

PROJECT-BASED LEARNING FRAMEWORK FOR NON-TECHNICAL SKILLS

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Special dedication to my beloved parents, Noordin bin Atan and Kamsiah binti Sumiran, my sweet wife, Nur Asilah Abd Ghafar, my cuppy cake son, Mukhlis 'Afy Muhammad Khair, my dear parents-in-law, Abd Ghafar bin Tahir and Latifah binti Ahmad, my brothers and sisters who have encouraged, guide and inspired me throughout my academic journey

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ABSTRACT

Non-technical skills are becoming crucial requirements for engineering graduates to be hired by companies or industries. Unfortunately, employers nowadays are expressing their dissatisfaction on the level of non-technical skills among engineers. A preliminary study conducted by the researcher found out that electrical engineers are not equipped with proficient non-technical skills. An appropriate teaching method need to be introduced as an effort to develop non-technical skills effectively. The main purpose of this research is to study the effectiveness of Project-Based Learning (PjBL) in developing the non-technical skills among electrical engineering students. Quantitative and qualitative methods are used in this study namely questionnaires, interviews and observations. The respondents consisted of the first year electrical engineering students from three universities in Malaysia, and the lecturers who are using PjBL, semi-PjBL and non-PjBL for teaching and learning. The findings of this research display that PjBL is an effective teaching method that is able to develop communication skills, problem solving skills, teamwork skills, lifelong learning skills and ethics among electrical engineering students compared to semi-PjBL and non-PjBL. PjBL also enables students to experience the real practice of engineers through the real world experience provided to them. Based on observations and interviews, a new framework of PjBL was constructed in order to develop the non-technical skills of engineering students effectively. Therefore, it is recommended for engineering education programmes to implement PjBL in their curriculum as an effort to develop the engineering students' skills and to produce better engineering graduates, who are equipped with both technical and non-technical skills.

ABSTRAK

Kemahiran bukan teknikal menjadi satu keperluan kritikal untuk graduan kejuruteraan bagi diambil bekerja oleh syarikat atau industri. Malangnya, majikan pada masa kini menyuarakan rasa tidak puas hati terhadap tahap kemahiran bukan teknikal dalam kalangan jurutera. Kajian awal yang dilakukan oleh penyelidik mendapati graduan kejuruteraan elektrik tidak dilengkapi dengan kemahiran bukan teknikal yang mencukupi. Satu kaedah pembelajaran yang sesuai perlu diperkenalkan untuk membangunkan kemahiran bukan teknikal secara berkesan. Tujuan utama kajian ini adalah untuk mengkaji keberkesanan Pembelajaran Berasaskan Projek (PjBL) dalam membangunkan kemahiran bukan teknikal dalam kalangan pelajar kejuruteraan elektrik. Kajian ini menggunakan kaedah kualitatif dan kuantitatif iaitu soal selidik, temubual dan pemerhatian. Responden terdiri daripada pelajar-pelajar kejuruteraan elektrik tahun pertama tiga buah universiti di Malaysia dan pensyarah-pensyarah yang menggunakan PjBL, separa PjBL dan bukan PjBL untuk pengajaran dan pembelajaran. Kajian ini menunjukkan bahawa PjBL merupakan satu kaedah pengajaran yang berkesan untuk membangunkan kemahiran komunikasi, kemahiran menyelesaikan masalah, kemahiran kerja berpasukan, kemahiran pembelajaran sepanjang hayat dan etika di kalangan pelajar kejuruteraan elektrik berbanding dengan separa PjBL dan bukan PjBL. PjBL juga membolehkan pelajar merasai pengalaman sebenar jurutera melalui pendedahan praktis sebenar yang diberikan kepada mereka. Berdasarkan pemerhatian dan temubual, satu kerangka PjBL yang baharu telah dihasilkan bagi membangunkan kemahiran bukan teknikal para pelajar kejuruteraan secara berkesan. Oleh itu, program pendidikan kejuruteraan disarankan untuk melaksanakan PjBL di dalam kurikulum mereka sebagai satu usaha membangunkan kemahiran pelajar kejuruteraan dan menghasilkan graduan kejuruteraan yang lebih baik, yang dilengkapi dengan kemahiran teknikal dan bukan teknikal.

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LIST OF ABBREVIATIONS

PjBL	-	Project-Based Learning
PBL	-	Problem-Based Learning
UA	-	University A
UB	-	University B
UC	-	University C
NACE	-	National Association of Colleges and Employers
ASEE	-	American Society of Engineering Education
BEM	-	Board of Engineers Malaysia
IEM	-	Institution of Engineers Malaysia
MCED	-	Malaysian Council of Engineering Deans
TNB	-	Tenaga Nasional Berhad
SPSS	-	Statistical Package for the Social Science
MQA	-	Malaysia and Qualification Agency
MOE	-	Ministry of Education
IEA	-	International Engineering Alliance
JABEE	-	Japan Accreditation Board for Engineering Education
ABET	-	Accreditation Board for Engineering and Technology
EAC	-	Engineering Accreditation Council
HKIE	-	The Hong Kong Institution of Engineers
ABEEK	-	Accreditation Board for Engineering Education of Korea
IES	-	Institute of Engineers Singapore
FKE	-	Faculty of Electrical Engineering
MEES	-	Malaysia Engineering Employability Skills

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Technology is a product and outcome of engineering and science. It is also application of knowledge of humans by manipulating and modifying nature to meet their needs. These changes can be achieved by transforming and improving the usage of tools, materials and techniques which have their effect on humans and other living things as well. Today's technology would not be the same as yesterday and will not be better than tomorrow. Every single day, there will be some improvement on technology which most likely will affect the engineering industries (Raymond and Albert, 2009). As such, requirements of the industries on engineering graduates will also keep changing. Possessing technical skills solely is not enough for engineers in the workforce, where most of them apply the trial and error technique that seems to be effective in the industry (Colwell, 2010). Employers or industries are not only seeking for those who are technically skilled but also possess non-technical skills that are deemed as marketable graduates (Low, 2006; Lee, 2003; Woodward, Sendall, and Ceccucci, 2010). This requirement does not mean that technical skills are not important, but non-technical skills are added values for engineering graduates seeking employment in the 21st century. Spang and Genis (2009:5) in their research stated that "Technical skill is necessary, but not sufficient to maintain high levels of

patient safety over time”. Traditional engineering education has put a lot of emphasize on technical problem solving skills by developing specialized and theoretical knowledge. As a result, engineers are well trained, yet lack some of the skills that make other professionals successful which are known as non-technical skills (Meadows and Samantha, 2006).

Table 1.1: Employers’ rating of the importance of candidate skills/qualities

No	Skill/Quality	Mean Score*
1	Ability to verbally communicate with persons inside and outside the organization	4.63
2	Ability to work in a team structure	4.60
3	Ability to make decisions and solve problems	4.51
4	Ability to plan, organize and prioritize work	4.46
5	Ability to obtain and process information	4.43
6	Ability to analyze quantitative data	4.30
7	Technical knowledge related to the job	3.99
8	Proficiency with computer software programs	3.95
9	Ability to create and/or edit written reports	3.56
10	Ability to sell or influence others	3.55

*5-point scale, where 1=Not at all important; 2=Not very important; 3= Somewhat important; 4=very important; and 5= Extremely important

Adapted from NACE Job Outlook 2013

From Table 1.1, we can see that technical skills are not as important as non-technical skills since technical skills are of lower priority, which is number seven and eight while non-technical skills are in the top six. As stated by Daggett (2010), engineering students do not have any problem in mastering technical knowledge, but the real challenge is to prepare them with sufficient non-technical skills. Employers nowadays are looking for employees with superior non-technical skills, as opposed to individuals with merely technical skills and knowledge to boast. So, it is proven that, it is important for engineers nowadays to equip themselves with proficient non-technical skills to compete not only with other engineers, but other individuals in different professions as well. There are big challenges for universities to prepare their

engineering graduates with the skills demanded by industries. Strong pressures from industries, community and undergraduates have been put on top of universities to carry such responsibilities (Huet et al., 2009). Preparing well equipped graduates is never an easy job. Therefore, engineering education needs to evolve along with the ceaseless globalization process. Technical skills are the foundation of knowledge for engineering graduates where they learn those skills by listening to lectures and doing laboratory work. According to Martin et al. (2005), technical skills can be divided into two categories which are: i) engineering science, which is also known as theoretical knowledge of mathematics and science to resolve engineering issues, ii) engineering practice, the process of identification of problem and its resolution. These skills and knowledge are the distinct line that separates the engineering profession from others and it is what makes engineers an engineer. Nevertheless, according to Tang, Luan and Tho (2005), success cannot be guaranteed by solely depending on technical skills since an engineer needs to possess a good set of non-technical skills as well. Thus, it is important for engineering graduates to equip themselves with sufficient non-technical skills to complement their technical skills.

