MASTERS OF SCIENCE IN TECHNICAL EDUCATION

(ELECTRICAL AND ELECTONIC ENGINEERING)

Students' Experience on Project Based Learning in Engineering Education in Bangladesh.

By

IBRAHIM ADAMU

STUDENT NO: 153607

MSC.TE (EEE)

DEPARTMENT OF TECHNICAL AND VOCATIONAL EDUCATION (TVE)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DHAKA-BANGLADES

08 NOVEMBER, 2017.

STUDENTS' EXPERIENCE ON PROJECT BASED LEARNING IN ENGINEERING EDUCATION IN BANGLADESH.

By

IBRAHIM ADAMU

STUDENT NO: 153607

MSC.TE (EEE)

Name of Supervisor: Dr. Md. Shahadat Hossain Khan

Thesis submitted in partial fulfilment of the requirements of the degree of

Masters of Science in Technical Education with specialization in

Electrical and Electronic Engineering

DEPARTMENT OF TECHNICAL AND VOCATIONAL EDUCATION

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

BOARD BAZAR, GAZIPUR-1704, DHAKA-BANGLADESH

08 NOVEMBER, 2017.

RECOMMENDATION OF THE BOARD OF EXAMINERS

The thesis titled **"Students' Experience on Project Based Learning in Engineering Education in Bangladesh."** submitted by **Ibrahim Adamu**, Student No. **153607** of Academic Year **2016-2017** has been found as satisfactory and accepted as fulfilling the requirement for the degree of Master of Science in Technical Education (M.Sc.TE) with specialization in Electrical and Electronics Engineering.

BOARD OF EXAMINERS

----

1. **Dr. Md. Shahadat Hossain Khan** — **Chairman**
   TVE Department. — (Supervisor)

----

2. **Prof. Dr. Che Kum Clement** — **Member**
   Head, TVE Department — (Ex-officio)

----

3. **Dr, Md. Aktaruzzaman** — **Member**
   TVE Department.

----

4. **Dr. Shafiqul Alam** — **Member**
   Director, Bangladesh Open University.
   Board Bazar, Gazipur.

DECLARATION

This is to certify that the work presented in this thesis is the outcome of the investigation carried out by **Ibrahim Adamu** under the supervision of **Dr. Md. Shahadat Hossain Khan** (Assistant professor) in the Department of Technical and Vocational Education (TVE), Islamic University of Technology (IUT), Gazipur, Bangladesh. It is hereby declared that this thesis/report or any part of it has not been submitted elsewhere for the award of any Degree or Diploma.

Dr. Md. Shahadat Hossain Khan
Supervisor and Assistant Professor
Dept. of Technical and Vocational Education (TVE)
Islamic University of Technology (IUT)
Gazipur, Bangladesh.

Date----------------------------

Ibrahim Adamu
Student No: 153607.
Academic year 2016/2017

Date----------------------------

DEDICATION

This research project is dedicated to my dear mother Habiba Ismail Babamele and father Baba Adamu Fara-Fara.

ACKNOWLEDGEMENT

I am immensely indebted to Almighty Allah (SWA) for granted me the health, protection and made it possible for me to start and accomplished this work.

My appreciation goes to my supervisor **Dr. Shahadat Hossain Khan** for his patience, advice and spending his scarce time to read this work and make necessary correction**.** I am really proud to have you as my supervisor. The researcher likes to convey his deep gratitude and appreciation to **Prof. Dr. Che Kum Clement,** Head of Technical and Vocational Education (TVE) Department, Islamic University of Technology (IUT) for his guidance and mentoring which gave significant contribution to the success of my study.

I equally recognize the effort of my lecturers from Technical and Vocational Education (TVE) Department, and Electrical and Electronic Engineering (EEE) department, Islamic University of Technology (IUT) for given me the great insight on the task before me.

This work would not have been possible, if not for the sixteen participants from Islamic University of Technology, and Daffodil International University all in Dhaka Bangladesh who freely provided their valuable time and ideas during the interviewed. I sincerely thanks all of them.

My deepest thanks and heartfelt gratitude go to my parents Baba Adamu Fara-Fara and Habiba Ismail Baba Mele who are always the source of my inspiration. To my friends Yusuf, Sunusi, Basirka, and Ya balah as well as my brother Uthman and my sister Fatima, who have endured my absence of contacting them. Many thanks also go to all my classmates' M.SC.TE class of 2017 who contributed in one way or the other to the success of my study.

Finally I would like to thank my dear wife Hussaina and loving children Ahmad and Saddiya who continually support me and provide me emotional strength to conduct this study successful.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

CSE	Computer science and Engineering
EEE	Electrical and Electronic Engineering
MCE	Mechanical and chemical Engineering
CEE	Civil and Environmental Engineering
PBL	Project Based Learning
MIT	Massachusetts Institute of Technology
CDIO	Conceive-Design-Implement-Operate
IUT	Islamic University of Technology
DIU	Daffodil International University

ABSTRACT

In this study, a qualitative research approach, phenomenography was used to examine students' experiences on project-based learning (PBL) in engineering education in Bangladesh. Sixteen engineering students from two universities in Bangladesh participated in semi-structured in-depth interviews where they discussed their experiences about PBL, specifically how they experienced it in their engineering class setting. The interviews were analyzed using seven steps of phenomenographic data analysis. The outcomes revealed that, PBL in engineering education is conceived in four qualitatively different ways: understanding engineering concept; enhancing networked learning; changing conceptual development; and linking knowledge to the real practices. Four dimensions of variation were identified and explored to establish relationships that exist among these conception, which include: purpose of PBL; role of the teachers; role of the students; and level of engagement in PBL. The findings reveal that, PBL is a pedagogical techniques that provides deeper understanding of engineering knowledge and skills. It also provides engineering students with the opportunity to developed new knowledge and how to apply this newly developed knowledge into real practice. Therefore, this study will provide empirical study to understand the present pedagogical application of PBL in engineering education of Bangladesh, and the empirical findings of this study also provides useful insights about the different ways of seeing PBL in engineering class setting.

CHAPTER I

INTRODUCTION

1.1 Background of the Study

The global requirements for a successful career in the 21st century are extremely different from that of 20th century (Morgan, Moon and Barroso, 2013; Gavin, 2011). As a result of the ever changing technological advancement and new problems being identified daily, we have to prepare students for jobs and challenges that possibly do not even exist today (Morgan, Moon and Barroso, 2013). One of the biggest hindrances for the country's economic and technological development is the limited scope for engineering education (Chowdhury & Alam, 2012). While, recent reports on engineering education stated that, additional improvements are required upon knowledge and skills acquired by engineering graduates to meet the present challenges in the real world of work (Jamieson & Lohmann, 2009; Sheppard, Macatangay, Colby, & Sullivan, 2009). Realization has also emerged that, engineering and Technology education, aid nation to achieve its development goals and economic prosperity (Chowdhury & Alam, 2012). Therefore, technology plays a vital role in economic development of both developing and developed countries and this has impact on the standard of living of the people of these countries. However, the advancement of engineering and technology education is one of the major factor that make countries like United State, Germany, England, China, India, Canada and Japan considered in the world as developed countries. For the developing countries to developed, they have to integrate various technological programs that foster the development of engineering education of these developed countries into their educational system.

To ensure quality of engineering education of many countries around the globe, Accreditation Board for Engineering and Technology (ABET) was established. One of the criteria for ABET is to ensure student outcomes that prepare graduates to attained educational objectives, such as an ability to: apply knowledge of mathematics, science, and engineering; design and conduct experiments, as well as to analyze and interpret data; function on multidisciplinary team; identify, formulate, and solve engineering problems; communicate effectively; engage in lifelong learning; use the techniques, skills, and modern engineering tools necessary for engineering practice among others (ABET, 2017).

In the same vein, numerous studies around the world have proposed PBL as the most suitable means of achieving effective competence-based education that integrates self-learning, knowledge, problem-solving skills, and creativity (ChanLin, 2008; Karaman and Celik, 2008; Palmer and Hall 2011; Zhou 2012). The 20-year experience with PBL in Technical University of Madrid described it as the most adequate educational methodology for the development of competences, connecting teaching with the professional sphere (de Los Rios, Cazorla, Díaz-Puente, & Yagüe, 2010). Similarly, Research has shown that, students in PBL classrooms acquired knowledge and skills better than students in traditional classrooms (ChanLin, 2008; Karaman and Celik 2008; Marx et al., 2004; Rivet & Krajcik, 2004; William & Linn, 2003). Previous research showed that, PBL allows students to engage in a real world activities which enable them to learn by doing and applying ideas similar to the activities that adult professionals engage in a real world of work under the directive of a teacher (Erik and Anette; 2006). In the same vein, PBL environment focuses on establishing self-learning through practical activities, interactive discussions, autonomous operation or team cooperation, students reach the planned target and establish their own know-how. In this approach, teachers play the role of facilitator (Tseng, Chang, Lou, & Chen, 2013).

Consequently, report on Bangladesh engineering education asserted that, increasing the number of students is not the primary concern of engineering institutions, rather the quality of knowledge and skills acquired by engineering students (Chowdhury & Alam, 2012). One of the keys to preparing students to meet these challenges is to help them build knowledge and skills that they can readily adapt to address the complex problems that they will encounter (Litzinger, Lattuca et al. 2011). However, current understanding of expertise, and the learning processes that develop engineering education indicates that, it should encompass a set of learning experiences that allow students to construct deep conceptual knowledge, to develop the ability to apply key technical and professional skills, and to engage in a number of authentic engineering projects (Litzinger, Lattuca et al. 2011).

Based upon the fore going discussion, the researcher observed that, there is contradiction between the outcomes of engineering education of Bangladesh and the objective of ABET. In contrast, the engineering education of Bangladesh is not providing adequate knowledge and skills, in which PBL was found effective pedagogical approach for teaching engineering education as it was suggested by (Albanese & Mitchell, 1993; Blumenfeld et al., 1991; Vernon & Blake, 1993; Williams & Williams, 1997; Du et al, 2009). Chua, (2014) found that, When engineering students participate in design projects, they get a better appreciation of the purposes of the various fundamental topics they have to read as well as the opportunity to see the connection and usefulness of their acquired knowledge in tackling interdisciplinary engineering problems. Therefore, In order to enhance development of engineering education in Bangladesh, there is a need for adopting PBL as a pedagogy for teaching engineering education. These new challenges are the reason for integrating PBL in engineering Education.

While numerous studies was conducted on PBL in different discipline, (Lam, Cheng, & Ma, 2009; Keser, & Karahoca, 2010; Tuncay, & Ekizoğlu, 2010; Carter, 2016; Cömert, 2014; Krajcik, et al, 1998; Krajcik, et al, 1994) conducted their study in relation with sciences and social sciences while, (Hadgraft, 1992; Hendy, & Hadgraft, 2002; Hadgraft 1997; Mills, 2002; Mills, & Treagust, 2003) Conducted their studies on engineering discipline. Most of this study try to evaluate the effectiveness or appropriateness of PBL in a particular discipline, degree of success associated with implementation of PBL in such discipline or assess the role of student on PBL. But none of these study found evaluating qualitative differences of student conception or experience on PBL in engineering education. In this connection, the present study tries to investigate students' experiences on PBL in engineering education in Bangladesh.

1.2 Statement of Problem

Rossini, & Yam, (2010) stated that, "learning takes place through the active behavior of the student, it is what he does that he learns, not what the teacher does" (p.63). In PBL situations, students are asked to construct their own knowledge. Hence, PBL focuses on learning by doing or active learning (Chua, 2014). In this respect, PBL confirms more effective, fruitful and generative courses by allowing students to contribute in the learning process actively and to create in association with others (Cömert, 2014). PBL is a comprehensive approach to classroom teaching and learning that is designed to engage students in investigation of authentic problems (Blumenfeld et al., 1991). Similarly, its allows students to engage in a real world activities which enable them to learn by doing and applying ideas similar to the activities that adult professionals engage in a real world of work under the directive of a teacher (Erik and Anette; 2006).

But report on engineering education of Bangladesh stated that, Bangladesh falls into a low engineering and technology educated nation (Chowdhury & Alam, 2012). While, Du et al (2009) stated that, PBL has proven to be a successful educational strategy in many different study domains all over the world. Therefore, the researcher observed that, for improving current pedagogical techniques in engineering education of Bangladesh, implementation of PBL as a pedagogy of instruction will play a vital role. Therefore, empirical study is needed to understand the present pedagogical application of PBL in engineering education of Bangladesh. In order to address this issues, this study tries to find out students experience's on PBL in engineering education in Bangladesh.

1.3 The Objectives of the Study

The main aim of this study was to investigate students experience on PBL in engineering education of Bangladesh. In order to achieve this purpose, the following objectives were outline:

1. To identify qualitative different ways of experiencing PBL in engineering education in Bangladesh.
2. To investigate the similarities and differences of students' understanding on PBL in engineering education of Bangladesh.

