

CONSTRUCTING A FRAMEWORK IN APPLYING PSYCHOMOTOR DOMAIN  
MODEL FOR ELECTRICAL INSTALLATION WORKSHOP COURSE

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**DEDICATION**

*To my beloved husband, children and family*

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## ABSTRACT

Hands-on workshop course is an important component of electrical engineering and electrical engineering technology education in developing the students' psychomotor skills. It is therefore, very crucial for the engineering course to be properly designed with proper learning outcomes and with appropriate teaching and assessment strategies. The research presents a framework in implementing an Electrical Installation Workshop course by applying a psychomotor domain model for the diploma level course at Universiti Teknologi Malaysia. In this research, the learning outcomes applied in producing the framework was referred to the National Skills Standard as a benchmark. A qualitative method was employed in this research whereby, it included exploring and investigating the implementation of the course in Universiti Teknologi Malaysia as well as in other higher education providers (HEPs) in collecting the intended data. The data were collected through documents, interviews, and observations of the students' works. The data obtained were then analyzed by comparing it with the National Standard and with thirteen other HEPs data. Psychomotor domain models were also compared to the data found in this research especially to the implementation of this course at thirteen other HEPs. The findings showed that there were significant differences in the learning outcomes, teaching and assessment strategies in implementation of the Diploma Electrical Installation Workshop course conducted at Universiti Teknologi Malaysia compared to other HEPs. It was also found that the Romiszowski psychomotor domain model with the five levels of mastering the skills is deemed suitable to be applied in the teaching of the Electrical Installation Workshop course in developing students' technical skills.

## ABSTRAK

Kemahiran teknikal yang dijalankan di bengkel merupakan satu komponen penting dalam kursus Kejuruteraan Elektrik dan Kejuruteraan Teknologi Elektrik bagi membangunkan kemahiran psikomotor pelajar. Oleh itu, amat penting kursus bengkel kejuruteraan direka dengan hasil pembelajaran, strategi pengajaran dan penilaian yang bersesuaian. Kajian ini bertujuan untuk menghasilkan satu rangka kerja dalam melaksanakan Bengkel Pemasangan Elektrik dengan mengaplikasikan model domain psikomotor pada peringkat diploma di Universiti Teknologi Malaysia. Dalam kajian ini, hasil pembelajaran yang digunakan dalam menghasilkan rangka kursus telah dirujuk pada Piawaian Kemahiran Kebangsaan sebagai penanda aras. Satu kaedah kualitatif digunakan dalam kajian ini termasuk meneliti dan menyiasat pelaksanaan kursus di Universiti Teknologi Malaysia serta tiga belas institusi pengajian tinggi yang lain dalam mengumpul data yang dikehendaki. Data telah dikumpul melalui dokumen, temu bual dan juga pemerhatian hasil kerja pelajar di bengkel. Data yang diperoleh dianalisis dengan kaedah membandingkan data tersebut dengan Piawaian Kemahiran Kebangsaan dan dengan data di tiga belas institusi pengajian tinggi yang dirujuk. Model domain psikomotor juga dibuat perbandingan dengan data yang ditemui terutama pada pelaksanaan kursus di tiga belas institusi pengajian tinggi yang dirujuk. Dapatan kajian menunjukkan bahawa terdapat perbezaan yang signifikan dalam hasil pembelajaran, kaedah pengajaran dan penilaian dalam pelaksanaan kursus Bengkel Pemasangan Elektrik di Universiti Teknologi Malaysia berbanding dengan tiga belas institusi pengajian tinggi yang dirujuk. Didapati juga model domain psikomotor Romiszowski dengan lima aras menguasai kemahiran dapat diaplikasikan pada kursus Bengkel Pemasangan Elektrik dalam membangunkan kemahiran teknikal pelajar.

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## LIST OF ABBREVIATIONS

ABET	-	Accreditation Board for Engineering and Technology
BEM	-	Board of Engineers, Malaysia
DSD	-	Department of Skills Development
EAC	-	Engineering Accreditation Council
EPU	-	Economic Planning Unit
HEPs	-	Higher Education Providers
IMP	-	Industrial Master Plan
KST	-	Kolej Sains & Teknologi
MQA	-	Malaysian Qualification Agency
MQF	-	Malaysia Qualification Framework
NOSS	-	National Occupational Skills Standard
OBE	-	Outcome Based Curriculum
UNESCO	-	United Nations Education, Scientific and Cultural Organisation
UTM	-	Universiti Teknologi Malaysia

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## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Introduction**

It is the vision of the Malaysian government to make Malaysia a fully industrialized country by the year 2020. Therefore, it is very crucial that the quality of an industrial nation on producing technical manpower becomes important as it advances on the road to industrialization (Mohamad Sattar Rasul and A.P. Puvanasvaran, 2009). In moving forward to achieve this, Malaysian government has formulated the Industrial Master Plan (IMP) with the first IMP1 dated from 1986 to 1995, followed by the second IMP2 which started from 1996 to 2005 and the third IMP3, began from 2006 to 2020. These plans have been formulated to further develop and transform the manufacturing sector. Reviewing the performance of the IMP2, it has been determined that the manufacturing industries are the second major contributor to the country's gross domestic product (GDP) ((Economic Planning Unit (EPU), 2010; Mohd Nizam Ab Rahman, *et al.*, 2009). This has made the manufacturing sector the second largest source of employment.