1.2 Background of the research

This part explains on fews topics that related to the importance of development of non-technical skills for engineering students. Furthermore, this part also provides more details on how the problem for this research is arises.

1.2.1 The need for non-technical skills among engineers

To become an engineer is not difficult, but to be a competent and professional engineer is one tough job. In order to become one, Hasna (2008) reported that an engineer must contend with endless societal and technological transformation due to

the industry's rapid development. Engineers must know how to adapt themselves so that they always become productive in any kind of situation. According to ASEE (2003), an engineer is defined as "problem solvers, people, who search for quicker, better, less expensive ways to use the forces and materials of nature to meet tough challenges". In today's world, society has put a lot of burden on engineers where people are expecting the engineering world to provide creative and innovative solutions in order to make their life easier and comfortable (Clark and Andrews, 2010). As engineers, they need to fulfil the humans' needs, but at the same time they must put environment and nature into consideration. They cannot sacrifice the nature and environment in order to satisfy human desire. Thus, code of conduct or engineering ethics is established in order to provide guidelines to engineers. In other words, engineers must have good problem solving skills and ethics, which are part of non-technical skills.

In today's modern world, industries need to compete with each other in order to survive in the global market. Thus, employers are seeking graduates that are able to work immediately after they get hired (Azami et al., 2009), and of course they still need some training before they can perform the job. Nevertheless, the training is not very time consuming and the employers do not need to spend a big amount of money for the training program. In addition, fresh graduates without valuable soft skills will often be overlooked for graduates who possess firm grasp of both technical and non-technical skills since they take shorter period to be trained into becoming effective and efficient engineer (Walther and Radcliffe, 2007). On a related note, engineering professional body, Board of Engineers Malaysia (BEM) came out with a list of 10 generic skills attributes which *has* become a guideline to every engineering graduate in Malaysia in order to produce better and competitive engineer. These attributes consist of ability to apply engineering knowledge, ability to communicate with public, in-depth engineering technical competency, ability to solve problem creatively and critically, ability to evaluate operational performance, understand the principles of sustainability, ability to work ethically, ability to work in a team effectively, ability to understand the social, cultural and environmental responsibilities and ability to undertake lifelong learning. This guideline also has been acknowledged by other bodies namely Institution of Engineers Malaysia (IEM)

and Malaysian Council of Engineering Deans (MCED) (MegatJohari et al., 2002; Khairiyah et al., 2004).

Table 1.2: Legend for skills

A	Ability to acquire and apply knowledge of engineering fundamentals.
B	Having the competency in theoretical and research engineering.
C	Having competency in application and practical oriented engineering.
D	Ability to communicate effectively, not only with engineers but also with the community at large.
E	Having in-depth technical competence in a specific engineering discipline.
F	Ability to undertake problem identification, formulation and solution.
G	Ability to utilize a systems approach to design and evaluate operational performance.
H	Ability to function effectively as an individual and in a group with the capacity to be a leader or manager as well as an effective team member.
I	Having the understanding of the social, cultural, global and environmental responsibilities and ethics of a professional engineer and the need for sustainable development.
J	Recognizing the need to undertake lifelong learning, and possessing/acquiring the capacity to do so.
K	Ability to design and conduct experiments, as well as to analyze and interpret data.
L	Having the knowledge of contemporary issues.
M	Having the basic entrepreneurial skills



Figure 1.1: Mean gap between expectation and perception of industries

As for graduates, they need to learn and grasp all these skills mentioned by BEM when they are studying in universities. The big question now is, are Malaysian engineering graduates well prepared and equipped with all these attributes? To answer that, perceptions and expectations of industries and employers towards engineering graduates in the workforce can be considered as the best answer because they know what the graduates are lacking. Azami (2008) had conducted a gap analysis to identify employers' perception and expectation towards engineering graduates in Malaysia, which is shown in Table 1.2 and Figure 1.1. From Figure 1.1, attribute F (problem solving) has the highest gap, whereas attribute D (communication skills) and attribute H (team management) have the second and third highest gaps respectively. As the gap widens, the perceptions of industries towards graduates becomes worse since the industries put high level of expectations towards these skills.

In addition, a survey conducted by Yuzainee et al. (2009) also indicated that team management, problem solving and communication skills as the three most important skills sought by employers. Similar research was also conducted in another country, which was done by **Patil**, Nair and Codner (2008) where they surveyed graduates from Monash University, Australia. They found significant gaps in which graduates lacked in both oral and written communication skills, interpersonal skills and problem solving skills. Thus, it is clear that graduates are lacking non-technical skills instead of technical skills although there is also a gap in technical competencies. This statement was reinforced by Kamsah (2004) in his research, which stated that current engineering graduates are not deficient in technical capability or their knowledge but they are deficient in their soft skills which are important for them to work collaboratively and use their technical abilities. Hence, universities bear the burdens and responsibilities to equip and prepare their graduates with 21st century global engineering skills, which requiring the students to be equipped with both aspects of technical and non-technical skills.

1.2.2 Non-technical skills development for engineering students

Alas, rapid changes on the requirement of the industries towards graduates' skills rendered higher education institutions, especially universities, unable to keep up with the evolution. In a worst case scenario, universities fail to provide engineering undergraduate students with appropriate education, knowledge and skills which are sought by current industries and unable to prepare them adequately for professional practice (Jorgensen and Howard, 2000; Nair and Patil, 2008). Therefore, discrepancies emerge between what educations provided and industry needed (Arnold, 2010; Brent, 2009; Domal, Stappenbelt & Trevelyan, 2008; Walsh, Crockett and Zahed, 2008; Nair, and Patil, 2008; Mustafa et al., 2008, Azami, 2008). Walther and Radcliffe (2007) further added that universities and industries have different views and perspectives of skills needed by graduates. Such disconnectedness must be solved to make sure universities and industries are on the same page in terms of development of graduates' skills. In order for engineering graduates to be an engineer, a balance between technical and non-technical skills must be provided in their education. According to Nilsson (2010), universities put a lot of focus on substantive content of engineering with only a little focus on non-technical skills. Engineering education cannot put sole emphasis on in-depth technical knowledge because it will create a skills gap when students join the workforce since most of their work requires the practice of non-technical skills as well.

Academic qualification is only an entrance ticket to the working world (Nilsson, 2010) and it does not mean that with that ticket hopeful candidates will be accepted by all employers. The table above proved that academic results are not as important as non-technical skills since most of the employers rated non-technical skills as the most important qualities or skills that are expected from graduates. Moreover, researchers also have voiced out their perceptions on the importance of non-technical skills for engineering graduates. These skills are the additional ticket that they should have to get employed, maintain their employment and to succeed in their career. Nowadays, engineering graduates depend on final year project as their channel for improving both technical and non-technical skills (McDermott, Nafalski

and Özdemir, 2007). But, this is not enough because not all skills can be developed through final year projects. Case in point, students work alone on their projects, thus there is no room for teamwork skills to be put into practice.

