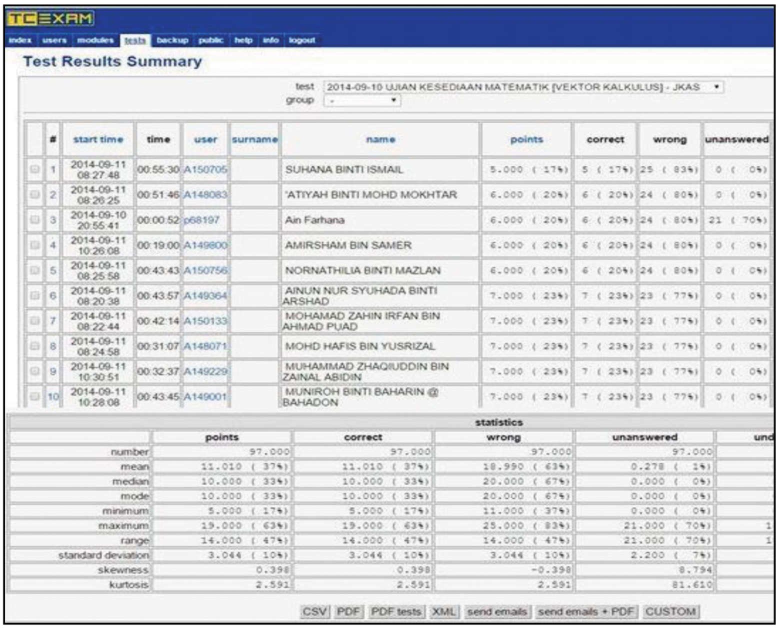


Figure 2. Interface displaying the questions.

Figure 2 shows the interface seen by the student when answering the questions online. Details such as the names and the test time can be seen at the top of the screen. For the mathematical readiness test set, the questions and answers administered to the students were randomly assigned to each student. The question menu can also be seen in Figure 2. This menu facilitated students in checking their answers and in detecting unanswered questions.

The TCExam results were then analysed using the Rasch Measurement Model. Figure 3 shows an output example of the readiness test results generated by the TCExam. The results for each student can be seen along with detailed questions if the lecturer wanted to gauge parts where students experienced problems the most. The percentage of students' scores can also be seen in Figure 3.



TCEXAM

index users modules tests backup public help info logout

Test Results Summary

test 2014-09-10 UJIAN KESEDIAAN MATEMATIK [VEKTOR KALKULUS] - JKAS

group -

#	start time	time	user	surname	name	points	correct	wrong	unanswered
1	2014-09-11 08:27:48	00:55:30	A150705		SUHANA BINTI ISMAIL	5.000 (17%)	5 (17%)	25 (83%)	0 (0%)
2	2014-09-11 08:26:25	00:51:46	A148083		'ATIYAH BINTI MOHD MOKHTAR	6.000 (20%)	6 (20%)	24 (80%)	0 (0%)
3	2014-09-10 20:55:41	00:00:52	p68197		Ain Farhana	6.000 (20%)	6 (20%)	24 (80%)	21 (70%)
4	2014-09-11 10:26:08	00:19:00	A149800		AMIRSHAM BIN SAMER	6.000 (20%)	6 (20%)	24 (80%)	0 (0%)
5	2014-09-11 08:25:58	00:43:43	A150756		NORNATHILIA BINTI MAZLAN	6.000 (20%)	6 (20%)	24 (80%)	0 (0%)
6	2014-09-11 08:20:38	00:43:57	A149364		AINUN NUR SYUHADA BINTI ARSHAD	7.000 (23%)	7 (23%)	23 (77%)	0 (0%)
7	2014-09-11 08:22:44	00:42:14	A150133		MOHAMAD ZAHIN IRFAN BIN AHMAD PUAD	7.000 (23%)	7 (23%)	23 (77%)	0 (0%)
8	2014-09-11 08:24:58	00:31:07	A148071		MOHD HAFIS BIN YUSRIZAL	7.000 (23%)	7 (23%)	23 (77%)	0 (0%)
9	2014-09-11 10:30:51	00:32:37	A149229		MUHAMMAD ZHAQIUDDIN BIN ZAINAL ABIDIN	7.000 (23%)	7 (23%)	23 (77%)	0 (0%)
10	2014-09-11 10:28:08	00:43:45	A149001		MUNIROH BINTI BAHARIN @ BAHADON	7.000 (23%)	7 (23%)	23 (77%)	0 (0%)

statistics

	points	correct	wrong	unanswered	und
number	97.000	97.000	97.000	97.000	
mean	11.010 (37%)	11.010 (37%)	18.990 (63%)	0.278 (1%)	
median	10.000 (33%)	10.000 (33%)	20.000 (67%)	0.000 (0%)	
mode	10.000 (33%)	10.000 (33%)	20.000 (67%)	0.000 (0%)	
minimum	5.000 (17%)	5.000 (17%)	11.000 (37%)	0.000 (0%)	
maximum	19.000 (63%)	19.000 (63%)	25.000 (83%)	21.000 (70%)	1
range	14.000 (47%)	14.000 (47%)	14.000 (47%)	21.000 (70%)	1
standard deviation	3.044 (10%)	3.044 (10%)	3.044 (10%)	2.200 (7%)	
skewness	0.398	0.398	-0.398	8.794	
kurtosis	2.591	2.591	2.591	81.610	

CSV PDF PDF tests XML send emails send emails + PDF CUSTOM

Figure 3. TCExam test results.

The statistical analysis provided by TCExam includes mean, median, mode and standard deviation, and all these can be used by lecturers. The Semester 1 Mathematical Readiness Test for 2014/2015 session was conducted in the computer lab of the Faculty of Engineering and Built Environment (FKAB), Universiti Kebangsaan Malaysia, as shown in Figure 4.

Figure 4. TCExam test environment.

RESULTS AND DISCUSSION

This section focusses only on the analysis of the mathematical readiness test (Linear Algebra). Questions in the mathematical readiness test and student results were analysed using the Rasch Measurement Model to obtain the reliability value as well as test quality and students' level of ability. The value of the Cronbach Alpha of 0.6 indicated that the mathematical readiness test questions were acceptable. Based on Figure 5, the value of the Item Reliability of 0.98 indicated high reliability of the readiness test questions. This is an important indication that the set of questions were able to measure students' mathematical ability in a more precise manner. Figure 5 shows the maximum and minimum values of the items in the mathematical readiness test questions which also reflect the item's position in the logit unit. The position of these items is based on their level of difficulty. The maximum item is located at +1.46 logit and the minimum item is at -2.55 logit.

SUMMARY OF 30 MEASURED Item

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	153.2	356.0	.00	.12	1.00	-.1	1.00	.0
S.D.	67.3	.0	.96	.01	.05	1.1	.07	1.1
MAX.	316.0	356.0	1.46	.17	1.13	1.8	1.21	1.9
MIN.	58.0	356.0	-2.55	.11	.90	-3.0	.88	-2.5

REAL RMSE .12 TRUE SD .95 SEPARATION 7.59 Item RELIABILITY .98
MODEL RMSE .12 TRUE SD .95 SEPARATION 7.66 Item RELIABILITY .98
S.E. OF Item MEAN = .18

Figure 5. Summary of item statistics.

Figure 6 shows the summary for the Person statistics. If the item's logit indicates the level of difficulty of the questions, then the Person's logit shows students' level of mathematical ability. Good students have the highest logit while poor students have the lowest logit and are located at the bottom part of the PIDM figure. According to Figure 6, the maximum Person value in this study was +2.15 logit while the minimum Person value was -3.07 logit.

SUMMARY OF 356 MEASURED Person

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	12.9	30.0	-.32	.42	1.00	.0	1.00	.0
S.D.	3.9	.0	.68	.04	.16	1.0	.24	1.0
MAX.	26.0	30.0	2.15	.77	1.59	3.3	1.92	3.5
MIN.	2.0	30.0	-3.07	.40	.61	-2.6	.52	-2.2

REAL RMSE .43 TRUE SD .52 SEPARATION 1.20 Person RELIABILITY .59
MODEL RMSE .42 TRUE SD .53 SEPARATION 1.26 Person RELIABILITY .61
S.E. OF Person MEAN = .04

Figure 6. Summary of Person statistics.