The manufacturing sector will therefore experience the largest increment in employment especially in the field of middle level professionals and technical (Economic Planning Unit (EPU), 2010). Therefore it is very important for the future workforce to have the employability skills required by all industries. The same is happening in industries in United Kingdom whereby it is viewed that certain electrical/electronic and systems engineering are particularly seen as likely to be of increasing importance. Looking at particular skills and attributes, there is strong

evidence that the top priorities in terms of future skills will be practical application, theoretical understanding, and creativity and innovation (Spinks, *et al.*, 2006). Therefore, it is very important to retain the first-world talent which include the key characteristic of having higher education qualifications in promoting knowledge generation and innovation with high skill-level in both technical and professional fields (Economic Planning Unit (EPU), 2010). These characteristics are also in line with the strategies laid out by IMP3; enhancing the quality and standards of the country's education and enhancing the output of Higher Education Providers (HEPs) graduates to meet the requirement of the industry (Ministry of International Trade and Industry Malaysia, 2010). This include preparing students both in theory and practice so that the students are well prepared to meet the challenges of the job market, especially in the manufacturing industries of the 21st century (Radharamanan and Jenkins, 2008).

Engineering education is very important in promoting the reality of Malaysia becoming an industrialized country in 2020. This is because engineering education is the foundation for the development of society. Without technological innovations, there will be no production of new goods, no economic growth and no human development (UNESCO, 2010). ABET, an engineering accreditation body in the United States developed accreditation criteria for the intention to assure quality and foster systematic improvement in the quality of engineering education (Prados, *et al.*, 2005). Therefore, developing the international mobility of engineers through international accreditation is a key issue in quality assurance.

IMP3 has also recommended to benchmark all levels of the education system in order to standardise best practice with the international recognition (Ministry of International Trade and Industry Malaysia, 2010). This supports a report from United Nations, Education, Scientific and Cultural Organisation (UNESCO) which implies that many countries lack the quality assurance and accreditation systems at the national level which directly create gaps at international level (UNESCO, 2010). The establishment of quality assurance systems is a necessity in monitoring quality in higher education delivered within the country, and for engaging in the delivery of higher education internationally (UNESCO, 2010).

In accordance to this requirement, the Malaysian Qualification Framework (MQF) and the Malaysian Qualification Agency (MQA) was established in 2007. With this advancement, another agency, the Department of Skills Development (DSD) was given the mandate to be the sole agency in developing and certifying the quality of the skills curriculum (Economic Planning Unit (EPU), 2010). However, a professional body such as the Board of Engineers Malaysia (BEM) which is the only recognized accrediting body for engineering degree programs offered in Malaysia is given the mandate in accrediting all engineering programs through the Engineering Accreditation Council (EAC) (Board of Engineers Malaysia, 2008).

Deputy Chief Executive Officer of the MQA stated that engineering graduates today have to serve not only the country's needs, but also the needs of both the regional and international market (JURUTERA, 2010). This can no longer be a problem since Malaysia has become the 13th signatory member of the Washington Accord; an international agreement body responsible for accrediting engineering degree programs internationally (JURUTERA, 2010). With this, local graduates can now look forward to job opportunities among the other signatory countries. For those who lack of alignment with the international benchmark standards will then limit the mobility of their graduates (UNESCO, 2010).

## **1.2 Background**

Since the establishment of the accreditation bodies for the engineering profession internationally and nationally, HEPs must deliberately comply with the standards developed by these bodies and consequently obtain recognition to programmes offered. Many educational accord signatories are looking in developing statements that would describe the competency required for registration as an engineer, an engineering technologists or as an engineering technician (Hanrahan, 2009). The role of these accreditation bodies is very important in shifting the traditional curriculum to outcome based (OBE) curriculum. The attraction of this concept is that it focuses on both teaching and learning efforts and ideally lends transparency to educational process (Walther J and Radcliffe D.F, 2007).

The formulation of outcome-based standards is a way of ensuring quality and in response to these needs; all HEPs are making major changes to their academic structure and organization especially in implementing OBE curriculum. Reforms are under way in all HEPs in Malaysia to include OBE in redesigning curriculum. The concept of outcomes is not new to education and training but now it is evidently important globally and nationally especially in any discussion on curriculum reform (European Centre for the Development of Vocational Training Cedefop, 2010).

OBE curriculum is based on three educational domains that are cognitive, psychomotor and affective. Globally, engineering educators have started to redesign engineering curriculum to meet the challenges of educating engineers in the twenty-first century using the OBE curriculum to include cognitive, psychomotor and affective domain (Engineering Accreditation Council, 2007; Felder and Brent, 2003; Vanasupa L, *et al.*, 2009). With the advancement of the technology at a rapid pace, it is very important for the engineers to have the appropriate knowledge, hands-on experience and the soft skills to keep up with the pace (Carlson and Sullivan, 1999; Nudehi, *et al.*, 2011). It shows that today's world requires engineers who are developed in analytical, psychomotor, creative, and compassionate abilities (Vanasupa L, *et al.*, 2009). Therefore, an outcome-based curriculum can provide a valuable platform for bridging the worlds of education and work. Engineering is a practical discipline and it is a hands-on profession where theory is put into practice (Feisel and Rosa, 2005). It is very important that engineering education reflects what engineers actually do in practice.

The questions concerning the proper balance between theoretical and practical education have been debated by educators for decades (Barbieri and Fitzgibbon, 2008). Engineering theory needs to be presented alongside engineering practice so that students can practice what they have just learned (UNESCO, 2010). For the engineers to have the hands-on experience, workshop practice course must be offered at the early stage of the curriculum which can supplement their existing courses (Carlson & Sullivan, 1999). However, Anderson (2007) insisted that this hands-on experience is implemented across the entire program. This is because the workshop practice course would be able to give the students the opportunities for them to gain skills and experience from the performed activities (Anderson, 2007). As a matter of

fact, hands-on courses provide students with the opportunity to observe the physical world compared to the quantitative descriptions of that world taught in the classroom (Perreault, *et al.*, 2006).

