THE EFFECTIVENESS OF PROBLEM-BASED LEARNING (PBL) FROM ENGINEERING STUDENTS' PERSPECTIVE

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Research Project in Partial Fulfillment of the Requirements

For the Degree of Master of Business Administration

Universiti Tun Abdul Razak

October 2022

DECLARATION

I hereby declare that the case study is based on my original work except for quotations and citation that have been duty acknowledged. I also declare it has not been previously or concurrently submitted for any other degree at Universiti Tun Abdul Razak (UNIRAZAK) or other institution.

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Date : 20 October 2022

Abstract of the Research paper submitted to the Senate of Universiti Tun Abdul Razak in partial fulfillment of the requirements for the Degree of Master of Business Administration.

ABSTRACT

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By

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Problem-Based Learning is a system of curriculum development and delivery that recognizes the need to develop problem-solving skills as well as the need to help students acquire the knowledge and skills they need. Future engineers need to develop the ability to adapt to new realities, create new job opportunities, and not just explore the existing ones, but be prepared to deal with creativity and flexibility, and not just reproduce well-known solutions.

Thus, this study aims to find out the effectiveness of problem-based learning from the perspective of engineering students. This study will be approaching undergraduate students in various engineering fields such as Civil, Mechanical, Chemical, Electrical, and Architecture. This study focuses on improving students' learning outcomes, skills, and creativity. The research method used is a literature review, which is a study conducted on research by analyzing the literature related to the topic to be studied. Data sources from this study used secondary data obtained through previous research studies. Data were derived from scientific articles published in certified journals and books, using data documentation techniques.

Keywords: Problem-Based Learning, Engineering, Students

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CHAPTER 1

INTRODUCTION

There are concerns around the world over efforts to achieve excellence in teaching and learning in higher education as well as the need for universities and institutions of higher learning to produce graduates who not only possess the knowledge but also the skills and competencies to apply that knowledge. Therefore, it is argued, that there is a need for pedagogical change in both undergraduate and graduate programs. An aspect of widespread concern is that current curricula and pedagogy often fail to prepare students to solve authentic problems encountered in the workplace or everyday life. In addition, students need to be equipped with high-level thinking skills and learning abilities as demanded by the market today.

1.1 BACKGROUND OF THE STUDY

Problem-Based Learning (PBL) is an appropriate pedagogical innovation to provide graduates with the content knowledge, skills, and competencies needed in their future professions. PBL is an innovative curriculum development and teaching approach that simultaneously develops both problem-solving strategies and disciplinary knowledge bases by placing students in active roles as problem-solvers faced with problems that reflect real-world situations (Finkle and Torp, 1995). Casey and Hawson (1993) also argue that the focus of cognitive approaches to education should be on the quality of thought processes, rather than the accuracy of the answers they produce. Shifts in teaching and learning approaches at the tertiary level based on cognitive and generic skills (Murray-Harvey and Slee, 2005) have contributed significantly to the development of the PBL curriculum in higher education.

According to Wood, D.F. (2003), Maastricht's seven-leap process involves terminology clarification, problem definition, brainstorming, structuring and hypotheses, learning objectives, independent study, and synthesis. Simply put, it is identifying things they already

know, things they need to know, and how and where to access new information that might lead to a solution to a problem.

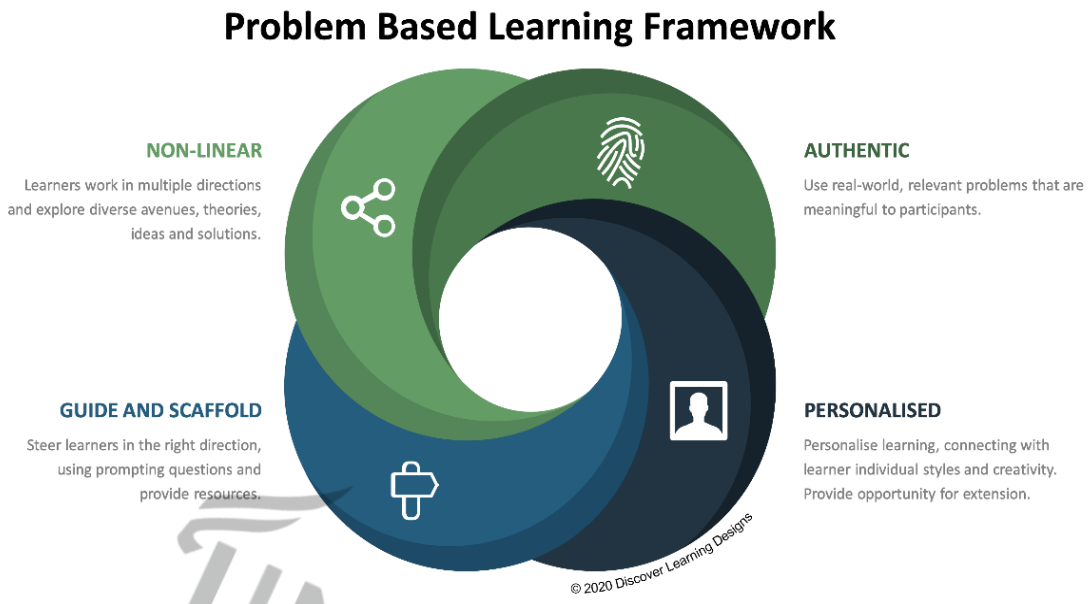

Figure 1.1: Problem-Based Learning Framework, *(instructionaldesign.com)*

The effectiveness of the methods applied in the study is the most significant issue that needs to be taken seriously. Student performance is important for any educational institution as it is a major driver. The performance of students is important for the educational institution to ensure that their objectives can be achieved. Furthermore, performance is important for students because completing any assigned task will be the reason they are satisfied with their learning.

PBL's goal is long-term learning that results in behavioural change, not just conceptual mastery (Brownell & Jameson, 2004). The approach emphasizes the practice "of problem-solving skills, usually not acquired in traditional college coursework" (Willis, 2002), and can "bridge the gap between theory and practice" (Hsieh & Knight, 2008). More than one decade ago, Sherwood (2004) noted, "problem-based learning has great potential for management education" (Sherwood, 2004).

1.2 PROBLEM STATEMENT

By the 1990s, more and more schools started introducing PBL. For example, Universiti Teknologi Malaysia (UTM), a technology-based public university, is leading PBL in its various engineering schools. Aiming to produce more high-quality graduates, it has been argued that an engineering graduate should be equipped with skills in lifelong learning, teamwork, communication, and problem-solving (Mohd - Yusof et al., 2005).

The recognition of soft skills in the research project can be observed in Figure 1.1. The results show how during integration projects and group work, students identify that it has contributed not only to the strengthening of tough competition. But soft skills have been strengthened especially teamwork, information seeking, responsibility, etc.

Students were asked according to their criteria what hard skills were acquired when developing this type of project. Figure 1.2 can be observed recognition of students' content-related competencies, where they have been able to have great experience advances in decision analysis, critique, interpretation, and innovation.

The University of Malaya (UM) pioneered the implementation of PBL in the Department of Chemical Engineering, inspired by the needs of electrical engineering graduates equipped with analytical skills, critical and lateral thinking, technical skills, teamwork, and time management. The encouraging results from the implementation of this pilot encouraged the other faculty to start applying PBL in the courses.

Since the PBL requires many changes from various points of view, it is important to highlight issues arisen during the implementation of PBL from previous research. PBL in Malaysian higher education is more integrated into engineering and medical schools, compared to other subject areas. Given that PBL is relatively new to Malaysian students, (Mohd-Yusof et al., 2005 and Said et al., 2005) suggested a hybrid PBL approach and the gradual introduction of PBL throughout the academic year.

Several issues emerged concerning PBL implementation within a variety of fields in Malaysian higher education. For the recent review, the implementation issues are divided into two parts. That is before implementation and during implementation.

Two factors need to be considered first in beginning PBL practice open thinking of faculty members in PBL acceptance and training of academic staff. PBL requires major changes in the processes, approaches, and principles of teaching and learning. In the PBL session, the lecturer turns roles from knowledge giver to facilitator. As a PBL facilitator, a lecturer needs to know how to motivate students in groups, know when to intervene, know how to encourage students to think critically and creatively, up to the extent to which they need to be informed, and address issues in group dynamics.

Top-down support is also an important factor in the success of PBL implementation. Malaysia's higher education system is very rigid; thus, the support, funding, and approval will come from the administration. Therefore, cooperation with the administrative section is essential.

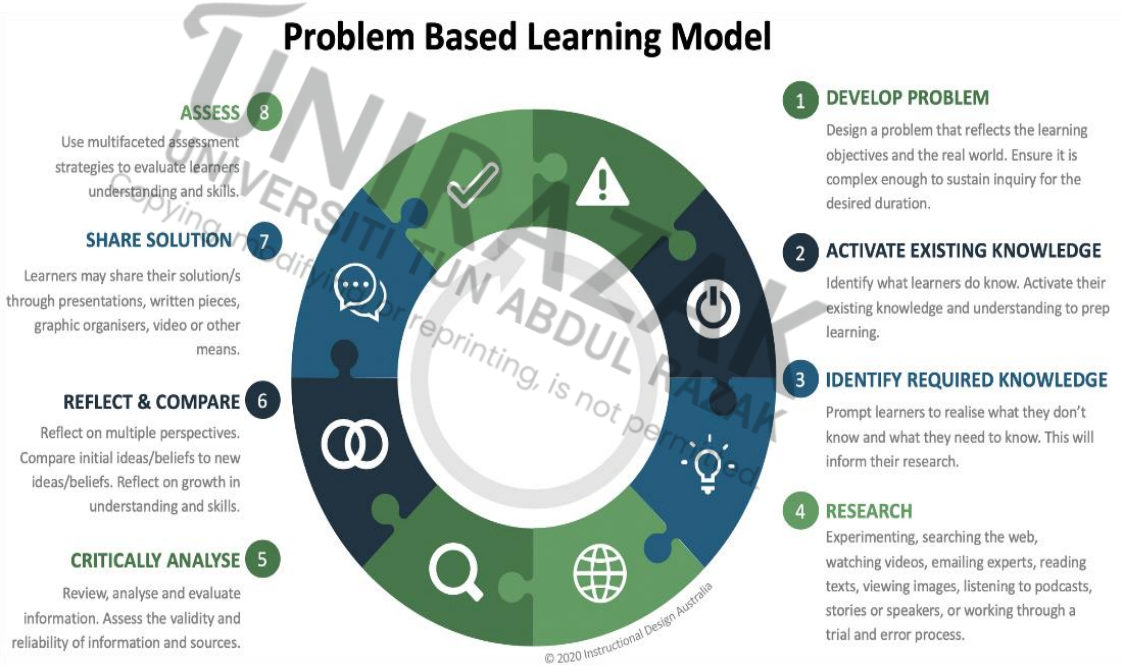

Figure 1.2: Problem-Based Learning Model, *(instructionaldesign.com)*

During the implementation of PBL, group learning is in which students understand learning thru interacting with stages in groups. Several group ideas have been summarised from previous implementations. Azila et al., (2001) discussed the difficulties faced by students in conducting PBL discussions in English which is their second language. There, of course, will

affect learning as students are not able to speak out their thoughts as fully as in their first language. In Malaysian institutions of higher learning, however, most medicine, sciences, and engineering countersue English as the medium of instruction as the aim of the national strategy is for internationalization and to expose Malaysian graduates to the impacts of globalization.