1.4 Research Questions

The following are the key research questions that guided the researcher in collecting the necessary evidence to achieve the objectives of the study.

1. How do you experience PBL in your engineering class setting?

2. What are the similarities and differences of students' understanding on PBL in engineering education?

These questions was selected based on Pramling's (1983) what/how framework as he used in studying children's conceptions of learning. The What-aspect here is to investigate what students conceptualize or understand with PBL in engineering education and the How-aspect also examines how relevant understanding of knowledge and skills acquisition remained to the students.

CHAPTER II

REVIEW OF RELATED LITERATURE

2.0 Introduction

This chapter is based on literature review and the review was conducted based on the previous researches on PBL, The essence of reviewing literature was to provide the researcher with an opportunity to identify any gaps that may exist in the body of literature and to provide a rationale for how the proposed study may contribute to the existing body of knowledge. The literature review helps the researcher to refine the research questions and embed them in guiding hypotheses that provide possible directions the researcher may follow. The concept reviewed include differences upon the conception of people about the PBL, and how it was being used as a pedagogical technique in different study domain all over the world. Since the study is on engineering student experience on PBL, general overview of student's conception on learning were reviewed and finally, constructivist school of learning were justified as a theoretical frame work for the study.

2.1 Project-based learning (PBL): Definition and rationale

Project is universally used in engineering practice as a "unit of work", usually defined on the basis of the client. Almost every task undertaken in professional practice by an engineer will be in relation to a project (Mills, & Treagust, 2003). Projects will have fluctuating time scales and difficulty. A project such as the construction of power station may take several years, at the same time other engineers may be involved on many small projects for various clients at any given time. While, Jurewitsch, (2012) define PBL as an instructional strategy where students are presented with a real-life complex problem that they need to solve. Similarly, Prince and Felder (2006), define PBL as learning where the context is initiated with 'an assignment to carry out one or more tasks that lead to the production of a final product'.

According to Chau (2005), the main objective of PBL is to 'provide students with the opportunity to develop learning skills and attitudes that would equip students with the abilities to become more effective students as well as independent lifelong learners. The pedagogic concept of PBL is different from that of traditional learning in that it tries to develop students into active learners who actively acquire necessary knowledge to resolve problems that appear in the project, not as passive learners who always receive second hand knowledge (Thomas, 2000). It is recommended that PBL incorporate opportunities for feedback and revision as student work progressively, as well as marks assessment activities, where students must clear the basis of their design solutions including reports and presentations (Helle et al, 2006). PBL is being used in higher education institutions throughout the world, particularly in Europe (Du, de Graaff, and Kolmos 2009). Some of the main reasons for using PBL have been the desire to reduce dropout rates, to stimulate learning and to support the development of new skills among students (De Graaff et al, 2007).

Moreover, Thomas (2000) asserted that, "what must a project have in order to be considered an instance of PBL? The five criteria are *centrality, driving question, constructive investigations, autonomy, and realism".*

PBL projects are central, to the curriculum: In PBL, the project is the central teaching strategy; students conceptualize the central concepts of the discipline via the project. If the central activities of the project can be carried out with the application of already-learned information or skills, the project is an exercise, not a PBL. The centrality criterion means that in PBL, students learn things that are not outside of their curriculum.

PBL focused on driving question: Projects are focused on questions or problems that drive students to encounter with the central concepts and principles of a discipline. It may be built around the intersection of topics from two or more disciplines, but the questions that students pursue, as well as the activities, products, and performances that occupy their time, must be arranged in the service of an important intellectual purpose.

PBL engage students in a constructive investigation: For a project to be considered as a PBL project, the central activities of the project must involve engaging students in construction of knowledge. Student have to engage in investigating new idea or way of doing a task. An investigation in PBL is a goal directed process that involves inquiry, knowledge building, and determination. It may be design, decision making, problem finding, problem solving, discovery, or model building processes.

PBL are student driven to some significant degree: PBL are students centered learning. Teachers are just a mere facilitators trying to guide the students in actualizing their objective. It is more student autonomy. In the process, students pursues solution to open ended problem by formulating question for investigation, designing plan or proposal, collecting and analyzing of information and creating products of their understanding. Teachers are monitoring the students to make sure that they are moving in right tract.

Projects are realistic, not school like: for a project to be considered PBL, it must incorporates real life challenges where the focus is on authentic problems or questions and where solutions have the potential to be implemented. Therefore, PBL allows students to engage in a real world activities which students learn by doing and applying ideas similar to the activities in a real world of work under the directive of a teacher.

In this study, PBL has been considered as a pedagogical approach that integrate learning across different discipline. Learners are engaged in designing or constructing an engineering project, they usually concentrate on independents or group learning as well as presenting various outcomes, and it requires both the acquisition as well as the application of new knowledge.

2.2 PBL as Pedagogical Approach for Teaching Engineering Education

During the 1980s and 1990s, education researchers gradually understand that when students are unengaged they feel bored and they are less expected to learn (Blumenfeld et al., 1991). Almost all students are bored in school, even the ones who score well on standardized tests as it was found in the studies of student experience (Csikszentmihalyi, Rathunde, & Whalen, 1993). During 1990, it became familiar to education researchers that the problem wasn't on the side of the students, there was something wrong with the structure of school system. If we could find an alternative way to involve students in their learning, to restructure the classroom so that student's interest and attention would be aroused to learn, that would bring a dramatic change (Land and Greene, 2000). Therefore, engineering education developed new types of programs and curricula, with the goal of increasing student engagement and helping them develop deeper understanding of important ideas. The new accreditation standards called accreditation board for engineering technology (ABET) reflected the ideas over engineering education which had been put forward in the previous decades (Felder, & Brent, 2003). In 2001 MIT launched the CDIO (Conceive-Design-Implement-Operate) Syllabus (Crawley, 2001). The objective of developing CDIO is to help in applying the engineering problem solving paradigm: This entails first developing and codifying a comprehensive understanding of the skills needed by the contemporary engineer; developing new approaches to enable and enhance the learning of these skills; exploring new systems to assess technical learning, and to utilize this assessment information to improve our educational process. Collectively these activities comprise the CDIO program at MIT (Crawley, 2001).

In another development, the education reform program in Hong Kong has been forced by a strong demand from society that students learn how to meet the challenges of a knowledge-based and rapidly changing society. Today's higher education is required to promote not only a knowledge of the subject area but also general skills, such as collaboration, communication, and problem solving skills. To empower students with these skills, teachers are encouraged to use more student-centered approaches in teaching. While, all this development was generally accepted as adoption of Learner's Centered Approach to teaching (Barcala Montejano et al, 2011), PBL is one of these student centered approaches that has been highly recommended in the reform as part of the instructional strategies (Lam, Cheng, & Ma, 2009; Thomas, 2000; Blumenfeld et al., 1991).

Learner centered methods of content delivery involve students in the learning process rather than allow the student to passively gather information from a conveyed lecture as usual (Slunt & Giancario, 2004). In learner centered approach, students are the center of the educational enterprise, and their cognitive and affective learning experiences should guide all decisions as to what is to be done and how to do it (Wright, 2011). In the student centered classroom, teachers do not see themselves as providers of information, but as facilitators who are responsible for creating an environment for students' self-directed learning. Students are considered to take an active role and responsibility for managing their learning process and developing their understanding (Khan & Markauskaite, 2016). This is in line with PBL class setting where Li, (2014) engage students in electronics project to solve challenging problems that are authentic, curriculum-based, interdisciplinary and real world problem. It involve students in design, problem-solving, decision making, or investigative activities; it give opportunity for students to work in group over extended periods of time, and conclude in realistic products. Some means of guidance is needed to assure that all groups get satisfactory results, because one of the aims of PBL is to get the students well motivated for their advanced study (Li, 2014). In particular, students appreciate how the development of PBL motivates them to generate deeper learning (Terrón-López, et al, 2016).

Nevertheless, the implementation of project for both learning and task achievement is most typically associated with action learning, which assumes that people learn most effectively when working on real-time problems that occur in their own work setting (DeFillippi, 2001). Raelin, (2006), sees action learning as a self-directed learning. In PBL environment, students considerably expanded and enlarged their technological knowledge base; they improved their technological skills and acquired teamwork abilities; the technological design process was learnt and developed to significantly high levels (Mioduser, & Betzer, 2008). Drawing on this reviewed, several papers give the contribution of PBL as an essential pedagogy for students learning in different study domain all over the world (Blumenfield et al., 1999; Krajcik et al., 1994).

2.3 General Overview of Student's Conception on Learning

Initially, the study of student learning has its roots in qualitative, phenomenographic research, which originated in Marton's work in the 1970s as found in (Marton 1975, 1976; Marton and Sa¨ljo¨ 1976; Lonka et al. 2004, Entwistle, & Peterson, 2004 Heikkilä, Niemivirta, Nieminen, & Lonka, 2011). While comprehensive studies of conceptions of learning was carried out by Sa¨ ljo¨ (1979), which involved interviews with adults who had different levels of education. In his study, five Categories of description was identify which are:

1. Learning as the quantitative increase in knowledge.
2. Learning as memorizing.
3. Learning as the acquisition of facts, procedures, etc. which can be retained and/or utilized in practice.
4. Learning as the abstraction of meaning.
5. Learning as an interpretative process aimed at the understanding of reality.

Marton, Dall'Alba, and Beaty (1993), repeated this study where they found these five Categories and added a sixth one, which applied more particularly to adult students, namely "changing as a person".

The first two Categories describe the learning which depends on dogmatically recalling factual information, usually by memorization. In this Categories, education is seen as the process of accumulating the distinct 'pieces' of knowledge provided from a teacher or other source. The third Category presents a noticeable qualitative change, as information is seen as having a purpose beyond recalling, that is it also has to be applied. In fourth category, learning is associated with understanding. People begin to see learning as concerning the effort to assimilate the ideas for themselves by relating it to their prior knowledge and experience, where knowledge are transformed into personal meaning. Fifth Category goes beyond that, in addition, learning involves seeing things in an importantly different ways, and so becomes fully transformative. Finally, people conceived learning as bringing about fundamental change: changing as a person.

In a nut shell, this study has identified two different conceptions of learning: quantitative, and qualitative learning. A quantitative conception of learning sees learning as a process of gathering information in order to reproduce or apply it. While, a qualitative conception of learning sees learning has to do with comprehension and interpretation of meaning.

Numerous studies have examined students' conceptions of learning in general; however, some researchers have asserted that students' conceptions of learning may be discipline wise (Buehl & Alexander, 2001; Tsai, 2004). For example, Eklund-Myrskog, (1998) found that, student nurses and car mechanic students, to a certain extent, showed different conceptions of learning, and the study concluded that conceptions of learning were to some extent contextually dependent. For example, students may have diverse conceptions of learning engineering from those of learning other discipline. Therefore, he recommend to review some prior studies on conception of learning in other discipline. For example, Tsai, & Kuo (2008), although this study conducted on phenomenography perspective and has revealed five Categories about the conceptions of learning and learning science, which include:

1. Learning (science) as memorizing.
2. Learning (science) as preparing for tests.
3. Learning (science) as calculating and practicing tutorial problems.
4. Learning as an increase of knowledge.
5. Learning (science) as understanding.

In another development, general student conception of learning engineering discipline was conducted by Marshall, Summer, & Woolnough, (1999) and were reviewed by the researcher, the findings reveals five Categories of description given below:

Conception (A): Learning as memorizing definitions, equations and procedures

Conception (B): Learning as applying equations and procedures

Conception (C): Learning as making sense of physical concepts and procedures

Conception (D): Learning as seeing phenomena in the world in a new way

Conception (E): Learning as a change as a person.

From the fore going discussion, it is observed that conception of learning in different discipline conducted on phenomenographic perspective have some similarities and differences, meanwhile the differences is more diverse than their similarities. In all these studies, conception of learning revealed only one common Category of description such as learning as memorization. Nevertheless, the study conducted by Sa¨ ljo¨ (1979), which was letter reviewed by Marton, Dall’Alba, and Beaty (1993), reveal similar Category with that of Tsai, & Kuo (2008), learning as understanding of reality and Learning (science) as understanding respectively. But conception of learning in engineering conducted by Marshall, Summer, &

Woolnough, (1999) don't reveal this Category at all. Therefore, study upon a conception of learning may have some few similarity with domain specific, but a wider differences may exist when there is a differences in culture, educational contexts, and knowledge domains as reported by (Tsai, & Kuo, 2008).

Moreover, recent research on conceptions of learning has observed additional conceptions, perhaps partly due to cultural variations. Several studies point out that students, especially in Asian cultures, might represent learning as a combination of memorization and understanding (Duarte, 2007). There is a possibility that the differences in Asian and western conceptions of learning surrounded in their cultures are the main contribution to the learning outcomes (Tsai, & Kuo, 2008). Li (2003, 2004) has undertaken several studies to reveal Chinese conceptualization of learning and compare it with that of Americans. From her cross-cultural studies, Li concluded that Chinese cultural beliefs about learning, different from the United States, mostly deal with "seeking knowledge" with emphases on achievement standards of breadth and depth of knowledge, and contributions to society (Li, 2003). In addition, Chinese students, even as early as in preschool stage, have some thoughts toward learning and the purposes of learning (Li, 2004).