The same view is supported by Ferris (2005) who emphasizes the importance of developing hands-on skills for the reason that engineers' role is to do either or both the development work of products and systems. Therefore, laboratories play crucial role in the education of future engineers. Engineering educators believe that hands-on experience of the laboratory is necessary to supplement the relatively passive experience of reading textbooks and listening to lectures (Corter, *et al.*, 20011; Ferris and Aziz, 2005). Besides, engineers should possess the capabilities to instruct or supervise other people in the development and manufacture of the products and systems (Ferris and Aziz, 2005).

It is also stressed out by Toohey (2002), that laboratory work can give students the opportunity to try out their new knowledge, get feedback, reflect and try again. According to Anagnos, et al (2007) , the laboratory component of engineering curriculum provides an excellent place for students to have the opportunities to design, modify and investigate particular issues that interest. Furthermore, laboratory works can help the students in acquiring the necessary skills according to their disciplines, and these experiences can further help to reinforce and deepen conceptual understanding of the course content (Corter, *et al.*, 2011). The advantages of doing laboratory works do not solve the constraints of traditional laboratory works which includes scheduling, cost of equipment, and location (Fabregasa E, *et al.*, 2011).

However, engineering curriculum rely heavily on cookbook experiments in which students simply follow a sequence of steps in the form of a recipe and arrive at a predetermined result. These types of experiments do not require design by the students and therefore, do not develop critical thinking skills which can lead to deeper learning (Anagnos, *et al.*, 2007). Clough (2002) commented that traditional hands-on experiences failed to meaningfully engage and enhance student learning. According to him in a cookbook laboratory experiments, most of the thing is done for the students and they have little reason to engage in learning.

In the 21<sup>st</sup> century, much attention has been given to the curriculum development and teaching methods and assessment (Feisel and Rosa, 2005; Watai, *et al.*, 2007). Unfortunately, little attention has been given to the learning outcome of the hands-on skills and on physical lab instruction and assessment (Feisel and Rosa, 2005). The physical lab courses should provide engineering students with the basic hands-on practical skills and knowledge that is necessary in the profession (Watai, *et al.*, 2007). It is very important for engineering students to acquire the appropriate skills because engineering is a practicing profession where knowledge is put into practice and lab course learning activities involve a lot of practical works.

Feisel (2005) laid out some of the reasons why not much attention was given to the hands-on skills development. Engineering in the eighteenth century was taught in an apprenticeship program and these early years, the focus was clearly on practice and hands-on skills (Abdulwahed Mahmoud and Nagy Zoltan K, 2008; Anderson and Hamilton, 2007; Feisel and Rosa, 2005). However, during the middle of the nineteenth century, many engineering schools were established and due to the Industrial Revolution and the Morrill Land Grant Act of 1862, engineering education began to shift from the shop floor to the classroom. At this period an accreditation body was established with the American Institute of Chemical Engineers (AIChE) which led to the establishment of Accreditation Board for Engineering and Technology (ABET) programmes for the purpose of maintaining quality (Barbieri and Fitzgibbon, 2008; Feisel and Rosa, 2005).

History has shown that changes in the engineering profession follow changes in cultural, social and political environment (Katehi, 2005). By 1970s funding for technology and for engineering education had declined significantly because the government gave priority to different areas. Enrolment in engineering school was reduced and in order to save dollars some engineering faculties opted to minimize laboratory courses and that practical activities become secondary importance (Feisel and Rosa, 2005). The minimum hands-on skill provided to the students and less experience on hands-on activities caused students to have less confidence in their practical ability and lead to less positive attitude about engineering as a career (Pereira A and Miller M, 2010).

In the UK, the English viewed that theory and practice should be separated and classroom should concentrate on the theoretical aspects whilst the practical activities were delivered in the workshop. Eventually this was all about the pursuit of knowledge as opposed to the practical aspects (Evans, 2007). This led to constraint of time and lack of assistance allocated for the students during the hands-on class (Toohey, 2002). With all these happenings, many engineering schools began graduating engineers who were steeped in theory but poor in practice (Feisel and Rosa, 2005). However, the UK government still felt that degree courses offered concentrated too much on academic knowledge and too little on the practical skills. Another point was also made by the UK government in 2002 whereby, the higher education must produce new graduates who will lead industry to victory in the worldwide technological competition (Toohey, 2002).

While engineering programs became more theoretical, industry continued to require individuals who possessed skills that are more practical. To provide these practically trained individuals, many institutions developed programs in engineering technology. Since many of these technologists filled positions formerly held by engineers, they often received that title, causing confusion between engineering and engineering technologist. This leads to ABET becomes the organization responsible for engineering and technology accreditation and maintain separate accreditation tracks for programs in engineering and those in technology (Feisel and Rosa, 2005).

With the 21<sup>st</sup> century engineering education program, ABET has included three criteria that emphasis on hands-on skills that include ((Engineering Accreditation Commission ( ABET), 2009; (Feisel and Rosa, 2005):

- *an ability to design and conduct experiments,*
- *an ability to design a system, component, or process to meet desired needs,*
- *and thirdly, the ability to use the techniques, skills, and modern engineering tools necessary for engineering practice*

The same scenario is happening to engineering education in Malaysia. There were also numerous discussions until 1999 on engineering graduates to be lacking the appropriate technical competency required by the industry. Consequently, the academicians responded to this by stating that no education system was capable of

producing graduates and perform the job required of them immediately after graduation. Furthermore, most of the industry were not willing to train the graduates because of the economic down turn and although Malaysia had a world class skills training infrastructure, the number of industry that used these facilities was low (Universiti Malaysia Perlis 2009; World Bank 2005).