Another recurring group issue reported about PBL implementations in Malaysian higher education is passive participation in group discussions and free riders. A free rider is a student wheezes a lot of other people's work.

These factors may lead to the ineffectiveness of the PBL.

1.3 RESEARCH OBJECTIVE

The main objective of this research is to investigate the effectiveness of Problem-Based Learning methods used in universities. This research focuses specifically on engineering students. As is well known, engineering itself requires a lot of work either in the lab or in the classroom. Here an engineering perspective is discussed on whether such a method is possibly used in engineering studies or not.

It is known that PBL has advantages. It focuses on students, which allows for active learning and better understanding, and retention of knowledge. It also helps to develop life skills that can be used in many domains. It can be used to enhance current content knowledge and at the same time foster the development of communication, problem-solving, critical thinking, collaboration, and self-learning skills. PBL may position students to function optimally using real-world experiences. By leveraging the intellect of a collective group, different perspectives may offer different perceptions and solutions to a problem.

Finally, as cited by Watering and Dochy (2005), PBL can be defined to help students in ways such as students learn through real-life problems, students work in small groups to solve problems, and students can develop better critical thinking skills.

1.4 RESEARCH QUESTIONS

According to White (2017) developing research questions is important to guide the research paper, providing focus and clear ideas about the study. Establishing research questions will help structure the process of gathering information, analysing data, evaluating results, and helping the purpose of this research study. Therefore, the research question to be analysed is as follows:

1. Is the guidance from the tutor/lecturer related to the effectiveness of PBL?
2. Is the relationship between interpersonal communication related to the effectiveness of PBL?
3. Is the relationship between feedback from the student to the tutor/lecturer related to the effectiveness of PBL?
4. Is the relationship between tutor/lecturer expertise related to the effectiveness of PBL?
5. Is the relationship between skill development related to the effectiveness of PBL?
6. Is the relationship between the infrastructure related to the effectiveness of PBL?

1.5 SIGNIFICANCE OF THE STUDY

This study will determine the effectiveness of Problem Based Learning applied to engineering students. This is useful for other researchers pursuing research in this area but also focusing on primary and secondary schools.

Thus, the findings of the study are hoped to help see how students actively participate in the learning process, hone information-seeking skills, hone cooperation and trust among peers in the group, and still their ability to function well as a team. Strong support from staff and faculty, and the readiness of students and lecturers seem to be the main ingredients for the successful implementation of PBL in Malaysia.

1.6 STUDY PLAN

A Gantt chart (Table 1.1) is built to provide a study/research roadmap so that researchers can look ahead to the research work and complete the study within the set time. Research Project timelines are tentative and subject to change according to unforeseen circumstances (semester extensions, deferred work, etc).

Table 1.1
Gantt chart for Research Paper time frame

WEEK	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
RESEARCH PROPOSAL																				
TOPIC SELECTION																				
JOURNAL ANAYSIS																				
CHAP 1 : INTRODUCTION																				
CHAP 2 : LITERATURE REVIEW																				
CHAP 3 : RESEARCH METHODOLOGY																				
REPORT PREPARATION																				
REPORT PRESENTATION																				
REPORT SUBMISSION																				
RESEARCH PROJECT (PLAN)																				
DATA COLLECTION																				
CHAP 4 : DATA ANALYSIS																				
CHAP 5 : CONCLUSION																				
REPORT PREPARATION																				
REPORT PRESENTATION																				
REPORT SUBMISSION																				

1.7 RESEARCH OUTLINE

This study is structured into five chapters. Here is an introductory description of each chapter:

Chapter 2, Literature Review: provides theoretical concepts related to the effectiveness of PBL. Prior literature was reviewed to gain an understanding of previous studies on the concepts of guidance, interpersonal communication, feedback, expertise, skill development, and infrastructure. In addition, a conceptual hypothesized model framework is developed and the relationships among guidance, interpersonal communication, feedback, expertise, skill development, and infrastructure are hypothesized.

Chapter 3, Research Methodology: the research approach and the present study design. It begins by describing the research design, research selection procedures, and the research experimental approach and is followed by a discussion of how the data were collected, analysed, and integrated. In addition, it also states the measures used to establish the quality and validity of research data.

Chapter 4, Data Analysis and Results: report the results of the quantitative analysis data collection. This chapter presents the results of hypothesis testing through statistical analysis and results from quantitative data analysis that are coordinated with the research theme.

Finally, Chapter 5, Conclusions and Recommendations: discusses the main findings and the hypothesized relative conceptual model. It also discusses the academic findings and theoretical contributions of the study, followed by evidence that guidance, interpersonal communication, feedback, expertise, skill development, and infrastructure influence PBL effectiveness.

CHAPTER 2

LITERATURE REVIEW

This chapter will discuss a selection of available publication documents related to the effectiveness of PBL, which contain information, ideas, data, and written evidence from the point of view of the importance of extensively reviewed studies to meet research objectives. Concerning the researcher's interest in the topic, several variables were selected as study subjects. The dependent variable (DV) is the Effectiveness of PBL. The independent variable (IV) is the interface between guidance, interpersonal communication, feedback, expertise, skills development, and infrastructure. This chapter describes the basic theories that support this study, explains each of the effects identified for the importance of the study, and proposes a conceptual framework for the research.

2.1 THEORETICAL FOUNDATION

Problem-based learning (PBL) is a method of teaching in which student learning takes place in the context of authentic problem-solving. PBL was initially developed out of a teaching need to help students learn their basic science knowledge in a more sustainable develop skills simultaneously. While PBL addresses these specific needs, it is also based on a well-established theory and paradigm of education. The authors discuss the theoretical foundations of PBL, which in turn, help readers understand why PBL can be effective as well as enable them to diagnose and improve the application of PBL when things are not going as planned.

Engineering education will be side-lined if the education system is passive. The education we provide to engineers must prepare them for more than just fulfilling the functions of technology. It needs to prepare engineers to be leaders in informed decision-making about technologies and policies that will foster innovation. The best practices of Engineering Education rely on designing and implementing effective courses and programs of study and providing a variety of conducive, enriching, and authentic learning experiences for students (King, 2008).

According to Xu et al. (2021), this PBL method was better than other methods. Although the satisfaction of the students with other methods is no different PBL apply can acquire knowledge and other competencies that are needed, Trullas et al. (2022).

2.2 EMPIRICAL STUDY

This study aims to examine the effectiveness of Problem-Based Learning from engineering students' perspective. Therefore, this section reviews four empirical research related to the study. The first part, reviewed the expertise that the tutor/lecturer has in order to making sure that the methods were successfully applied. The next section discussed about the skill development that students can adapt from the Problem-Based Learning method. Follow by how the infrastructure may help to the effectiveness of Problem-Based Learning. This shall lead to the final part discussion about the importance of guidance in order to implement Problem-Based Learning.

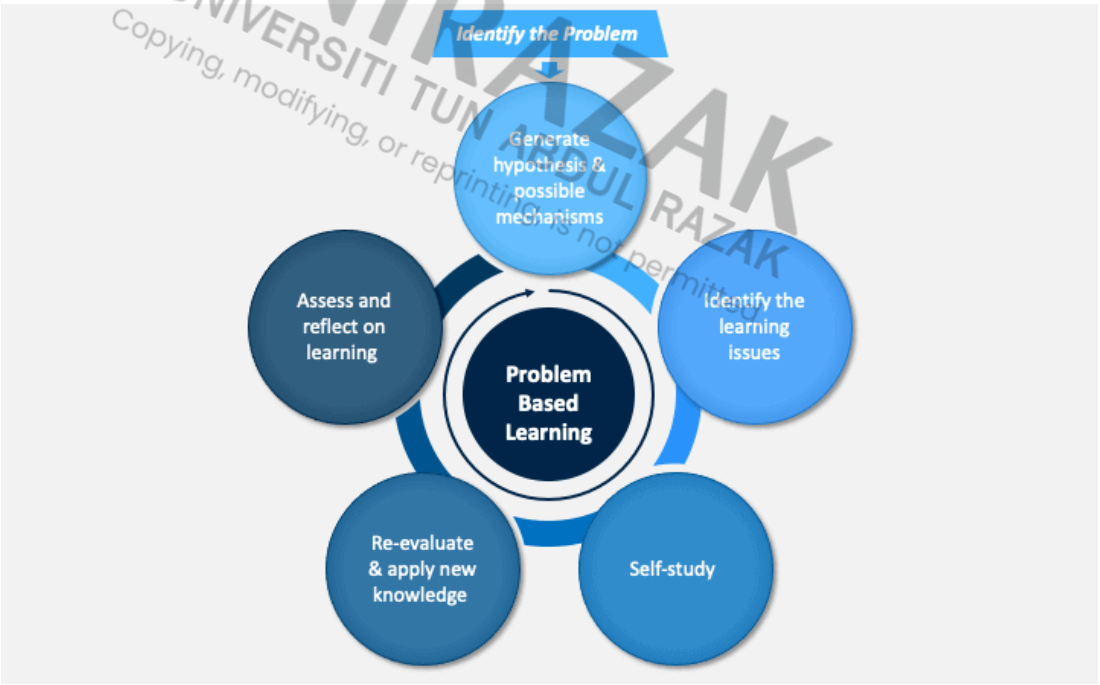

Figure 2.1: Problem-Based Learning Circle

2.2.1 TUTOR/LECTURER EXPERTISE

Barrow & Tamblyn (1980) claimed that the task of the tutor in a Problem-Based tutorial group is to facilitate student learning rather than impart knowledge. In developing an educational approach, tutors must allow students to determine for themselves what they need to know, and learn by studying diverse sources. Instead of telling students what they should learn and in what order they should learn it, tutors must help students decide this for themselves.