Furthermore, this study is upon student conception on PBL in engineering context. Even though there are some study found investigating engineering students conception on learning, this study is different since it specifically concerned with students experience on PBL. However, previous study shows some similarity about student's conception on learning from different discipline, and a wider differences exist in cultural wise. This study was conducted in Bangladesh which has different cultural setting with the existing study. However, despite the enormous contribution of PBL in engineering education as reviewed in this study, it is surprising that, none of the previous studies have been conducted focusing on student conception on PBL in engineering education in Bangladesh. In order to fill this gap, the objective of this study is to investigate qualitative similarities and differences of engineering student's experience's or conception on PBL in Bangladesh.

2.4 Theoretical Framework

This study was guided by constructivist school of learning, The constructivism is generally focus on individual ability to create their own new understandings on the basis of an interaction between what they have already known, believe, ideas and knowledge with which they come into contact (Resnick, 1989). According to them, knowledge is not received from the outside or from someone else; rather, it is the individual learner's interpretation and processing of what is received through the senses that creates knowledge (Ally, 2004, Resnick, 1989). Constructivists viewed learners as being active rather than passive (Duffy & Cunningham, 1996). Similarly, this approach suggests that, individual learners actively construct the meaning around phenomena, and that these construction are peculiar to a specific individual, depending on the learner's background knowledge (Richardson, 2003). Constructivist claims that, reality is more in the mind of the knower, that knower constructs a reality, or at least interprets it, based upon his or her appreciations (Nilsen, & Purao, 2005). The learner is the center of the learning, with the instructor playing an advising and facilitating role. Learners should be allowed to construct knowledge rather than being given knowledge through instruction (Duffy & Cunningham, 1996).

While PBL is dwelt on the belief that humans construct new knowledge over a bases of what we already know and of what we have experienced, which we make available through active participation and interaction with others (Gijselaers, 1996). PBL is considered as a promising pedagogical approach with strong roots in constructivist theories (Savery & Duffy, 1995), in the learning process of PBL, students are considered as an active agents (de Los Rios, et al, 2010, Mioduser, & Betzer, 2008, Resnik & Ocko, 1990, Blumenfeld et al., 1991). PBL is a form of situated based on the constructivist finding that students gained a deeper conceptualization of material when they actively construct their own knowledge by working with and using ideas (Marx et al., 2004; Rivet & Krajcik, 2004; William & Linn, 2003).

Up on this background, constructivist school of learning is considered essential for this study since it took in to account active student involvement in learning process and allowing students to construct there on knowledge based on their interaction with the environment. This is in line with the objective of this study as the study is trying to find out engineering students experience on a pedagogical approach (PBL) which believe an active involvement of student in learning process, a pedagogy that allowed students to construct their own knowledge.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter is based on the Methodological background used in this study. Phenomenography, participants, Data collection, Data analysis, Validity and Reliability of the study were described. In this section, the method used and the rationale behind using such methodology were justified. Extensive explanation on phenomenography and why it is suitable for this study were also described, the suitability of the instrument used, Sampling, Data collection and Data analysis were also justified, and finally how to ensure the Validity and Reliability of the instruments used in the study were also explained.

3.1 Phenomenography Approach

This study was conducted on the basis of phenomenography approach as its methodology since it belongs to qualitative research paradigm. The main purpose of selecting phenomenography approach in this study was because of its major focus on identifying qualitatively different ways in which people understand, experience and conceptualize object of the study (phenomenon) around them (Marton, 1981, 1986). The word "experience" comprising of ways of seeing, understanding, comprehending, conceptualizing and apprehending a particular phenomenon (Marton & Pong, 2005). Phenomenography research is specialized in searching for a comprehensive record of the variation in the experiences of people in such contexts (Case and Light, 2011; Jennifer and Gregory, 2011). Within the phenomenography research approach, conceptions are the central unit of description about people's experiences (Marton, 1996).

Phenomenography is a research approach based on a second-order perspective which means how subjects (the population of the research i.e. engineering student of Bangladesh) experienced an object (PBL) in a given situation. It is the engineering students conceptions derived from their understanding and experience towards the PBL. This is different from the first-order perspective in which the researchers are interested in how the PBL actually is (Marton, 1981; Sjöström & Dahlgren, 2002).

The range of qualitatively different ways of understanding a particular phenomenon is captured in what are known as "Categories of description" (Stamouli & Huggard, 2007). The relationships between these Categories of description are then analyses in terms of comprehensive hierarchical understanding of the participants (Berglund, 2005, Marton, and Booth, 1997). In a phenomenography study the object of the study is not the phenomenon itself, but rather the relation between the study's population and the phenomenon (Stamouli & Huggard, 2007). (Figure 3.1).

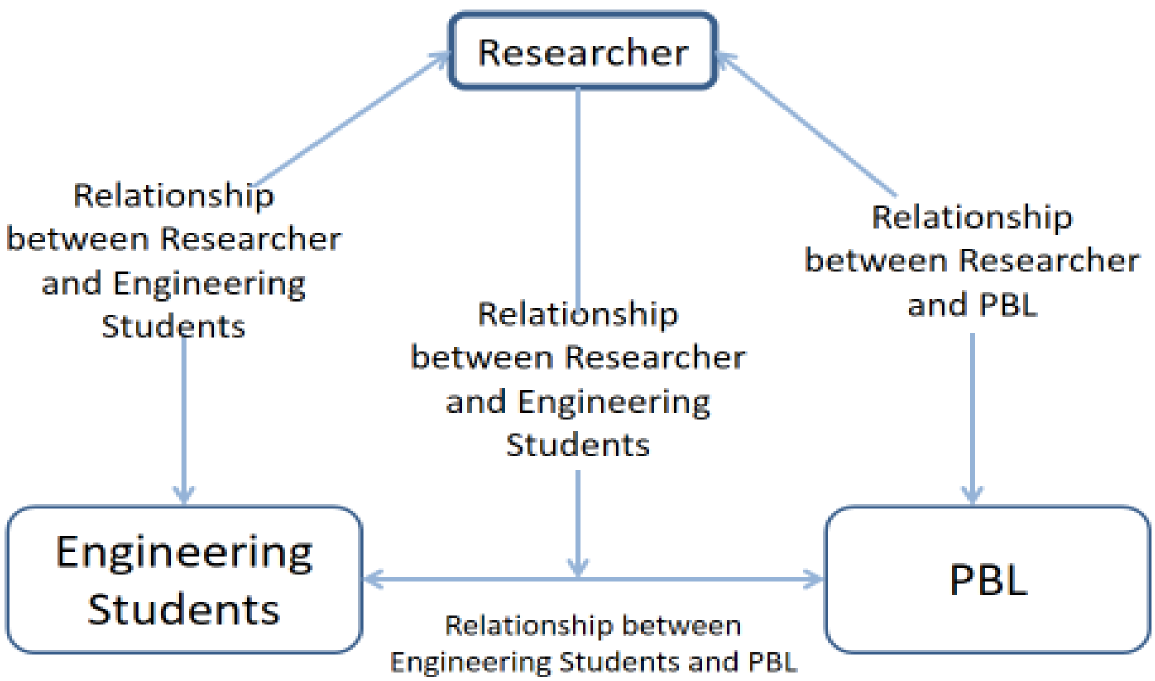

Fig 3.1 Relationship between PBL and Engineering Students (Adapted from Bowden, 2005)

As can be seen in Figure 3.1, the aim of this study is to find out the relationship between the engineering students and the PBL, that is how a PBL is experienced by a specific group of engineering students and the variation in the ways PBL is understood. Meanwhile, there is an unavoidable relationship between the researcher and the phenomenon (PBL) that is investigated in any study; this is because the researcher is required to have a thorough knowledge and understanding of all aspects of the phenomenon that they are attempting to analyze. This is necessary so that the researcher is able to discuss and query the interviewee about the related aspects of the phenomenon.

Nevertheless, Phenomenography research has been used primarily in education, including engineering education, to investigate variations in the ways students understand important concepts such as energy in solution processes (for example, Ebenezer & Fraser, 2001), and transient responses in student problem solving contexts (Carstensen & Bernhard, 2009). It has been used to identify conceptions of competent work among engineers in an auto manufacturing company (Sandberg, 2000), and Students' conceptions of learning in an engineering context (Marshall, Summer, Woolnough, 1999). However, it used to identify conceptions of the value of information-technology (IT) research among IT researchers and practitioners (Bruce, Pham, & Stoodley, 2004).

Thus, in line with the fore going discussion, this study is aimed to identify engineering student's experiences on PBL and their experience was captured in a categories of description. However, the relationships between these Categories of description are then analyses in terms of comprehensive hierarchical understanding of the engineering students. This is in line with the aimed of phenomenography methodology since Marton, (1994) asserted that, the aim of phenomenography research is to produce a set of Categories that are logically and hierarchically organized. Therefore, phenomenography methodology was considered suitable to identify variation of students' experience or understanding of PBL in engineering education in Bangladesh.

3.2. Participants

In order to ensure equal representation in the study, phenomenography approach suggests that the researcher will include participants with different feature such as gender, age, discipline, experience, religion, and so on (Green, 2005). Another argument is in relation to number of participants needs to be considered during data collection. Trigwell, (2000) suggested fifteen to twenty interviewees in his research practice. He had stated that a reasonable number of variations could be provided by a minimum of ten to fifteen participants, whereas effective management of the gathered data could be brought about and allowed by a maximum of twenty.

In this study, the researcher used sixteen participants whose gave different level of their understanding or experience on PBL. Two universities was purposively selected which are: Islamic University of Technology (IUT) and Daffodil International University (DIU) all from Dhaka Bangladesh. Four Participants each from four engineering department available in IUT and DIU were purposively selected. The engineering disciplines selected are Electrical and Electronic Engineering (EEE), Mechanical and chemical Engineering (MCE), Computer science and Engineering (CSE), and Civil and Environmental Engineering (CEE) (Table, 3.1).

Table 3.2 Summary of demographic features of participants

Participants	Level of study	Discipline	Current academic year	Gender	English
P1	Undergraduate	EEE	3rd year	Male	Fluent
P2	Undergraduate	MCE	4 year	Male	Fluent
P3	Undergraduate	EEE	3 year	Male	Fluent
P4	Undergraduate	CSE	3 year	Male	Fluent
P5	Undergraduate	CSE	4 year	Male	Fluent
P6	Undergraduate	CEE	3 year	Male	Fluent
P7	Undergraduate	CSE	4 year	Male	Fluent
P8	Undergraduate	MCE	3 year	Male	Fluent
P9	Undergraduate	CSE	4 year	Male	Fluent
P10	Undergraduate	EEE	3 year	Male	Fluent
P11	Undergraduate	EEE	4 year	Female	Fluent
P12	Undergraduate	CCE	2 year	Male	Fluent
P13	Undergraduate	MCE	4 year	Male	Fluent
P14	Undergraduate	MCE	4 year	Male	Fluent
P15	Undergraduate	CEE	4 year	Male	Fluent
P16	Undergraduate	CEE	4 year	Male	Fluent

The reason for selecting four participants from each departments is to ensure equal representation from all departments and level. The participants was from different level in order to ensure variation of experience among respondents. As stated, it is therefore important to maximize the potential variation of experience in the sample of individuals interviewed, ensuring the sample is fully representative of potential experience with respect to the phenomenon under consideration: not all the highest performing students, for instance, nor all the poorest performing students (Case & Light, 2011)

3.3 Data Collection

Different method of data collection have been used in phenomenography research work such as observation, drawings, behavior and the products of work (Marton, 1988), questionnaire (Loyens, Rikers, & Schmidt, 2009; Purdie & Hattie, 2002), Written discourse (Christine Susan Bruce, 1994), and mixed method, using both questionnaire and interview (Lee, Johanson, & Tsai, 2008; Marshall, Summer, & Woolnough, 1999). Interview (Eklund-Myrskog, 1998; Marshall et al., 1999; Tsai, 2004). Nevertheless, interview is the most preferred data collection technique in phenomenography research (A° kerlind 2012; Marton and Booth 1997; Khan & Markauskaite, 2016).

Therefore, a semi-structured interview schedule was adopted (Appendix 1) for this study. The interview was started with broad questions, (For example, what do you understand by PBL?) then follow by leading questions, (For example, why do you think this?), for further clarification of information by the interviewer more extensively. Similarly, the depth of the data was achieved by asking the participant more information (Christine S Bruce, 1994). Following Marton and Booth (1997)'s recommendation, the main emphasis of the follow-up questions was on the interviewee's experience of a particular aspect in a state of in-depth understanding. All interview questions were open-ended which allowed the interviewees to describe their own view (Khan & Markauskaite, 2016).

