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Engineering Conventional and Engineering Technology Programs in Malaysian Universities

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Abstract: One of the goals of the education system in Malaysia is to ensure the development of highly educated, highly skilled and strongly motivated human resources to fulfill the needs of the nation and the requirements of the industry as well as to support the country's aspiration to be an industrialized nation. Thus, several government-funded universities in Malaysia are required to offer engineering technology programs. These universities are known as Malaysian Technical Universities Network (MTUN), comprising Universiti Teknikal Melaka, Universiti Malaysia Pahang, Universiti Tun Hussein Onn and Universiti Malaysia Perlis with a mission to educate and train highly skilled manpower that can contribute to the world class industrial nation. The purpose of engineering technology programs is to complement existing engineering conventional programs. This study reports the differences between engineering conventional programs and engineering technology programs in terms of curriculum design and delivery and assessment of student learning. This knowledge is important as it will differentiate the job scope of the graduates from both programs. The data collection method in this study was qualitative method involving document analysis and focus group interviews. The documents analyzed were Malaysian Qualifications Agency Program Standards for Engineering and Engineering Technology and Malaysian Engineering Program Accreditation Manual. The teaching staffs from MTUN were interviewed for data triangulation. The results indicate that there exist differences in the curriculum design and delivery and assessment of student learning for both programs.

Key words: Engineering conventional, engineering technology, curriculum design assessment, MTUN, education

INTRODUCTION

In Malaysia, engineering education and training can be categorized into several levels of study, namely certificate, diploma, bachelor degree, master degree and doctoral degree. Both engineering conventional programs (or traditionally known as engineering) and engineering technology programs at the undergraduate level (or bachelor degree program) are offered in public or Government-funded Universities (GU) and Private-funded Universities (PU). However, this paper will only focus on the bachelor degree programs offered by GU.

Engineering programs have been offered as early as nineteen sixties in one of the public universities in Malaysia (Anonymous, 2000). From there on, the number of GU and PU keep on increasing (i.e., five GU in early 1970 and 21 GU in 2016). Most of these GU offered engineering conventional programs at the undergraduate level.

As reported by Mariun and Hasan Malaysian industries need engineering graduates who are more practice-oriented. The report was based on a study conducted by the Board of Engineers Malaysia (BEM), Institution of Engineers Malaysia (IEM) and Federation of Engineering Institution of Islamic Countries (FEIIC) on the Malaysian Engineering Technologist and Engineering Technician profession. As a result, the Malaysian government through the Minister of Education established the Malaysian Technical Universities Network (MTUN) which comprises Universiti Teknikal Melaka (UTeM), Universiti Malaysia Pahang (UMP), Universiti Tun Hussein Onn (UTHM) and Universiti Malaysia Perlis (UniMAP) in 2007. MTUN universities focus on higher-level technical and technology programs which are more practical-oriented with a mission to educate and train highly-skilled manpower that can contribute to the world class industrial nation. More recent studies by

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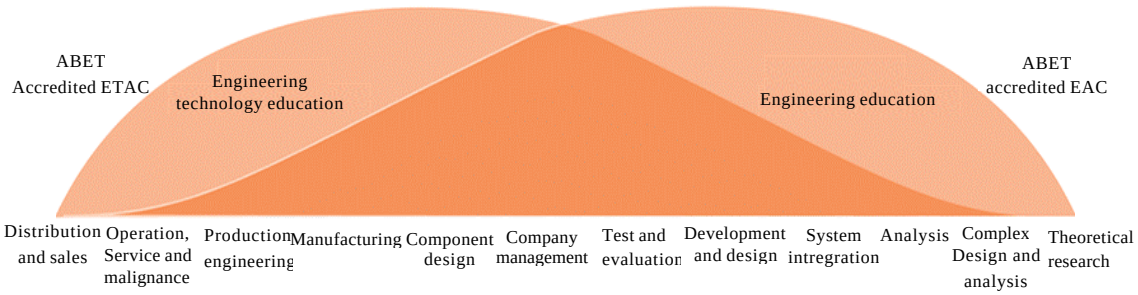

Fig. 1: Work spectrum for both engineers and engineering technologists; American society for mechanical engineers

Yahaya *et al.* (2012) also found that there is an urgent need for practice-oriented engineers (also known as engineering technologists) in Malaysia.

MTUN universities offer both Engineering Conventional (EC) and Engineering Technology (ET) programs at the undergraduate level. The purpose of ET programs is to complement existing EC programs.