2.2.2 SKILL DEVELOPMENT

According to Biswajit (2021), PBL is a teaching method that challenges students to 'learn to learn, working in groups to find solutions to real-world problems. This problem is used to attract students' interest & initiate the learning of the subject. PBL prepares students to think critically and analytically as well as to find and use appropriate learning resources.

Critical thinking refers to the way students look at or reflect on a situation. PBL can help improve critical thinking skills because it encourages people to process a situation before trying to solve it. Before a team starts solving problems, students may benefit from understanding the situation first so that they can work more effectively to solve it. They can then continue to use critical thinking skills to determine possible solutions. This skill can help people at work because when a challenge arises, people can think about it in an organized way by connecting facts, ideas, and concepts.

2.2.3 INFRASTRUCTURE

When conducting activities to improve PBL or people will experience challenges at work, give the group enough time to complete the project. Avoid prompting others. This is because everyone needs some time to process and understand the situation, figure out what steps to take and execute those steps. If the team is on a deadline, this means it may need to use time management to give everyone enough time to complete the task. Having enough time helps to think through challenges and reduce stress.

2.2.4 GUIDANCE

Problem-Based Learning (PBL) is an instructional strategy in which students attempt to solve a problem or set of problems they are not familiar with. PBL is supported by a constructivist approach, thus it encourages active learning. Activities are carried out with student groups, usually in a tutorial or seminar setting.

According to C.Karthikeyan (2021), the Problem-Based Learning core principle is constructive, collaborative, contextual, and self-directed. There have seven steps of the effectiveness of PBL consisting of (1) formulating the expected learning outcome, (2) understanding the concept of the teaching materials, (3) skill training, (4) designing the project theme, (5) making the project proposal, (6) executing the task of projects and (7) presentation of the project report.

The role of the tutor/lecturer in the PBL classroom is as a coach or guide. Since learning to solve problems is one of the main goals of PBL, students need to be guided during the search and solving process. By asking questions to students, a teacher can model problem-solving.

2.3 PROPOSED CONCEPTUAL FRAMEWORK

Based on the literature review, a conceptual framework for this study was developed as Figure 2.1. There are six independent variances (guidance, interpersonal communication, feedback, expertise, skill development, and infrastructure) that will be measured in this study in order to achieve the effectiveness of PBL.

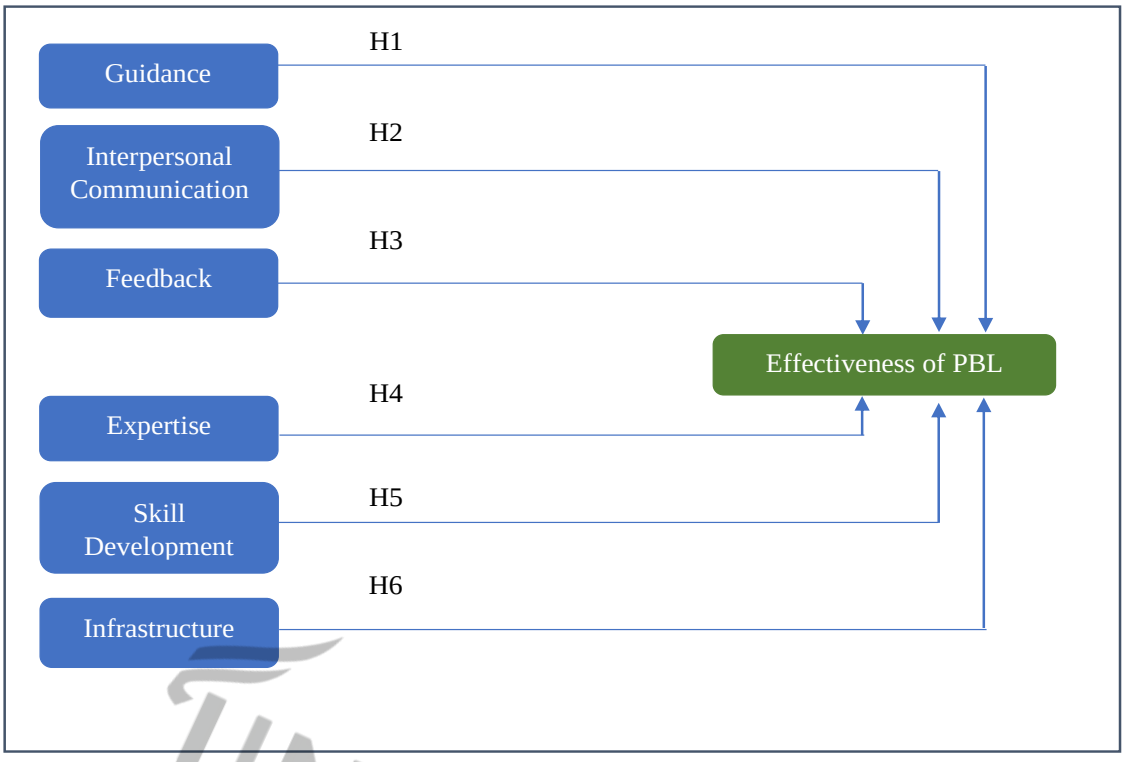

Figure 2.2: Theoretical Framework

2.4 HYPOTHESIS DEVELOPMENT

RH 1: There is a significant relationship between the guidance from the tutor/lecturer with the effectiveness of PBL

RH 2: There is a significant relationship between interpersonal communication with the effectiveness of PBL

RH 3: There is a significant relationship between feedback from the student to the tutor/lecturer with the effectiveness of PBL

RH 4: There is a significant relationship between tutor/lecturer expertise with the effectiveness of PBL

RH 5: There is a significant relationship between skill development with the effectiveness of PBL

RH 6: There is a significant relationship between the infrastructure with the effectiveness of PBL

2.5 SUMMARY OF CHAPTER 2

This chapter describes the extensive literature review that has been reviewed before this research and is fundamental to the basic theory of the effectiveness of PBL. This chapter detail accounts for all selected factors; guidance, interpersonal communication, feedback, expertise, skills development, and infrastructure.

However, there are limitations in this research because the study of the effectiveness of PBL in recent years is more focused on the medical field. This is because the current situation is more geared toward medical studies due to the Covid 19 pandemic.

CHAPTER 3

RESEARCH METHODOLOGY

This chapter provides a comprehensive interpretation of the research approaches and methodologies used to determine the relationship between the effectiveness of PBL with the identified detectors. The chapter also covers research design and sampling, the target population, research instruments, and data collection for each variable. Finally, the method of data analysis is explained comprehensively with the research project schedule and cost estimates used throughout the study.

3.1 RESEARCH DESIGN

Research design is a strategic plan charted during a study to reach valid conclusions, with special consideration is given to researcher selection and assignment to situations, data collection, and data analysis. Research design can take many forms, including experimental, observational studies, longitudinal designs, surveys, focus groups, and other non-experimental methods. In research design, researchers must create a step-by-step guide to ensure that research objectives are achieved. It consists of a blueprint for data collection, measurement, and analysis of the collected data and is a set of conditions for the collection and evaluation of data in a manner designed to combine relevance to the purpose of the research.

This study is a quantitative study that uses statistical techniques to analyse data. This research can be categorized as non-experimental research and it is a hypothesis study, meaning that there is a hypothesis to be tested. The aim of this study is to examine the effectiveness of Problem Based Learning and improve the findings made by Rui, et al. 2015 and Binshabaib, et al, 2019. This study involves establishing a relationship between six variables namely guidance, interpersonal communication, feedback, expertise, skill development, and infrastructure.

Descriptive studies will be conducted to ascertain and be able to describe the characteristics and relationships of the dependent, independent, and moderating variables defined in this research. Of all the different types of research strategies, a survey study will be selected to conduct this research as it is the best scheme to gather information from the targeted individuals. Questionnaires will be used to gather information from subjects of interest to describe, compare and explain. A cross-sectional study will be conducted among members of the Faculty of Engineering.

3.2 TARGET POPULATION

According to Sundram et al., (2016), the term "target population" refers to a category of people of interest to the researcher. Berndt & Petzer (2011) suggest that it is important to consider that the population and sample should be realistic and achievable, as well as easily accessible. Therefore, this study takes into account the selection of students in the Faculty of Engineering as a medium of study because of the topics discussed to consider feedback from engineering students.

The population for this study was randomly selected from students at the Faculty of Engineering and Construction, UKM. Non-probability convenience sampling method was used in this study to select the sample. This method is used because respondents are selected based on their willingness and availability to answer the questionnaire (McCombes, S. 2019).

Table 3.1
Target Population (Respondent), (Faculty of Engineering and Built Environment, UKM)

Department in Faculty	**No of Students**
Department of Civil Engineering	105
Department of Architecture and Built Environment	85
Department of Chemical and Process Engineering	75
Department of Mechanical and Manufacturing Engineering	85
Department of Electrical, Electronic and System Engineering	80
Total	**430**

3.3 DATA COLLECTION

The survey questionnaire form is a quantitative technique and as a means of the primary data, this method was chosen for this study because it is a simple method to obtain information from the respondents. According to Hox & Boeije (2005), primary data is defined as the collection of data directly from the source to help researchers obtain the clear and crude information needed to answer research questions.

The questionnaire will be in a bilingual format (English and Malay) to accommodate the majority of faculty students who do not use English as their first language in the identified organizations. The questionnaire will be translated from English into Malay and the draft translation will be certified by a local linguist who is fluent in both languages. This is in line with the back translation method proposed by Brislin (1980) to ensure consistency of meaning.

A set of questionnaires were distributed (Appendix A) to the students and answered within two weeks. The data collection begins in the first week of September 2022 and is completed by the third week of September 2022. This has been arranged in collaboration with the lecturers of the department and senior students. The respondents were advised that their participation in the survey was voluntary and anonymous. The design of the questionnaire should take less than 5 minutes to answer. A total of 380 respondents participated in answering the distributed questionnaire. All respondents were coded in the SPSS program to be analysed.