In 2003, a study by the Board of Engineers Malaysia, Institution of Engineers Malaysia and Federation of Engineering Institution of Islamic Countries (BEM/IEM/FEIIC) on the Engineering Technology Path was carried out. In this report it is said that Malaysia need highly skilled engineering workforce particularly for Malaysian industries, which have been predominant by the agriculture, manufacturing and construction sector (Board of Engineers Malaysia, Malaysia, & Countries, 2003). The IMP3 report that reviews IMP2 commented the same point in which the manufacturing sector is still the second largest source of employment. Manufacturing industries which invest in Malaysia have the equipment, machinery, and sophisticated technology in line with their abilities as experts in a particular field. Sophisticated equipment must be utilized by skilled workers with high technical skills so that they can be used with maximum efficiency. The problems were faced by the industries were that worker who handled and operated equipment and machines were without the ability to translate learned knowledge into assigned tasks. This is due to not clear understanding of subject ((Ahmad Nabil Md. Nasir, *et al.*, 2011).

The Ministry of International Trade and Industry Malaysia (MITI) in its report has recommended to the HEPs that in producing graduates that meet the requirement of the industries is very important in enhancing the quality and standards of the country's education (Ministry of International Trade and Industry Malaysia, 2006). However, in 2003, the Board of Engineers Malaysia (BEM) with its group found that the characteristics of engineers that the industry was looking for were hands-on engineers. The study also found that the least characteristic of engineers in demand by the industry was the ability for the engineers to do research and development (Board of Engineers Malaysia, *et al.*, 2003).

A research in 2002 by Edward, found that vast majority of the students expected to enter industry and not become researchers. Therefore, it is very important



that the practical work must reflect industrial needs (Edward, 2002). One of the most important factors in enhancing the engineering graduate qualities is the practical component of the engineering curriculum. The professional engineering community expects engineering graduates to develop practical skills during their undergraduate educational experience (Nedic, *et al.*, 2003). Enhancing laboratory education can serve as a motivating factor towards an engineering career (Abdulwahed Mahmoud and Nagy Zoltan K, 2008).

Another survey done by the World Bank in 2005 also stated that almost one-third of the Malaysian workforce in the manufacturing sector lacked the skills they needed to do their job especially skills needed to adapt to labour market change. Due to this shortage of university graduates, the industry was forced to hire workers with diploma qualifications to do the jobs of an engineering graduates (World Bank, 2005). Hands-on skill engineers were also recommended by the Malaysian Engineering Education Model (MEEM) where the students must be directly involved with hands-on activities on real-life situation. This technical competency is required to perform specific engineering tasks professionally (Megat Johari Megat Mohd Noor, *et al.*, 2002).

Most importantly, engineering graduates who cannot apply what they have learned in their learning institutions to the actual practice will not be very useful to the industry. It seems that in many engineering fields, schools should not graduate engineers who have never performed hands-on experiments (Anagnos, *et al.*, 2007). With that, a task force was set up by the government to look into this and four college universities were built with hands-on approach, believing that the graduates can directly perform tasks expected of them in the industry without them having to undergo long and rigorous trainings at the work places (Universiti Malaysia Perlis, 2009). This is because to the industry, it is not cost-effective to design systematic training programs for employees (Jing L, *et al.*, 2011).

Graduates from the college universities do not face any problem working in the private sector but, the graduates that intend to work in the public sector are facing problem especially on the salary scheme. This is because the Board of Engineers could not accredit the programmes offered by these college universities and that

causes a big outcry by the stake holders especially the parents. As a result, in 2007 the government upgraded the college universities to full university status (Universiti Malaysia Perlis, 2009). This resulted in the redesign of the curriculum and less emphasis was given on the practical skills.

The World Bank (2007) in another report commented further on the skill mismatch in Malaysian industry and weak private sector demand for research and development. This led to the establishment of another university that is supposed to provide the hands-on skills that is demanded by the industry. The university is a private university under another government entity called Majlis Amanah Rakyat (MARA) and the university is known as University Kuala Lumpur (UNIKL). UNIKL claimed that it is one of the country's leading technical university (Universiti Kuala Lumpur, 2007). UNIKL has campuses all over Malaysia specializing in different engineering disciplines such as electrical, manufacturing, marine and aeronautical. The graduates from UNIKL can now register with their own society called MySET which was established to provide a powerful platform for its members such as engineering technologists and technicians.

According to MySET president, the government has agreed to the formation of the Malaysian Board of Technologists (MBOT) for registering engineering technologists and technicians in the country. Further to that MySET is also committed to assisting the country in achieving signatory status of the Sydney and Dublin Accords for international recognition of Malaysian engineering technologists and technician qualifications in the future (<http://www.mset.org.my/>). Sydney and Dublin Accord is an entity that provides joint recognition of academic programs for engineering technologies and technicians and also operates as the Washington Accord (Sweeney, 2005).

While waiting for another signatory such as the Sydney and Dublin accord, Malaysia is already now the signatory of the Washington Accord. Therefore, it is mandatory for all engineering programmes to follow the ABET criteria which include three practical skills criteria that are *ability to design and conduct experiment, ability to design a system, component or processes and thirdly the ability to use the techniques, skills and modern engineering tool necessary for engineering practice*

(American Board of Engineering Technology, 2009). The Accreditation Board of Engineering and Technology in 2005 has already proposed a set of objectives for the use of laboratories in engineering education. These objectives make clear that laboratories can provide the assessment and improvement of a range of student competencies. Some of these educational objective skill areas involve the psychomotor skills (Corter, *et al.*, 2011).