Therefore, every participants was invited to a one-to-one semi-structured interview at his or her convenience time, and the interview was lasted for about 40 to 50 minute. The interviewee was asked open-ended questions following the introductory of the subject. All interviews conducted was digitally audio recorded.

3.4 Data Analysis

Data analysis started after all the interview had been conducted. Each interview had been digitally audio recorded during the interview for further analysis of the data. The digital audio recorded was then transcribed for further data analysis (Bowden, 2005).

Moreover, Phenomenography research aims to explore the range of meanings within a sample group, as a group, not the range of meanings for each individual within the group (Åkerlind, 2012). The analysis usually starts with a search for meaning, or variation in meaning, across interview transcripts, and is then supplemented by a search for structural relationships between meanings. Nevertheless, the researcher was constantly adjust his thinking in the light of reflection, discussion and new perspectives as recommended by (Åkerlind, 2012).

Furthermore, different steps were available for the analysis of Phenomenography research González, (2010), for example, employed five steps while Sjöström & Dahlgren (2002) and Khan (2015) employed seven steps. Notwithstanding, This study adopted seven steps of data analysis as used by (Sjöström and Dahlgren 2002, Khan, 2015). The researcher observed that seven steps were conducted in professional studies which is in line with a current studies. The steps are:

Familiarisation stage**:** After the transcription phase, all the transcripts was read several times for error checking and to be familiar with the content. ***Compilation stage***: During the second stage, all answers to certain questions will be compiled from all respondent. During this stage the research will mainly focus on identifying the most significant elements in the answers given by each respondent to a particular question. ***Condensation stage*****:** The third stage is mainly focused on reducing of individual answers from longer dialogues without distorting the meaning. The researcher will have to consider the whole transcript of a respondent, for clarity and ensuring integrity of the data, before condensing it. ***Preliminary grouping stage*****:** Basing on the similarities and differences identified in the previous stage, the researcher will identify the significant aspects in order to form preliminary category basing on the meaning drawn. ***Preliminary comparison of category stage*:** The preliminary conception per category is cross checked with all transcripts to ensure the integrity of meaning is maintained. The preliminary conceptions per category should share similarity among them and they should be different from those in other categories in order to establish the border between the categories. ***Naming the categories stage*:** Each category is named depending on internal key elements and distinguishing features shared among them. ***Contrastive comparison*:** During this last stage, the researcher will establish a structural relationship among the categories by describing the unique character per category as well as the resemblance among them.

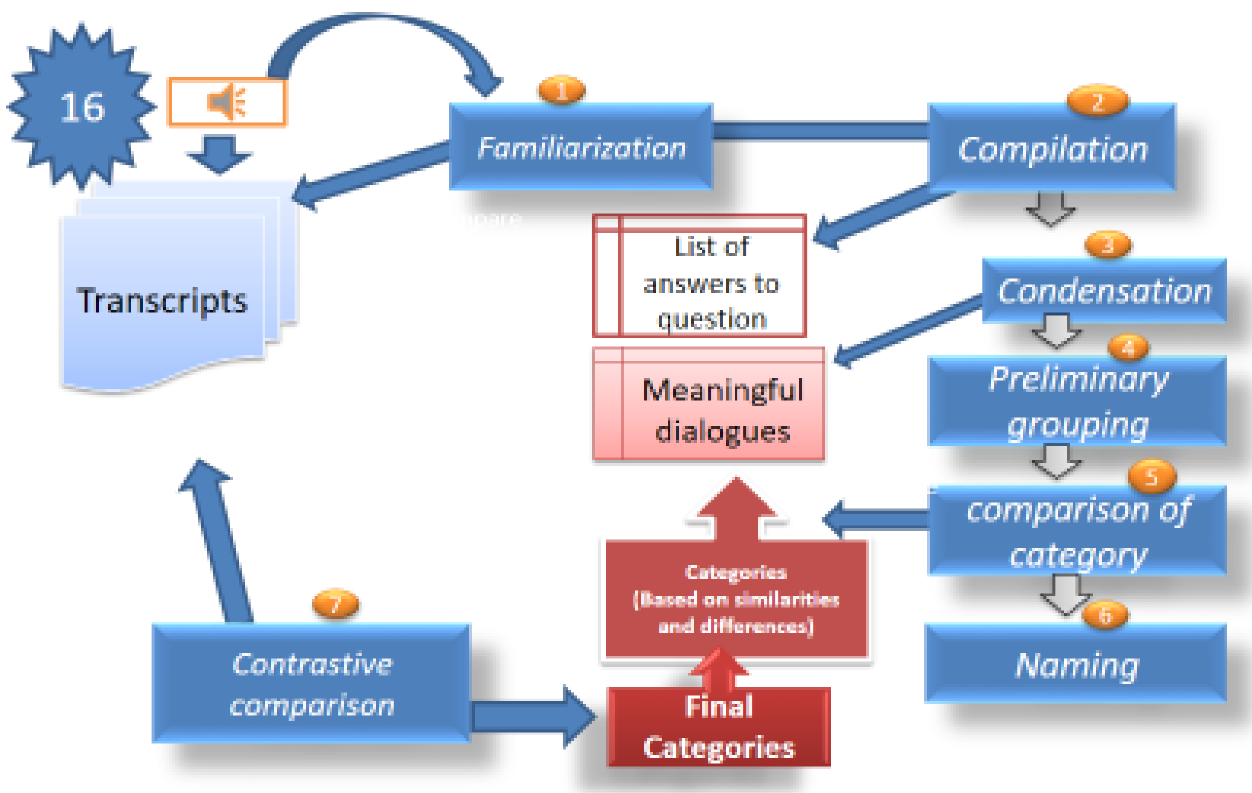

Fig 3.2. Seven Steps of Phenomenography Data Analysis

3.4 Validity and Reliability of the Instruments

Establishing trustworthiness in a phenomenography research study is imperative and it is generally ensured by checking validity and reliability.

3.4.1 Validity

Validity is widely regarded as the extent to which a study find out what it aimed to investigate, or the degree to which the research findings actually reflect the phenomenon being studied (Gay, Mills, & Airasian, 2011). However, a phenomenography researcher asks not how well their research outcomes correspond to the phenomenon as it exists in 'reality', but how well they correspond to human experience of the phenomenon (Uljens, 1996). Kvale (1996), identify two types of validity checks, such as: communicative and pragmatic validity.

This study adopted communicative validity checks. In communicative validity check, a strong emphasis must be placed on a researcher's ability to argue convincingly for the particular interpretation that they have proposed. There is no longer a search for the 'right' interpretation, but for an interpretation that is defensible (Guba, 1981; Sandberg, 1994, 1996; Kvale, 1996; Marton & Booth, 1997). Therefore, in this study a researcher provided a barking argument that support the results of this study and the outcome of the study were validated through feedback from two lecturers who had phenomenographic research experience.

3.4.2 Reliability

From a qualitative research perspective, reliability may be seen as reflecting the use of appropriate methodological procedures for ensuring quality and consistency in data interpretations (Guba, 1981; Kvale, 1996). A reliability check that were adopted for this study was that, researcher make his interpretive steps clear to readers by fully detailing the steps, and presenting examples that illustrate them as suggested by (Guba, 1981; Sandberg, 1994, 1996; Kvale, 1996).

CHAPTER IV

INTERPRETATION OF DATA

4.0 Introduction

Data analysis commenced after completing data collection as recommended by Bowden (2005) that the phenomenographic data analysis should not start until all the interviews had been completed. Each interview was transcribed verbatim by the researcher to get a deep understanding of the data. The analysis was done by following seven main steps of data analysis as used by (Sjöström and Dahlgren 2002, Khan, 2015). Which are: Familiarisation stage; Compilation stage Condensation stage; Preliminary grouping stage; Preliminary comparison of Category stage; Naming the Categories stage; and Contrastive comparison stage. For details see page 22.

This analysis undergoes several repetitive review and modification of outcome by the researcher. After preliminary Categories were decided on, the researcher met frequently with the supervisor to discuss and refine the outcomes. During the final stage of confirming the outcome space, the supervisor went through all the Categories and dimensions of variation and checked if they could be simply recognized within the data.

4.1 Findings

Four *Categories of description*, indicating qualitatively different ways of experiencing PBL in engineering education were detected. PBL in engineering is viewed as:

I. Category A: Understanding engineering concept.
II. Category B: Enhancing networked learning.
III. Category C: Changing conceptual development.
IV. Category D: Linking knowledge to the real practices.

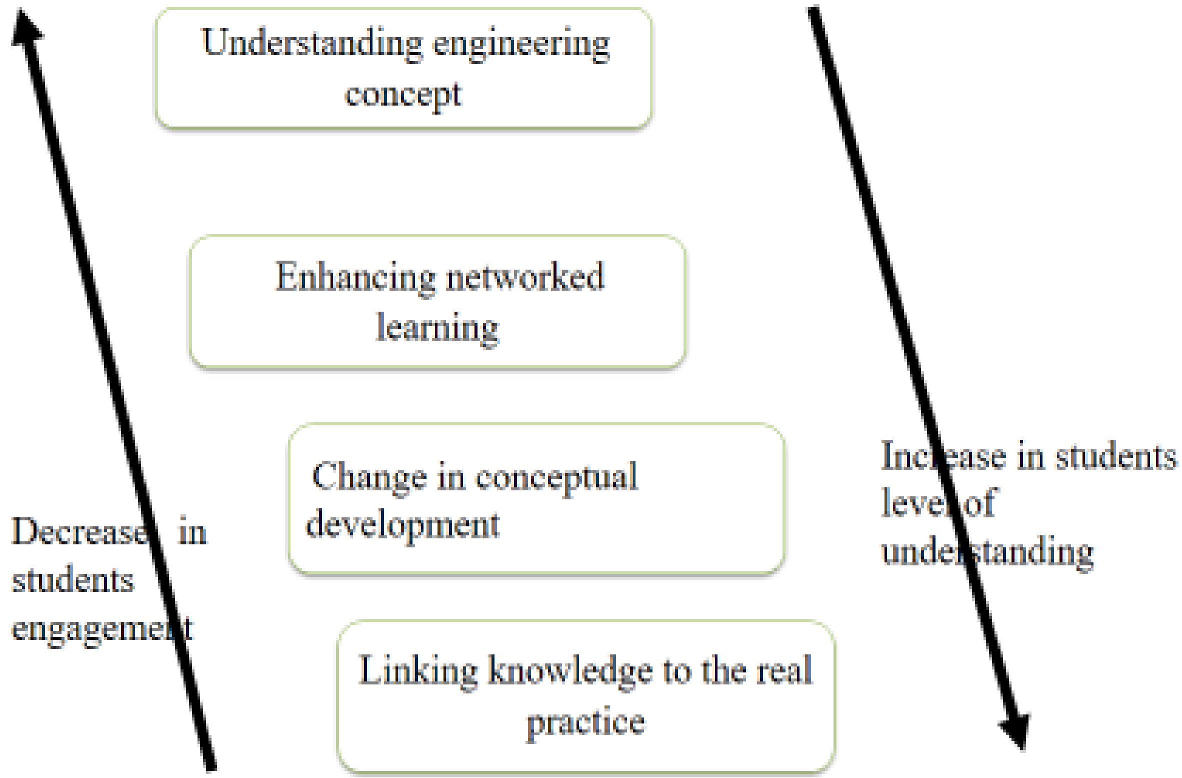

Fig 4.1. Hierarchical arrangements of Categories of Description

With consideration to the participants' responses, these Categories of description were arranged hierarchically ranging from low to high level of understanding moving downward from category A to D. While, in terms of engagement, teachers engagement are weakening, moving from category A to D, while students engagement are decreasing, moving from Category D to A, as shown in fig 4.1. Each Category of descriptions were further explained and illustrated in detail using the quoted words extracted from the interviewed transcript. At the end of each quotation, a participant's identification number were used to keep interviewees identity confidential, but allow record tracing.

4.1.1. Category A: Understanding engineering concept

In Category A, PBL is viewed as a pedagogical approach that integrates information across multiple aspects to support students understanding of engineering concept. The aim of using PBL approach in a class situation is to stimulate students to understand engineering concept. For instance, participants conceived that, learning under the canopy of PBL stimulate them to understand the meaning of the engineering concept rather than dogmatically storing what is exactly given to them by the teacher.

"PBL inspire you to understand engineering content more clearly in details, is not like memorizing your study rather understanding them, if you learn something by using that [PBL] *it will remain for a long… than how it will remain when you memorize its."* [P 16]

According to this view, teachers should focus more on practical project than preliminary theoretical explanation at PBL class setting. For example, participants see learning engineering concepts as more easily provided the teachers are practically oriented.

"if we learn by means practical project our learning will have an overall completion we believe that there will be better understanding of the knowledge that we are gaining, because once you learn it practically [by means of PBL] *we will definitely understand it better"* [P 15]

Category A also involves the use of clear examples of engineering content in PBL environment for student's understanding. The engineering students perceived that, using an appropriate examples facilitate students' understanding of engineering task or activities without being subjected to practical activities.