Table 1.3: Employer's rating of the importance of candidate skills/qualities

No	Skills	Mean Score
1	Communication Skills	4.7
2	Honesty/integrity	4.7
3	Interpersonal skills (relates well to others)	4.5
4	Motivation/initiative	4.5
5	Strong work ethic	4.5
6	Teamwork skills (works well with others)	4.5
7	Computer skills	4.4
8	Analytical skills	4.3
9	Flexibility/adaptability	4.3
10	Detail-oriented	4.2
11	Organizational skills	4.0
12	Leadership skills	4.0
13	Self-confidence	4.0
14	Friendly/outgoing personality	3.9
15	Tactfulness	3.9
16	Well-mannered/polite	3.8
17	Creativity	3.7
18	GPA (3.0 or better)	3.6
19	Entrepreneurial skills/risk-taker	3.3
20	Sense of humor	3.2
21	Bilingual skills	2.3

(5-point scale, where 1=not important, 2=not very important; 3=somewhat important; 4=very important, and 5=extremely important)

Adapted from NACE Job Outlook 2007

Traditional lectures and traditional laboratories seem obsolete since these methods are unable to develop these skills. In lectures, lecturers deliver the information and the students just need to absorb it, and eventually their level of theoretical and technical knowledge will be evaluated through paper-based examination, thus, leaving the development of non-technical skills behind (Berhannudin et al., 2007; Khairiyah et al., 2004). Engineering education in Malaysia needs to be reviewed and reassessed in order to find an effective way to improve the teaching and learning system. Accordingly, the development of non-technical skills can be integrated in technical subjects (Shahrin et al., 2004). Such method can be seen as killing two birds with one stone where students not only improve on their technical skills, but indirectly, on their non-technical skills as well. Regardless, adding extra subjects into the curriculum to teach students about non-technical skills seems less effective because these courses often lack the direct application to the students' engineering experiences and the ability to track and improve over time (Kedrowicz et al., 2006).

1.2.3 Changes needed in engineering education

Table 1.4 shows the relation between the need for changes in engineering education and how PjBL can fulfill the need by developing crucial non-technical skills in engineering students. There are a few changes needed in engineering education in order to ensure this field of study is able to produce engineering graduates that possess the qualities and skills sought by the industries. As such, academic institutions must tailor their teaching and learning programs in such a way that these goals are met in order to keep pace with the industries' requirements (Olorunfemi & Ashaolu, 2008) . That said, it is important to have collaboration between universities and industries in nurturing future engineers, apart from providing enhancement and improvement in the quality of teaching and learning in engineering education. Teacher-centered approach is unsuitable to be implemented in engineering education because it will lead to passive learning (Catalano & Catalano,

Table 1.4: Relationship between changes in engineering education and PjBL

		CHANGES IN ENGINEERING EDUCATION							
		Project related work	Emphasize on non-technical skills besides technical skills	Non-technical context must be learned along with technical context	Theory and application must be closely related	Multidisciplinary – integration of knowledge	Student centered approach	Focus on active learning	Responsive to demand of industries
PROJECT-BASED LEARNING	Integration and application of knowledge – learning by doing		√	√	√	√			√
	Active and collaborative learning		√				√	√	
	Real world experience- facing real problems	√	√	√	√	√			√
	Work in a group			√					√
	Student centered – students develop and formulate their own design and experiment	√	√	√	√		√	√	√

1999), where active learning should and must take place in the teaching and learning process (Domínguez & Magdaleno, 2008). Active learning can be promoted by changing teacher-centered to student-centered approach for a more student-driven learning process.

According to Tu (2006), engineering education nowadays need to emphasize on project related work in order to provide early exposure on the real practice in the industry to engineering students. They can neither be taught using traditional method nor solely doing laboratory work that require them to follow instruction as their cognitive and practical skills cannot be improved since these methods close the opportunity for them to apply knowledge and skills. Project work is able to motivate them (Yam, 2010) and enhance their interest in engineering education. On the other hand, non-technical skills development should be considered in educating engineering students besides technical skills (Mardam-Bey, Sanjay & Saran, 2008). Non-technical skills are very important nowadays since these are the skills that are sought by the industries among engineering graduates. Without these skills, it will be difficult for engineering students to get employed. Alternately, even if they are successfully employed, surviving in the industry may not be as easy. Also, their career advancement opportunities may be slim and they may lose out on any chance to get promoted in their job position. Engineering students must be taught non-technical skills within technical context (Shahrin, 2004). This is a great way to instill and improve their non-technical skills, but at the same time, testing their technical skills.

Non-technical skills cannot be acquired by teaching them through a subject about non-technical skills; instead the skills can only be developed and honed through practice and training (Pop & Barkhuizen, 2010). Engineering education must ensure that theory and practice are closely related (Zulikifli et al, 2009). Although the students are able to do laboratory work, it is not enough since laboratory work only provide a task that is related to one subject without taking other subjects into the consideration. Thus, the gap between theory and practice become wider (McCollum, 2006), causing students to wonder if it is necessary for them to learn a particular

subject without knowing how to apply it. In order to improve laboratory work, multidisciplinary task must be emphasized on engineering students (Ashford, 2004). This aspect is important to ensure that students understand the relevance of each subject that they have learned so that they will be able to integrate and apply their knowledge into practice. By looking into the characteristics of PjBL, the implementation of PjBL may be able to fulfill all the changes needed in engineering education. Several characteristics have been chosen in order to match and meet the changes, which can be seen from table 1.4.

1.2.4 Project-Based Learning for Engineering Education

According to Kolmos, (2009), the solution for the new requirement of skills of undergraduates in engineering education is by implementing problem-based learning (PBL) or project-based learning (PjBL). Both methods emphasize on student-centered learning and negate traditional teacher-driven approach. As seen in the table above, PjBL and PBL show the best characteristics compared to others methods. These characteristics provide motivation and are suitable for the development of non-technical skills. Nevertheless, these two approaches of learning were deemed confusing and people misjudge both methods as the same thing. The fact is, as the names differ, so are the methods although they have a lot of similarities which was stated previously. Jon-Chao (2007) has listed the differences between PBL and PjBL as summarized in table 1.5.

In the real world, engineers work on projects and must ensure that every project meets the customers' specifications and expectations. From the table, the PjBL approach seems most suitable for engineering education because it provides the best practice for students, which mirrors the task of an engineer in the workforce (Marlia, 2010; Chartier & Gibson, 2007; Hiscocks, 2006). This statement was reinforced by Mills and Treagust (2003: 13) in their research which stated that:

It therefore seems that project-based learning is likely to be more readily adopted and adapted by university engineering programs than problem-based learning.

Lowenthal (2006: 1) in his research stated that:

Project-Based Learning incorporates methods from problem-based learning, cooperative learning, active learning and project management theory.