Psychomotor skills include laboratory experiments and field studies which will provide greater support for learning through complementary theories, calculations and theoretical demonstrations. These activities should lead to the development of the students' analytical, critical and practical skills. Laboratory work studies aim to generate interest in a particular subject area (Hassan O.A.B, 2011). Therefore, with all the evidences on the importance of practical skill, this research provides a significant important to the curriculum development. This research will produce a framework of implementing an electrical installation workshop course by applying a psychomotor domain model at Universiti Teknologi Malaysia (UTM).

The Electrical Installation Workshop course in UTM has not undergone reviewing for a long time. According to the instructor who has been teaching the course for more than 10 years from 1995, the only change that had been done was to relocate the workshop to a bigger space in 1997. Previously the students were doing installation on a horizontal installation bay and during the relocation of the class; the vertical panel bay was built which is similar to the real structure in domestic wiring work. In this research, the data gathered are categorised for common existing activities. The framework separates the data into learning outcomes, teaching strategies and assessment strategies. The research is aim to develop another approach of implementing Electrical Installation Workshop course by applying a psychomotor domain model.

### 1.3 Statement of Problem

A survey done by the BEM and its group in 2003 found out that the industry needs more technicians than engineers. To the industry, these technicians can be upgraded by undergoing training (Board of Engineers Malaysia, et al., 2003). In the year 2007, a report by the World Bank titled *Building a World-Class Higher Education System*, highlighted the needs for Malaysia to have educated skilled workers who were creative, imaginative, knowledgeable and have design capabilities. Notably important, these workers were the main source of national prosperity and wealth. The report recommended the need for Malaysia to address an increasing human resource shortage of qualified workers with scientific and technical skills.

Another factor that is described in the report was the skills mismatch among the graduates. This is due to the shortcomings in the tertiary education institutions such as in the quality of education, staff and pedagogy. It was recommended that the instructions should be tailored to the market needs. However, it was also mentioned that skills mismatch have many dimensions which can be expressed as the balance between technical and generic skills; and balance between the theory and practice-orientation of education and training received. For example among the engineering diploma graduates, the skills mismatch is considerably high between 39% to 43% (World Bank 2007). Skill mismatch affects efficiency and further economic growth whereby, it prevents the labour market from using the available human capital to its fullest potential (World Bank 2007). Therefore, it is essential requirement for successful skills formation in aligning the skills development systems with the needs of the labour market. However, skills development systems in Asia region tend to operate in isolation of labour market demand and with little or no employer participation (Asian Development Bank, 2008).

In the World Bank report in 2007, interviews with the students indicated that they did not believe that academic programs in the higher institutions fostered skills that were required in the workplace. Therefore, it is recommended by the report that it is very crucial for the Universities, public and private to strengthen their linkages with the private sector and the industry to ensure that their curriculum better reflect the needs of the workplace (World Bank, 2007). Even though the public and private

universities are facing with such challenges, the scenario is different for those Diploma program offered by the polytechnics in Malaysia.

The polytechnics graduates are at an advantage because the polytechnics programmes are monitored and coordinated directly by the Department of Polytechnic Education (DPE) which is under the Ministry of Higher Education (MOHE). This department is responsible to design and reviewed the curriculum accordingly with the inputs from the industry. These inputs were gathered directly through The National Industry Dialogue organized by this department. The objectives were to promote and strengthen industry-education collaboration so as to develop a common understanding of the industry's needs. Consequently this leads to the ability of the polytechnics colleges to fulfill the international and national market. This link is mutually beneficial for both parties and would help train students who were both academically and industry oriented (Department Of Polytechnic Education & Ministry Of Higher Education Malaysia, 2009).

In 2009, the fourth dialogue was organized at PICC, Putrajaya. There were 207 participants with 83 representatives attending the dialogue from 56 agencies, associations and public listed companies from the industry together with senior officers from the Ministry of Higher Education, and polytechnics. From the dialogue, industries raised their concerns which were:

- a. programmes offered should focus on niche markets and psychomotor skills;
- b. assessment should be based on skills training and not academically inclined;
- c. students should be trained as more hands-on technicians and executives;
- d. lecturers should give more opportunities for the students to interact with them;
- e. classes were large and the use of technologies in teaching was commented to be infrequent;
- f. some laboratories required modernization.

These lead to heavy workload among the teaching staff which deterred them from developing and experimenting with innovative teaching methods (Department Of Polytechnic Education & Ministry Of Higher Education Malaysia, 2009). To a lecturer, laboratory teaching is a second-rate job that does not contribute to his or her

professional development (Watai, *et al.*, 2007). There was hardly any career-related incentive for faculty to spend the time required in the laboratory (Watai, *et al.*, 2007). The main concern on laboratory works was that it was considered as secondary role and therefore, the lecturers and students handle it casually. Another concerns is that the laboratory works is organized in such a way that the students did not find them useful and motivating (Mathew and Earnest, 2004). Therefore, workplace experiences for engineering students in public and private higher institutions were obtained through the industrial training. Thus, industrial training is important in exposing the students to real work situation and to equip them with the necessary skills so that they would be job ready when they graduated (Mohd Zaidi Omar, *et al.*, 2008).

Almost all diploma programmes offered by the HEPs include one semester of industrial training in the curriculum (Education, 2010; Kementerian Belia dan Sukan 2010; MARA Rembau 2008). The students have to go through at least one semester of industrial training as provided in the curriculum. Unfortunately, for UTM engineering diploma programmes, the industrial training is not included in the curriculum. Nevertheless, the students are encouraged to go for the industrial training by filling in the required forms and submitting them to the Academic Administration Office that allow them to attend the industrial training.