The analysis then focussed on evaluating students' ability in the mathematical readiness test. The value of the Person's average of 0.32 given in Figure 6 shows that the level of student ability in the mathematical readiness test was weak and below expectations. This can be seen in the Person and Items on a Distribution Map (PIDM) as shown in Figure 7, which indicates items and the Person's position according to their respective logit values. The comparison between these two can be made when both are adjusted using logit. The item's position in PIDM determines the question's level of difficulty while the Person's position in turn determines students' level of ability. The higher the position of the item, the more difficult the questions will be, and the lower the position of the item, the easier the question will be to the students. As for Person, higher position in the diagram indicates that the students are good. Figure 7 shows the item's mean located at+0.00 logit. This is based on the Rasch theory that states that every student has a 50:50 chance to answer the question correctly. Thus, the further the position of item from the item's mean, the probability of the students answering the question correctly also varies, according to the question's level of difficulty. In other words, if the item is at the top of the diagram, then the question has a high degree of difficulty; thus, the probability that the student would answer the question correctly is low.

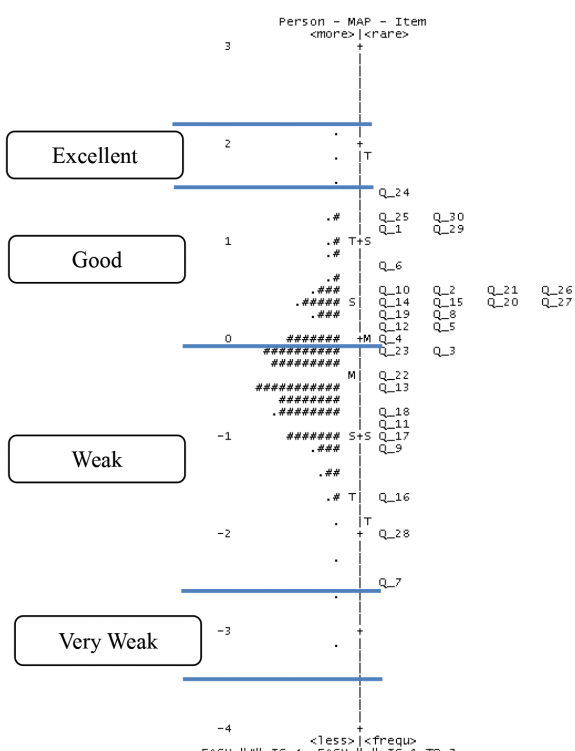


Figure 7. PIDM figure for the mathematical readiness test (Linear Algebra).

Figure 7 shows the position of four groups of students based on their level of ability by logit. These groups were classified as very weak, weak, good and excellent. Based on Figure 7, 70.2% of the students (250 out of 356 students) were below the item's mean; +0.00 logit indicated that the students' level of ability upon answering the mathematical readiness test was below expectations. These groups of student were labelled as very weak and weak. These two groups of students found the maths readiness questions administered to them quite challenging, and this can be seen in the position of 18 items that were above the students' level of ability in Figure 7. These 18 items were located above the logit of the item's mean, +0.00 logit.

However, a few important observations with regards to the students' level of ability were observed. Four students who had a high level of ability were placed in the excellent group. Their level of ability exceeded the readiness test questions' level of difficulty administered to them. This indicated that these readiness test questions did not measure the overall level of ability of all four students because for them, the questions administered were quite easy. Upon closer examination, overall, the marks for these students were seen to be more than 80%, with less than six wrong answers out of 30 questions. This was different for the very weak students as they had a very low level of ability and were located under the easiest item. This indicated that the readiness test administered to them was not able to assess their ability as the questions were too difficult for them. Overall, the results of these readiness tests was less than 10%, with only two to three questions answered correctly. These students must be given special attention.

Next, the students' level of ability according to their logit was broken down by their pre-university CGPA groups (university entrance CGPA) as shown in Table 1. As can be seen in Table 1, the group of students who obtained a CGPA of 3.75-4.00 during their pre-university studies recorded the highest number of students, but only 40% of them belonged to a group who had a high level of ability based on their readiness test (Linear Algebra) results. The majority of them belonged to the weak group and are located below the Item's Mean= + 0.00, based on their mathematical readiness test, even though this group was expected to perform better than the other two groups based on their pre-university CGPA. Interestingly, 26% and 14% of the students who belonged in the group of CGPA 3.50-3.74 and 3.00-3.49, respectively, performed well in the mathematical readiness test. It shows that CGPA at the pre-university level does not necessarily reflect good mathematical readiness.

Table 1
Students' Level of Ability in Readiness Test (Linear Algebra) Grouped by Pre-University CGPA

CGPA	Below Item's Mean =+0.00 logit		Above Item's Mean =+0.00 logit		Total
3.75-4.00	96	60%	64	40%	160
3.50-3.74	82	74%	29	26%	111
3.00-3.49	72	86%	12	14%	84
Total	250	70%	105	30%	355

The results obtained via the correlation analysis also indicated the same results. Correlation analysis is a statistical technique to quantify the dependence of two or more variables. The correlation coefficient (r) value lies between +1 and -1. Any value of r more than 0.5 or close to 1.0 shows a strong positive correlation, which means that the values of both the variables increased simultaneously, showing linear dependence. The results showed a very low value of correlation, r=0.224, which explained the weak correlation between the students' CGPA during their pre-university studies and their level of ability in the early stages of the semester when they entered the undergraduate courses in the university. This reflects the need to conduct a mathematical readiness test to determine students' level of ability at the beginning of the semester and not depend solely on their results of their pre-university studies.

SUMMARY

Results from the analysis reflected that the students' level of mathematical ability was low and that they were weak in the subject, indicating that the maths readiness test was needed at the early stage of their enrolment into university. This is further supported by a weak correlation between the students' CGPA in the pre-university stage and the readiness test results, which indicated that lecturers should not solely depend on students' results during pre-university. This study showed that there were some students who needed further help with certain important topics.

Overall, the TCExam system can assist lecturers in simplifying and accelerating the process of marking and assessing students' maths readiness. Material cost and time can be reduced while quality and reliability can be enhanced with the use of the Rasch Measurement Model.

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A Case Study of Programme Educational Objectives (PEOs) Assessment Requirements for the Electrical and Electronic Engineering Programme in Malaysian Public Universities

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ABSTRACT

Programme Educational Objectives (PEOs) are a statement of specific goals to describe the expected achievement of graduates a few years after graduation. Even though the requirements used by all the institutions are the same, the attributes within an engineering programme may differ from one university to another. This paper seeks to fill this gap, as it aims to look into the differences in approach, trait and specific need as well as the generic terms applied for the differences. In this study, 24 PEOs were used to find similarities in the attributes for five Malaysian research universities using the Venn diagram format. The results were plotted in the Venn diagrams with specific generic common attributes, shared attributes and unique attributes selected by the research institutions. The similarities indicator was achieved using input from five research universities reviewed online. This case study will highlight preferences given in selecting right PEOs among the universities to meet the main requirements of the Engineering Accreditation Council (EAC) standards. In this study, it is hoped that PEO selection is updated and current best practices and market expectation needs for graduates can be materialised. PEO selection is a dynamic process; any changes and amendments made reflect the maturity of the faculty's curriculum and the courses offered in public universities. By continually exploring the expectation and demand of future graduates, important feedback from stakeholders can be collected to improve and design a programme structure that complements their future career paths.

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INTRODUCTION

It is the hope of every higher learning institution that their graduates succeed in their future undertakings, especially in today's challenging employability market. With a clear vision and mission, each Research University can easily determine the employability of their graduates. Demands may differ due to the needs of the industry and unforeseen market changes. Therefore, to produce quality graduates, the educational system needs to be aligned and should complement the industry needs and prepare graduates to embark on the right employment. Apart from having good academic grades and attitudes, the characteristics of graduates are also given much attention. The challenge then for training institutions is to design engineering curricula that can ensure that the student is able to meet the expected outcomes set by the programme. One of the important purposes in implementing Outcome-Based Education (OBE) is to set up the correct PEOs that specify the aims of institutions in producing graduates to fulfil employability alongside becoming competent persons in their respective career. The objectives for the use of an OBE programme are defined (ABET, 2009) as broad statements describing what graduates are expected to attain within a few years of graduation based on the constituencies needed. Meanwhile, according to the EAC manual (EAC, Programme & Manual, 2012), PEOs should be published, clearly linked to Programme Outcomes and clearly demonstrate the involvement of stakeholders in their continual quality improvement (CQI) process. The formulated PEOs are consistent with the vision and mission of the university and faculty and have been formulated to ensure needs relevant to the profession. Based on the review of PEOs by five research universities, five non-research universities, 12 private universities, four university colleges and four foreign branch universities, we have identified 24 keywords of PEOs as shown in Table 3.