Table 1.5: Differences between PjBL and PBL

Area	PjBL	PBL
Basic operational structure	Emphasizes on the development of students' skill to design and carry out projects.	Emphasizes on the development of students' skills to design questions.
Practice procedures	<ul style="list-style-type: none"> i. Recognize the final project ii. Identify who will be the target consumer iii. Find out the implication of the project iv. Design the project v. Create a milestone or Gantt chart for the project vi. Start working on the project vii. Solve any upcoming problems or conflicts. viii. Finish the project 	<ul style="list-style-type: none"> i) Students start to conjure questions as they face the problems ii) Students delve into the problems iii) Emergence of extra questions iv) Specify the scope of knowledge v) Suggest a plan to get additional information vi) Carry out essential researches vii) Share the new knowledge viii) Make the conclusions

From the statement, it can be asserted that PBL is the subset of PjBL. If PjBL is implemented, PBL will be indirectly implemented as well. In addition to that, PjBL covers a wide scope of model of instructions which makes it the best method

for engineering undergraduates. PjBL more often correlates to the field of engineering and science. While PBL is also implemented in those fields, it originated from the medical field and other professional preparatory training (Chakravarthi and Haleagrahara, 2010). This statement is supported by Perez et al. (2010), which stated that PjBL was established in the engineering field to provide experience for engineering students, which is able to promote life-long learning and cognitive abilities.

Table 1.6: PjBL and PBL differences from various aspects

Area	PjBL	PBL
End product	End products will drive the students to shape and describe the whole production, planning and evaluation process. E.g.: Usage of CAD in engineering project which needs a lot of effort and comprehensive planning.	End products are much simpler E.g.: Group's report on the research findings.
Learning process	Learning process focuses on the production of model	Primary focus of the learning process is given to research and inquiry
Problems	An amount of problems will appear as students implicitly assumed on the projects which problem solving skills are needed to solve them	Students start with clearly described problems and a set of solution or conclusions in direct response are needed.
Evaluation	Success of the PjBL is evaluated through skills obtained during the process of production of the model.	Success of PBL is evaluated through the how effective the solution is.

Furthermore, project works are able to retain students in engineering program (Richardson et al., 1998) and are able to improve their motivation to learn future material (McKenzie, Pelliccione and Parker, 2008). PjBL puts an emphasis on

students to come out with an end product in which something can be seen, as compared to PBL that expects abstract outcomes. Donnelly and Fitzmaurice (2005) in their research stated that the continuous differences between both methods can be seen from two aspects. Clearer distinction between these two can be further made as stated in table 1.6. Notwithstanding, they share a lot of characteristics other than student centered. Purpose of both methods is to connect the students in the real world tasks to improve learning by working on open ended problems or projects. The role of lecturer will be never the same since they act as tutor, coach or facilitator (Jon-Chao, 2007). Moreover, lecturer just provides them with guidance in order to make sure they are working in right path instead of spoon-feeding them with direct answer. Both methods imparting the students an in-depth understanding of a topic (Bell, 2010), connect the students to higher level of thinking (Savery, 2006), providing students with auxiliary, flexible and stimulating environment (Maier, 2008) and based on constructivist learning theory (Donnelly and Fitzmaurice, 2005). PjBL already proved that it is able to provide a lot of of benefits, especially to the students during the teaching and learning process. Those benefits were able to be obtained due the good characteristics of PjBL itself as shown in Table 1.7.

Table 1.7: Characteristics and benefits of PjBL

Characteristics:	Benefits:
1. PjBL is the process of application of knowledge – students apply what they have learned (theory) into practice – hands-on approach.	1. Learn how to solve problems using relevant knowledge independently of the discipline source
2. Integration of knowledge – interdisciplinary learning	2. Students retain the knowledge that they have learned for a longer period
3. Problems are based on real world problems - problems are relevant and contextual. It is in the process of struggling with actual problems that students learn content and critical thinking skills	3. Activities are focused on exploring and working practical problems with an unknown solution
4. End products will drive the students to shape and describe the whole production, planning and evaluation process.	4. Involve several contents of the same discipline or the interaction of different disciplines
5. Emphasizes on the development of students'	5. Application of knowledge or theory of different interdisciplinary knowledge into practice – appreciate the relationship between different disciplines in the

Characteristics:	Benefits:
<p>skill to design and carry out project</p> <ol style="list-style-type: none"> 6. PjBL is learner-centered - learners are progressively given more responsibility for their education and become increasingly independent of the teacher for their education 7. Learning process focuses on the production of model 8. Success of the PjBL is evaluated through skills obtained during the process of production of the model. 9. Provides real world experience to students 10. Teachers or lecturers act as facilitator who give them guidance and help. 11. Emphasizes on higher level thinking skills 12. Students develop and formulate their own designs and experiments 13. Students work on the project as a group 14. Consumes a lot of time to finish the product 15. It is carried out in risk-free environment where it provides positive feedback and allows students to make their choice 	<p>development of a particular subject</p> <ol style="list-style-type: none"> 6. Allowing the search of open solution so students are free to create new knowledge 7. Allows for more other conventional teaching and learning to occur in parallel 8. Can create situations that can be authentic or real life scenario. 9. Motivates students to study and to develop a product while providing them with an experience regarding engineering practice. 10. Creates closer ties or bonds between students, technical supervisors and industrial partner. 11. Improves students' non-technical skills such as communication, project management, leadership, problem solving, teamwork and critical thinking skills. 12. Provides contextual knowledge to help students learn concepts in relation to one another. 13. Helps motivate students to learn the building blocks because they know the end goal and why it will be useful. 14. Allowing students to move beyond mere knowledge and comprehension skills into application, analysis, synthesis and evaluation 15. Allowing students to be in charge of their own learning and thinking 16. Increases students' attendance and motivation to learn 17. PjBL produces independent, life-long learners - students continue to learn on their own in life and in their careers.

1.2.5 Preliminary Study

In order to provide better insight on the background of the problems on electrical engineering field, the researcher has conducted a preliminary study on senior electrical engineers and electrical engineers who work at Tenaga Nasional Berhad (TNB).

1.2.5.1 Preliminary Study Methodology

The data for this research were gathered from the electrical engineers from and senior engineers from Tenaga Nasional Berhad (TNB), Malaysia. Since TNB is the main company that provides electricity in Malaysia and is one of the major companies in Malaysia with a large number of electrical engineers under its employment, it is relevant for the researcher to set a sample study from the electrical engineers there. Based on the statistics provided by Department of Human Resource, TNB, the population for electrical engineers is 10,000, while the population for senior electrical engineers is 1500. The instruments that were used in this study were questionnaires, as the main instrument, and interviews as second instrument to support and strengthen data from the questionnaires. The questionnaires were used to collect data from the electrical engineers and senior electrical engineers, while the data from interviews were collected from electrical engineers only. There are two different set of questionnaires, where the first set is for the electrical engineers and the second set is for the senior electrical engineers. The first set consists of seventeen questions and the questions were divided into five parts, whereas the second set consists of thirty questions and divided into seven parts. The questionnaires for electrical engineers were different from senior engineers because the questionnaire for the former were for them to evaluate themselves in terms of non-technical skills competency, whereas the second set of questionnaires for the senior engineers was for them to evaluate the competency of non-technical skills among fresh electrical engineers in TNB. The data collecting process had to be done in three phases, all of

which are through questionnaires, because the response rate for each set of questionnaires was very low. The phases for the questionnaires distribution are shown in table 1.8. For the first phase, the researcher mailed 760 questionnaires to every TNB General Manager offices in the peninsular Malaysia, but the response rate is very low, which is 5.66%.

Thus, the researcher conducted the second phase for this process, in which the researchers sent 90 questionnaires to three randomly selected TNB General Manager's offices in Peninsular Malaysia by hand. Unfortunately, the researchers only obtained 30% of response rate through the second phase. As the researchers tried to collect more data, the researcher conducted the third and last phase of data collection. In the third phase, the researchers used online questionnaire and links for the online questionnaires were emailed to every TNB electrical engineers' email, which were sent through TNB Human Resource officer. The online questionnaires were opened for two months, but only collected 24 questionnaires. Overall, the researchers were able to obtain 62 questionnaires from the electrical engineers and 32 questionnaires from the senior electrical engineers in TNB.