3.4 SURVEY METHOD

The questionnaire will be divided into 7 segments with the first segment covering demographic measures while the last 6 segments will cover each of the independent variables. To determine the respondents' agreement with the question, the 5 -point Likert scale method will be used. The Likert scale is a scale used to measure surveys taken directly from respondents on a factor. To minimize the bias of the data collected as well as ensure that no sensitive information is concealed, all questionnaires will be conducted anonymously.

Students will be assured that the information received from them will be used for research and study purposes only and that no questionnaire will be issued to their respective organizations.

Table 3.2
Five Point Likert Scale

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Sangat Tidak Setuju	Tidak Setuju	Berkecuali	Setuju	Sangat Bersetuju
1	2	3	4	5

Data analysis techniques may include identifying coherent patterns and summarizing relevant information revealed by the study. IBM Statistics Package for the Social Sciences Version 28.0.1. (SPSS 28.0.1) to analyse the data collected from the questionnaire will be used to conduct Reliability Analysis, Descriptive Analysis, Frequency Distribution Analysis, Correlation Analysis, and Multiple Regression.

3.5 VARIABLE AND MEASUREMENT

The independent variables for this study were guidance, interpersonal communication, feedback, expertise, skill development, and infrastructure. While the dependent or outcome variable is effectiveness. Table 3.3 shows the constructs and items contained in the questionnaire.

All items were measured using a five-point Likert scale ranging from strongly disagree to strongly agree.

Table 3.3
Constructs and items included in the questionnaire

Construct Items	Items	Measurement	References	Notes
Guidance	GD1	PBL lecture-based hybrid system is better than the entire lecture-based curriculum	Binshabaib et al. (2019)	Modified question
	GD2	PBL strategy is interesting	Binshabaib et al. (2019)	Modified question
	GD3	The tutor/lecture stimulated students to give constructive feedback about group work	Binshabaib et al. (2019)	Modified question
	GD4	The tutor/lecturer stimulated students to generate clear learning issues	Binshabaib et al. (2019)	Modified question
Interpersonal Communication	IC1	PBL improved students' communication skills	Rui et al. (2015)	Modified question
	IC2	Students actively participated in PBL	Rui et al. (2015)	Modified question
	IC3	PBL trained students' ability to cooperate with other team members	Rui et al. (2015)	Modified question
	IC4	PBL helps students assure responsibility for their learning	Rui et al. (2015)	Modified question
Feedback	FB1	PBL is more enjoyable than conventional teaching	Rui et al. (2015)	Modified question
	FB2	PBL decreased the academic burden to some extend	Rui et al. (2015)	Modified question
	FB3	Role of the tutor/lecturer in the process of PBL helpful	Rui et al. (2015)	Modified question
	FB4	PBL helps students elaborate knowledge	Rui et al. (2015)	Modified question
	FB5	PBL helps students organize knowledge	Rui et al. (2015)	Modified question
	FB6	The tutor/lecturer was clearly motivated to fulfil their role as a tutor	Rui et al. (2015)	Modified question
Expertise	EX1	Knowledge in PBL organized around problems rather than disciplines	Binshabaib et al. (2019)	Modified question

	EX2	Proper training of PBL given before the implementation	Binshabaib et al. (2019)	Modified question
	EX3	The tutor/lecturer stimulated students to understand the underlying mechanisms/theories	Binshabaib et al. (2019)	Modified question
	EX4	The tutor/lecturer stimulated students to search for links between issues discussed	Binshabaib et al. (2019)	Modified question
Skill Development	SD1	PBL improved students' decision-making skills	Rui et al. (2015)	Modified question
	SD2	PBL enhanced students' analytical and problem-solving skills	Rui et al. (2015)	Modified question
	SD3	Under PBL, students conducted self-directed learning	Rui et al. (2015)	Modified question
	SD4	PBL enhanced students' ability to retrieve and utilize information	Rui et al. (2015)	Modified question
Infrastructure	IF1	Compare to traditional teaching approaches, the knowledge learned through PBL is structured	Binshabaib et al. (2019)	Modified question
	IF2	Compare to traditional teaching approaches, the knowledge learned through PBL is systematic	Binshabaib et al. (2019)	Modified question
	IF3	PBL enhances the ability to find information using the internet/library	Rui et al. (2015)	Modified question
	IF4	PBL makes students active processors of information	Rui et al. (2015)	Modified question

3.6 ANALYSIS PROCEDURE

The study will be conducted using analytical procedures as below. There are seven categories in this procedure involving a total of 31 questions.

Table 3.4
Analysis Procedure

Part	Categories	Items	Analysis Technique
A	Demographic Information	5	Descriptive Analysis
	Dependent Variable Aspect		
	Independent Variable Aspect		
B	Guidance	4	Reliability Analysis, Descriptive Analysis, Correlation Analysis, and Multiple Regression
C	Interpersonal Communication	4	
D	Feedbacks	6	
E	Expertise	4	
F	Skill Development	4	
G	Infrastructure	4	
	Total of Question	31	

Data analysis techniques are an important part of research and the researcher must be able to identify the correct modus operandi to obtain the desired results. It is an application of logic to understand the subject. Techniques of data analysis may include identifying coherent patterns and summarizing relevant information revealed by the study. IBM Statistical Package for Social Sciences Version 28.0.1. (SPSS 28.0.1) will be used to conduct Reliability Analysis, Descriptive Analysis, Correlation Analysis, and Multiple Regression to analyse the data collected from the questionnaire.

3.6.1 RELIABILITY ANALYSIS

According to Altheide & Johnson (1994), reliability refers to the stability of findings, while validity is represented as the truth of findings. Gaus (2017) suggested that research reliability refers to the ability of other researchers to apply the same research process and obtain similar results or it refers to ensuring that the research findings remain consistent throughout the data analysis activity.

In order to investigate the reliability (internal consistency) of the variable instrument, Cronbach's Alpha was used. When the result is greater than 0.7 ($\alpha > 0.7$) it indicates a higher level of internal consistency (Hair et al. 2018). In the next step, the reliability and validity of the measurement were tested by calculating the composite reliability (CR) of the construct followed by the Average Variance Extracted (AVE) (Fornell & Larcker, 1981).

In general, the cut-off value for composite reliability should be greater than 0.7 and the cut-off value for AVE is 0.5 (Hair et al. 2018), however, as suggested by Suprapto, W., and Stefany, S. (2020), the value of 0.6 is also acceptable for the composite reliability (CR) and 0.4 is still acceptable for the AVE.

Table 3.5
Interpretation of Cronbach's Alpha

Cronbach's Alpha (α)	Internal Consistency
Less than 0.6 (< 0.6)	Poor
0.6 to Less than 0.7 (0.6 - < 0.7)	Moderate
0.7 to Less than 0.8 (0.7 - < 0.8)	Good
0.8 to Less than 0.9 (0.8 - < 0.9)	Very Good
More or equal to 0.9 (≥ 0.9)	Excellent

3.6.2 DESCRIPTIVE AND INFERENTIAL STATISTICS ANALYSIS

Usually in most research conducted on groups of people, both descriptive and inferential statistics will be used to analyze the results in order to conclude. According to Krosnin (2008), descriptive analysis is a method of data analysis that helps to explain, examine and summarize data quantitatively and constructively so that patterns may emerge that will meet each condition of the data that has been collected.

However, descriptive analysis alone will not be sufficient to conclude the data that have been analyzed about the hypotheses made for this research. It is simply a way of describing data collected from a sample population.

Hence why descriptive analysis is paired with inferential analysis which is a strategy that allows the use of sample population data to make generalizations about the population from

which the sample was taken. Descriptive analysis consisting of the percentage and frequency of each respondent variable will be used quantitatively by using the mean and standard deviation of individual pressure in this research and inferential analysis based on secondary data will be used for more accurate and reliable analysis.

Table 3.6
Mean Score Level for Descriptive Analysis

Mean Score	Level
1.00 – 2.33	Low
2.34 – 3.67	Moderate
3.68 – 5.00	High

3.6.3 CORRELATION ANALYSIS

Correlation analysis is significant and will be used in this research to identify, investigate and define the relationship between the dependent, moderator, and independent variables. Pearson's correlation is used to examine and see the relationship between two quantitative and continuous variables. According to Guildford (1973), the Pearson correlation measures the strength of the linear relationship between two variables. It has values ranging from -1 to 1, with a value of -1 meaning total negative linear correlation, 0 no correlation, and +1 meaning total positive correlation. It indicates that the two variables are correlated with each other. The strength of the relationship is shown in the table below where if the correlation analysis is more than 0.90, then it has very high reliability of the relationship between variables.

Table 3.7
Correlation Table

R	Strength of Relationship
<20	Almost negligible
0.20 – 0.39	Low correlation, definite but small relationship
0.40 – 0.69	Moderate correlation with substantial relationship
0.70 – 0.89	High correlation; marked relationship
>0.90	Very high correlation; very dependable relationship

3.6.4 MULTIPLE REGRESSION ANALYSIS

Finally, a multiple regression analysis will be conducted to assess the strength of the relationship between the effectiveness of Problem-Based Learning [the dependent variable] and the identified independent variables and the importance of each question to the relationship.

3.7 SUMMARY OF CHAPTER 3

A detailed review of the researcher's methods and strategies for measuring dependent and independent variables is clearly outlined in this chapter. In addition, the study design, population, and sampling techniques are all described in this chapter. This chapter also covers study design, sample acquisition strategy and sample population, data collection methods & operations, and measurement of each variable.

Finally, the method of data analysis is explained thoroughly.

CHAPTER 4

DATA ANALYSIS AND RESULTS

As described previously in Chapter 3, IBM Statistical Package for the Social Sciences Version 28.0.1. (SPSS 28.0.1) was used to carry out Reliability Analysis, Descriptive Analysis, Correlation Analysis, and Multiple Regression to analyse the data collected from the questionnaire.

The questionnaire was sent in a bilingual format (English and Malay) to accommodate the majority of students at the Faculty of Engineering and Built Environment who were encouraged by UKM to use Malay as their medium of instruction. This questionnaire was initially created in an English language format based on the PBL effectiveness questionnaire by Rui et. al, (2015), and Binshabaib et. al, (2019). It was then translated from English to Malay and the draft translation was verified by a local linguist fluent in both languages who followed the back translation method recommended by Brislin (1980) to ensure consistency of meaning.