In general, students enrolled in EC and ET programs are exposed to almost similar courses. However, the distribution of theoretical content and practical hands-on skills are slightly different (Malaysian Qualifications Agency, 2011). EC programs are more theoretical and often focus on the application of scientific knowledge and higher-level mathematics for designing products, processes or systems Agency 2011. On the other hand, ET programs focus on the application and implementation of scientific and engineering knowledge together with technical skills to support engineering activities (Malaysian Qualifications Agency, 2011). Some of the basic courses offered in ET programs are algebra, trigonometry and applied calculus.

In terms of profession, graduates of EC programs who are known as engineers are expected to be a leader and coordinator in design, research and development and formulation of new systems, products and technology. Graduates of ET programs are known as engineering technologists. They play important roles in various sectors such as construction, manufacturing, product development, testing, maintenance, biomedical, transportation and quality control (Malaysian Qualifications Agency, 2011).

Figure 1 shows the work spectrum for both engineers and engineering technologists. The figure indicates that most of the jobs are suitable to engineers and engineering technologists. The employment continuum shown in Fig. 1 is similar to the findings by Land (2012) which indicated that EC and ET graduates perform almost the same engineering functions (around 81%) such as field, test and sales engineers.

In Malaysia, Malaysian Qualification Framework (MQF) has provided program standards for EC and ET programs. Universities that intend to offer EC and ET programs should follow the given guidelines in order to be accredited. In addition, EC programs should also follow the guidelines provided by the Malaysian Engineering Accreditation Council (EAC) to ensure the accreditation of the programs. MQF has stated several aspects that should be fulfilled by EC and ET programs. These are (Malaysian Qualifications Agency, 2011) program aims program learning outcomes curriculum design and delivery assessment of students student selection academic staff educational resources program monitoring and review leadership, governance and administration continual quality improvement. However, this study will only compare and discuss the curriculum design and delivery and assessment of students learning between EC and ET programs. This knowledge is important as it will inform the job scope of EC and ET graduates in Malaysia. Furthermore, a recent study indicates that 80% of engineers (out of 100,000 engineers) are actually performing an engineering technologist's job functions.

MATERIALS AND METHODS

This study employed qualitative data collection method which involves documents analysis and Focus Group Interviews (FGI). The following documents were analyzed to obtain the required information on program design and delivery and assessment of student learning. Malaysian Qualifications Agency Program Standards for Engineering and Engineering Technology (MQA) Malaysian Engineering Accreditation Council (EAC).

Twenty-four teaching staff (i.e., lecturers and teaching engineers) from three GU Universities that offer Engineering Technology programs were interviewed. Each interview session was audio recorded with the permission of the participants and lasted about one hour. The feasibility and trustworthiness of the interview questions were determined by performing pilot interviews and obtaining expert's validation.

The data recorded during the FGI session was transcribed word-by-word by the authors. The content

analysis of the interview transcript was performed in order to obtain the required information. Personal communication through email was also carried out for clarification of the information that was not clear after the analyzing process and for additional information. The results of the document analysis together with the information gathered from the FGI will be discussed in the following session.

RESULTS AND DISCUSSION

Results from the analysis on MQA and EAC documents as well as interview transcripts are discussed in this section. The main objective is to compare the curriculum design and delivery and assessment of student learning between EC and ET programs.

Table 1 shows the results obtained from content analysis of MQA and EAC documents. Compulsory courses are courses related to national and university requirements such as Malaysian and Moral Studies and courses on personal development such as languages and communication skills (Malaysian Qualifications Agency, 2011). Common core courses refer to courses that are common to all engineering disciplines in EC and ET programs such as computing, mathematics and sciences (Malaysian Qualifications Agency, 2011). The details of the compulsory and common core courses for EC and ET programs can be found in EAC and MQA documents respectively.

From Table 1 it can be seen that the main difference between EC and ET programs is the total number of credits that students need to complete before graduating. Another difference is the total credits assigned for industrial training. In general, one credit hour of industrial training is equivalent to two weeks of training in the related field. EAC has specified that students in EC program have to attend a minimum of eight weeks of continuous, structured and supervised industrial training. However, the duration of industrial training for EC programs may vary depending on the university. A study by Phang *et al.* (2014) found that the length of industrial training in most of government-funded universities is from 10-12 week.