"…you see some teachers are very much easy for us to understand because while they are teaching,[before assigning a project] *they also try to demonstrate with examples, some time we see clear example… this actually help us to understand theoretical knowledge without practical knowledge".* [P 10]

In conclusion, understanding of engineering concept in this Category can be achieved by using PBL as a strategies for inculcating knowledge and skills to engineering student. While some participants viewed practical project can foster students understanding of engineering discipline. Other participants conceived that, using an appropriate examples can also help student to understand how to perform an engineering task.

4.1.2. Category B: Enhancing networked learning

In Category B, the focus is on using PBL to create and maintain interaction throughout learning process. In addition to Category A, Category B focuses on explicit networked between people [teacher and students] as well as learning resources for the purpose of supporting students understanding. Participants mainly focus on three type of interaction such as teacher-students interaction, student-students interaction and students-content interaction. These were explained with the help of quoted extract from our interview transcripts below.

In Category B, students-teacher interaction is viewed as a communication between students and teacher in PBL setting. This includes students to contact teacher upon any difficulties encountered while conducting a project and teachers also to give feedback for what students are looking for. For instance, participants see that, engineering teachers assigned task to a student, and students keep on visiting the teacher to ask question on area of difficulties. Similarly teachers guide them on how to do the task accurately.

"Yes like in programming, java and software development process, here a teacher will assign you a work and students…keep on visiting the teacher to see your progress or guide you when necessary" [P 4]

Students-students interaction is viewed in PBL environment as a collaborative learning process between the peers. In this process, students share their knowledge, skills and idea with one another. Teachers used to supervise the process to ensure that every students are participating actively in the learning process. For example, participants conceived that, when students interact in project learning environment, they shared their knowledge and skills with each other and this widened the understanding of their discipline.

"…Students will interact with each other, they will came to know more by sharing their skills, knowledge with each other", [P 12]

The use of PBL is also seen as a pedagogy that team up student to work together and learn what they do not know from their colleagues. Participants' view on PBL process shows that, engaging students in group work enhanced student's ability to learn what they don't know or did not understand from their colleagues.

"As we are doing the task sometime even if I don't know if someone it happen to be in our group know it, and he is doing it for us if I am serious, I am listening I will definitely learn from him" [P, 9]

Student-contents interaction is seen, as a students learning under a supervision of their teacher. For instance, participants stated that teacher assigned students to work in a group project under supervision, every students actively participate and learn from what he contributes as well as what other colleagues contribute in the process.

"*But in PBL as I observed at least there is a supervision of a teacher, so every student must have to participate or contribute this can improved our learning because we will learn from each other*" [P 4]

Student-contents interaction is viewed as a process in which students actively learned their discipline. For example, participant mentioned that, the use of project assignment to actively engage student to search for an answers from the library, you tube, Google and all available learning resources enhanced their understanding of their engineering discipline.

"...everyone will go and do research and search all the necessary search engine and try to get more knowledge on that topic that you give him, and you will be able to depend its if you came to class, and if he ask you, will be able to defend what you learn" [P 8]

Participants conceived that, YouTube, Google, and all other available learning resources facilitate their understanding of a particular topic in their disciplines if they were not clear from the teacher explanation during class hour.

"sometime if we don't understand we came back to our room we have you tube we have allot of resources, we can learn from there, sometime I experience that I did not understand the topic then I came back to my room search on the Google and you tube when I found a particular lecture on that I went through it I saw it, then I concluded a decision on how I do it" [P 12]

Overall, PBL process creates different type of networked learning such as students-teacher interaction, students-students interaction and students-content interaction. Students-teacher interaction employed effective communication and regular feedback between teacher and student in PBL process. While student-student interaction is a collaborative learning between students at which students shared their knowledge and skills with other students, aiming to facilitate students understanding. Finally, Students-content interaction is seen as an interaction between students with a learning materials. Searching Google, YouTube, and library are among students content interaction as highlighted in this study.

4.1.3. Category C: Changing conceptual development

In Category C, PBL is viewed as a pedagogical approach that helps students to acquire deeper understanding of knowledge as well as changes upon existing understanding of engineering discipline. Category C, is not only limited to establishing interaction that lead to understanding of engineering discipline. In addition, it integrates comprehensive familiarization of engineering field which can bring a higher order thinking as well as development of new ideas or techniques in engineering field of study. Participants mainly focus on three main features that PBL environment will developed to the engineering students if it is fully implemented. In-depth acquisition of knowledge and skills through practice, develop new idea through critical thinking and provision of an everlasting engineering knowledge. These were explained with the help of quoted extract from our interview transcripts below.

PBL is viewed as a pedagogical technique that give room for students to practically participate in designing and constructing of an engineering project, for student learning. For instance, participants conceived that, engineering students are frequently involved in project learning, they gradually became more familiar with the task. Hereafter, they got deeper understanding of that knowledge.

"*Because when I am doing something with my hand, I will understand what is going on inside it fully… and I will not forget."* [P 10]

"*…if I am to participate on everything definitely I will never forget it, I don't know others and it is to all"* [P 11]

PBL is also seen as engaging engineering students with a certain activities or task in form of project that make them to interact with learning materials and other students. In the process, students has to derive the final conclusion about the task and present it during a class hour. When this were repeated frequently will developed students critical thinking ability. For instance, participants reported that, teachers engaged them in design and presentation of a task that drive them to go for further investigation in YouTube, Google library etc. During presentation, audience asked questions that sometime make them to think critically for them to accurately reply to such questions.

"*…my lecturer gives us a group assignment* [inform of project] *with some of my colleagues, at that time we visited library we read many books, we Google the internet, YouTube individually and come up with different ideas, we sit down together and arrived at a final answer, finally we present it in front of our general class mate and the teacher, they ask us many question we depend it correctly really it make us think in-depth and the teacher conclude and give final judgment, really I learn a lot , each group in the class did it"* [P 6]

PBL in engineering setting is also seen as a pedagogical techniques that developed critical thinking ability to a students. This help student to learn a new way of doing a task or solving a novel problems. Participants mentioned that, when student are engaged in designing and constructing a group project for learning, they used to encountered a new problem but they have to think critically and found a new way of doing or solving that problem.

"As such PBL help to developed critical thinking to a student's…and problem solving skills to a students, and it make students to be flexible as well as adaptability he has to be adaptable with such kind of problem, also productivity, productivity is how productive such student should be as they said practice make perfect as you practice such approach more and more you will be came productive so that whenever you have a problem you can solve its within short period of time. [P 3]

"This technique helps students to collaborate, to bring out some critical thinking and also try to work together in order for them to get some knowledge or skills" [P 3]

In a nut shell, PBL in this Category is a pedagogical technique that developed higher order thinking skills to engineering students. It enrich student with a productive knowledge or comprehensive understanding that will be used to solve problems, or explain phenomena in a novel dimension. This can be achieved through frequent engagement of student with a task that demand presentation as well as subjecting them in to critics from their colleagues. It conclude that frequent involvement of engineering students in to design and construction of a project will help them to learn how to solve novel practical problem.

4.1.4. Category D: Linking knowledge to the real practice.

In Category D, PBL is viewed as a pedagogical approach in which complex real-world problems are used as a means to promote student learning. Category D, differs from Category C, by applying newly developed idea to solve societal or industrial problem. Three main aspects are the dominant features in this Category: developing Problem-solving abilities, providing leadership and fellowship ability, and acquisition of knowledge that will make students fit for the job field immediately after graduation. These were explained with the help of quoted extract from our interview transcript below.

In Category D, PBL is viewed as an inevitable pedagogy that bring real object or situation to facilitate students understanding of practical knowledge in engineering discipline. This can be achieved by taking students to the site and see how exactly what they are reading theoretically happening in the world of work. For example, participants mentioned that in PBL setting, teachers take students to the field and show them how exactly things are being constructed or done. This give them a better experience and deeper understanding on how it is being done than reading it in textbook. Therefore, it gave students self-assurance to do it practically when they found themselves in the job field.

"*….Now I am sitting in my room, reading in the book that side of the beam should be 12 * 10 inch, the side of the column should be 8 * 8 inch, the thickness of the slab should be 7 inch but if you look around you can't see the side of the beam here, you can't see the thickness of the slab all you see is plaster, so we have to see with our own eye how the dimension of a beam is been set, how the slab is being casted, if I could see that I think I could be more benefitted than studying it in my book, I think I could be able to do it myself when I am an engineer and when I will be assign to do a job like that"* [P 16]

PBL is also seen as an approach that developed leadership and fellowship ability to the students. This can be attained by engaging engineering students to work in group with colleague as a leader and others as a follower. Participants asserted that it gave them firsthand experience on leadership and fellowship experience. For example, Participants reported that, when they were involve in team learning in designing or constructing a project, they learned how to lead and how to follow a leader this kind of experience promote their ability to lead or follow a leader in the society, industry or any place they found themself.

"We will learn how to work in a group, supposed we are a student now but after some days we will worked in a power sector, we will worked in some company, we will know how to lead a team because in each project there is a leader, we will know how to flow the command of our leader, these think actually grow inside us by so doing" [P 10]

PBL is also viewed as strategies that gave engineering students' knowledge and skills that should put into practice in the society. This can be attained by involving students in to practical construction of engineering project in their learning process. For example, participants explained that, if students are trained practically they can acquire the skills faster and they can instantly contribute it to the society after graduation.

"*for example, if we are practically taught something we can understand it faster and even better and we can contribute to the society much faster, so once we graduate we can immediately go to the field and work in those area because we have enough knowledge to work in this area I think this is biggest advantage of PBL"* [P 15]

PBL is seen as an approach that prepare engineering students to face the challenges at job field. Participants reveal that if student are trained using practical project they should acquire knowledge and skills that should make them competent, and fit for the job field immediately after graduation.

"*for a competitive engineering, skills does not came from memorization and restitution, if you are given a project and you really carry out such project, you will acquired the necessary skills needed which will help you to overcome 80 to 90% of the challenges in the field after graduation* [P 1]

In this Category, PBL in engineering is seen as a pedagogical strategies that link classroom environment with real life situation. Participants has reported that, teachers linked the subject matter with the real world happening through several approaches among them are: Visiting the site with the students to see how exactly things are being constructed; actively involving students in the practical construction of a project; assigning a leader in any group work giving to the students; and engaging students to conduct a research and found solution to a practical problem encountered during project activities. This activities as express by the participants developed, competency in problem solving skills, leadership and fellowship ability as well as independents knowledge discovery. All this knowledge should be used in solving practical problem in the industries, society or any other applicable situation after student graduation.

4.2. Relationship between Categories of Description

In this section, identified relationships between the Categories of description along the four dimensions of variation were presented and discussed. These identified variation were supported with evidence extracted fr om the quoted extract from the interview transcripts. Each of the Categories of description reflect a distinctive characteristics that shows how each Category is deviated (distinct) from next Categories. The four qualitatively different ways experiencing PBL in engineering are explained by variations along these four inter-related dimensions:

1. Purpose of PBL.
2. Role of the teachers.
3. Role of the students.
4. Level of engagement in PBL.

The innate characteristics of PBL was further explored in two main horizon: *internal* and *external horizons*. The internal horizon was represented by the central awareness of the participants. While the external horizon was defined as the way in which PBL was connected to its environment. In this study, the four dimension (Purpose of PBL, the role of teachers, the role of students, and the level of engagement in PBL in engineering education) was included as internal horizon while there was no any external horizon found. These four dimension were described in details focus on the relationship among the four previously presented Categories of description which provide a broader understanding on PBL in engineering education.

4.2.1. Dimension 1: Purpose of PBL

Dimension one, represents the theme depicting the expanding focus on the purpose of PBL from providing understanding of engineering discipline to application of newly developed knowledge in to practice (Table 4.2.1.). The relationship between each Category with regard to the *purpose* of PBL is describe in the following section with the help of the quoted extract from the transcribed data.

Table 4.2.1 Variation in the Purpose of PBL in engineering Education

Category	**Purpose of PBL**
A: Understanding Engineering Concept	Support student in understanding engineering concept.
B: Enhancing Networked Learning	Provide deeper understanding of engineering discipline through collaboration learning.
C: Changing Conceptual Development	Provides not only deeper understanding of knowledge but also develops new ideas in this discipline.
D: Linking Knowledge to the real practice	Extends their knowledge and skills to the real life situation.

To elaborate in Category A, the purpose of PBL in engineering is to support student in understanding engineering concept. This can be achieved mainly by teachers' ability to demonstrate the concept effectively in a manner that will help students to sense the meaning rather than memorizing what is given to them by the teacher. For example, participants perceived that, PBL environment display the real object or an engineering materials inform of animation or demonstration to the student. This certainly helps capturing students interest and motivate them to understand engineering effectively.