Five research universities were chosen for this study, namely Universiti Malaya (UM), Universiti Kebangsaan Malaysia (UKM), Universiti Sains Malaysia (USM), Universiti Teknologi Malaysia (UTM) and Universiti Putra Malaysia (UPM). All of these public universities are ranked as research universities granted by the Ministry of Education and the Malaysian Government. One of the criteria for becoming a research university is that the institution must be involved in research with creative, innovative and potential commercial products.

Table 1
A Summary of the Vision and Mission of Malaysian Public Research Universities

	Public Research Universities in Malaysia				
	UM	UKM	USM	UTM	UPM
University vision	To be an internationally renowned institution of higher learning in research, innovation, publication and teaching	To be ahead of society and time in leading the development of a learned, dynamic and moral society	Transforming higher education for a sustainable tomorrow	To be recognised as a world-class centre of academic and technological excellence	To become a university of international repute
University mission	To advance knowledge and learning through quality research and education for the nation and for humanity	To be the learning centre of choice that promotes the sovereignty of Bahasa Melayu and internationalises knowledge rooted in the national culture	To be a pioneering, trans-disciplinary research-intensive university that empowers future talent and enables the bottom billions to transform their economic well-being	To be the leader in the development of human capital and innovative technologies that will contribute to the nation's wealth creation	To make meaningful contributions towards wealth creation, nation building and universal human advancement through the exploration and dissemination of knowledge
Engineering Faculty vision	To be an internationally renowned Faculty of Engineering in research, innovation, publication and teaching	To be a centre of excellence for the development of engineering and architecture knowledge at the international level, leading the development of a civilisation	To produce professional engineers who are responsible for research and development, project management, production planning and control and accreditation of equipment in various fields in the country	To be a world class centre of excellence and a leader in teaching and learning within the field of electrical engineering	To become a university of internationalrepute in engineering and research

TABLE 1 (continue)

	Public Research Universities in Malaysia				
	UM	UKM	USM	UTM	UPM
Engineering Faculty mission	To advance engineering knowledge and learning through quality education and research in the pursuit of fulfilling the aspirations of the university and the nation	To produce dynamic, creative and ethical engineers and architects	To provide quality education and sustainable research that produce professionals with the necessary knowledge, skills and character that are required for the advancement of engineering and technology	- To provide a world class programme in teaching and learning within the field of Electrical Engineering - To develop technology and technologists in the field of electrical engineering who possess high values and morals; and - To spearhead technology knowledge in the field of electrical engineering	To produce high-quality graduates who are able to compete in the workplace, and who are able to continually improve themselves

Sources: Mission and Vision (M&V) are taken from research universities websites (“Vision & Mission,” n.d.) (“Introduction,” n.d.)(“Mision & Vision,” n.d.)(“Visi/Misi/Matlamat Kami/Dasar Kualiti,” n.d.)

Table 2
A Summary of Malaysian Public Research Universities’ PEOs for Electrical and Electronics Engineering Programmes

PEO	UM	UKM	USM	UTM	UPM
PEO1	Graduates will achieve and continuously develop professional competency in innovative Electrical Engineering	Graduates will become engineers who have an understanding of the fundamental knowledge prerequisite for their role as efficient engineers	Graduates will be employed in the Electronic/ Electrical Engineering and related fields	Graduates will become electrical engineers who are competent, innovative and productive in addressing customer needs	Graduates will be competent and have knowledge of appropriate skills
PEO2	Graduates will possess the personal qualities and skills to progress in their chosen career	Graduates will be engineers with professional attitudes and ethics necessary for fulfilling their responsibilities towards the Creator, clients and society	Graduates will be innovative, pursue continuous career development and participate in social activities	Graduates will grow professionally and be proficient in soft skills	Graduates will be creative and innovative

TABLE 2 (continue)

PEO	UM	UKM	USM	UTM	UPM
PEO3	Graduates will contribute to sustainable development	Graduates will be engineers who will uphold the Malay Language as a language of knowledge in the engineering field and at the same time be able to communicate in English	Graduates will have leadership qualities, ethical values and awareness of sustainability issues	Graduates will demonstrate a high standard of ethical conduct, positive attitudes and societal responsibility	Graduates will be able to adapt to a global working environment and lifelong learning
PEO4		Graduates will be engineers who are able to adapt to the international/ global work environment			Graduates will have knowledge to perform problem solving as well as to design
PEO5		Graduates who will be engineers who are able to lead an engineering organisation based on knowledge of important current issues in engineering			
PEO6		Graduates who are able to conduct research in the field of engineering whether at postgraduate level or in their own organisation			

Sources: These Programme Educational Objectives (PEO) were taken from the websites of research universities (“Programme Educational Objectives,” n.d.), (“Brochure-Bachelor of Engineering Electrical. pdf,” n.d.), (“Programme Educational Objective,” n.d.), (“Bachelor of Engineering School of Electrical and Electronic Engineering Handbook,” n.d.)

Twenty-four PEOs were identified from among the PEOs of IHLs in Malaysia. The IHLs were public and private universities, foreign branch universities and university colleges (Table 3 Sources: Each university websites).

Table 3
Programme Educational Objectives (PEOs) Attributes Used in the Statements

	Keywords		Keywords
PEO1	Knowledgeable in engineering	PEO13	Entrepreneurship
PEO2	Communications/Interpersonal skills	PEO14	Multidisciplinary/Skills engineers
PEO3	Competency in field/Tech expert/ Registered	PEO15	Build career/Personal qualities development
PEO4	Problem solving	PEO16	Creative & Innovation engineers
PEO5	Know-How skills/Productive/System approach	PEO17	Continue Education/Professional development training
PEO6	Sustainability development awareness	PEO18	Carrying research & development work
PEO7	High ethics, values and professionalism	PEO19	Practice/Contribute expertise
PEO8	Individual leadership/Teamwork	PEO20	Possess military leadership/Profession
PEO9	Promote general sustainability in cultural, environmental, economic, safety, cost/ Global impact/changes	PEO21	Possess engineering management
PEO10	Lifelong learning	PEO22	Proficiency in soft skills
PEO11	Inspiring	PEO23	Forefront of technology
PEO12	Focus on niche/specialised area	PEO24	Commercialised products

OBJECTIVE

A system accreditation unit certifies a Institute Higher Learning (IHL) as an institution that can assure quality in the field of teaching and learning that is suitable for achieving its qualification goals. This is to ensure the quality standards of the IHL's programmes and to create a quality culture that is supported by broad quality awareness throughout the IHL. Complying programmes, which are set up after system accreditation in accordance with the requirements of the accredited system, receive accreditation. The relevant structures and processes for teaching and learning are then reviewed to see whether they are capable of meeting the qualification objectives and to ensure high quality of the subjects offered. The certification process usually requires a higher workload, extra meetings and tedious document preparation. It is not a one-loop operation; accreditation should be frequent and it requires extensive rounds of reviews. Therefore, a new platform needs to be developed that will involve many people from various management operational positions in the hierarchy to come together under systematic planning and strategy. In this paper, the main objective was to propose an ideal platform that can assist in preparation of a self-assessment report and other supporting documents.

LITERATURE BACKGROUND

OBE Educational Programme

The accreditation of an engineering programme is generally judged with respect to the defined educational objectives and outcomes. Each programme must have defined outcomes in producing graduates with certain skills and abilities to meet the needs of stakeholders (Puteh et al., 2009). Each programme must also have assessments in place for continuous improvement and properly documented results. The implementation of OBE, therefore, becomes an important backbone and the strength of engineering education in Malaysia. The curriculum is one of the most crucial aspects of engineering education that needs to be planned systematically and must be aligned with current industrial and academic needs (Chowdhury et al., 2013).