Table 1.8: Phase for questionnaires data collection process

Phase	Questionnaires Distributed	Questionnaires collected	Response rate (percentage, %)
First	760 (mailed)	43	5.66
Second	90 (by hand)	27	30
Third	500 Online questionnaires (e-mailed)	24	4.88

As for the data for the interviews, five electrical engineers were interviewed. The sampling method that was used for the questionnaires was non-probability sampling, which is snowball sampling. The data from the interviews were used as supportive data for the questionnaires and to gather the electrical engineers' opinions in order to improve and enhance engineering education in Malaysia.

1.2.5.2 Preliminary Study Data Analysis

The collected questionnaires were analyzed using IBM SPSS Statistics version 20 software. All data was analyzed by using descriptive statistics, in which the researchers obtained frequencies and mean scores for the questionnaires. From the first set of the questionnaires, it is identified that most TNB's electrical engineers (82.3 %) participated in this study have obtained their Bachelor's degree in their qualification, whereas the number of engineers who hold diploma and Master's degree are very low, which are 8.1% and 9.7% respectively as shown as in table 1.9.

Table 1.9: Qualification of electrical engineers at TNB

Qualification	Frequency	Percent	Valid Percent	Cumulative Percent
Diploma	5	8.1	8.1	8.1
Degree	51	82.3	82.3	90.3
Master	6	9.7	9.7	100.0
TOTAL	62	100.0	100.0	

In order to analyze the result from the questionnaires, the level of competence or importance will be discussed according to the level of competence or importance based on the descriptors in Table 1.10.

Table 1.10: Level of competence or importance based on mean value (6-point Likert Scale)

Competent/Important			Less competent/ Less important	Not competent/ Not important	
Extremely competent/ Extremely important	Very competent/ Very important	Competent/ Important		Not competent/ Not important	Not competent at all/ Not important at all
* ≥ 5.2	4.4-5.1	3.5-4.3	2.8-3.4	2.1-2.7	≤ 2.0

*Mean value

Adapted from Zubaidah (2006)

Table 1.11 shows the descriptive statistics for the questions in the first set. The descriptions of each part on the first set are as below:

- i. meanSOFT - how the electrical engineers perceived themselves to be equipped with enough non-technical skills after they graduated from university.
- ii. meanDEVELOP - how the electrical engineers agreed they were able to develop their non-technical skills while in university.
- iii. meanAWARE – how the electrical engineers are aware of the importance of non-technical skills for engineers before they graduated.
- iv. meanREAL – how the electrical engineers perceived the importance of non-technical skills after they work as engineers.

Table 1.11: Mean scores for every part of the first set of questionnaires.

Part	Mean
meanSOFT	3.2688
meanDEVELOP	3.1263
meanAWARE	3.4597
meanREAL	4.4086
Valid N (list wise)	

Table 1.12 shows the level of competence or importance for every part in the first set of questionnaires. The electrical engineers in this study rated themselves as being less competent in terms of non-technical skills right after they graduated from university and they also agreed that the teaching and learning method in university is less competent in developing their non-technical skills while they were studying there. The electrical engineers also claimed that they were aware of the importance of non-technical skills while in university, and found that non-technical skills are very important as they started working in the industries. Laboratory works also provided an important role in their career as the experiments carried out in laboratories can be applied in real applications.

Table 1.12: Level of competence or importance for each part in the first set of questionnaires

Part	Level
meanSOFT	Less competent
meanDEVELOP	Less competent
meanAWARE	Important
meanREAL	Very Important

As for the findings that the researchers obtained from the interviews, which are shown in figure 1.2, it was found that the engineers were aware of the importance of non-technical skills for them to work in the industry. However, some of them claimed that they did not have sufficient non-technical skills after they graduated. This situation was caused by the lecturers who put a lot of emphasis on the technical aspect without giving much weight on the development of students' non-technical skills. Moreover, the engineers also claimed that they were only able to develop their non-technical skills after they began working in the industry, which provides a better platform for them to practice their non-technical skills. Even though some of the engineers stated that they were able to develop non-technical skills sufficiently; it was mainly on account of their participation on extracurricular programs during their study in university. Nevertheless, all of them agreed that formal teaching and learning in the university was unable to provide them with significant effect on their non-technical skills development.

Table 1.13 shows the mean score for questions in the second set. The descriptions of each part on the first set are as below:

- i. meanCOM – how the senior engineers perceived the level of communication skills among fresh electrical engineers.
- ii. meanPROB– how the senior engineers perceived the level of problem solving skills among fresh electrical engineers.
- iii. meanTEAM – how the senior engineers perceived the level of teamwork skills among fresh electrical engineers.
- iv. meanLIFe – how the senior engineers perceived the level of lifelong learning skills among fresh electrical engineers.
- v. meanETH – how the senior engineers perceived the level of ethics among fresh electrical engineers.