Since the questionnaire was bilingual, the final data were all translated back to English to enter the data into SPSS software. Demographic analysis is using both English and Malay. No feedback has been altered in the process to preserve the authenticity and accuracy of the data. Only the participant profile information and Likert Scale in Malay were translated into English as in the table below using Microsoft Excel before entering all 381 data sets into SPSS.

This chapter focuses on the analysis of the questionnaire that has been collected from the respondents. In the first part presented are the demographic results of the respondents, followed by the results regarding the feedback on the effectiveness of PBL from the perspective of the respondents. Next, in a quantitative aspect, it presents the validity and reliability of the measures tested before reporting the results after examining the hypothesis. Following that, is a measurement model to show a positive relationship in the variables in relation to the objectives of the study. At the end of this chapter is a chapter summary.

4.1 DEMOGRAPHIC ANALYSIS

In this study, 450 questionnaires were distributed using Google Form to engineering students at the Faculty of Engineering and Built Environment. However, only 381 questionnaires were returned representing an 85% response rate for the overall study. As stated by DeMaio (1980), it is not expected to get a maximum response in studies where participation in the survey is voluntary. Meanwhile, Baruch & Holton (2008), claim that the average aggregate response rate to be a benchmark must be settled at about 50%.

Before analysing the data provided by the sample, it is important to gain some insight into the characteristics of the respondents who participated in this study, regarding their demographic and socioeconomic profile. This is a standard practice that provides the background for the analysis that follows. The characteristics discussed here include gender, age of the respondent, religion, course taken by the respondent, and ethnic group.

Based on the SPSS analysis obtained in Table 4.1a, there are 219 female respondents (57.5%) and 162 male respondents (42.5%) out of 381 participants.

Table 4.1a

Gender Demographic Profile (n=381)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female / Perempuan	219	57.5	57.5	57.5
	Male / Lelaki	162	42.5	42.5	100.0
	Total	381	100.0	100.0	

The age distribution of the participants (Table 4.1b) was 345 (90.6%) for the range between 21-25 years, 10 (2.6%) for the range between 26-30 years, 8 (2.1%) for the range of 31-35 years, 18 (4.7%) for age range more than 35 years old. It shows that the majority of the students in the faculty are between the ages of 21-25 years old.

Table 4.1b

Age Demographic Profile (n=381)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	21-25 years old / 21-25 tahun	345	90.6	90.6	90.6
	26-30 years old / 26-30 tahun	10	2.6	2.6	93.2
	31-35 years old / 31-35 tahun	8	2.1	2.1	95.3
	More than 35 years old / 35 tahun dan ke atas	18	4.7	4.7	100.0
	Total	381	100.0	100.0	

For religion (Table 4.1c), the result of the study indicated that 286 (75.1%) respondents were Muslim, 39 (10.2%) respondents were Christian, 31 (8.1%) respondents were Buddhist and 25 (6.6%) respondents were Hindu.

Table 4.1c

Religion Demographic Profile (n=381)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Buddhist / Budha	31	8.1	8.1	8.1
	Chistian / Kristian	39	10.2	10.2	18.4
	Hindu / Hindu	25	6.6	6.6	24.9
	Islam / Islam	286	75.1	75.1	100.0
	Total	381	100.0	100.0	

For the ethnic group (Table 4.1d), the result of the study showed that 286 (75.1%) respondents were Malay, 31 (2.1%) respondents were Indian, and 64 (16.8%) respondents were Chinese.

Table 4.1d

Ethnic Demographic Profile (n=381)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Chinese / Cina	64	16.8	16.8	16.8
	Indian / India	31	8.1	8.1	24.9
	Malay / Melayu	286	75.1	75.1	100.0
	Total	381	100.0	100.0	

The analysis of the respondents according to the course taken at the faculty is shown in Table 4.2, showing that 84 (22.0%) of the respondent were Civil Engineering students. Followed closely by Mechanical Engineering students with 79 (20.7%) respondents. There are 71 (18.6%) respondents who were Electrical Engineering students, and both Chemical Engineering and Architecture 69 (18.1%) respondents.

However, there are a small number of respondents who are not from the field under study. This is likely because the researcher distributed the link randomly to technical staff and lecturers too.

Table 4.2

Frequency and Percentage Respondent Course

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Architecture / Senibina	69	18.1	18.1	18.1
	Banking	2	.5	.5	18.6
	Chemical Engineering / Kejuruteraan Kimia	69	18.1	18.1	36.7
	Civil Engineering / Kejuruteraan Awam	84	22.0	22.0	58.8
	Electrical Engineering / Kejuruteraan Elektrik	71	18.6	18.6	77.4
	Finance	1	.3	.3	77.7
	Kakitgn Awam	1	.3	.3	78.0
	lain -lain	1	.3	.3	78.2
	Materials Science	2	.5	.5	78.7
	Mechanical Engineering / Kejuruteraan Mekanikal	79	20.7	20.7	99.5
	Microbiology	1	.3	.3	99.7
	Petroleum Eng	1	.3	.3	100.0
	Total	381	100.0	100.0	

4.2 DESCRIPTIVE ANALYSIS

4.2.1 EFFECTIVENESS OF PROBLEM-BASED LEARNING (DV)

Table 4.3 shows the respondent's results derived from the Effectiveness of Problem-Based Learning questionnaire's statement. All the dependent variable questions are picked from every independent variable question.

Based on statement one indication, 64.5% of the respondents strongly agree that the tutor/lecturer stimulated students to generate clear learning issues. The second statement indicates that 66.6% of the respondents strongly agree that PBL helps students to assure responsibility for their learning. The third statement indicates that 62.6% of the respondents strongly agree that the role of the tutor/lecturer in the process of PBL is very helpful. Another three statements indicate that 63.4% of the respondents strongly agree that proper training of PBL given before the implementation leads to effectiveness. 64.7% of the respondents strongly agree that students under PBL, students may conducted self-directed learning, and lastly 68.2% of the respondents strongly agree that PBL makes students an active processors of information.

Table 4.3

Itemized Questions for the Effectiveness of PBL (DV) in Row Percentage

Items	Statements	1	2	3	4	5
		Value in %				
DV1	The tutor/lecturer stimulated students to generate clear learning issues	0.5	0.2	1.6	33.2	**64.5**
DV2	PBL helps students assure responsibility for their learning	0.5	0.5	1.6	30.8	**66.6**
DV3	Role of the tutor/lecturer in the process of PBL helpful	0.5	0.5	2.5	33.9	**62.6**
DV4	Proper training of PBL given before the implementation	0.5	0.8	1.6	33.7	**63.4**
DV5	Under PBL, students conducted self-directed learning	0.5	0.1	1.3	33.4	**64.7**
DV6	PBL makes students active processors of information	0.2	0.8	1.3	29.5	**68.2**

**Note: 1: Strongly Disagree, 2: Disagree, 3: Neutral, 4: Agree, 5: Strongly Agree*

4.2.2 INTERFACE OF TUTOR/LECTURER GUIDANCE

Table 4.4 shows the respondent's results derived from the first independent value which is an interface of the tutor/lecturer guidance. There are three statements in this segment and the first statement indicates 81.1% of the respondents strongly agree that the PBL lecture-based hybrid system is better than the entire lecture-based curriculum. 73.2% of the respondents also strongly agree that the PBL strategy is interesting and lastly 65% of the respondents strongly agree with the statement, the tutor/lecture stimulated students to give constructive feedback about group work.

Table 4.4

Itemized Questions for the interface of Tutor/Lecturer Guidance (GD) in Row Percentage

Items	**Statements**	**1**	**2**	**3**	**4**	**5**
		Value in %				
GD1	PBL lecture-based hybrid system is better than the entire lecture-based curriculum	0.7	1.1	2.1	15.0	**81.1**
GD2	PBL strategy is interesting	0.5	1.0	0.8	24.5	**73.2**
GD3	The tutor/lecture stimulated students to give constructive feedback about group work	0.3	0.5	1.6	32.6	**65.0**

**Note: 1: Strongly Disagree, 2: Disagree, 3: Neutral, 4: Agree, 5: Strongly Agree*

4.2.3 INTERFACE OF INTERPERSONAL COMMUNICATION

Table 4.5 shows the respondent's results derived from the second independent value which is an interface of interpersonal communication. There are three statements in this segment and the first statement indicates that 75.3% of the respondents strongly agree that the PBL improved students' communication skills. 66.3% of the respondents also strongly agree that students actively participated in PBL and lastly, 69.3% of the respondents strongly agree that PBL trained students' ability to cooperate with other team members

Table 4.5

Itemized Questions for the interface of Interpersonal Communication (IC) in Row Percentage

Items	Statements	1	2	3	4	5
		Value in %				
IC1	PBL improved students' communication skills	0.5	0.3	2.1	21.8	**75.3**
IC2	Students actively participated in PBL	0.5	0.3	2.1	30.8	**66.3**
IC3	PBL trained students' ability to cooperate with other team members	0.5	0.5	0.8	28.9	**69.3**

**Note: 1: Strongly Disagree, 2: Disagree, 3: Neutral, 4: Agree, 5: Strongly Agree*

4.2.4 INTERFACE OF FEEDBACK TO TUTOR/LECTURER

Table 4.6 shows the respondent's results derived from the third independent value which is an interface of feedback to tutor/lecturer. There are five statements in this segment and the first statement indicates that 74.2% of the respondents strongly agree that the PBL is more enjoyable than conventional teaching. 67.6% of the respondents also strongly agree that PBL decreased the academic burden to some extend, 64.7% of the respondents strongly agree that PBL helps students elaborate knowledge, 63.4% of the respondents strongly agree that PBL helps students organize knowledge and lastly, 58.4% of the respondents strongly agree that the tutor/lecturer was clearly motivated to fulfill their role as a tutor

Table 4.6

Itemized Questions for the interface of Feedback to Tutor/Lecturer (FB) in Row Percentage

Items	Statements	1	2	3	4	5
		Value in %				
FB1	PBL is more enjoyable than conventional teaching	0.5	0.3	2.1	22.9	**74.2**
FB2	PBL decreased the academic burden to some extend	0.8	0.5	3.2	27.9	**67.6**
FB3	PBL helps students elaborate knowledge	0.5	0.3	1.3	33.2	**64.7**
FB4	PBL helps students organize knowledge	0.5	0.3	1.1	34.7	**63.4**
FB5	The tutor/lecturer was clearly motivated to fulfil their role as a tutor	0.5	0.3	3.2	37.6	**58.4**

**Note: 1: Strongly Disagree, 2: Disagree, 3: Neutral, 4: Agree, 5: Strongly Agree*

4.2.5 INTERFACE OF TUTOR/LECTURER EXPERTISE

Table 4.7 shows the respondent's results derived from the fourth independent value which is an interface of tutor/lecturer expertise. There are three statements in this segment and the first statement indicates that 75.3% of the respondents strongly agree that knowledge in PBL is organized around problems rather than disciplines. 62.1% of the respondents also strongly agree that the tutor/lecturer stimulated students to understand the underlying mechanism/theories and lastly, 59.5% of the respondents strongly agree that the tutor/lecturer stimulated students to search for links between issues discussed.