During industrial training, students are attached to a relevant workplace or industry to gain industrial experience as well as to enhance their generic skills. EAC also specifies that students should fulfill the training requirement before the final semester. Normally students are required to record their industrial training activities in a log book. From the researcher's experience, most students in EC programs attend industrial training in semester seven which is the second-last semester as required. However, results of document analysis indicated that description of the details of the industrial training that must be fulfilled by students in ET programs is not specifically mentioned in the MQA document.

Table 2 indicates the results obtained from content analysis of the interview transcripts. Since several of the teaching staff were involved in teaching EC programs before they were attached to the ET programs, information on assessment that was not available in the MQA and EAC documents was obtained by interviewing them.

Item 4 and item 5 indicate that EC programs include more theory and less practical hands-on compared to ET programs. This is in accordance with the MQA requirement which stated that the EC program is more theory-based compared to ET program (Malaysian Qualifications Agency, 2011). The percentage given in Table 2 is only for the engineering discipline core courses. The approach used in ET programs to ensure the percentage of practical hands-on is higher compared to the percentage of theory is by implementing laboratory incorporated courses (item 6). Laboratory incorporated course is a course where the laboratory experiments are implicitly included in the engineering courses. Students will conduct the experiment after they learned about the related theory in class.

On the other hand, in a laboratory separated course, laboratory experiments are separated from the engineering courses. Laboratory experiments are designed as laboratory courses and are assigned with specific course code and credits. According to the teaching staff, almost

Table 1: Curriculum design and delivery for engineering conventional and engineering technology programs

Items	Engineering conventional	Engineering technology
No. of credits	120	140
No. of weeks/semester	14	14
Duration of study (years)	4	4
Compulsory and common core courses	40 credits (33%)	32-42 credits (23-30%)
Discipline core courses (inclusive of Final Year Project (FYP))	80 credits (67%) FYP: 6-12 credits (5-10%)	80-84 credits (57-60%)FYP: 8-10 credits (6-7%)
Industrial training	*4-6 credits (3-5%)	8-12 credits (6-8%)
Elective courses	-	8-14 credits (6-10%)

*Credit hours for discipline core courses of EC program is inclusive of industrial training

Table 2: Curriculum design and delivery for engineering conventional and engineering technology programs

Items	Engineering conventional	Engineering technology
No. of credits	120	140
No. of weeks/semester	14	14
Duration of study (years)	4	4
Content (theory)	60%	40%
Content (practical hands-on)	40%	60%
Type of laboratory work	lab separated	lab incorporated
Assessment (course work)	50%	60%
Assessment (final examination)	50%	40%

all of the engineering courses in the ET programs are laboratory incorporated, whereas almost all of the engineering courses in the EC programs are laboratory separated. By implementing laboratory incorporated courses, students in the ET programs are exposed to more practical hands-on work compared to students in the EC programs.

Item 7 and item 8 are related to assessment of students. In general, the assessment consists of two parts, namely coursework and final examination. The data shows that the mark allocation for final examination is higher in EC programs compared to ET programs. Final examinations for both EC and ET programs are related to the theoretical aspects of the course. ET programs allocate 60% of the overall marks for coursework which consists of laboratory reports, laboratory practical test, theory test, quizzes and assignments. However, coursework for the EC programs normally consists of two theory tests, quizzes and assignments. The content of the coursework clearly indicates the reasons for higher mark allocation (60%) for the coursework in the ET programs.

From the analysis of the interview transcripts, the authors discovered that the duration of the industrial training for ET programs are around 24 weeks. Students attend the industrial training in the eight (final semester). According to the teaching staff, depending on the student's performance, some companies may offer permanent post to the students who have completed industrial training at the company. Thus, by attending industrial training in the final semester, students can easily join the company that offers them employment.

CONCLUSION

The curriculum design and delivery of engineering conventional programs are different from engineering technology programs. The Malaysian Engineering Accreditation Council (EAC) that is responsible in accrediting the engineering conventional programs has provided guidelines for developing the programs. Similarly, Malaysian Qualification Agency (MQA) that is responsible for accrediting engineering technology programs also recommends guidelines for developing the programs. The guidelines provided by EAC and MQA are quite general and it is the responsibility of the institutions to detail out the curriculum design and delivery. The main differences between engineering conventional programs and engineering technology programs are in terms of the total number of credits for completing the programs and the numbers of hours allocated for practical hands-on. The results of the focus group interviews indicate that student assessment in engineering technology programs emphasizes more on practical hands-on skills compared to engineering conventional programs.

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