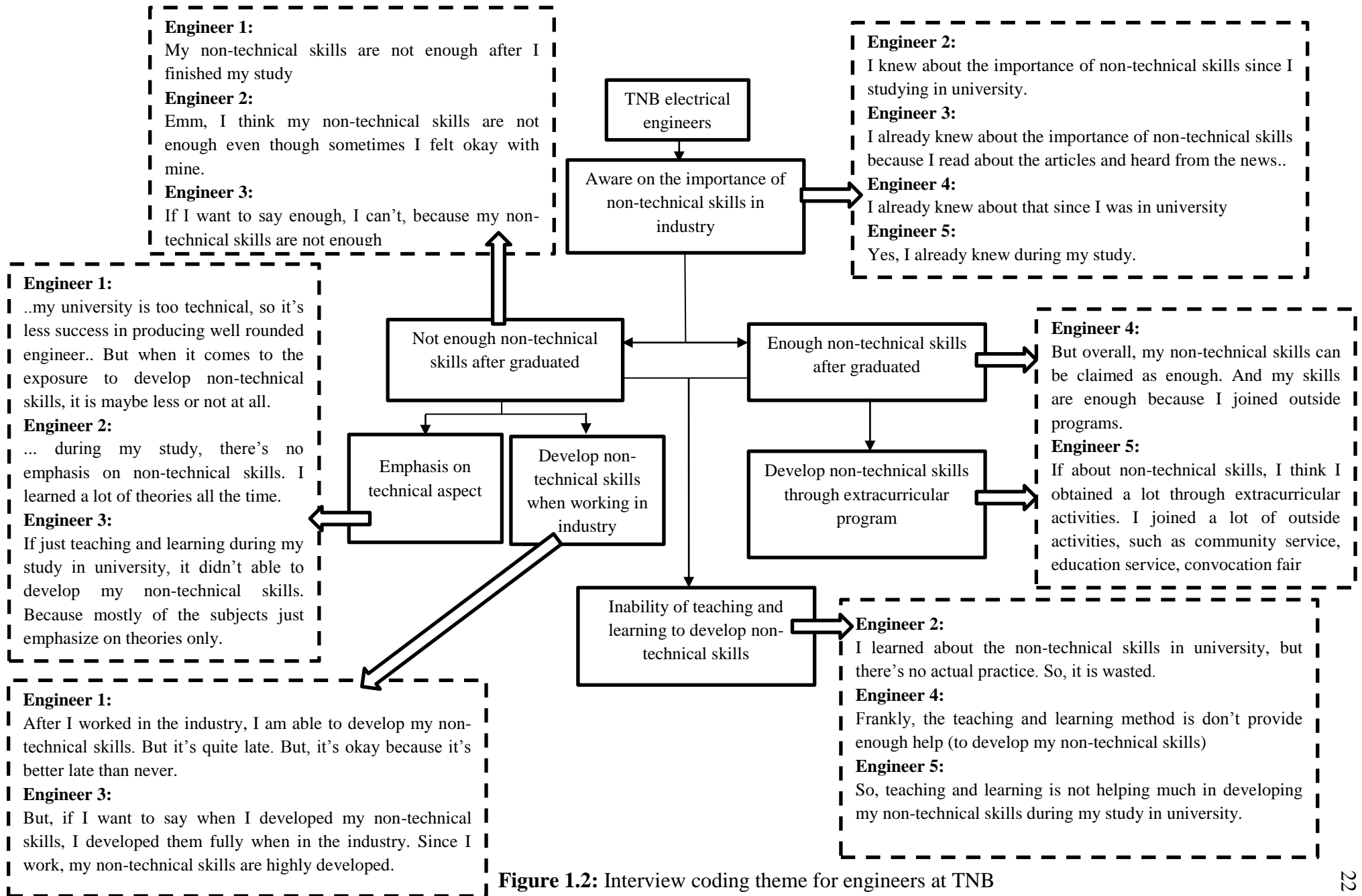


Figure 1.2: Interview coding theme for engineers at TNB

- vi. meanSOFT – how the senior engineers perceived the overall level of non-technical skills among fresh electrical engineers.
- vii. meanIMP – how the senior engineers perceived the importance of non-technical skills for engineers.

Table 1.13: Mean score for non-technical skills of fresh electrical engineers based on senior engineers' perception

No	Non-technical skills	Mean score
1	Communication	3.23
2	Problem Solving	3.42
3	Teamwork	3.37
4	Lifelong learning	3.64
5	Ethics	3.73
6	Overall	3.20
7	Importance of non-technical skills	3.94

Table 1.14: Level of competence or importance of each part in the second set of questionnaires

Part	Level
meanCOM	Less competent
meanPROB	Less competent
meanTEAM	Less competent
meanLIFE	Competent
meanETH	Competent
meanSOFT	Less competent
meanIMP	Important

Table 1.14 was generated from Table 1.13 in order to identify the competency level of non-technical skills among fresh-entry electrical engineers. The table below shows the perception of senior engineers towards the level of non-technical skills among fresh electrical engineers who are employed at TNB. The findings show that fresh electrical engineers were less competent in communication skills, problem solving skills and teamwork skills, but were well-equipped with lifelong learning skills and ethics. The senior engineers' general perception is that fresh electrical engineers

were less competent in their non-technical skills. The senior engineers also viewed the non-technical skills as a crucial skill engineers must be equipped with.

1.2.5.3 Preliminary Study Discussions

From the findings, the senior engineers from TNB deemed non-technical skills as important skills that electrical engineers need, as an additional quality and to complement their technical skills. These skills are important for them to survive in the industry because engineers nowadays do not work with machines only. Their scopes of work are changing as they need to deal with people from a variety of backgrounds, which requires a set of non-technical skills.

From the perspectives of senior engineers, fresh electrical engineers are less competent in their communication, problem solving and teamwork skills. These results correspond to the gap analysis that was conducted by Azami (2008), in which it was found that these three non-technical skills have the highest gap compared to the other non-technical skills. In other words, these skills are the skills that are least possessed by engineers in Malaysia. Moreover, this result also can be compared to the skills or qualities that are sought by employers, which is obtained from NACE Job Outlook 2013. Communication, problem solving and teamwork skills are extremely important skills that are highly sought after by employers when hiring an employee. On the other hand, the senior engineers in this study divulged that the fresh electrical engineers are proficient at lifelong learning skills and ethics. Nevertheless, according to their overall perceptions, the senior engineers considered the fresh electrical engineers are incompetent and are poorly equipped when it comes to non-technical skills.

As perceived by their superiors, the electrical engineers from TNB also rated themselves as less competent in their non-technical skills when they started working there. They also claimed that the teaching and learning method in universities are less competent or less effective in developing their non-technical skills, since the teaching and learning in universities put too much focus on theoretical aspects and only assesses their theoretical knowledge by giving so many assignments, tests, quizzes and examinations. They further added that the teaching and learning in universities do not put any or enough emphasis on the development of non-technical skills. This situation is similar to what was claimed by Nilsson (2010), which stated that universities put a lot of focus on substantive content of engineering with only a little focus on non-technical skills. Thus, it puts a lot of burden on the engineering students as they struggle to get better results, which is mostly evaluated through paper-based evaluations.

Although some of the electrical engineers claimed that they are prepared with enough non-technical skills after they graduated, they also agreed that the teaching and learning in universities did not help them to sharpen their non-technical skills.. Most of the electrical engineers in the study stated that they tried to develop their non-technical skills on their own while they were university students, as they were aware of the importance of having non-technical skills before becoming an engineer. They know that these skills are important for them to be developed, but they did not get enough opportunity to train and practice non-technical skills since nurturing these skills require time and consistent training. As an alternative, some of them stated that they voluntarily joined extracurricular activities and club-organized programs that were unrelated to any academic subjects in order to develop their non-technical skills as well as to gain additional experience. As an institution of higher education, universities should play their role properly as they need to make sure that their teaching and learning programs are able to produce well rounded graduates, especially engineering graduates. Universities need to provide a proper platform for their engineering students to train and practice their non-technical skills, because not all engineering students are able to take initiative in joining extracurricular activities and outside-based programs.

When they enter the workforce as an engineer, they belatedly realized that non-technical skills are very important for them as they claimed that they need to work and communicate with their subordinates and their higher-ups. In addition, they mostly work in a team when they work on projects. So, as an engineer, the non-technical skills are a set of skills that they must equip themselves with in order to keep surviving and being relevant to today's industry requirements. Without these non-technical skills, one can be considered as unnecessary and irrelevant with regards today's requirements (Azami, 2008). And of course, one is unlikely to get promoted and instead, will have to stay on the same position as they do not have the proficiency essential in interacting and dealing with people. As for the experiments students did in the laboratory, the experiments are not fully applicable in the industry as they only learn the basics and fundamentals of electrical system. Despite that, these experiments, though not comprehensive, still provides the students with a picture of how real systems that are used in the real world. But, it is important for today's engineering education to provide better experimental and laboratory experiences that remains relevant with today's technology with the purpose of exposing the students to real world problems, since there are a lot of universities that still provide both out-dated experiments and technology. Without real world experience, the students are unable to develop their non-technical skills within the engineering context. Moreover, this situation can lead to bad consequences for the students as they are not able to keep pace with current technology, as well as not knowing how to operate technological features when they start working in the industry.

1.3 Statement of the Problem

Nowadays, graduates produced by universities do not possess and meet the requirements of the industries due to their lack of skills especially non-technical skills such as communication, problem solving, leadership and team working (Nair and Patil, 2008). In this modern era, gaps between expectations and perceptions can

broaden if universities keep using the same approach of teaching. Such a problem can be viewed from the perspective of engineers in the industries towards engineering education which asserted that engineering education should put more emphasis on communication skill, leadership and management skill and must put in tremendous effort in order to nurture interest towards engineering profession among undergraduates (Mustafa et al., 2008). Kamsah (2004) in his research stated that current engineering graduates are not deficient in technical capability or their knowledge but they are deficient in their soft skills which are important for them to work collaboratively and use their technical abilities. Based on the findings from the preliminary result, the electrical engineers in TNB also confessed that they were not equipped with sufficient non-technical skills when they graduated. Moreover, they claimed that the teaching and learning in universities did not put sufficient emphasis on the development of non-technical skills.

On the other hand, senior engineers in TNB also stated that most fresh engineers had a poor set of non-technical skills and did not meet the expectations of employers. In addition, the senior engineers also voiced out the importance of non-technical skills to be integrated in fresh electrical engineers. PjBL seems the best method for engineering education in teaching and learning nowadays, and it is proven that it is effective to develop skills among engineering graduates (Mills & Treagust, 2003). The purpose of this study is to investigate the effectiveness of PjBL in engineering education in higher-education institutions in Malaysia. The research project was developed to investigate the use of PjBL on student's satisfaction and the effectiveness of this teaching and learning method in order to increase student's non-technical skills.