Relationship of Vision, Mission, PEO, PO and Curriculum Design

Three main domains that should be included in any engineering programme are development of the IHL direction (establishment), evaluation process (assessment) and continuous quality improvement (CQI) efforts. For instance, there are two targets set, namely, short-term target and long-term target. The short-term target aims to achieve necessary competency by students by the end of the programme, while the long-term target is deliberately required of alumni to achieve specific competency after three to five years of graduation. Both of these targets, Programme Educational Objectives (PEOs) and Programme Outcomes (POs), complement each other and are related in fulfilling stakeholders' requirements. The objectives and outcomes must be assessed and evaluated. The PEOs are explicit goals consistent with the vision and mission of the institution of higher learning, and are responsive to the expressed interest of programme stakeholders describing expected achievements of graduates in their career and professional life after three to five years of graduation. The criteria of good PEOs include being unique, explicit, measurable, achievable, result orientated and having a time frame.

All programmes that are assessed and evaluated at different levels and through different assessments during the programme define their POs to continually monitor the achievement level of their graduate students. POs incorporate the knowledge and skills that need to be attained by students who are graduating with a set of standard criteria to equip them in becoming professional engineers. Moreover, the PEOs should have a clear path to the POs and curriculum design. Besides that, both POs and curriculum design should be measured and analysed to find the achievement level for each programme. Any weakness must be improved in stages with proper CQI planning.

The measurement processes should also be carried out by two different committees. The committees should be formed at the Department or Faculty level and should focus on developing database, assessment instruments on data analysis and programme design improvements. Some of the activities include monitoring performances, reviewing external examiners and EAC comments and digesting valuable input and feedback from alumni, stakeholders and industrial advisory panels (Kahveci et al., 2012). Other than those mentioned, the structural framework for the structural relationship between key components for engineering accreditation is designed to provide clear linkage between the components as shown in Figure 1.

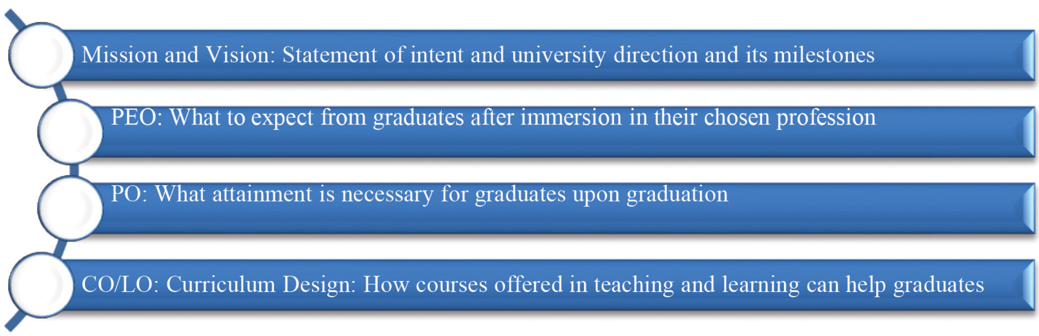


Figure 1. Relationship between vision and mission – PEO-PO-CO/LO.

Programme Educational Objectives (PEOs)

PEOs are broad statements that describe what graduates are expected to attain within a few years after graduation (normally three to five years and above) upon immersion in their chosen career. The establishment of PEOs is based on the needs of the programme's constituencies/stakeholder expectations and interest. PEOs are sometimes defined as extraordinary features that differentiate an institution's graduates from those of other institutions. The domains that are usually used in PEO statements are sustainability, leadership, ethics, lifelong learning, Malaysian aspiration, economic development, competency and entrepreneurship, among others. In fact, ABET (2009) has said that they have not fixed domains in university's PEO statements as these should be determined by the universities themselves through a systematic and structured process. For instance, the PEOs need to be documented, published and made known to all interested parties with the university's clearly defined vision and mission. Rashid (2012) suggested that the relationship between PEOs and the institution's mission should be mapped in matrix format (Rashid, 2012).

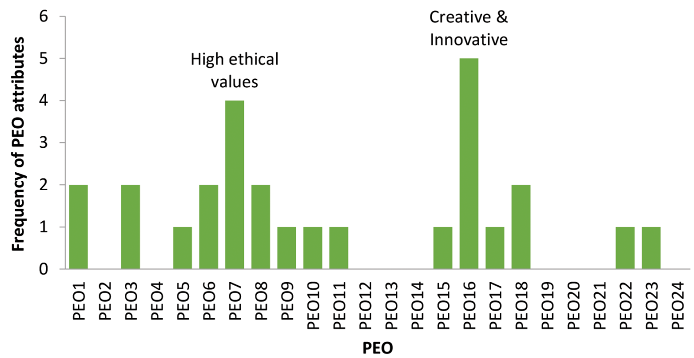
The process of setting PEOs involves three processes, namely, establishment, assessment and quality improvement. Moreover, two methods of assessment can be applied to measure the attainment of alumni, namely, indirect and direct measurement methods. Direct measurement is the tool used to assess the achievement of an alumni; this can be achieved through a survey. The questionnaire used for this method must be invented strategically and indirectly to reflect the actual attainment of the alumni.

Meanwhile, the indirect method can be implemented by mapping the PO attainment with the PEOs; the analysis is done by mapping the PO attainment with respect to the PEOs. Indirect assessment is important in predicting PEO attainment before the students enter the actual work field before graduation. However, the direct and indirect methods have to be correlated. For instance, ABET (2009) reported that they did not define the method of assessment and allowed the university to determine a suitable method to assess the alumni attainment level. A clear link between PEO and PO attainment should exist throughout the establishment process and this must be properly documented.

While the vision and mission of a university are permanently fixed over a certain period of time, PEOs are more flexible and require revision in the range of three to five years with consultation with alumni and stakeholders. Moreover, the domains in the PEO statement must be revised for their relevancy and consistency with the vision and mission. The arrangement meeting with stakeholders is set every year and the deliberation of this meeting should be recorded as minutes of the meeting. Having more and various stakeholders is better in order to have significant domains expressing interest among different groups.

In every PEO, domain statement is very important as it determines the direction and the roadmap for the future of the programme. Besides that, the domain must be congruent with the existing POs (proposed by EAC), but is not limited to the given framework. The domains of PEOs must also be specific, measurable, attainable, realistic and timely. PEO evaluation is done by means of assessment and examining findings based on objective evidence. Shaping and reviewing PEOs is done through a few mechanisms such as industrial panel meetings, employer questionnaires, industrial training input and alumni survey (Ezeldin, 2013). For instance, one of the effective methods used to evaluate the perception of employers and external stakeholders is using the 5-level Likert scale in evaluating PEO statements. The results range from ‘not relevant’ to ‘very important’ based on questionnaires related to the PEOs (Abdullah et al., 2008).

In order to strategise the process, a new platform of EAC preparation is highly recommended. For example, in Faculty of Engineering and Built Environment, UKM, there is a specific committee under the supervision of the Vice Dean (Student and Alumni) to ensure that PEOs are standardised across the departments. The alumni liaison committee is also responsible for devising the survey questions, analysing survey forms and proposing improvements in solving and minimising any discrepancies. The objective development programme will also be applied in the following areas of the process of domain formulation: Involvement of stakeholders as strategic partnership, assessment process and tools for achieving PEOs, performance analysis of PEOs and management academic CQI. These areas show that involvement in establishing, assessment and continuous improvement is important for meeting targets and stakeholders' interest. These activities are in line with efforts of institutions of higher learning to deliver improvement in quality education, enhance creativity and innovation as well as prepare graduates to enter the job market (Moscinska, 2014).



Note: Frequency for PEO Attributes : 0-1 (Unique) 2 (Sharing) >3 (Common).

Figure 2. Histogram of PEO attributes distribution among Malaysian research universities (RU) with EE programme (UKM, UM, USM, UPM and UTM).

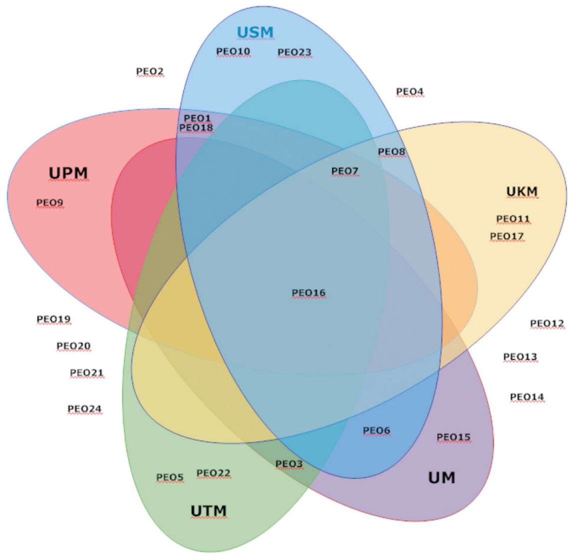


Figure 3. Venn diagram format for relationship between PEO attributes for Malaysian research universities.