Table 4.7

Itemized Questions for the interface of Tutor/Lecturer Expertise (EX) in Row Percentage

Items	**Statements**	**1**	**2**	**3**	**4**	**5**
		Value in %				
EX1	Knowledge in PBL organized around problems rather than disciplines	0.2	0.3	2.9	21.3	**75.3**
EX2	The tutor/lecturer stimulated students to understand the underlying mechanisms/theories	0.2	0.5	1.1	36.1	**62.1**
EX3	The tutor/lecturer stimulated students to search for links between issues discussed	0.5	0.0	1.3	38.7	**59.5**

**Note: 1: Strongly Disagree, 2: Disagree, 3: Neutral, 4: Agree, 5: Strongly Agree*

4.2.6 INTERFACE OF SKILL DEVELOPMENT

Table 4.8 shows the respondent's results derived from the fifth independent value which is an interface of interpersonal communication. There are three statements in this segment and the first statement indicates that 75.8% of the respondents strongly agree that the PBL improved students' decision-making skills. 70.5% of the respondents also strongly agree that PBL enhanced students' analytical and problem-solving skills and lastly, 64.2% of the respondents strongly agree that PBL enhanced students' ability to retrieve and utilized information.

Table 4.8

Itemized Questions for the interface of Skill Development (SD) in Row Percentage

Items	Statements	1	2	3	4	5
		Value in %				
SD1	PBL improved students' decision-making skills	0.5	0.0	1.1	22.6	**75.8**
SD2	PBL enhanced students' analytical and problem-solving skills	0.5	0.3	0.8	27.9	**70.5**
SD3	PBL enhanced students' ability to retrieve and utilize information	0.5	0.1	0.5	34.7	**64.2**

**Note: 1: Strongly Disagree, 2: Disagree, 3: Neutral, 4: Agree, 5: Strongly Agree*

4.2.7 INTERFACE OF INFRASTRUCTURE

Table 4.9 shows the respondent's results derived from the last independent value which is an interface of infrastructure. There are three statements in this segment and the first statement indicates that 77.1% of the respondents strongly agree that compare to the traditional teaching approach, the knowledge learned through PBL is structured. 66.8% of the respondents also strongly agree that compare to the traditional teaching approach, the knowledge learned through PBL is systematic and lastly, 70.8% of the respondents strongly agree that PBL enhances the ability to find information using the internet/library.

Table 4.9

Itemized Questions for the interface of Infrastructure (IF) in Row Percentage

Items	Statements	1	2	3	4	5
		Value in %				
IF1	Compare to traditional teaching approaches, the knowledge learned through PBL is structured	0.5	1.4	2.6	18.4	**77.1**
IF2	Compare to traditional teaching approaches, the knowledge learned through PBL is systematic	0.3	1.3	2.1	29.5	**66.8**
IF3	PBL enhances the ability to find information using the internet/library	0.3	0.0	0.5	28.4	**70.8**

**Note: 1: Strongly Disagree, 2: Disagree, 3: Neutral, 4: Agree, 5: Strongly Agree*

Table 4.10 shows the summation of all variables with the mean and median and standard deviation values.

Table 4.10

Summation for all variable

	N	Minimum	Maximum	Mean	Std. Deviation
Guidance	381	1.67	5.00	4.6824	.46928
Interpersonal Communication	381	1.00	5.00	4.6640	.50465
Feedback	381	1.00	5.00	4.6126	.49102
Expertise	381	1.00	5.00	4.6238	.47100
Skill Development	381	1.00	5.00	4.6772	.47376
Infrastructure	381	1.00	5.00	4.6710	.50925
DV	381	1.00	5.00	4.6172	.42898
Valid N (listwise)	381				

4.3 RELIABILITY ANALYSIS (CRONBACH ALPHA)

According to Hair Jr., Black, Babin, & Anderson (2014), the range of Cronbach's alpha should be between 0 and 1 with the minimum acceptable limit of 0.7. A value below 0.6 is considered to have poor internal consistency. Reliability is a measure that is established in testing both consistency and stability. Cronbach's alpha is a "reliability coefficient that indicates the extent to which items in a set are positively correlated with one another." (Sekaran and Bougie, 2013)

Table 4.11

Interpretation of Cronbach's Alpha

Cronbach's Alpha (α)	**Internal Consistency**
Less than 0.6 (< 0.6)	Poor
0.6 to Less than 0.7 (0.6 - < 0.7)	Moderate
0.7 to Less than 0.8 (0.7 - < 0.8)	Good
0.8 to Less than 0.9 (0.8 - < 0.9)	Very Good
More or equal to 0.9 (≥ 0.9)	Excellent

Table 4.12 are showing the reliability of the dependent variable tested. The value was α>0.7 which is a very good making correlation with one another.

Table 4.12

Reliability Value for Effectiveness of PBL

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.839	.839	6

Table 4.13 are showing the reliability value for tutor/lecturer guidance tested. The value was α<0.7 which is a moderate value.

Table 4.13

Reliability Value for Tutor/Lecturer Guidance

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.682	.687	3

Table 4.14 until Table 4.18 are showing the reliability of every independent variable tested. The value was α>0.7 which is a very good making correlation with one another.

Table 4.14

Reliability Value for Interpersonal Communication

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.833	.832	3

Table 4.15

Reliability Value for Feedback to Tutor/Lecturer

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.870	.871	5

Table 4.16

Reliability Value for Tutor/Lecturer Expertise

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.769	.768	3

Table 4.17

Reliability Value for Skill Development

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.829	.829	3

Table 4.18

Reliability Value for Infrastructure

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.826	.825	3

4.4 PEARSON CORRELATION ANALYSIS

The Pearson correlation measures the strength of the linear relationship between two variables. It has values ranging from -1 to 1, with a value of -1 meaning total negative linear correlation, 0 no correlation, and +1 meaning total positive correlation. The strength of the relationship is defined in the table above from the strength of the Pearson Correlation relationship that describes how reliable the independent variable is with the dependent variable.

Table 4.19

Correlation Table

R	Strength of Relationship
<0.20	Almost negligible
0.20 – 0.39	Low correlation, definite but small relationship
0.40 – 0.69	Moderate correlation with substantial relationship
0.70 – 0.89	High correlation; marked relationship
>0.90	Very high correlation; very dependable relationship

Table 4.19 shows the correlation coefficients between the independent variables and the dependent variables themselves, including the interface of tutor/lecturer guidance, interpersonal communication, feedback to tutor/lecturer, tutor/lecturer expertise, skill development, infrastructure, and also the variables independent of this with the dependent variable of the effectiveness of PBL. The variables tested all showed a positive relationship.

Table 4.20

Pearson Correlation Table

		Guidance	Interpersonal Communication	Feedback	Expertise	Skill Development	Infrastructure	DV
Guidance	Pearson Correlation	1						
	N	381						
Interpersonal Communication	Pearson Correlation	.636	1					
	Sig. (2-tailed)	<.001						
	N	381	381					
Feedback	Pearson Correlation	.671	.751	1				
	Sig. (2-tailed)	<.001	<.001					
	N	381	381	381				
Expertise	Pearson Correlation	.568	.596	.703	1			
	Sig. (2-tailed)	<.001	<.001	<.001				
	N	381	381	381	381			
Skill Development	Pearson Correlation	.606	.593	.640	.624	1		
	Sig. (2-tailed)	<.001	<.001	<.001	<.001			
	N	381	381	381	381	381		
Infrastructure	Pearson Correlation	.641	.628	.692	.675	.637	1	
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001		
	N	381	381	381	381	381	381	
DV	Pearson Correlation	.766	.699	.798	.733	.764	.732	1
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	
	N	381	381	381	381	381	381	381

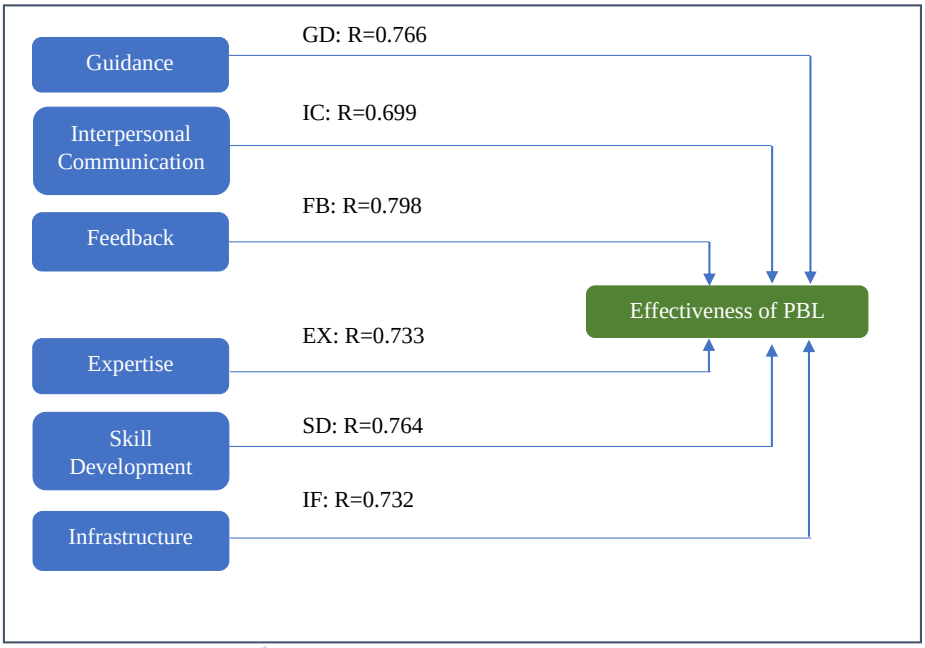

Figure 4.1: Pearson Correlation for the independent variable with the Effectiveness of PBL

The strongest relationship of the independent variable with the dependent variable is between feedback to tutor/lecturer (FB) at 0.798, tutor/lecturer guidance (GD) at 0.766, skill development (SD) at 0.764, tutor/lecturer expertise (EX) at 0.733, and infrastructure (IF) at 0.732. All these five independent variables marked very high correlation and got a relationship with the dependent variable. Although the interpersonal communication (IC) value is 0.699, it still marks a moderate correlation with the substantial relationship.