"When student see something is working live, it help to capture his interest, attention of the students this will come naturally if you captured the interest of the students you can captured their motivation and off course they will learn" [P 13]

In Category B, the purpose of PBL is expanded to provide better understanding of engineering discipline through collaboration and independent learning. In this context PBL is not only used to support student understanding, but also for enhancing deeper understanding by networking students to interact with colleagues, teacher and available learning materials. Students share their knowledge and skills, and seek teachers' assistance and feedback while conducting both independent and collaborative learning activities. For example, participants reported that engineering students get an insight on what they did collaboratively with their colleagues because they used to share their knowledge and skills with each other. They insist that engineering student get further understanding of what they did themselves than waiting for the teacher to do everything for them.

"*The good think I want to share with you here is that, sitting down and discuss things with my colleagues give me a better understanding of what I am doing and I learn how to think and depend my point in front of many people, developed me professionally and I understand how people think differently really this is a good way of learning to me".* [P 6]

"It help me to understand what I did myself than waiting for the teacher to do everything for me. So given opportunity for a students to lay hand on doing things is one of the advantage of PBL" [P 5]

While in Category C, the main purpose of PBL is extended to assist engineering students to achieve deeper understanding of engineering concept that will lead to development of new idea or construction of new way of doing an engineering task. In this context, PBL is not only used to provide deeper understanding of engineering discipline, but also for acquisition of an everlasting knowledge and skills. This can be accomplished by frequent involvement of students in the learning process and exposing them in to class presentation with their colleagues as an audience. For example, Participants mentioned that, once they were frequently involved in active learning that instigates them to acquired in-depth knowledge and skills that should not be forgotten in their life time.

"To my own opinion I like what we called it practice when I practice I gain more knowledge and skills and this will help me to retain what I learn permanently i.e. long term retention" [P 3]

"…if student are involve in to a PBL, definitely no doubt there should be a quiet understanding and success skills student should acquire more success like that, through motivation, through communicating, through project participation, … So by doing that I think student will acquired deeper knowledge and understanding of a subject matter [P 11]

Finally, in Category D, the purposes of PBL is not only to provide an everlasting knowledge and skills, but to apply this newly developed knowledge in to practice. PBL empowers engineering students with the ability to link disciplinary knowledge and skills acquired in the class hour into real workplace practices. When learners work on a real task problems, they feel motivated, and make them familiar with the challenges that he/she will encountered in the field work after his/her graduation from the institution of learning. For example, participant's revealed that, when they see how to do a task or do it themselves it give them confidence on how to practice it when they found themselves in the industries or where this thing need to be implemented than mere reading it in their book.

"*A building cannot be constructed by just knowing how much reinforcement you should employed there, we have to see with our own eye, we have to know how a building is actually constructed"* [P 16]

"if my teachers has told me go to the construction site…and see how the workers are doing, see how the structure is buildup I will learn more, I could get more experience it could help me in the future to do my work when I am out of this university" [P 16]

4.2.2 Dimension 2: The Role of Teacher

Dimension two is represented by an expanding the role of teacher in PBL environment from motivating student to understand engineering discipline to providing scenario which links with real workplace practices (table 4.2.2.). The relationship between each Categories upon the role play by the teacher is described with the help of quoted extract from interviewee's data.

Table 4.2.2. *Variation of teachers" role in PBL process in engineering education*

Categories	**Role of the teachers**
A: Understanding Engineering Concept	Arouse the curiosity, interest and motivate student toward understanding of engineering discipline.
B: Enhancing Networked Learning:	Create a conducive avenue for different type of interaction in PBL environment.
C: Changing Conceptual Development	Engage students with the task that require a research, developed critical thinking and construction of new knowledge in engineering.
Linking Knowledge to the real practice	Bring a complex real-world problems and to provide scenario which link with workplace practices.

To elaborate in Category A, the teacher's role in PBL environment places emphasis on motivating students to understand engineering discipline effectively. This Category provides abstract knowledge of what students should learn in that course before assigning task or project to the students. For example, participants asserted that, it could be favorable if a teacher will explained the abstract application of the course to the students at the beginning of the semester before they embarked into project. This arouse the curiosity and interest of a students and empower student to understand the content rather than memorizing its.

"Do you know what power plant do, student will say no, power plant is used to generate electricity and then the student can said yes electricity in my country is very big problem because it goes away. The student will said may be if I know how to generate electricity I will save my country so the student will be very interested because he show the application of what is that subject is for." [P 13]

"...suppose we will learn something about power system, may be before the course there can be one short visit to the services station just to grow interest among the students no need to explain all the thing things in details among the students in the service station just group of student will go, one teacher will be there to said this is a transformer, this is a boiler, this is a turbine. What actually it will grow the interest of the student in learning something, and they will believe themselves that I am going to be an engineer" [P 10]

In Category B, the role of teacher in PBL environments is expanded to create a facilitative space that will attract networked learning. In this context, teachers are not only to motivate students in understanding the disciplined, in addition, teachers has to create conducive environment for student to collaborate with one another, teacher himself and learning materials. For example, participants sees the role of teacher in PBL environment is to create atmosphere that will engage student either independently or in group with a task that will push them to search information from Google, YouTube etc. and collaborate with other student to sort out the actual solution needed and contact a teacher to get feedback upon every stage when required.

"The teacher has to introduce the topic to the students, state his objective and explain all the necessary basic knowledge or background of the topic then the teacher will assign them in to group or individual tell them which work they should do, he should ask them to seek his assistances where necessary" [P 4]

"*Supposed a teacher has three classes in the week, whatever he has told us in this three classes he could tell us that you have to complete an assignments (project) based on this three classes in the weekend and submit that assignments or project in the next week when I came to the class. So we will definitely learn about the thing we did in the previous week and we will remember upon our semester final exam or even far be young that"* [P 16]

In Category C, the role of teacher in PBL is extended to engaging students with learning activities that will lead to development of new knowledge, technique or idea of doing a particular task. In this Category, the role of teacher is not only to create networked learning, but also to assign a task to the engineering student that required investigation which will help students to acquire an everlasting knowledge as well as change their conceptions about the phenomena they are studying. This can be done by frequent assigning of a task to the students that required a research and thorough investigation before drawing a conclusion. For example, participants sees the role of teacher in PBL is to give a task to the student that they should go and conduct a research and come up with new idea, technique or knowledge that is relevant to the engineering field of study.

"I think a teacher can split some learning content and coined some question for a student as an individual or a group to distribute its to the students to find its themselves. As they are finding, they have to be making a kind of research, while they are researching they are increasing their knowledge and at the end of the day, they should came up with something new that is much benefit or much important to the course than to just wait for the teacher to solve its for them" [P 5]

the teacher may introduces the topic to the students and ask them some questions which required in-depth investigation and critical thinking students will select an approach that they think is suitable for them" [P 3]

In Category D, the role of teacher is not only to assign learning activities that will provide an everlasting knowledge or new idea about the phenomena to the students, rather it is seen as alternative ways of bringing a complex real-world problems and links it with workplace practices. This can happen by involving students in to real engineering task that will developed practical knowledge and skills to the students, and that should be practice at the society or industry. For example, participants mentioned that, when teacher shows them how real engineering task are done, and involved them in doing it while they were learning, they can easily do it in the field or in the industries after graduation from the school.

"You see when a teacher take us to site and see how real work are done or even do it myself then and then I start feeling confidence on myself that I will be an engineer so is very good and it is encouraging" [P 4]

4.2.3 Dimension 3: Role of students

Dimension two explain the role play by students in PBL environments ranges primarily from being recipients of information, to being responsible in construction of knowledge as well as application of such knowledge in to real life situation (table 4.2.3.). The relationship between each Categories upon the role play by the teacher is described with the help of quoted extract from interviewee's data.

In Category A, students' role is to pay attention on what teacher is explaining before commencement of designing and construction of engineering project. This can be achieved through teachers' ability to persuade student interest by relating the content with an abstract application. In this Category, student are passively receiving the information. For example, engineering students mentioned that, they are paying attention and follow what teachers are explaining before they were embark in to the project task.

"We have to pay attention and follow what a teacher is saying I thing that is all we are doing" [P 6]

Table 4.2.3. *Variation of student's role in PBL process in engineering education*

Categories	Role of the Student
A: Understanding Engineering Concept	Students receive information as a passive learner that enhance their understanding
B: Enhancing Networked Learning:	Students interact with learning material, teachers and minded colleagues to develop a better understanding of engineering concept.
C: Changing Conceptual Development	Students construct their own knowledge and skills.
D: Linking Knowledge to the real practice	Students apply their knowledge to solve problems which has linked with workplace practices

In Category B, the role of students is not only to received information from the teacher, rather it is extended to interaction with learning material, teachers and minded colleagues in order to get deeper understanding of the phenomena under study. In this category, the role play by student mainly to engaged in independent and collaborative learning, consulting teacher whenever they experience any difficulty in their independent or collaborative learning and to share their knowledge and skills with one another during collaborative learning. For example, participants said that, students are searching Google and all other available learning materials when they were engaged in collaborative or independent learning in order to get deeper understanding of knowledge as well as to share their knowledge and skills with other students.

If I have to sum it up I can said, PBL should be team effort and engagement between the students on what they learn or about a particular problem not only in terms of bookish knowledge but also through working on practical labs and design based project. [P 14]

"*……Whatever I am saying, connection between teachers and student is very important, whatever you are doing, you have to be consulting your teachers to make sure what you are doing is right or wrong"* [P 12].

In Category C, the role of students is not limited to interaction with teachers, learning materials or students, it is extended to the construction of new idea or way of doing a task. This can be attained through regular involvement of student in learning activities. Students are also more motivated when they believe that the outcome of learning is under their control as such it provide an everlasting knowledge to the students. For example, participants explained that, when they were engage fully in their learning process both theoretically and practically what they learn remained to be with them permanently.

"So if we are ask to do the task our self we tend to learn and the learning retain to be in us permanently…than just hearing or something like that" [P 9]

In Category D, the role of students goes beyond developing new idea or way of doing a task, but to think critically on how to relate this newly developed knowledge into real life situation. Students are more motivated when they value what they are learning and when their educational activity is associated with personally meaningful tasks. In this Category, students are more engage since they are solving a real societal problem during school hour. For example, participant reported that, if students are engaged in solving real life problem, the knowledge acquired will be extended to solve institutional, industrial and societal problem.

"…Second project was calculator that was very good project, actually we learn from the project how to design on PCB, we design the layout on PCB and all the team member we have to work hard we did divider circuit, multiplier circuit, adder circuit, subtraction circuit and all the thing we design it by ourselves and we take help from the internet and it worked almost 80 (eighty) percent correctly" [P 10]

4.2.4 Dimension 4: Level of engagement in PBL

This dimension is represented by expanding focus from considering the level of engagement mainly from students passively receiving information from the teacher, to considering the level of engagement on real life activities (Table 4.2.4). The relationship between each Categories with respect to the level of engagement by both teacher and students were explained in the following section.

Table 4.2.4. *Variation in level of engagement in PBL process in engineering education*

Categories	Level of engagement in PBL
A: Understanding of Engineering Concept	Students' are passively receiving information from the teacher
B: Enhancing Networked Learning	Students engage in different types of networked learning
C: Changing Conceptual Development	Students engage frequently in in different type of collaborative learning
D: Linking Knowledge to the real practice.	Students engage mainly on real life activities

In Category A, the level of engagement is mainly focus on student's passive reception of information from the teacher. Even though both teachers and students are seen mainly engage, the level of teacher's engagement is more since he has to actively organize the lesson under the canopy of PBL with full explanation, demonstration and motivation. While student are receiving information passively from the teachers, but they has to show some degree of optimism, attention, perseverance, curiosity, interest, and passion when they are being taught by the teachers to the extent that they should understand and progress in engineering discipline. For example, participants explain that, while teachers are explaining how students should carry out a task, student also has to exhibit some observable behaviors such as attending class, listening attentively, and following rules and regulation can help student to understand the content effectively.

"*I think a teacher has to come to a class and explain what he want students to do in the class and he will group students and give them a project that they should do within a speculative time… student have to be curios and pay more attention on what teachers are saying, understand it very well so that they can be able to performed all the necessary activities that a teacher recommend them to do"* [P 2]

In category B, the level of engagement is expanded beyond paying attention. In addition, it included engagement in networked learning style. In this Category, teachers provide conducive atmosphere and create interaction among the teacher-student, students-student and student-content for different type of networked learning to take place, but the level of teachers engagement is less compare to category A, meanwhile student engagement in this category is higher than category A, because they should go beyond paying attention rather they should interact with engineering content (curriculum) and other students colleagues for deeper understanding of engineering concept. For example, participants reported that, teachers are assigning them a task that make them to interact with different learning materials, to extract relevant information and collaborate with other student to share their knowledge and skills for deeper understanding of the phenomena under study.