METHODOLOGY

The process of setting PEOs involves three processes, which are established, assessment and quality improvement. The current formation of PEOs can be the basis for new formulations or PEO revision. The input for revision can be gathered internally and externally, depending on each department of engineering coverage. Stakeholder feedback is considered a very important input in reviewing the current PEO statement in terms of its relevancy and current industry needs. The same is true for input received internally by institutions' goals and targets in line with their vision and mission.

Once PEOs are published and authorised they should be displayed and made known to all involved in the implementation of the system. Assessment of PEOs is necessary to ensure that the PEO statement can be achieved and the performance set will be valuable for the university to design, improve and further revise the strategy of ensuring their graduates entering the employment market have the correct attributes and attainment. Reviewing the PEOs every after few years is a good quality improvement step in ensuring the graduates meet the institutions' goals. The relevancy of PEOs in meeting stakeholders' expectations is the most important goal in terms of the institutions' vision and mision.

RESULTS

PEOs Among Malaysian Public Research Universities

The most common PEO statement used by Malaysian public research universities is to incorporate creative and innovative elements (PEO16) in their careers as shown in Figure 2. Public universities with research status in Malaysia have to be active in generating new ideas, especially in the latest research niches such as renewable energy, optics, biomedical etc. Apart from generating new ideas, each public research university also focusses on ethical issues (PEO07) pertaining to their research as shown in Figure 2. This is essential to ensure that product patents, plagiarism and copyright issues are complied with. On top of this, most Malaysian public research universities are inspired to produce more engineers with leadership skills and sustainability awareness and who are competent in their respective fields. In order to keep the reputation as a research university, the status granted by the government is expected to produce quality innovation results from these institutions. Moreover, many awards and achievements as a result of research and development work have successfully contributed to the success of local universities, some of whom have gained international recognition with their innovations and research findings.

The results of similarities for PEO attributes from Malaysian research universities are represented in Venn diagrams as shown in Figure 3. The highest selection of PEO attributes is for creative and innovative (PEO16), indicating that research universities agreed to have this element as they aimed at producing graduates able to think creatively and generate new ideas. For the attribute, high ethical values and professionalism (PEO7), only one university was not sharing and applying it. As for the other PEO attributes, only a few universities were sharing the same attributes.

For easy understanding, PEO attributes are categorised under three major groups among local Malaysian research universities (see Figure 4).

(A) Common PEOs – refer to attributes that are aimed at meeting the expectations of stakeholders. This includes the university, employers (industries), alumni, the Industrial Advisory Panel (IAP) etc. This common PEO is the main EAC requirement that is relatively applied to all institutions that run engineering programmes.

(B) Shared PEOs – refer to the one or more sharing attributes used to illustrate attributes similarly applied in local research universities. These sharing attributes are normally derived from stakeholders' requirements, which are about the same for all the institutions.

(C) Unique PEOs – refer to the uniqueness of attributes applied only to a particular university in line with its vision and mission. Normally, the vision and mission (V&M) of each university is somewhat unique as each institution formulates its own unique identity and expectations for its graduate attainment.

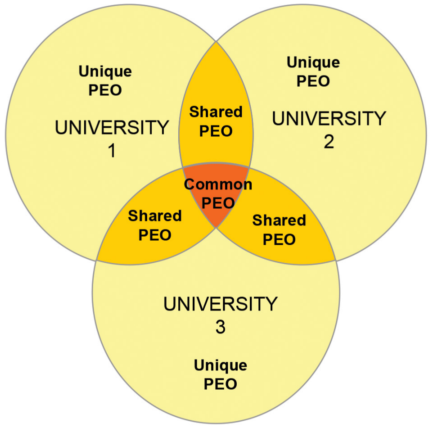


Figure 4. Venn diagram showing common, shared and unique PEO attributes among universities.

Common PEOs Among Malaysian Public Research Universities

There are two distinguished attributes commonly applied for Research Universities (RU) in Malaysia. All public universities with RU status expect their graduates to have the capability of applying creative and innovative ideas in their workplace. Engineers produced by research universities do have strong knowledge of engineering and are able to materialise learning experiences into real working situations. The results of the analysis shows that Malaysia is moving towards becoming a developed nation by 2020; this goal is also in line with the vision and mission of these universities. For instance, all universities with RU status would like to be portrayed as leaders either locally, regionally or even internationally and be seen as renowned, reputable or world-class higher learning providers. By setting a high standard, the quality of electrical and electronics engineers produced by these research universities will be above that of their competitors in terms of contributing to human and intelligence capitals.

The second attribute most commonly used by public research universities in Malaysia is generating ethical values among engineering graduates. This is truly important as engineers from institutions of higher learning need to be responsible and accountable and act professionally in their career. Engineering by status does not just hold knowledge in technical expertise but also demands that engineers abide by the rules of professionalism. Issues such as patents, copyright, plagiarism and intellectual property are just some of the common engineering rules that need to be followed by these groups. Therefore, it is common to adapt to this ethical standard so that engineers in Malaysia can be trusted and respected and they can gain a worldwide reputation. Apart from being the centre of excellence in education, ethical issues are given top priority by many professional bodies in benchmarking standards and acceptance by industry standards.

Sharing PEO among Malaysian Public Research Universities

Local research universities in Malaysia share several PEOs. One distinguished PEO might be shared by another university of similar status. The difference is just a sharing code with another university with similar objective, but this does not apply to all research universities. Below are a number of examples in support of this study.

UM and USM are two different RUs that share a common PEO on sustainability issues. Both universities place an emphasis on the importance of the contribution of their graduates towards sustainable development in the engineering field. Furthermore, sustainable development is shared due to the situation and need to sustain available resources and ensure continuous progress in engineering by emphasising sustainability development during its implementation.

UKM and USM have similar PEO attributes for their graduates in the area of leadership. Their graduates are trained to be leaders in their organisation who are strong in technical knowledge. Leadership and teamwork are focussed on in the curriculum to produce graduates who are capable of working in a team and able to portray themselves as future leaders in the organisation of their choice. Having leadership qualities makes graduates more confident in their specialised areas and capable of leading an organisation in order to take it to greater heights.

UPM and USM have linked research and development to train their graduates to produce good results in their research area. UPM is known as a research university focussing on agricultural matters, while USM is an innovative university that provides solutions to industry, especially through engineering. Besides being research-orientated, both institutions focus on training their graduates in value-added research and development work in order to create wealth for the nation. They are also committed to building reputation as research universities.

Two other universities, UTM and UM linked efforts to emphasise competency and specialised values held by their graduates. Getting recognised and competent in the engineering field is an essential objective as many professionals in this field do require graduates to possess credibility in carrying out their tasks. As professional and capable graduates, they are expected to perform better and be more reliable according to industrial needs. There has been strong emphasis on producing graduates who are not only capable of delivering engineering solutions but also competent and registered with professional bodies such as the Malaysian Board of Engineers (BEM).

The above examples are some graduate attributes applied to local research universities in Malaysia. With strong support from the government, local public universities are expected to produce more reliable engineers for the country in the future.

Unique PEOs among Malaysian Public Research Universities

Each research university has its own uniqueness that differentiates it from other institutions. This makes universities competitive and provides graduates choice as well as ensures that the universities fill their unique niche. UKM, for example, is the only research university in Malaysia selecting 'Malaysian aspiration' as its goal. Being the national university of Malaysia, UKM has proven that preserving the Malay language and enriching its content internationally will help boost the uniqueness of its graduates. Not only is it capable of accumulating a pool of great scholars, its graduates enshrine the name of Malaysia worldwide through quality engineering education.

UM requires its graduates to possess personal qualities to progress in their personal career. This unique attribute distinguishes UM graduates in terms of their personal development along their career path. Having a balance between technical knowledge and well-being of personal character in an organisation makes UM a prime choice for tertiary education among students.