1.4 Objectives of the Research

The main objective of this study is to investigate the effectiveness of PjBL to develop electrical engineering students' non- technical skills by comparing the performance of engineering students in three categorical groups, which are PjBL, semi-PjBL and non-PjBL. At the end of this study, the researcher intends to develop a new framework of PjBL that is effective in developing the non-technical skills for engineering students. Specifically, the objectives of this study are to:

1. Investigate the opinions of electrical engineering students after they underwent PjBL teaching method on their satisfaction on the development of non-technical skills
2. Investigate the effect of PjBL in providing an environment that mirrors the practice of engineers in the real world for the engineering students
3. Investigate the effect of PjBL, semi-PjBL and non-PjBL towards the level of non-technical skills among electrical engineering students.
4. Develop a new framework for PjBL in order to develop non-technical skills among electrical engineering students

1.5 Research Questions

The research question is based on the statement of problem and the objectives of the study. These questions include:

1. What are the opinions of electrical engineering students after they underwent PjBL, teaching method on their satisfaction on the development of non-technical skills?

2. Is PjBL providing an environment that mirrors the practice of engineers in the real world for the engineering students from the perspective of engineering lecturers and students?
3. What is the effect of PjBL, semi-PjBL and non-PjBL towards the levels of non-technical skills among electrical engineering students?
 - i. What are the levels of non-technical skills among electrical engineering students before they are exposed to PjBL, semi-PjBL and non-PjBL?
 - ii. What are the levels of non-technical skills among electrical engineering students after they are exposed to PjBL, semi-PjBL and non-PjBL?
 - iii. What are the differences of level of non-technical skills among electrical engineering students before they are exposed to PjBL, semi-PjBL and non-PjBL?
 - iv. What are the differences of level of non-technical skills among electrical engineering students after they are exposed to the PjBL, semi-PjBL and non-PjBL?
 - v. What is the difference in terms of non-technical skills level among electrical engineering students before and after they are exposed to the PjBL?
 - vi. What is the difference in terms of non-technical skills level among electrical engineering students before and after they are exposed to semi-PjBL?
 - vii. What is the difference in terms of non-technical skills level among electrical engineering students before and after they are exposed to non-PjBL?
4. How to develop a new framework for PjBL in order to develop non-technical skills among electrical engineering students?

1.6 Significance of the research

The researcher hopes that this study can give a new vision and perspective to the PjBL approach, which is widely implemented in engineering education nowadays. Nevertheless, PjBL is a new approach in Malaysia and it is hardly known by educators and researchers. This study is important in helping responsible parties in order to provide and equip engineering undergraduates in Malaysia with critical skills that is required by employers in recent days. Furthermore, this research can bridge or close the gap between the perception and expectation of industries towards the level of fresh graduates' skills. There are four (4) target groups that will reap the benefits from this research, which are the policy maker, the implementers, the engineering students and the scholars.

The first target group, the policy maker in this study is the Ministry of Higher Education. They are the highest level of authority that can change the education system in Malaysia and strive to make Malaysia a world-class Centre of excellence in parallel with their mission, which is 'to develop and put in place a higher education environment that encourages the growth of premier knowledge centers and individuals who are competent, innovative with high moral values to meet national and international needs.' This research will help them to make better policy that will benefit the educators and other stakeholders in order to make Malaysia a better place for Centre of knowledge dissemination.

The second target group, the implementers are the engineering faculties and lecturers in universities or higher learning institutions. As implementers, they have a very important role in order to realize the objectives of the policy maker. They need to make sure that PjBL is successfully implemented in the curriculum, therefore PjBL must be carefully planned so that the learning and educational objectives can be achieved. Furthermore, they will be able to catch up and meet the needs of industries by providing competent and versatile fresh graduates. Thus, industry-university relationships will be enhanced and industries will not hesitate to

collaborate in projects with universities. Besides, universities will be able to produce local graduates that are comparable or even better with overseas graduates.

The third target group is the engineering students. As students, they are required to accept every change in the PjBL learning process since PjBL is based on student-centered approach. Thus, the students play significant roles in order to make sure PjBL implementation is successful in developing both engineering students' technical and non-technical skills. The fourth target group is the scholars or the researchers. Other researchers in any field of education can conduct further study regarding PjBL. PjBL is not limited to engineering education, but it is flexible and can be widely used in any fields or courses. PjBL still needs a lot of studies in order to reveal its real potency and effectiveness by taking different perspectives and opinions from different sides and parties.

1.7 Scope of the problem

Based on the literature review, there are a lot of similarities of the engineering graduates' attributes between countries although Japan only shares two attributes with the others. By excluding Japan in the context of similarities, there are five (5) non-technical attributes that are in common, which are:

1. Lifelong learning
2. Effective communication
3. Engineering problem solving and decision making skills
4. Interpersonal or team working skills
5. Understand professional and ethical responsibilities

The attributes that are mentioned are important attributes shared by different kinds of engineering professional bodies. All of these are non-technical skills that are

sought by industries and should be possessed by engineering graduates in order to get employed. Furthermore, the skills mentioned above are also in line with the Ministry of Education (MOE) of Malaysia and Qualification Agency (MQA) requirements as shown in table 1.15.

Table 1.15: Mapping of skills between PjBL and requirement of MOE and MQA

Skills	MOE	MQA
Lifelong learning	√	√
Communicate effectively	√	√
Engineering problem solving and decision making skills	√	√
Interpersonal or team working skills	√	√
Understand professional and ethical responsibilities	√	√

Hence, these five skills are the list of non-technical skills that will be used in this study. Moreover, this study is only focused on the first year electrical engineering students that underwent PjBL, semi-PjBL and non-PjBL, in University A, University B and University C respectively. Electrical engineering students were chosen as the respondents for this study because electrical engineering is the widest field in engineering field (Matić, Kovač & Sirković, 2009). Moreover, the field of electrical engineering is very flexible because its knowledge can be related and linked other engineering fields such as chemical, mechanical, civil and petroleum as well. First year students were chosen because they have never been exposed to the curriculum and teaching methods in the university. Thus, the researcher might be able to observe how these first year students develop their non-technical skills during the learning process. Moreover, they were not exposed to any other extracurricular activities in the university that might be able to influence their non-technical skills development.

1.8 Operational definitions

Non-technical skills - Non-technical skills have been referred to by different names, for example, 'soft skills' (Ahmad Nabil et al., 2011), 'professional skills' (Colwell, 2010), 'key competencies' (McLeish, 2002), 'generic skills' and 'employability skills' (Shahrin, 2004). Zubaidah et al. (2006: 30) defined non-technical skills in her research as "skills that refer to general skills such as communication, negotiation, teamwork, problem solving, positive work attitudes and cooperation, which are not specific to any particular job position or workplace environment". According to Noor Azizi et al. (2001), non-technical skills comprise the ability to carry out specific tasks. They include initiative, group work, reading and writing abilities, computerization, problem solving, personal attitudes, ethical and professional skills, communication skills, accounting and financial skills, leadership, decision-making skill, general knowledge to execute tasks, analytical, mathematical, statistical, interpretation, project management, knowledge from other relevant disciplines, self-projection, and awareness on global issues. Non-technical skills consist of many skills were stated in conceptual definitions. Nonetheless, this research will adapt non-technical skills from the students' attributes as stated in the engineering accreditation of a few countries from Washington Accord. There are five non-technical skills, which are identified by looking at the similarities of respective accreditation. The non-technical skills are communication skills, problem solving skills, teamwork skills, lifelong learning skills and engineering ethics.