"they will just introduces the courses for us and then they will allowed us to go back and discuss it among ourselves as a student he allowed us this freedom, because we are open we are not limited only to the teachers, we go we search on it we understand we learn from each other that is how we did it" [P 7]

"PBL to my understanding is an aspect of teaching approach that has to do with students centered mode of learning where by a teacher assign a task to a student's either individually or in a group to performed one or two thing" [P 5]

In Category C, the level of engagement goes beyond networked learning, rather it also integrated frequent collaboration that will lead to construction of new knowledge or way of doing a task. Unlike Category B, students has to conduct an intensive investigation about a particular task to come up with new recommendation or findings that will contribute to the domain of learning. Students also has to come forward and present their findings assignments, or projects assign to them by the teacher in front of their classmate. As perceived by participants, when student conduct an investigation and present their findings in front of their colleagues they learn new way of doing an engineering task.

"*PBL to my understanding is an aspect of teaching approach that has to do with students centered mode of learning where by a teacher assign a task to a student's either individually or in a group to performed one or two task in the process student develop their knowledge and new way of doing such task"* [P 5]

"Yes we are very lucky that within the three semester that we have experience suffered. We did so many presentation, we did a practical survey" [P 11]

In category D, the level of student engagement goes beyond frequent collaboration that lead to the development of new way of doing the task as in Category C rather applying such knowledge in to real practice. The level of engagement in PBL environment is more on student involvement in practical designing and construction of engineering project for better acquisition of practical skills. For example, participant viewed on PBL shows that, if students are involve in doing a practical project they can easily do it in the society or industries when they found themselves.

"*…when I visited site and see how building is being constructed and participate in that work… I can do small renovations, such as addition of a room, or renovation of a bathroom with confidence and I think if I found myself in the site I can do many job myself so to me bookish knowledge alone will not make me an engineer"*[P 6]

4.3. Summary and Relationships among the Categories.

In summary, engineering student perceived PBL in four different Categories as shown in table 4.2.4 which signify referential component of the study. Similarly, relationship between the four categories of description was found by critically analyzing the purpose of PBL, role play by teachers, role play by students and the level of engagement in PBL process. Table 4.2.4 provide the detail of different conception of engineering student on PBL and how they are internally related.

Table 4.3. *Relationship among categories of descriptions of PBL in engineering education*

	Category A	**Category B**	**Category C**	**Category D**
Purpose of PBL	Support student in understanding of engineering concept.	Provide deeper understanding of engineering discipline through collaboration and independent learning.	Provides not only deeper understanding but also developing new ideas in this discipline.	Extends their knowledge and skills towards real life situation.
Role of Teacher	Arouse the curiosity, interest and motivate student toward understanding of engineering discipline.	Create a conducive avenue for different type of interaction in PBL environment.	Engage student with the task that required a research, developed critical thinking and construction of new knowledge in engineering.	Bring a complex real-world problems and to provide scenario which links with workplace practices.
Role of Student	Students received information as a passive learner that enhance their understanding	Students interact with learning material, teachers and minded colleagues to develop a better understanding of engineering concept.	Students think critically and construct their own knowledge and skills.	Applying their knowledge to solve problems which has linked with workplace practices
Level of Engagement	Students' are passively receiving information from the teacher	Students engage in different types of networked learning	Students engage frequently in different type of collaborative learning	Students engage mainly on real life activities

CHAPTER V

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

In this chapter, the discussion, conclusion and implication, the limitation as well as recommendation of this study were presented.

5.1 Discussion

The main aim of this study was to examine the differences of engineering student experience on project-based learning (PBL). This study identified four qualitatively different Categories of description of engineering student's views on PBL: (A) understanding engineering concept; (B) enhancing networked learning; (C) changing conceptual development; and (D) linking knowledge to the real practices. The study also recognized and discovered four dimensions of variation that provides how four Categories are internally linked with each other: (1) purpose of PBL; (2) role of the teachers; (3) role of the students; and (4) level of engagement in PBL. This analysis showed that four Categories of description had a hierarchical relationship, ranging from higher to deeper level of understanding with Category B being more inclusive than Category A, and Category C being more inclusive than Category B. Similarly, Category D, is more inclusive than Category C. In another development, Categories of description were arranged in a hierarchical order in terms of engagements, for instance, teachers engagement are diminishing moving from category A to D, while students engagement are increasing moving from Category A to D. Therefore, engineering students main conceptions were characterized by the central features as student's views expressed during the interviews which will be presented below.

The results of this study are generally in line with the findings from research in these areas, but also offer new insights. In particular, Category A, "understanding engineering concept" has been identified in the phenomenography studies of conceptions of learning science in (Tsai, & Kuo 2008) as his fifth Category of description, "learning (science) as understanding". But most of the Categories of description about conceptions PBL have been found exceptional as compared to previous studies of conception of learning in phenomenography perspective. These conceptions include: "*networked learning*" which has emphasized on interaction between teacher-students, student-student and student-content; "*changing conceptual development*" which mainly focused on developing new idea about the phenomena under study and "*linking knowledge to the real practice*" which emphasized on directing learning towards attainment of skills, knowledge that is required in the industry or future job careers. Therefore, these Categories of description was considered as a new insight in phenomenography studies on conception of learning in general.

Nevertheless, some of the features of these Categories are in line with the general area of previous findings of PBL. For instance, an aspect of Category A, in which the engineering students' viewed PBL as a pedagogy that gave an overall completion and good understanding of the engineering discipline. Is in line with the findings of research which asserted that, learners in PBL performed better in skill development and knowledge compilation than those who did not use PBL (Marx et al., 2004; Rivet & Krajcik, 2004; William Linn, 2003; Chan Lin, 2008; & Karaman and Celik, 2008). Similarly, the finding of this study reveals that, learning under the canopy of PBL motivate students to understand the meaning of the engineering concept rather than dogmatically storing what is exactly given to them by the teacher. The results is in accordance with the study by Bingolbali et al. (2007) which concluded that, PBL activity was the major cause of raising student learning interest and motivation towards engineering.

In Category B, PBL is seen as a pedagogical techniques that focused on connections between students and teacher as well as learning resources for the purpose of supporting one another learning in engineering discipline. This is in consistent with the results of Chua, (2014) which found that, PBL deepened student's interaction with various individuals, and had active group participation in learning process. Similarly, De Los Rios et al, (2010) also conclude that, PBL is a learning technique based on collaboration, active participation and interaction. Likewise, the current study reveals that, students-students interaction in project learning environment makes learners more active (learner centered learning) in exploring engineering knowledge and skills while teachers are mere facilitators, try to guide the students. This is in line with previous research findings which reported that, PBL maintained to generate learning processes in which students are not passive recipients of knowledge, but are immersed in learning activities (De

Los Rios et al, 2010). Similarly, Guerra, & Guerra, (2017) found that PBL is a problem orientation and self-directed learning. Kunberger (2013) also found that, PBL class setting also increased students' ability to independently acquire wider breadth of knowledge. However, this finding is in line with constructivist school of learning which viewed learners as being active rather than passive in the learning process (Duffy & Cunningham, 1996).

While In Category C, PBL was described by engineering students as an essential strategies for developing new idea of doing task through critical thinking. The view is broadly in line with De Los Rios et al, (2010) findings where he found that, PBL strategies arouses a spirit of investigation, innovation and creativity for the generation of new knowledge. This is also in line with the idea of constructivist school of learning which claims that, reality is more in the mind of the knower, that knower constructs a reality, or at least interprets it, based upon his or her appreciations (Nilsen, & Purao, 2005).

In Category D, PBL was described as a pedagogical approach in which complex real-world problems are used as a means to promote student learning in engineering discipline and the knowledge and skills acquired are used to solve societal problem. This is in consistent with the result of Tseng, Chang, Lou, & Chen, (2013) which asserted that, A curriculum combining PBL with science, technology, engineering and mathematics (STEM) could be applied to solve real world problems and to increase effectiveness in daily lives. Students were able to apply the knowledge of STEM practically and generated meaningful learning via the PBL activity. Nevertheless, this study found that if student are trained using practical project they should acquire an everlasting knowledge and skills that should make them competent, and fit for the job field immediately after graduation. This is in line with the findings of Erik and Anette, (2006) who's found that, PBL allow students to engage in a real world activities which enable them to learn by doing and applying ideas similar to the activities that adult professionals engage in a real world of work.

The current study also offer some new insights into students experience about PBL. Particularly, Category A reveals that, using an appropriate examples in engineering discipline, facilitate students' understanding of engineering activities without being subjected to practical activities. This findings has not been identified in the earlier PBL studies. Therefore, it is considered new insight from this study. However in category D, the study revealed that, when students are involve in a team learning, it promote their ability to lead or follow a leader in the society, industry or any place they found themself. This aspect also was not identified in other similar studies. Therefore, is considered as a new insight from this study. However, the current study also consistently revealed that, if engineering students are frequently involved in project learning, they gradually became more familiar with the task. Hereafter, they got deeper understanding of the knowledge and skills required. This aspect also was not identified in other similar studies. Therefore, is considered as a new insight from this study. Nonetheless, in Category B, the study reveal that, Students-teacher interaction is viewed as a communication between students and teacher in PBL setting. This include students to contact teacher upon any difficulties encountered while conducting a project and teachers also to give feedback. This aspect also was not identified in recent PBL studies and therefore, is considered as a new insight from this study

5.2. Conclusions and implications

The findings of this study have theoretical, methodological and practical implications in engineering discipline. Based on my knowledge, this is the first study that use phenomenography as its theoretical and methodological basis in investigating engineering student's experience on PBL in Bangladesh. Therefore, this study provides empirical evidence to understand the present pedagogical application of PBL in engineering education of Bangladesh, and provides a basis that a future study will be grounded.

The empirical findings of this study also provide useful insights about the different ways of seeing PBL in engineering class setting. In this study, PBL has proved to be a dominant pedagogical approach that developed deeper understanding of engineering knowledge and higher levels of skill to the engineering students. It also help students to developed new knowledge and skills and how to apply it into real practice.

Naturally, students listen to each other's comments, ask each other questions, and build rapport through frequent contact. This study also show that, once student-student interaction is established students can learned what they don't know from there student's colleagues. In conclusion, engineering teachers has to organize their PBL setting full of collaboration between students since it was found that, if students shared their knowledge and skills with other students, higher level of learning are achieved.

Teachers should take into account that, engagement in PBL is continues process for deeper acquisition of knowledge and skills building. Therefore, this study conclude that, frequent involvement of engineering students in to design and construction of a project during school hour will help them to learn how to solve novel practical problem whenever they found themselves in the society or industries. Consequently, integration of PBL in engineering education of any developed or developing countries will accelerate the technological knowhow of that country and enhance it economic prosperity. In conclusion, PBL enhanced student's ability to engage in active learning, active discovery, and active application of knowledge.

5.3 Limitation

It is important to acknowledge the limitations of this study. *Firstly*, the sample included sixteen engineering student. This sample size could be considered as small in some methodologies, such as quantitative research, however it is adequate for a qualitative phenomenography study. Trigwell, (2000) recommended 15–20 interviewees for this research approach and stated that the reasonable variation could be provided by a minimum of 10–15 participants.

Secondly, the participants came from two universities in Bangladesh with only one female engineering student. In the first institution, there is no female student at the recommended level of the study while in the other institution, several invitation were sent to both male and female engineering students, unfortunate only one female was agreed to participate in this study voluntarily. However, the participants has diverse backgrounds and subject specialization, and their expressed views reflected a broad range of ways of experiencing PBL in their class setting. Nevertheless, the outcome space may not capture some ways of experiencing the phenomenon that might emerge from a larger and broader sample of participants. Therefore, these findings should not be generalized to the outcome of PBL in another contexts in Bangladesh or at a global level unless if the education setting is similar to the institution selected.

Thirdly, the time needed to complete this study was short, when compared with the content coverage of the study and specifically some respondent were not very free to accept to participate in the study, as they though the interviewee identity will remain open to the general public.

5.4 Future research recommendation

The following recommendation have been made for further studies:

I. The faculty of engineering in Bangladesh where the study took place, has more than four engineering programmes (both bachelor and master levels). This study interview only 16 bachelor which does not create a full picture of how PBL is practiced across the faculty. Further research may consider engaging engineering students from other programmes in a large scale, preferably the whole Bangladesh in particular or southern Asia at large.

II. This study did not investigate teacher's conception on PBL which may bring another input. Further research may also consider engaging teachers in similar study.

III. Finally, this study used (qualitative) semi structure interview schedule as the only instrument for data gathering which limited the scope of the participants in this study. Therefore, further study may conduct with both quantitative and qualitative tool for data collection in order to get triangulation of data and generalize the finding to the entire population.

BIBLIOGRAPHY

ABET (Accreditation Board for Engineering and Technology). Criteria for Accrediting Engineering Programs, 2016 – 2017; http://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2016-2017/

Åkerlind, G. S. (2012). "Variation and commonality in phenomenographic research methods." Higher education research & development **31**(1): 115-127.

Ally, M. (2004). Foundations of educational theory for online learning. *Theory and practice of online learning*, *2*, 15-44.

Albanese, M. A., & Mitchell, S. (1993). Problem-based learning: a review of literature on its outcomes and implementation issues. *Academic medicine*, *68*(1), 52-81.