Likewise, USM uses forefront technology as a niche to enhance its graduates' quality. USM, being recognised as the only APEX status university in Malaysia, uses technological advancement to help its graduates succeed in their career. With a strategic location close to one of Malaysia's Silicon Valley industrial areas, it puts the university among the key players in the field of engineering and technology.

Nowadays, employers seem to be interested in employing graduates who have soft skills such as good communication skills and leadership and who are able to work in teams. Thus, the lack of soft skills is considered unmarketable. UTM is a local research university that adds value to its graduates' training by equipping them in soft skills. The attributes and generic skills are embedded in the context of the students' studies. These soft skills are recognised by professional bodies and therefore, distinguish UTM graduates from others. Encouraging graduates to diversify and expand their soft skills will help improve their professional goals. Some of the soft skills include mastering languages, programming and computing skills.

Another university, UPM, is known as a public research university that emphasises sustainability. Since the foundation of the university is in agricultural and natural sciences, sustainability is emphasised. Engineering projects are strongly urged to add sustainability as an attribute. This teaches graduates to be more responsible in carrying out engineering projects as well as ensures that sustainability is prioritised. Graduates are also taught not to aim only to make a profit, but also to think of preserving the environment, safety issues and health matters for the community at large.

DISCUSSION

The comparison of PEO selection among Malaysian public research universities is considered diversified in nature. However, other aspects such as gearing towards becoming high reputable and excellent institutions are similar goals among these universities. Such attributes are what concern shareholders. There are few variations in the universities' expectations in general. There are several reasons why different public universities set different expectations for their graduates. Among these are:

1. Lack of awareness among local public universities of current trends and markets for its engineering graduates when offering engineering courses
2. Lack of knowledge in choosing suitable engineering courses
3. Lack of common attributes among public universities for engineering courses that are required by the accreditation standard (EAC & MQA)
4. Lack of review of PEOs that are no longer relevant to current needs
5. Lack of consultation and advice or chosen IAP/consultation in different lines of expertise and fields
6. No mapping with mission and vision of the IHL as well as the internal requirements

CONCLUSION

There seems to be an opportunity to conduct further research on the actual needs of PEO determination through internal, external and third parties for each university. It is up to the institution to come up with the best selection of PEOs reflecting its vision and mission objectives. The correct methodology in determining the rightt process is an advantage in fulfilling accreditation requirements and improving overall the academic management system for any engineering programmes held. Once the appropriate PEOs are set from internal, external and previous assessment views, the outcome for this process becomes clearer. There is always no one correct methodology for setting PEOs that can satisfy all stakeholders' needs. This allows each university to claim its niche by identifying its unique PEOs.

RECOMMENDATION

Perhaps, one of the best solutions offered for closing the gap between local research universities is to have collaboration and sharing on best practices among them. All three listed domains must collaborate on graduate attributes, among which are skills, knowledge and the right attitude in accepting ever challenging engineering careers. Collaboration among research universities and the accreditation agency helps in improving PEOs. For example, a bi-annual discussion on engineering and market employability trend can be organised. There is a lot of relevant information pertaining to PEOs that can be valuable input for the universities and its stakeholders.

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The Assessment and Application of Student Competency in 'Land Survey, Building and Measured Drawing' Course

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ABSTRACT

Competency is a set of related knowledge, skills and abilities required to successfully perform work or tasks in a defined work setting. Besides having good grades, a graduate must be able to respond well, be a visionary and be a contributor in building a noble society. By exercising soft skills as part of teaching and learning, students are expected to effectively develop and apply competencies. This paper documents generally one teaching and learning approach used in design courses to train students in soft skills, the training of which is also one of the course's learning outcomes. A project management team is formed, dividing students into different segments and tasks, monitored by an advisor and assisted by a project manager who is made liable for task completeness. Students must be able to perform well in communication skills, teamwork, critical thinking skills and professional ethics, among others, the assessment of which contributes to the total course marks. A self-rated assessment by the students at the end collected as a measure for this study shows some positives improvements in their competencies as a result of the approach applied here.

Keywords: Competency, soft skills, measured drawing

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INTRODUCTION

This paper describes and documents a teaching and learning approach used in a design course in architecture run by UKM. As one of the elective subjects offered by the programme, the course is generally aimed at equipping students with basic construction knowledge in building design, as well as to introduce them to relevant research methods in built environment studies. Implementing generic skills as a teaching approach seems to give a positive impact on students' development throughout their studies in university, making them highly employable at the same time. Besides being a means of content delivery through course work and case studies, this approach also hones students' soft skills as they are trained to practise critical thinking, communication, teamwork and planning, creativity and innovation and ethics in conflict management throughout the course. The course does not merely aim to produce students with good grades and academic results, but also to equip them with the basic skills required by industry; a benefit of this is that students' career path in the future will be enhanced.

Competency is viewed as a set of abilities, knowledge and skills necessary for completing an action. It is a set of related knowledge, skills and abilities required to successfully perform work or tasks in a defined work setting. According to Sampson and Fytros (2008), assessing competencies depends on different application fields, their goals and the approach employed by the organisation. Competency is an important component in evaluating employee workability.

A major challenge for educational institutions is to produce graduates who are able and capable of meeting market needs. Rather than merely producing good grades, university graduates must also be able to support and contribute to nation building in all its aspects. Graduate employability is widely discussed locally and throughout the world, and it has become an urgent goal of universities to produce graduates who will be good enough for the job market. According to David Rae (2007), employability is a set of skills, knowledge and personal attributes that make an individual more likely to secure employment and be successful in their chosen occupation to the benefit of themselves, the workforce, the community and the economy. Among the common causes was the development of students' self-skills, specifically, those that are typically enhanced by continuous exposure. Soft skills have a high impact on employability (Shafie, 2010). Graduates need to be more proactive and be able to solve problems in a creative way, and this is what employers are looking for when recruiting new employees (Zehrer & Mossenlechner, 2009). According to Bagshaw (1996), generally, employers are hiring individuals with good communication skills, empathy, motivation, decision-making skills, good planning ability and ability to improve situations and solve problems. Employers are not looking only for good academic results; they are more interested in how potential employees envision themselves and their abilities and potential during job interviews (Che Ani, 2013).

Based on these demands, several approaches have been taken to enhance the employability of architecture graduates. One is to emphasise soft skills in the course's learning outcomes. UKM's Architecture Department adapts project management as a learning strategy to improve students' skills. This is an early marketing strategy to enhance their employability in order to help them with job hunting.

The Land, Building Survey and Measured Drawing course (KKSB 2223) is generally a combination of the engineering and architecture courses. The course covers survey in planning, design and implementation of engineering projects, such as the use of basic surveying equipment, leveling, traverse, mapping, contour, staking and setting. In a particular week, students are introduced to research methodology and documentation of various information about national heritage buildings either through measured drawings, interviews, visual, library research or discoveries etc. Incorporating field studies, the course exposes students to actual problems and obstruction, which enables them to generate critical thinking skills and other interpersonal skills. The course begins with a series of lectures for three weeks and follows up with students' projects till the end of the semester. In their final week, students are required to prepare a final report as part of the outcomes of this course.

One of the course outcomes is to use and apply soft skills as part of the learning process (refer to Appendix A2). Adapting project management helps students to practise communication skills, teamwork, critical thinking and much more. Generally, there are no specific learning sessions where students are taught these skills; students are expected to explore and acquire these soft skills through self-directed learning. The teacher's role only as a facilitator and to supervise. The approach emphasises on managerial and team work, and this provides space for students to be outstanding in management skills. This provides a challenge for students that they may not otherwise meet in university, diversifying their learning experience.

METHODOLOGY

The approach is similar to Contract Learning, which exercises soft skills as part of students' learning experience. Contract Learning, generally, is a set of written items provided by the teacher that students consent to before the course begins; one item under this contract or agreement between the teacher and the students is that students agree to complete tasks within a given timeframe (McCabe, 2008). This method is a bridge between theory and practical work as it requires the demonstration of knowledge transferred to practice (Rolfe, 1996). Generally, it is compulsory for students to engage in project work demonstrate the application of theory.