Communication skills - According to Larson et al. (1978), communication skills are defined as the ability of a person to exhibit relevant communicative behavior in a particular situation. Furthermore, communication skills include the ability to listen, write, speak, read and presentation skills (Mehta & Mehta, 2002; Vampola et al, 2010; Blair & Robinson, 1995). English is the most important language that must be mastered by all engineering students since it is the lingua franca and the language that can be understood worldwide (Riemer, 2002; Mehta & Mehta, 2002). Students are expected not only to have the ability to speak in English, but must have the proficiency in writing and representation techniques (Patil & Reimer, 2004). In this

research, communication skills consist of listening, speaking, reading and writing. Listening is the ability to accept people's idea and giving response accordingly. Speaking consists of the ability to present, deliver the idea and information, convince people, negotiate and ask. While writing is the ability to write a report, graphs, tables, charts, figures, problem statements, summary. Reading is defined as the ability to understand problem, data and information. Communication skills in this context also emphasizes on the ability to communicate in the English language.

Problem Solving skills - Problem solving skills can be defined as the ability of an individual to analyze a situation and then finding the best solution to an unknown or a decision that is subject to some constraints (Mourtos, Okamoto and Rhee, 2004). According to The Principles and Standards, problem solving skills are defined as “engaging in a task for which the solution method is not known in advance” (NCTM, 2000, p. 52). An open-ended problem, which is complex and ill structured is appropriate and in line with the definition above. Thus, this research will provide an open-ended problem in order to promote problem solving skill. Problem solving skills consist of the ability to define the problem (Mourtos, Okamoto and Rhee, 2004), think creatively and critically (Mantha and Sivaramakrishna, 2006), be flexible in decision making (Adams et al., 2009), as well as plan, implement and evaluate the solution (Azlinda, Badrul and Mohd Farouq Rafiq, 2010). In identifying the problem, students must be able to understand and explore the problem and are willing to spend time to gather information. Students must also think creatively and critically in their planning process by using their imagination, intuition, experience and common sense to develop a solution. Other than that, flexibility in decision making is also important as a part of planning a solution towards the problem, which can be done by keeping the options open, viewing the situation from different perspectives, willing to risk and cope with ambiguity, and welcoming change and managing stress. Students also must be able to implement the solution in an effective manner, record every process during implementation and make sure there are available resources to implement the solution. Lastly, students must know how to evaluate their solution by looking into the effectiveness of the solution and analyze every forthcoming problem.

Teamwork Skills - Team itself can be defined as a group of two or more individuals, who perform some work related task, interact with one another dynamically, have a shared past, have a foreseeable shared future, and share a common fate (Beaubien & Baker, 2004). Therefore, teamwork is defined as behaviors that facilitate effective team member interaction. Common examples include communication, situational monitoring, and decision making. Whereas teamwork definition provided by Baker et al. (2005) stated that teamwork is a team consists of two or more individuals who must interact to achieve one or more common goals that are directed towards the accomplishment of a productive outcome. The context of teamwork consists of a few aspects, which are group leadership, group orientation, mutual performance monitoring & adaptability (Cosgriffe & Dailey, 1969). Baker et al. added a few aspects which are group decision making, interpersonal relations and communication among group members. Operational definition of teamwork given by Cosgriffe & Dailey (1969) defined that teamwork happens when two or more persons commit themselves to a series of systematic actions. There are four aspects that need to be measured from teamwork skills, which are group decision making, adaptability, interpersonal relations and communication. Commitment is the attribute of teamwork. In decision making process, students must have the ability to manage information and set the goals. Furthermore, adaptability is the ability of students to be comfortable in the group and provide assistance to each other. Interpersonal relation is described as the students' ability to compromise with each other's idea and share the work together. Lastly, communication is students' ability to listen to others and share information effectively.

Lifelong learning skills - Lifelong learning is about attitude and students understanding that they must be proactive and be responsible for their learning. It requires discipline, initiative, self-confidence, self-management, motivation, future orientation, organization, and educability (Simon, 1998; Parkinson, 1999; Marra, Campese and Ligzinger, 1999). The definition of lifelong learning provided by The European Commission's "Memorandum on Lifelong Learning" (2000) stated that lifelong learning as an essential policy for the development of citizenship, social cohesion and employment. Another view on its definition, which is provided by the

Commission “Making the European Area of Lifelong Learning a Reality” (2001), states lifelong learning as all learning activities undertaken throughout life, with the aim of improving knowledge, skills and competencies within a personal, civic, social and/or employment-related perspective. This definition is also stated by Dong (2004) in this research, which stated that lifelong learning skills refer not to the specific information that students acquire during their formal education, but to how successfully they can continue to acquire information after their formal education has ended. There are four aspects that can be measured from lifelong learning skills, which are knowing the learner (self-awareness), planning for learning (self-management), understand how to learn (meta-learning) and evaluating learning (self-monitoring) (Stäuble, 2005). Self-awareness is students’ ability to understand their previous knowledge and perspectives towards learning. The students play an important role in defining their own capability and identity. Self-management is the ability of students to identify the goal of their learning and make a plan on how to achieve the goal, whereas meta-learning is the ability of students to develop their apprehension with respect to a variety of methods of learning and learning styles. Lastly, self-monitoring is students’ ability to analyze the learner’s own performance from all aspects and able to reflect and think critically, by referring to the plan and the goal of learning that was initially set up.

Engineering ethics - There are many definitions of ethics provided in dictionaries. One of them can be found from Webster’s New World Dictionary, 3rd College Edition which defines ethics as “relating to what is good or bad, having to do with moral duty and obligation.” Furthermore, Josephson Institute of Ethics (2000) stated that ethics is not about being better than someone else; it is about being the best we can be. Thus, according to Luegenbiehl (2004) engineering ethics can be defined as accountability for engineering decisions with ethical implications, based on established international and national rules of conduct. (‘Accountability’ in this context means being able to provide a reasonable justification for how a particular decision is founded in already established rules). In another perspective, engineering ethics is defined as being concerned exclusively with the actions and decisions made by persons, individually or collectively, which belong to the profession of engineering (Zandvoort, Van de Poel and Brumsen, 2000). Engineering ethics consist

of a few aspects that need to be considered, which are ethical reasoning, relationship between team members, honesty and persistence (Loui, 2005; Zandvoort et al., 2000). Ethical reasoning is student's ability to make decisions by considering the risk and safety of the public, whereas relationship between team members is the ability of students to report any misbehavior, solve conflicts and care about team members. Honesty is the ability of students to keep their promise, trustworthiness and fairness. Lastly, persistence is students' self-confidence, motivation and determination towards the work they do.

Reflection towards the practice of an engineer - This term can be called 'reflective practice' as students try to apply their skills with the intention to improve their professional practice. According to Kottkamp (1990), "reflective practice is a mode that links thought and action with reflection. It involves critically analyzing one's actions with the goal of improving one's professional practice." This reflection links the experience gained by the students to the situation of engineers in the industries.

Gap Analysis - Gap analysis is defined as the distance between our current condition and the condition we want to have (Gomm, 2009). On the other hand, Eldredge (2004) defined gap analysis as a methodology to investigate the differences between the customers' expectation on institution and the potential of the institution to meet expectations. In this study, the gap analysis is defined as the difference between employers' expectation and employers' perception on the level of non-technical skills of fresh engineers.

1.12 Conclusion

Nowadays engineering students need to be equipped with non-technical skills before they graduate. This is an imperative action to be taken by universities or

engineering faculties as an early step to produce marketable engineering graduates. In order to realize that mission, a suitable teaching method must be implemented in engineering education. As for this research, PjBL is proposed as a suitable teaching method due to its excellent characteristics and the benefits it provides.

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