This indicates that the participants agree all the independent variables questioned are related to the effectiveness of the Problem-Based Learning activities.

4.5 MULTIPLE REGRESSION ANALYSIS

Based on Table 4.21, the ANOVA analysis shows the significant value is <0.001 which is all the significant value is <0.05, hence this model is acceptable.

Table 4.21

Regression Analysis

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	44.488	3	14.829	219.736	<.001[b]
	Residual	25.442	377	.067		
	Total	69.930	380			

a. Dependent Variable: AggDependent

b. Predictors: (Constant), GD3, GD1, GD2

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	35.250	3	11.750	127.732	<.001[b]
	Residual	34.680	377	.092		
	Total	69.930	380			

a. Dependent Variable: AggDependent

b. Predictors: (Constant), IC3, IC1, IC2

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	45.749	5	9.150	141.899	<.001[b]
	Residual	24.181	375	.064		
	Total	69.930	380			

a. Dependent Variable: AggDependent

b. Predictors: (Constant), FB6, FB4, FB1, FB2, FB5

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	38.488	3	12.829	153.831	<.001[b]
	Residual	31.442	377	.083		
	Total	69.930	380			

a. Dependent Variable: AggDependent

b. Predictors: (Constant), EX4, EX1, EX3

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	40.816	3	13.605	176.173	<.001[b]
	Residual	29.114	377	.077		
	Total	69.930	380			

a. Dependent Variable: AggDependent

b. Predictors: (Constant), SD4, SD1, SD2

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	38.054	3	12.685	150.018	<.001[b]
	Residual	31.877	377	.085		
	Total	69.930	380			

a. Dependent Variable: AggDependent

b. Predictors: (Constant), IF3, IF1, IF2

4.6 HYPOTHESIS TESTING

Based on Table 4.22, the results indicated that all the independent variable has a significant influence on the effectiveness of PBL.

Table 4.22
Hypothesis Testing

No	Hypothesis Statement	Results	Hypothesis State
RH1	There is a significant relationship between the guidance from the tutor/lecturer with the effectiveness of PBL	Model 1: R = .798[a], R Square = .636, Adjusted R Square = .633, Std. Error of the Estimate = .25978. a. Predictors: (Constant), GD3, GD1, GD2	Hypothesis Accepted
RH2	There is a significant relationship between interpersonal communication with the effectiveness of PBL	Model 1: R = .710[a], R Square = .504, Adjusted R Square = .500, Std. Error of the Estimate = .30330. a. Predictors: (Constant), IC3, IC1, IC2	Hypothesis Accepted
RH3	There is a significant relationship between feedback from the student to the tutor/lecturer with the effectiveness of PBL	Model 1: R = .809[a], R Square = .654, Adjusted R Square = .650, Std. Error of the Estimate = .25393. a. Predictors: (Constant), FB6, FB4, FB1, FB2, FB5	Hypothesis Accepted
RH4	There is a significant relationship between tutor/lecturer expertise with the effectiveness of PBL	Model 1: R = .742[a], R Square = .550, Adjusted R Square = .547, Std. Error of the Estimate = .28879. a. Predictors: (Constant), EX4, EX1, EX3	Hypothesis Accepted
RH5	There is a significant relationship between skill development with the effectiveness of PBL	Model 1: R = .764[a], R Square = .584, Adjusted R Square = .580, Std. Error of the Estimate = .27790. a. Predictors: (Constant), SD4, SD1, SD2	Hypothesis Accepted
RH6	There is a significant relationship between the infrastructure with the effectiveness of PBL	Model 1: R = .738[a], R Square = .544, Adjusted R Square = .541, Std. Error of the Estimate = .29078. a. Predictors: (Constant), IF3, IF1, IF2	Hypothesis Accepted

Table 4.22 shows the summary results of hypothesis testing for this study on the effectiveness of PBL. In hypothesis testing, the p-value of the hypothesis is significant, where the p-value < 0.01. For the above-mentioned hypotheses, all hypotheses are accepted. This shows that the interface of tutor/lecturer guidance, interpersonal communication, and feedback to tutor/lecturer, tutor/lecturer are important to a certain degree to the effectiveness of PBL.

4.7 SUMMARY OF CHAPTER 4

This chapter analyses the field survey data from the questionnaire and summarizes the research findings. This chapter broadly discusses Reliability Analysis, Descriptive Analysis, Correlation Analysis, and Multiple Regression Analysis used to analyse data. It also explains the validity of the data and the acceptance or rejection of the hypothesis.

CHAPTER 5

DISCUSSION AND CONCLUSION

The focus of this study is to determine the effectiveness of Problem Based Learning from the engineering students' perspective. In this context, the study was tested using a survey of engineering students at the Faculty of Engineering and Built Environment, UKM. Data were collected and analysed using IBM Statistical Package for Social Sciences Version 28.0.1. (SPSS 28.0.1).

This chapter discusses in more detail the results from the previous chapter. Then both the theoretical and managerial implications of the study will be discussed. Next, suggestions for future research will be suggested and finally, conclusions will be stated.

5.1 DISCUSSION OF RESEARCH FINDINGS

This research study aimed to understand the problems that affect the effectiveness of Problem Based Learning method. Of several factors that were done in other research, only six independent variables were selected namely tutor/lecturer guidance, interpersonal communication, feedback to tutor/lecturer, tutor/lecturer expertise, skill development, and infrastructure. A comprehensive study was conducted during the literature review to understand the importance of the effectiveness of PBL and based on the study, six independent variables were selected by the researcher that fit the context of the Problem Based Learning method. In addition, despite looking at the determinants of variables, demography is also part of the research content. Due to the sampling methodology used, specific demographic profiles such as age, gender, religion, course, and ethnicity were included as part of the research design. All the six independent variables that selected by researcher, all of the variables have a positive relationship with the dependent variable based on numerous tests conducted. Among the factors received, feedback from students to tutors/lecturers has the greatest impact (r=0.809) followed by guidance from tutors/lecturers (r=0.798), followed by skill development

(r=0.764), tutor/lecturer expertise (r =0.742), infrastructure (r=0.738) and finally interpersonal communication (r=0.710). However, based on multiple regression analysis, all six independent variables contributed significantly to the dependent variable (PBL effectiveness) with a significance value of <0.05.

5.2 COMPARISON WITH PREVIOUS STUDIES

Rui et al. (2015) and Binshabaib et al. (2019) reported two studies on the role of problem-based learning and the application of problem-based learning in practical teaching. Comparing the results obtained in this research with theirs, it is found that there were three factors that were common in the two studies.

Table 5.1

Comparison with Problem-Based Learning Study in China

Similar Factors	Preliminary investigation into application of problem-based learning in the practical teaching of diagnostics by Rui et. al (2015)	The Effectiveness of Problem-Based Learning (PBL) From Engineering Students' Perspective by Nur Farhana Rohdizad (2022)
1	Problem-solving skills	Skill development
2	Communication skills	
3	Participation	Interpersonal communication

Table 5.2

Comparison with Problem-Based Learning Study in Saudi Arabia

Similar Factors	Role of problem-based learning in undergraduate dental education: a questionnaire-based study by Binshabaib et. al (2019)	The Effectiveness of Problem-Based Learning (PBL) From Engineering Students' Perspective by Nur Farhana Rohdizad (2022)
1	Implementation	Expertise
2	Active processor	Infrastructure
3	Decision-making skills	Skill development

5.3 STRENGTH OF THE STUDY

This is the first comprehensive study of the effectiveness of Problem-Based Learning among engineering students in Malaysia. The questionnaire adapted from previous research on Problem-Based Learning (Rui et. al, 2015; Binshabaib, 2019) is very specific to this group. There were no systematic differences between the sample of students in all the courses. The response rate was high at 85% therefore selection bias was minimal. A sample size of 381 is more than enough for this statistical method. This is also the first study to be conducted using a questionnaire that is adopted in a bilingual format (English and Malay). The questionnaire was translated from English to Malay and the draft translation was verified by a local linguistic expert fluent in both languages.

5.4 LIMITATIONS OF THE STUDY

There are several limitations to this research. The student population in the faculty is about 400 people. The sample population obtained is only 381. Although it is based on a valid theory, the feedback may have different implications for various students among all Engineering faculties in Malaysia.

In the design of the questionnaire, there were only six factors for the perception of PBL effectiveness that were tested by the participants and the researcher did not find suggestions for any additional statements that might be a bigger factor to achieve better results. As with all cross-sectional studies, the stability of the questionnaire could not be assessed as well and no pilot testing was performed to include or exclude factors that might have changed the Cronbach Alpha to increase the reliability of the study.

At the same time, conversely, there may be a bias for respondents to leave certain truths in answering the questionnaire for fear that the management may take action against them if the survey results are against the interests of the management, even though it is clearly stated that all the questionnaires are anonymous and the purpose is for research purposes only.

5.5 FUTURE RESEARCH STUDIES

Future research should plan better strategies to eliminate at least minimize information bias and conduct research with a wider sample population to confirm the findings more accurately. A pilot questionnaire should be included before the research with more factors that can be obtained from previous studies to broaden the scope of the study. The mediating and moderating variables should be tested to check the deviation of the data based on the age group, and the course to understand the effect of those variables on effective methods for PBL.