The structure of the 14-week course starts with a briefing on the course content. Students must know what is required of them and what will be assessed. This allows them to plan and strategise a route for success in the course early on in the course. The second, third and fourth weeks provide course content through lectures while the remaining weeks are allocated for project work. Divided into several groups, the students carry out their project work; each group member takes on a different task within the group and each group is given a specific task as a division to complete the project. Together, the divisions form an organisational structure that plans and executes the project. The group structure or the designed organisation is shown in Figure 1.

During project implementation, the teacher is to advised and responsible for assisting students when problems crop up. In this study, the master or project leader was chosen from among the students and was assisted by the group leader of each division. The project leader reported to the advisor and monitored all the given tasks in addition to providing support to group members according to the project planning. This organizational structure enabled students to exercise managerial and coordination skills in completing tasks. Group leaders are tested on coordination, leadership skills and negotiation, among others. Students are expected to make competent use of diplomacy skills and coordination strategies and to formulate a working plan and to deliver workload and other instructions to all group members. Students were expected to play their role as a team, understand orders, deliver tasks by giving assistance, provide input and thoughts and be capable of providing positive interaction with the team. Good communication skills were among the competencies needed to achieve successful project delivery. Effective communication between team leaders formed good practice in conveying information. This included sufficiently interlinked communication between divisions. This can be explained through Figure 2.

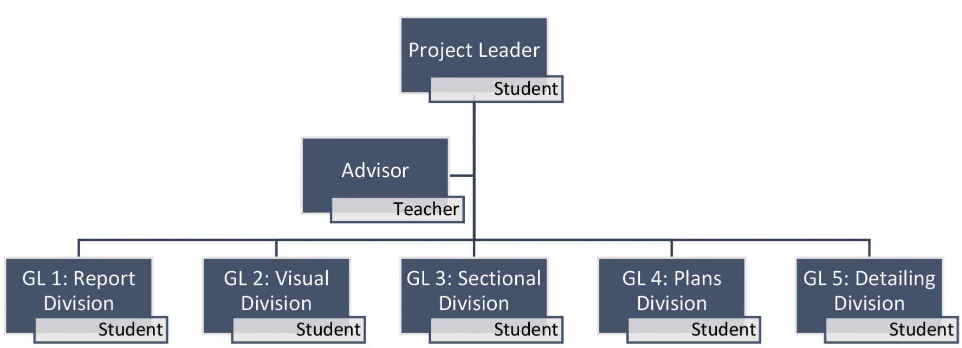

Figure 1. The organisational setting for KKSB 2223.

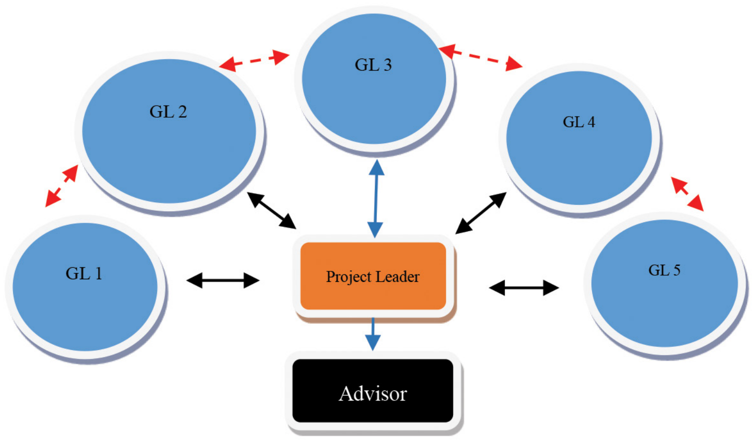

Figure 2. The instructions, information and communication delivered among the teams.

Group formation allowed each member to participate and play his/her respective role. Group leaders monitored their team on completing specific tasks within the given time. Other than delegating tasks, the project leader was also the main editor of the report that would be prepared by the group and was involved entirely in the implementation of the final stage of the project. Also the liaison between the students and the lecturer, he had to report to the advisor, seeking help and advice when needed, and monitoring each segment completely to ensure each group completed its task. The project started in the fourth week of the semester and ended in the 14th week or until the product was delivered. Each student or team member was required to be responsive and to completely deliver the assigned task to enable assessment of individual skill. Lack of commitment could seriously affect the quality of the output.

Each group member was assigned to a different segment. Generally, the objective of this course is to provide an understanding of architectural heritage. Students are required to measure, record and make a small-scale model as the final output, which eventually increases their understanding of building technology and construction of a building. They were required to collect, record all relevant information on the selected building, identify the significance of its architectural heritage, observe interaction patterns and understand the construction in terms of its surroundings, as well as to appreciate the uniqueness of historical evidence. The methodology was observation of a selected building (observing it as a whole of the site, including the building and its surroundings, and various perspectives, including the details of special construction), through photographs as evidence (photos focussing on special characteristics of the building), data collection (gathering information by keeping records and making detailed measurement of each building element), interview sessions (to discover historical perspective and information, background and details of ownership, including renovation details), desk study of previous reports and documentation (grants, archival information and interviews with identified communities).

A report was produced in which students had to be able to write and use proper language. This required them to be able to use MS word processing as well as design software such as AutoCAD and Sketch-Up in completing the task. They had to be able to understand and make use of whatever technology that was available. A guideline for the report was provided by the teacher in table-of-content form. The teacher helped to monitor work, troubleshoot problems, especially during task delegation, and supervise the final content. Group leaders, who were also responsible for editing the report, had to eliminate redundancy in the report. This was to encourage good communication and information delivery as well as to ensure that the final output clearly met the objectives outlined earlier.

Apart from writing the report, students are required to make an architectural drawing of the project, as stated earlier in the course objectives. Taking the actual measurement during the site survey enables students to sketch, re-draw and transfer the measurements into 2D and 3D drawings. The drawing includes building plans, two sections (section X and Y), left and right elevations, detailing and special construction detailing and perspective drawings. The appendices contain an example of the report guidelines, while the project work plan can be referred to in Table 1.

Table 1
Course Planning and Soft Skill Matrix

Weeks	Items	Soft Skill					
		Leadership & Teamwork	Communication	Critical Thinking	Social Skills	Ethics & Professionalism	Creativity & Innovation
1	Project Introduction -Briefing on building restoration, general course content -Theory of the usage of measuring tools		x				
2	Group formation	x	x		x		
3	Group formation and working plan	x	x	x	x		
4	Site survey (historical, site measurement)	x	x	x	x		x
5	Site survey (historical, site measurement)	x	x	x	x		x

TABLE 1 (continue)

Weeks	Items	Soft Skill					
		Leadership & Teamwork	Communication	Critical Thinking	Social Skills	Ethics & Professionalism	Creativity & Innovation
6	Site survey (historical, site measurement)	x	x	x	x		x
7	Site survey (historical, site measurement)	x	x	x	x		x
8	Studio work (2D, 3D, Report writing)	x	x	x		x	x
9	Studio work (2D, 3D, Report writing)	x	x	x		x	x
10	Studio work (2D, 3D, Report writing)	x	x	x		x	x
11	Studio work (2D, 3D, Report writing)	x	x	x		x	x
12	Preparing presentation (Review)	x	x	x		x	x
13	Preparing presentation (Review)	x	x	x		x	x
14	Presentation and Final product	x	x			x	x

RESULTS AND DISCUSSION

At the end of the semester, apart from submitting the report, students' soft skills were assessed; this contributed to the overall assessment. According to the project plan, the assessment was done during the project execution and the main contribution was field work. The rest of the assessment constituted of continuous observation, with no specific date and time and the teacher usually observed students' performance based on how they contributed, responsiveness and work as a team. In their final presentation, the question and answer session helped the teacher to determine the final marks of the assessment. Students who had not contributed much or at all to the project would usually have a hard time during this session.

The presentation is deliberately arranged to present their final work and is also a session for students to perform verbal communication skills and critical thinking. It is a platform for them to train and enhance their self-confidence before the next phase of their studies. Table 2 shows the content and details of what was assessed in the coursework. In this course, the assessments were based on percentage divided into three sections (a) Fieldwork (30%), (b) Presentation (20%), and (c) Report Write-up (50%). This is shown in Table 2.