As a result input from industries were not received directly as lecturers were not given the opportunities to visit their students while doing the industrial training. Therefore, as mentioned by the Head of Department of the diploma programmes in UTM, the only time for the academicians to get input from the industry was when a new curriculum was designed or during the modification of the curriculum and this will only happen after three to five years of implementing a new curriculum. In fact, it is an advantage to offer the industrial training where the lecturer can get first hand information regarding the needs of the industry.

Since UTM diploma programmes students do not have the opportunity to attend the industrial training, it is therefore, very crucial and mandatory for the institution to provide the students with necessary technical skills before they can enter the workplace. As a result, the programme must provide the real-world experience and insights into the classroom before they graduate. If this does not happen then the

graduates of UTM are losing out on employability with other diploma graduates especially graduates from polytechnics and MARA colleges.

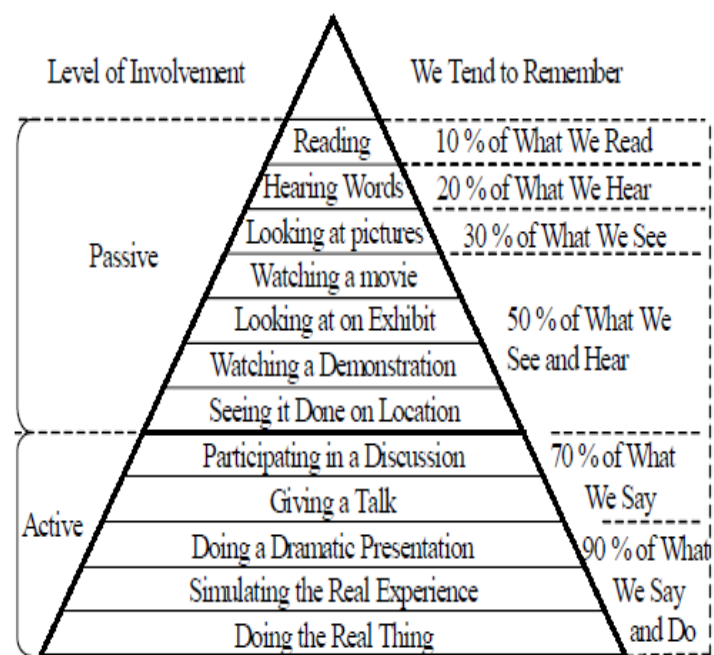
The description provided by the Malaysian Qualification Framework (MQF) regarding the diploma programme education is that it must balance theory and practice/practical and also stresses on instillation of value (Malaysian Qualification Agency 2010). With this statement given by MQF, it is very important therefore, to develop hands-on course that demonstrates the skill performance of the students at the end of the course. Therefore, it can be concluded that it is very essential that the curriculum are designed towards the need of the stakeholders and benchmarking the MQF learning outcome domains.

There are eight learning outcome domains with practical skills as the second domain. Practical skills are demonstrated as carrying out professional task and applying learnt skills in safe environments (Malaysian Qualification Agency, 2010). After years of compelling research on the field, it is commonly agreed that the most effective learning methods involving direct, purposeful learning experiences are through hands-on or field experiences (Feisel and Rosa, 2005; Heitmann, 2003; Mathew and Earnest, 2004). This fact is illustrated, for instance, by the popular Dale's cone of learning (Figure 1.1) (Krivickas, 2005), where passive learning would happen when people learn from activities such as reading, observing and hearing.

Dale's Cone of Experience shows that the different learning experience has the influence on learning achievement. According to a research, the least effective method is at the top of the cone which, involves learning from information presented and, the most effective methods is at the bottom which involves direct, purposeful learning experiences, such as hands-on or field experience (Yeh, Hsieh, Chang, Chen, & Tsai, 2011). It is also true that according to the Dale's cone of learning experience, students would retain 90% of the learning experience if they say and do the activity (Bell, 2007; Panadero, *et al.*, 2010; Pantchenko, *et al.*, 2011).

Unfortunately, although much work has been devoted to curriculum and teaching methods, relatively little has been done on physical laboratory instruction

and assessment (Watai, et al., 2007). Therefore, there must be a deliberate initiative to have students learn through doing especially related to real life situation. This is also illustrated in the Dale's cone of learning whereby, the cone shows the various level of educational experiences to real life. For instance the bottom level of the cone represents the closest things to real, everyday life. Consequently, each level above it moves a step further away from real life experiences and therefore, the furthest from the base of the cone focuses on the verbal experiences only (Alabama Department of Education, 2003).



**Figure 1.1** Dale's cone of learning experience (Krivickas, 2005)

As a result, practical study is a very important component in engineering education and it acts not only as a bridge between theory and practice but also solidifies the theoretical concepts presented during lectures (Manesis and Koutri, 2003). This therefore, provides a basis for this study to be undertaken with the purpose of analyzing the existing implementation of the Electrical Engineering Installation Workshop course conducted at Universiti Teknologi Malaysia (UTM). The outcome of the study is to construct a framework in applying the psychomotor domain model with reference to the National Skills Standard for the implementation of the Electrical Installation Workshop course.