5.6 CONCLUSION

This study exercise has confirmed that there was a positive significant relationship among the interface of tutor/lecturer guidance, interpersonal communication, feedback, expertise, skill development, and infrastructure towards the effectiveness of the Problem-Based Learning method. PBL will be effective when students were encouraged with the right tools and indeed can produce students that are equipped with high-level thinking skills and learning abilities as demanded by the market today.

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APPENDICES

APPENDIX A

QUESTIONNAIRE

Dear Participant,

I am a postgraduate student at UNIRAZAK currently pursuing a Master in Business Administration (Project Management) and I am conducting research on the Effectiveness of Problem Based Learning (PBL) from Engineering Students' Perspective. The purpose of this research is purely academic and the focus will only be driven toward results. Data analysis will be carried out ethically, considering the interests of all parties involved.

All data collected is anonymous and will not be disclosed or sold to any third party for commercial purposes. Your privacy will be maintained, will not be traceable to any individual respondent, and will be confidential. You will be asked questions about the effectiveness of PBL methods and specific instructions will be given in each section. The entire survey will take less than 5 minutes.

Please complete the questionnaire by answering all the questions in each section. I would like to thank you in advance for participating in this survey and taking the time to answer the questionnaire. Your participation in this survey is essential to the success of this study.

Thank you very much.

Yours sincerely,

Nur Farhana Rohdizad, M20711049

Graduate School of Business, UNIRAZAK

QUESTIONNAIRE / *SOAL SELIDIK*

I have read and understand the information given to me here and I voluntarily agree to participate in this research.

- ○ Yes

SECTION A: DEMOGRAPHIC PROFILE / *PROFIL DEMOGRAFI*

Instruction: Please tick (√) your answer.
Arahan: Sila tandakan (√) jawapan anda.

1. Gender / *Jantina*:
   - ○ Male
   - ○ Female

2. Age / *Umur*:
   - ○ 21 – 25 years old / 21 – 25 *tahun*
   - ○ 26 – 30 years old / 26 – 30 *tahun*
   - ○ 31 – 35 years old / 31 – 35 *tahun*
   - ○ More than 35 years old/ *35 tahun dan ke atas*

3. Religion / *Agama*:
   - ○ Islam / *Islam*
   - ○ Christian / *Kristian*
   - ○ Hindu / *Hindu*
   - ○ Buddhist / *Budha*

4. Course / *Bidang*:
   - ○ Civil Engineering / *Kejuruteraan Awam*
   - ○ Mechanical Engineering / *Kejuruteraan Mekanikal*
   - ○ Chemical Engineering / *Kejuruteraan Kimia*
   - ○ Electrical Engineering / *Kejuruteraan Elektrik*
   - ○ Architecture / Senibina
   - ○ Others / *Lain-lain*
     Please Specify …….
     Sila Nyatakan …….

5. Ethnic Group / *Kumpulan Etnik:*
   - ○ Malay / *Melayu*
   - ○ Chinese / *Cina*
   - ○ Indian / *India*
   - ○ Others / *Lain-lain*
     Please Specify …….
     Sila Nyatakan …….

SECTION B: TUTOR/LECTURER GUIDANCE / *BIMBINGAN DARI TUTOR/PENSYARAH*

Instruction: Please tick (√) your answers according to the scale below.
Arahan: Sila tandakan (√) jawapan anda mengikut skala di bawah.

1	Strongly Disagree / *Sangat Tidak Setuju*
2	Disagree / *Tidak Setuju*
3	Neutral / *Berkecuali*
4	Agree / *Setuju*
5	Strongly Agree / *Sangat Setuju*

No.	Statement / *Penyataan*	1	2	3	4	5
1	PBL lecture-based hybrid system is better than the entire lecture-based curriculum *Sistem hibrid berasaskan kuliah PBL adalah lebih baik berbanding keseluruhan kurikulum berasaskan kuliah*					
2	PBL strategy is interesting *Strategi PBL menarik*					
3	The tutor/lecturer stimulated students to give constructive feedback about group work *Tutor/pensyarah merangsang pelajar untuk memberikan maklum balas yang membina tentang kerja berkumpulan*					
4	The tutor/lecturer stimulated students to generate clear learning issues *Tutor/pensyarah merangsang pelajar untuk menjana isu pembelajaran yang jelas*					

SECTION C: INTERPERSONAL COMMUNICATION / *KOMUNIKASI INTERPERSONAL*

Instruction: Please tick (√) your answers according to the scale below.
Arahan: Sila tandakan (√) jawapan anda mengikut skala di bawah.

1	Strongly Disagree / *Sangat Tidak Setuju*
2	Disagree / *Tidak Setuju*
3	Neutral / *Berkecuali*
4	Agree / *Setuju*
5	Strongly Agree / *Sangat Setuju*

No.	Statement / *Penyataan*	1	2	3	4	5
1	PBL improved students' communication skills *PBL meningkatkan kemahiran komunikasi pelajar*					
2	Students actively participated in PBL *Pelajar mengambil bahagian secara aktif dalam PBL*					
3	PBL trained students' ability to cooperate with other team members *PBL melatih keupayaan pelajar untuk bekerjasama dengan ahli pasukan yang lain*					
4	PBL helps students assure responsibility for their learning *PBL membantu pelajar memastikan tanggungjawab untuk pembelajaran mereka*					

SECTION D: FEEDBACKS TO TUTOR/LECTURER / *MAKLUMBALAS TERHADAP TUTOR/PENSYARAH*

Instruction: Please tick (√) your answers according to the scale below.
Arahan: Sila tandakan (√) jawapan anda mengikut skala di bawah.

1	Strongly Disagree / *Sangat Tidak Setuju*
2	Disagree / *Tidak Setuju*
3	Neutral / *Berkecuali*
4	Agree / *Setuju*
5	Strongly Agree / *Sangat Setuju*

No.	Statement / *Penyataan*	1	2	3	4	5
1	PBL is more enjoyable than conventional teaching *PBL lebih menyeronokkan daripada pengajaran konvensional*					
2	PBL decreased the academic burden to some extend *PBL sedikit sebanyak mengurangkan beban akademik*					
3	Role of the tutor/lecturer in the process of PBL helpful *Peranan tutor/pensyarah dalam proses PBL membantu*					
4	PBL helps students elaborate knowledge *PBL membantu pelajar menghuraikan pengetahuan*					
5	PBL helps students organize knowledge *PBL membantu pelajar menghuraikan menyusun pengetahuan*					
6	The tutor/lecturer was clearly motivated to fulfill their role as a tutor *Tutor/pensyarah jelas bermotivasi untuk memenuhi peranannya sebagai tutor/pensyarah*					

SECTION E: TUTOR/LECTURER EXPERTISE / *KEPAKARAN TUTOR/PENSYARAH*

Instruction: Please tick (√) your answers according to the scale below.
Arahan: Sila tandakan (√) jawapan anda mengikut skala di bawah.

1	Strongly Disagree / *Sangat Tidak Setuju*
2	Disagree / *Tidak Setuju*
3	Neutral / *Berkecuali*
4	Agree / *Setuju*
5	Strongly Agree / *Sangat Setuju*

No.	Statement / *Penyataan*	1	2	3	4	5
1	Knowledge in PBL organized around problems rather than disciplines *Pengetahuan dalam PBL disusun berdasarkan masalah dan bukannya disiplin*					
2	Proper training of PBL given before the implementation *Latihan PBL yang betul diberikan sebelum pelaksanaan*					
3	The tutor/lecturer stimulated students to understand the underlying mechanisms/theories *Tutor/pensyarah merangsang pelajar untuk memahami mekanisme/teori asas*					
4	The tutor/lecturer stimulated students to search for links between issues discussed *Tutor/pensyarah merangsang pelajar untuk mencari kaitan antara isu yang dibincangkan*					

SECTION F: SKILL DEVELOPMENT / *PEMBANGUNAN KEMAHIRAN*

Instruction: Please tick (√) your answers according to the scale below.
Arahan: Sila tandakan (√) jawapan anda mengikut skala di bawah.

1	Strongly Disagree / *Sangat Tidak Setuju*
2	Disagree / *Tidak Setuju*
3	Neutral / *Berkecuali*
4	Agree / *Setuju*
5	Strongly Agree / *Sangat Setuju*

No.	Statement / *Penyataan*	1	2	3	4	5
1	PBL improved students' decision-making skills *PBL meningkatkan kemahiran membuat keputusan pelajar*					
2	PBL enhanced students' analytical and problem-solving skills *PBL meningkatkan kemahiran analisis dan penyelesaian masalah pelajar*					
3	Under PBL, students conducted self-directed learning *Di bawah PBL, pelajar telah menjalankan pembelajaran kendiri*					
4	PBL enhanced students' ability to retrieve and utilize information *PBL meningkatkan keupayaan pelajar untuk mendapatkan dan menggunakan maklumat*					

SECTION G: INFRASTRUCTURE/ *INFRASTRUKTUR*

Instruction: Please tick (√) your answers according to the scale below.
Arahan: Sila tandakan (√) jawapan anda mengikut skala di bawah.

1	Strongly Disagree / *Sangat Tidak Setuju*
2	Disagree / *Tidak Setuju*
3	Neutral / *Berkecuali*
4	Agree / *Setuju*
5	Strongly Agree / *Sangat Setuju*

No.	Statement / *Penyataan*	1	2	3	4	5
1	Compare to traditional teaching approaches, the knowledge learned through PBL is structured *Berbanding dengan pendekatan pengajaran tradisional, pengetahuan yang dipelajari melalui PBL adalah tersusun*					
2	Compare to traditional teaching approaches, the knowledge learned through PBL is systematic *Berbanding dengan pendekatan pengajaran tradisional, pengetahuan yang dipelajari melalui PBL adalah sistematik*					
3	PBL enhances the ability to find information using the internet/library *PBL meningkatkan keupayaan mencari maklumat menggunakan internet/perpustakaan*					
4	PBL makes students active processors of information *PBL menjadikan pelajar pemproses maklumat yang aktif*					

APPENDIX B

APPROVAL

TITLE OF PROJECT PAPER:	**THE EFFECTIVENESS OF PROBLEM-BASED LEARNING (PBL) FROM ENGINEERING STUDENTS' PERSPECTIVE**
NAME OF AUTHOR:	**NUR FARHANA BINTI ROHDIZAD**

The undersigned certify that the above candidate has fulfilled the condition of the project paper prepared in partial fulfillment for the degree of Master of Business Administration.

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Supervisor

Date:

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