Table 2
Weightage of Assessment for KKSB 2223

	DESCRIPTION	Percentage
A	**FIELD WORK (30%)**	
	Group (20%)	
	Problem solving	5%
	Information and data collection	10%
	Teamwork	5%
	Individual / Student competency (10%)	
	Teamwork/Social & Responsibility/Communication	5%
	Problem solving/Creativity/Ethics & Professionalism	5%
B	**PRESENTATION (20%)**	
	Content	10%
	Delivery creativity & Time management	5%
	Q&A session	5%
C	**REPORTING (50%)**	
	Delivery (language, format, creativity)	5%
	Content (historical and building)	20%
	Building drawings	20%
	Teamwork & Punctuality	5%

The main contribution of soft skills assessment was done during fieldwork. Students should be able to demonstrate problem-solving, delivering information and communication as well as be able to commit to every task challenge. The teacher observed and did a formal assessment on how the students responded, demonstrated and performed as described in Appendix A3. Using 1 as the scale for 'very unlikely' and 5 for 'very likely', the total score of each soft skill is then converted to 10% (5% for Social and Communication category and another 5% for Skills and Knowledge category). For the reporting section, a small allocation for soft skills served as top-up marks, coming as it did from group assessment. This provided overall efficiency on how they managed and sorted a lot of information. Appendix A2 shows the course learning outcomes and their relation to soft skills while Appendix A3 is mainly about assessment content based on students' competencies used as a basic guideline for the course learning outcomes. Students' self-learning skills were developed, and this was a way for them to make use of whatever knowledge they had to complete the task. This had to be monitored by the teacher so that students could be guided in their learning.

At the end of the semester, other than the course's assessment, students assessed themselves through a quick survey, rating them performance before and after the project. The assessment, however, was only for internal purposes and did not contribute to the overall marks as the information it provided was for course improvement for subsequent cohorts. The quick survey using the Likert Scale (1 for low score and 5 for high score) is a student evaluation to help identify enhancement of their soft skills. Most of them gave positive rates for their skills based on the given description. An average score from 2.9 to 3.3 was recorded for 'Before' and 4.2 to 4.4 for 'After'. Refer to Appendix A4 for the abstract from the assessment content. Figure 3 shows the student's assessment of their soft skills.

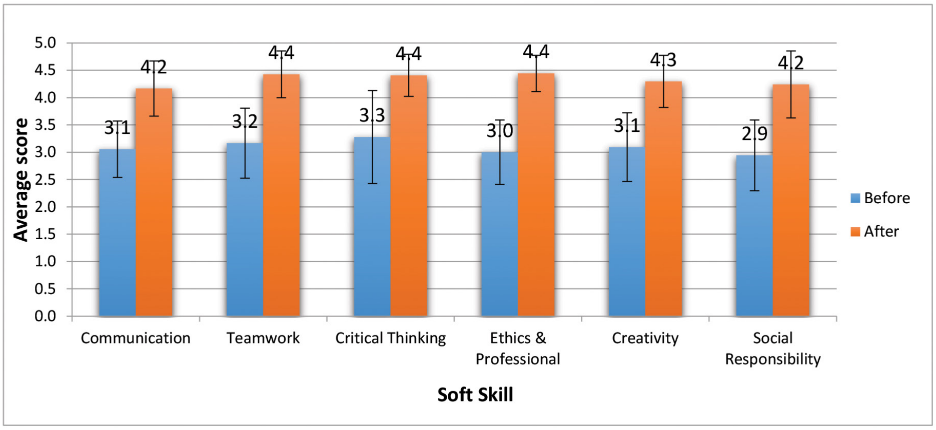

Figure 3. Students' Self Assessment on Soft Skills.

CONCLUSION

In developing countries, skilful and knowledgeable human capital remains the most important resource for developing the nation. This, however, is a challenge for higher educational institutions to produce competent graduates who meet industry needs. The employability of graduates emphasises soft skills and how competent graduates are in completing tasks. By exercising soft skills as part of teaching and learning through project management, it is hoped that students can enhance their generic skills. Soft skills are part of the overall course outcomes and the students are expected to be able to communicate well, show an increase in confidence level, be competent to work in a team as well as be able to unleash their inner expertise. In the project management approach, the student learns much through self-learning but must be assisted by the teacher, who provides minimum input while the student puts in effort to learn and improve. This implementation hopes to stimulate and improve students' generic skills, which will equip them for employment.

ACKNOWLEDGEMENT

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APPENDICES

Appendix A1

The Report Outline

Table of Content		
Acknowledgement		
Abstract		
Research Methodology		
List of Figures, Photos, Tables		
Chapter 1: Introduction	Chapter 2: Research Introduction	Chapter 3: History and Background of Subject
Background subject (Site studies) Geographical, climate, history of the selected site, customs & religion	Traditional Malay house architecture Traditional Malay house architecture – Site studies Differences in criteria	History and background of construction House ownership & family background Customs/Religious background
Chapter 4: Architectural Study of Subject	Bab 5: Architectural Analysis of Subject	Chapter 6 : Working Drawings
Construction methods, measurement concepts, building materials, external description, internal description, building details, renovations and adaptation, home maintenance		Plan Views Sections Details and specification Axonometric
Chapter 7: Summary	References	

Appendix A2

Learning Outcomes and Soft Skills Matrix

No	Learning outcomes for KKSB 2223 Course	Soft skill					
		Leadership & Teamwork	Communication	Critical Thinking	Social Skills	Ethics & Professionalism	Creativity & Innovation
1	Ability to obtain data and analyse information from a variety of maps	x	x	x			
2	Ability to perform detailed mapping as required in engineering design	x		x			x
3	Ability to accurately perform plot and setting	x	x	x			x
4	Ability to work in a team to conduct a large survey	x	x	x			x
5	Ability to prepare reports and present the results of the engineering work	x	x	x	x	x	
6	Ability to recognise and understand the standards and construction symbols in building construction (construction drawings/ work), especially in the fields of architecture and other related industries such as standard structure symbols, standard mechanical symbols and standard electrical symbols			x		x	x
7	Ability to read/interpret simple working drawings		x				

Appendix A3

Examples of Students' Soft Skills Assessment (Modified from Mohammed Sani, 2012; Carraciao, C., 2004; Pusat Citra UKM, 2013)

Soft skills	Execution of work	Presentations/Reports
Effective communication	Ability to deliver and accept instructions clearly Ability to use language correctly	Ability to use language correctly Ability to present ideas clearly and answer questions in conformity with requirements
Leadership and Teamwork	Ability to act as leaders and followers (pass and accept instructions and lead a team to achieve goals) Ability to cooperate, respect and accept the opinions of other individuals (response to problems and referrals) Ability to involve self and contribute to planning and coordinate the results of the group's efforts	Ability to help team members (Apportioning of work, consensus on answers)
Critical thinking	Ability to convey ideas and suggestions in troubleshooting Ability to analyse and evaluate problems and solutions Ability to strategise effective plans	Ability to provide thoughtful responses in a short period of time and to justify responses
Social skills	Ability to interact with members of the group and external community/groups Ability to act responsibly in any undertaking	Ability to interact while being a team member and be responsible for the task entrusted
Ethics and Professionalism	Ability to act in a more rational way and resolve conflicts with prudence Ability to show integrity in any circumstances or when problems crop up	Ability to be responsible for the originality of presentation of information and tasks entrusted
Creativity and Innovation	Ability to produce a remarkable idea in problem solving Ability to renew and improve existing weaknesses and to show variation from the norm	Ability to generate ideas and creativity in information delivery

Appendix A4

Student' Self-Assessment

No.	Description
1.	Effective communication
	Information delivery, Accepting information, Correct use of language
2.	Teamwork
	Demonstrate and cooperate on any task, Give opinion and participate in discussion, Respect and accept other opinions
3.	Critical thinking
	Convey ideas and suggestions, Analyse and evaluate problems & solutions, Plan strategy for particular situations
4.	Ethics and Professionalism
	Act with rationality and tolerance, Integrity in any circumstances and in solving problems
5.	Creativity
	Able to produce remarkable ideas, Renew and improve existing weaknesses, Generate a variety of solutions/improvements
6.	Social responsibility
	Interact with group members and society, Respond to social matters/ demonstrate care and concern for solving community problems, Act responsibly in any undertaking

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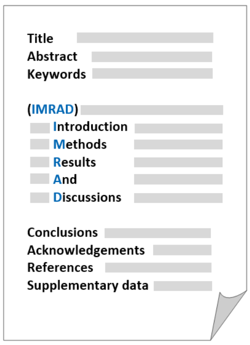

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