## **1.4 Objectives**

The main purpose of this study is to develop a framework by applying a psychomotor domain model in the implementation of the Electrical Installation Workshop course with reference to the National Skills Standard and cross reference with the International Standard. The construction of the framework will be done in exploring the implementation process of this course in UTM and with the comparison of other HEPs that offer the same course. The main objectives of this research are:

1. To investigate the current practice in the implementation of the Electrical Installation Workshop course for a Diploma Electrical Engineering programme at UTM based on the National Standard.
2. To examine the similarities and differences among the Higher Education Providers that offer similar Electrical Installation Workshop course.
3. To compare the current practice of implementing the laboratory based Electrical Installation Workshop course by UTM with other HEPs.
4. To construct a framework by applying a selected psychomotor domain model to be used in the Electrical Installation Workshop course that complies with the National Skills Standard.

## **1.5 Research Questions**

The research focuses on specific research questions such as the content, the method of teaching, the material used and the assessment approaches in implementing this workshop course. The research questions are as follows:

- RQ1 How is the current practice in the implementation of the Electrical Installation Workshop course for a Diploma Electrical Engineering programme at UTM?
- a. What are the stakeholders' points of view on the implementation of a hands-on course conducted by the HEPs?

- b. What are the learning outcomes of the students performing the workshop?
- c. How are the teaching strategies conducted in this course through documents, observations and interviews?
- d. How are the students being assessed in the course through documents, observations and interviews?
- e. Is there any significant learning domain existed in the teaching and learning process of the Electrical Installation Workshop course?
- f. Which professional bodies or accreditation agencies that put any requirement on implementing the Electrical Installation Workshop course?

RQ2 What are the differences between the Higher Education Providers (HEPs) that offer Electrical Installation Workshop course based on the National Standard?

- a. What are the differences between the Higher Education Providers (HEPs) with the National Occupational Skill Standards on the learning outcome of the Electrical Installation Workshop course?
- b. What are the differences between the Higher Education Providers (HEPs) on the teaching strategies of the Electrical Installation Workshop course?
- c. What are the differences between the Higher Education Providers (HEPs) on the assessment strategies of the Electrical Installation Workshop course with the National Standard?

RQ3 How are the current practices of conducting Electrical Installation Workshop course in Universiti Teknologi Malaysia compared to that conducted at other HEPs?

- a. What are the gaps identified in achieving the learning outcomes?
- b. What are the disparities in the teaching strategies?

- c. How is the psychomotor domain addressed with respect to the components of the instruction design system approach model by the HEPs?
- d. How is the current practice in UTM aligned to the National Skills Standard?

RQ4 How does the findings of the current practice can best contribute to develop the selected framework for assessing the psychomotor domain in the Electrical Installation Workshop course that complies to the National Skills Standard?

- a. Is there any psychomotor domain model that had be proposed by the Ministry of Higher Education (MOHE) and the National Occupational Skills Standard (NOSS) in conducting the hands-on course?
- b. What is the psychomotor domain model proposed by MOHE to be implemented in a workshop course?
- c. Is the proposed psychomotor domain model appropriate for implementing the workshop course?
- d. Is there any other model that aligns to the current practice in conducting the workshop course?
- e. What is the outcome of the framework in applying a psychomotor domain model in the implementation of the Electrical Installation Workshop course?

Finally, using the information gathered from all the responses to these questions, the research is aimed at employing another approach in constructing an Electrical Installation Workshop course framework by applying the psychomotor domain model. This study primarily addresses the aspects of adapting psychomotor domain model in proposing the learning outcomes, the teaching strategies and the assessment strategies in delivering this course.

## 1.6 Scope of Research

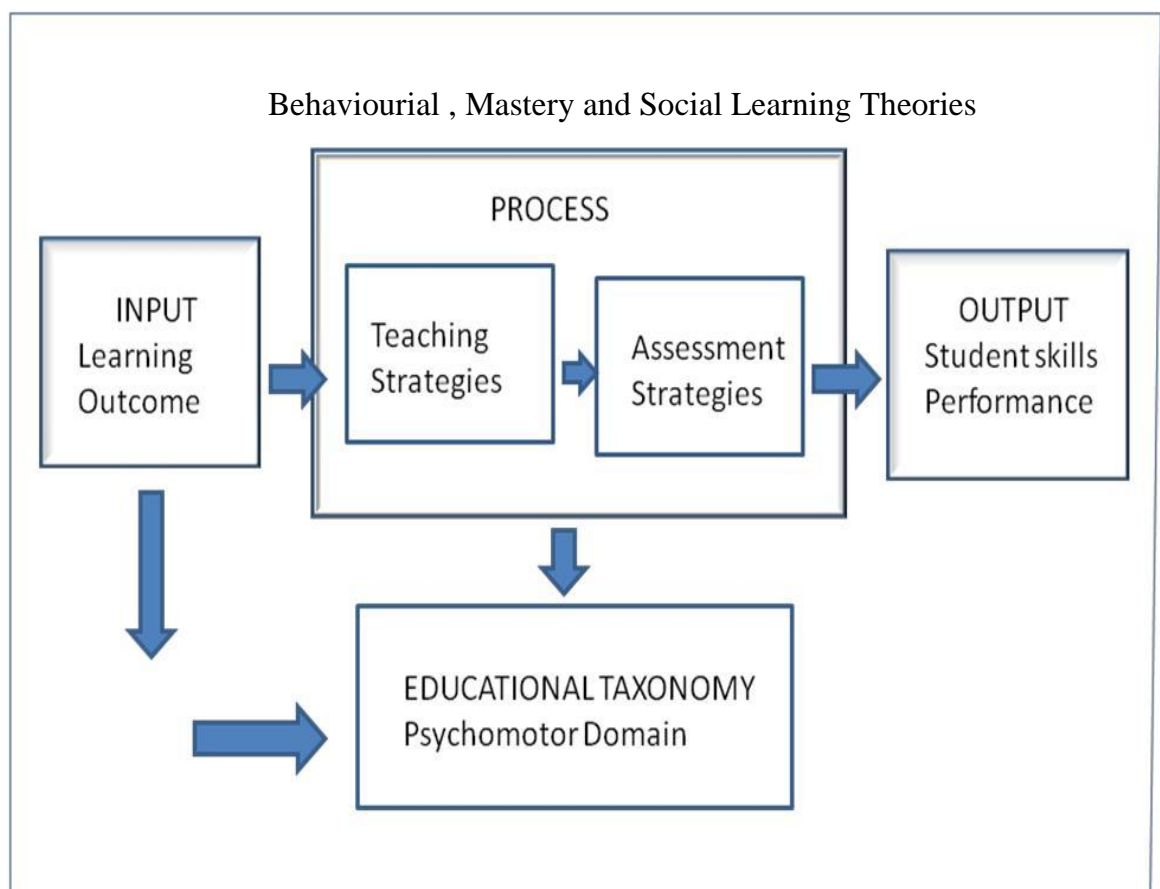
The scope of the study focused on the Electrical Installation Workshop course conducted for first year students of the Diploma of Electrical Engineering programme in Universiti Teknologi Malaysia *International Campus*. The students registered in the academic year session of 2008/2009. Other HEPs that have been chosen as samples in this research are offering similar course during the first year Diploma of Electrical Engineering programme. It takes into account the similarities and differences in the implementation of the course. The NOSS used for this research is the Job Profile Chart For Wireman Level 1 and 2 (Appendix M). The international standard used which is the WorldSkill standard is as a cross reference to the National Skills Standard.

The Malaysian National Standard development of skill used in this research refers to The National Vocational Training Council which is now known as the Department of Skills Development (DSD) Malaysia. The instructional design in this research refers to the system approach with reference to mastery skills learning that is associated with the behavioural and social learning theories in defining the learning outcomes, teaching strategies and assessment strategies for the Diploma in Electrical Installation Workshop course at UTM.

## 1.7 Conceptual Framework

The conceptual framework for the study is shown as in Figure 1.2. The framework employs the systems approach to education. This approach describes the process of educational development where the input, output and the actual process of teaching and assessment are clearly defined. The output implies a description of the performance of students after being subjected to the educational process (Rompelman & Graaff, 2006). In the first step which is the input stage, the educator determines the learning outcomes of this course. Then in the process stage, appropriate teaching strategies are selected to achieve the learning outcomes together with the assessment strategies in determining to which extent, the learning outcomes have been achieved.

Finally, at the output stage the product of the learning experiences are then, translated into students' performance which in this course is the grade given to the students. This system approach of developing a course is also referred to as the educational taxonomy. The educational domain chosen will then align the input and the process stage, in producing the required output. In the development of a workshop course which involves hands-on skill, the psychomotor domain of the educational taxonomy is applied. The conceptual framework in developing a psychomotor domain course will be based on three learning theories which are the mastery learning theory which is associated with the behavioural learning theory and finally the social learning theory. However, it is also important in the development of the course to consider benchmarking the existing course to the International and National Skills Standards.



**Figure 1.2:** Conceptual framework

## **1.8 Significant of Study**

The purpose of this study is to produce a framework by using another approach of implementing an Electrical Installation Workshop course by applying a psychomotor domain model with reference to National Skills Standard. The framework for acquiring skills in the Electrical Installation Workshop course will also apply the Outcome Based Education design. The learning outcomes of the course are referred to the National Skills Standard. The framework will be a great contribution to the body of knowledge in implementing a workshop course in acquiring the specific skills demanded by the industry. This framework will also provide a reference in developing any other engineering workshop practice course.

## **1.9 Operational Definition**

The terms used in this research, are according to the educational standards in Malaysia that are provided by Malaysia Qualification Agency (MQA) and Malaysia Qualification Framework (MQF), Department of Skills Development (DSD) and Universiti Teknologi Malaysia teaching and learning policy (UTMT&L).

1. Definition by the Malaysian Qualification Agency (MQA) and Malaysia Qualification Framework (MQF) on:

a. Higher Education Providers (HEPs)

A higher education provider is a corporate body, organization or other body of persons which conducts higher education or training program including skills training programme leading to the award of a higher education qualification or which award a higher education qualification. These include the public or private higher education providers, examinations or certification bodies or their representatives.

b. Benchmarked standards

Benchmarked standards must be met and its compliances are demonstrated during a program accreditation exercise. Benchmarked standards are expressed as a “must”.

c. Learning Outcomes

Learning outcomes are statements on what a learner should know, understand and able to perform in completing a course or upon the completion of a period of study.

d. Assessment

Assessment principles, methods and practices must be aligned with Learning Outcomes and program content.

i. Formative Assessment

Formative assessment is the assessment of students' progress throughout a course, in which the feedback from the learning activities is used to improve students' performance.

ii. Summative Assessment

Summative assessment is the assessment of learning, which summarizes the progress of the learner at a particular time and is used to assign the learner a course grade.

2. Department of Skills Development (DSD)

a. Job Profile Chart

A Job Profile Chart (JPC) is where duties and tasks are presented in the form of graphical profile.

b. Duties and Tasks

Statements that have been identified through the process of job analysis brainstorming session and together with the statements that the trainer will able to do in an occupation.

3. Universiti Teknologi Malaysia Policy of Teaching & Learning (UTMT&L)

a. Programme

A study programme that is approved by the University as an academic programme for the purpose of awarding a diploma or degree.

b. Learning Outcome

The knowledge, skills and attitudes acquired by students at the end of a course through the learning process, experienced by the students.

c. Course

A component of a curriculum which contains the syllabus and distinctive code.

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