Barcala Montejano, M. A., Rodríguez Sevillano, A., Gandia Agüera, F., & Holgado-Vicente, J. M. (2011). Project based learning activities as a means of adapting conventional curricula to the demands of the 21st century aeronautical engineer: The design and building of the EYEFLY 1

Bingolbali, E., Monaghan, J., & Roper, T. (2007). Engineering students' conceptions of the derivative and some implications for their mathematical education. *International Journal of Mathematical Education in Science and Technology, 38(6), 763–777.*

Blumenfeld, P. C., Soloway, E., Marx, R. W., Krajcik, J. S., Guzdial, M., & Palincsar, A. (1991).Motivating project-based learning: Sustaining the doing, supporting the learning. *Educational psychologist*, *26*(3-4), 369-398.

Bowden, J. (2005). Reflections on the Phenomenographic Team Research Process. In J. Bowd & P.Green (Eds.), *Doing Developmental Phenomenography* (pp. 11-31): Melbourne: RMIT University Press.

Bruce, C., Pham, B., & Stoodley, I. (2004). Constituting the significance and value of research: Views from information technology academics and industry professionals. *Studies in Higher Education*, *29*(2), 219-238.

Bruce, C. S. (1994). Research students' early experiences of the dissertation literature review. *Studies in Higher Education*, *19*(2), 217-229.

Buehl, M. M., & Alexander, P. A. (2001). Beliefs about academic knowledge. *Educational Psychology Review, 13,* 325–351.

Berglund, A., (2005) Learning Computer Science in a Distributed Project Course: the what why, how and where. PhD thesis, Uppsala University, Interfaculty Units, Acta Universitatis Upsaliensis,

Carter, S. (2016). *Traditional vs. project-based learning: The effects on student performance and motivation in honors level mathematics courses*. Liberty University.

Carstensen, A. K., & Bernhard, J. (2009). Student learning in an electric circuit theory course: Critical aspects and task design. *European Journal of Engineering Education*, *34*(4), 393-408.

Case, J. M., & Light, G. (2011). Emerging methodologies in engineering education research. *Journal of Engineering Education, 100*(1), 186.

ChanLin, L. J. (2008). Technology integration applied to project-based learning in science. *Innovations in Education and Teaching International*, 45(1), 55–65.

Chowdhury, H., & Alam, F. (2012). Engineering education in Bangladesh–an indicator of economic development. *European Journal of Engineering Education*, *37*(2), 217-228.

Chua, K.J. (2014) A comparative study on first-time and experienced project based learning students in an engineering design module, *European Journal of Engineering Education*, 39:5, 556-572, DOI: 10.1080/03043797.2014.895704

Chau, K. W. 2005. "Problem-based Learning Approach in Accomplishing Innovation and Entrepreneurship of Civil Engineering Undergraduates." *International Journal of Engineering Education* 21 (2): 228–232.

Cömert, G. G. (2014). The effect of project based learning oriented instruction on students'und erstanding of human circulatory system concepts and attitude toward biology (doctoral dissertation, Middle East technical university

Crawley, E. F. (2001). The CDIO Syllabus. *A statement of goals for Undergraduate Engineering Education*.

Csikszentmihalyi, M., Rathunde, K., & Whalen, S. (1997). *Talented teenagers: The roots of success and failure*. Cambridge University Press.

DeFillippi, R. J. (2001). Introduction: Project-based learning, reflective practices and learning.

De Los Rios, I., Cazorla, A., Díaz-Puente, J. M., & Yagüe, J. L. (2010). Project–based learning in engineering higher education: two decades of teaching competences in real environments. *Procedia-Social and Behavioral Sciences*, *2*(2), 1368-1378.

Duarte, A. M. (2007). Conceptions of learning and approaches to learning in Portuguese students. *Higher Education*, *54*(6), 781-794.

Du, Xiangyun, Erik de Graaff, and Anette Kolmos. (2009). *Research on PBL Practice in Engineering Education*. Rotterdam: Sense Publishing.

Duffy, T. M., & Cunningham, D. J. (1996). Constructivism: Implications for the design and delivery of instruction. In D. H. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 170-198). New York: Simon & Schuster Macmillan.

De Graaff, Erik, and Anette Kolmos. (2007). Management of Change: Implementation of Problem-based and Project-based Learning in Engineering. Rotterdam: Sense Publishers.

Ebenezer, J. V., & Fraser, D. M. (2001). First year chemical engineering students' conceptions of energy in solution processes: Phenomenographic categories for common knowledge construction. *Science Education*, *85*(5), 509-535.

Eklund-Myrskog, G. (1998). Students' conceptions of learning in different educational contexts'.*Higher Education*, 35, 299–316.

Entwistle, N. J., & Peterson, E. R. (2004). Conceptions of learning and knowledge in higher education: Relationships with study behaviour and influences of learning environments. *International journal of educational research*, *41*(6), 407-428.

Erik D. G. and Anette. K. (2006). *Management of Change Implementation of Problem-Based and Project-Based Learning in Engineering*, Sense Publishers, http://www.sensepublishers.com

Felder, R. M., & Brent, R. (2003). Designing and teaching courses to satisfy the ABET engineering criteria. *Journal of Engineering Education*, *92*(1), 7-25.

Gavin, K. (2011) Case study of a project-based learning course in civil engineering design, European Journal of Engineering Education, 36:6, 547-558, DOI: 10.1080/03043797.2011.624173

Gay, L. R., Mills, G. E., & Airasian, P. W. (2011). *Educational research: Competencies for analysis and applications*. Pearson Higher Ed.

Jennifer M. C and Gregory L. (2011). Emerging Methodologies in Engineering Education Research; Journal of Engineering Education; Vol. 100, No. 1, pp. 186–210 © 2011 . http://www.jee.org

Gijselaers, W. H. (1996). Connecting problem-based learning with educational theory, in: L. Wilkerson & W. H. Gijselaers (Eds) *Bringing problem-based learning to higher education: theory and practice.* San Francisco, CA, Jossey-Bass, 13-21.

Gonzalez, C. (2009). Conceptions of, and approaches to, teaching online: a study of lecturers teaching postgraduate distance courses. *Higher Education*, *57*(3), 299-314.

Green, P. (2005). A rigorous journey into phenomenography: From a naturalistic inquirer standpoint.

Guba, E. G. (1981). Criteria for assessing the trustworthiness of naturalistic inquiries. *Educational Technology Research and Development*, *29*(2), 75-91.

Guerra, A., & Guerra, A. (2017). Integration of sustainability in engineering education: Why is PBL an answer? *International Journal of Sustainability in Higher Education*, *18*(3), 436-454.

Hadgraft, R. G. (1992). Experiences of two problem-oriented courses in Civil Engineering. *European Journal of Engineering Education*, *17*(4), 345-353.

Hadgraft, R. (1997). Student reactions to a problem-based, fourth-year computing elective in civil engineering. *European journal of engineering education*, *22*(2), 115-123.

Heikkilä, A., Niemivirta, M., Nieminen, J., & Lonka, K. (2011). Interrelations among university students' approaches to learning, regulation of learning, and cognitive and attributional strategies: a person oriented approach. *Higher Education*, *61*(5), 513-529.

Helle, L., Tynjälä, P. and Olkinuora, E. (2006). Project-based learning in post-secondary education – theory, practice and rubber sling shots. *Higher Education*, 51 (2), 287–314.

Hendy, P.L. & Hadgraft, R.G., (2002).Evaluating problem-based learning in Civil Engineering. In 13th Annual Conference of the Australasian Association for Engineering Education, 30 Sept–2 Oct, 2002, Canberra, Australia. pp. 133-138,

Jamieson, L. H., & Lohmann, J. R. (2009). Creating a culture for scholarly and systematic innova-tion in engineering education. Washington, DC: American Society for Engineering Education. http://www.asee.org/about-us/the- organization/advisory-commit-tees/CCSSIE

Jurewitsch, Brian. (2012). "A Meta-Analytic and Qualitative Review of Online Versus Face-to-face Problem-Based Learning." Journal of Distance Education (Online) 26 (2): 1.

Karaman, S., & Celik, S. (2008). An exploratory study on the perspectives of prospective computer teachers following project-based learning. *International Journal of Technology and Design Education*, 18(2), 203–215.

Keser, H., & Karahoca, D. (2010). Designing a project management e-course by using project based learning. *Procedia-Social and Behavioral Sciences*, *2*(2), 5744-5754.

Khan, S. H. (2015). Emerging conceptions of ICT-enhanced teaching: Australian TAFE context. *Instructional science*, 1-26.

Khan, M.H. & Markauskaite, L. High Educ (2016). Dois : 10.1007/s10734-016-9990-2

Krajcik, J., Blumenfeld, P. C., Marx, R. W., Bass, K. M., Fredricks, J., & Soloway, E. (1998). Inquiry in project-based science classrooms: Initial attempts by middle school students. *Journal of the Learning Sciences*, *7*(3-4), 313-350.

Krajcik, J. S., Blumenfeld, P. C., Marx, R. W., & Soloway, E. (1994). A collaborative model for helping middle grade science teachers learn project-based instruction. *The elementary school journal*, *94*(5), 483-497.

Kunberger,T. (2013). “Revising a Design Course from a Lecture Approach to a Project-based Learning Approach.” *European Journal of Engineering Education* 38 (3): 254–267.

Kvale, S. (1996). *Interviews: an introduction to qualitative research interviewing* Thousand Oaks, CA: Sage.

Lam, S. F., Cheng, R. W. Y., & Ma, W. Y. (2009). Teacher and student intrinsic motivation in project-based learning. *Instructional Science*, *37*(6), 565.

Land, S. M., & Greene, B. A. (2000). Project-based learning with the World Wide Web: A qualitative study of resource integration. *Educational technology research and development*, *48*(1), 45-66.

Li, J. (2003). U.S. and Chinese cultural beliefs about learning. *Journal of Educational Psychology, 95,* 258–267.

Li, J. (2004). “I learn and I grow big”: Chinese preschoolers’ purposes for learning. *International Journal of Behavioral Development, 28,* 116–128.

Li, L. (2014): Project-based learning in electronic technology: a case study, *European Journal of Engineering Education*, DOI: 10.1080/03043797.2014.987650

Litzinger, T., et al. (2011). "Engineering education and the development of expertise." *Journal of Engineering Education* **100** (1): 123-150.

Lee, M. H., Johanson, R. E., & Tsai, C. C. (2008). Exploring Taiwanese high school students' conceptions of and approaches to learning science through a structural equation modeling analysis. *Science Education, 92*(2), 191-220.

Lonka, K., Olkinuora, E., & Ma¨kinen, J. (2004). Aspects and prospects of measuring studying and learning in higher education. *Educational Psychology Review*, 4, 301–324.

Loyens, S. M., Rikers, R. M., & Schmidt, H. G. (2009). Students' conceptions of constructivist learning in different programme years and different learning environments. *British Journal of Educational Psychology, 79*(3), 501-514.

Marshall, D., Summer, M., & Woolnough, B. (1999). Students' conceptions of learning in an engineering context. *Higher education*, *38*(3), 291-309.

Marton, F. (1975). On non-verbatim learning: I. Level of processing and level of outcome. *Scandinavian Journal of Psychology*, 16, 273–279.

Marton, F. (1976). What does it make to learn? Some implications of an alternative view of learning. In N. Entwistle (Ed.), Strategies for research and development in higher education (pp. 32–43). Amsterdam: Swets & Zeitlinger.

Marton, F. (1981). Phenomenography—describing conceptions of the world around us. *Instructional Science, 10,* 177–200.

Marton, F. (1986). Phenomenography—a research approach to investigating different understandings of reality. *Journal of thought*, 28-49.

Marton, F., & Booth, S. (1997). *Learning and awareness*: New Jersey: Lawrence Erlbaum Associates.

Marton, F., Dall'Alba, G., & Beaty, E. (1993). Conceptions of learning. *International Journal Of educational Research*, 19(3), 277–300.

Marton, F., & Sa¨ljo¨ , R. (1976). On qualitative differences in learning. I. Outcome and process. *British Journal of Educational Psychology*, 46, 4–11.

Marton, F., & Pong, W. Y. (2005). On the unit of description in phenomenography. *Higher Education Research and Development*, *24*(4), 335-348.

Marton, F. (1988). Describing and improving learning. In R. Schmeck (Ed.), *Learning strategies and learning styles* (pp. 53-82). New York, NY: Plenum Press.

Marton, F. (1994). Phenomenography In T. Husen & T. Postlethwaite (Eds.), *The International Encyclopedia of Education* (pp. 4424 - 4429). Oxford: Pergamon.

Marx, R. W., Blumenfeld, P. C., Krajcik, J. S., Fishman, B., Soloway, E., Geier, R., & Revital T. T. (2004). Inquiry-based science in the middle grades: Assessment of learning in urban systemic reform. Journal of Research in Science Teaching, 41(10), 1063–1080.

Mills, J.E., (2002) A case study of project-based learning in structural engineering, In American Society for Engineering Education (ASEE) Annual conference, June 16-19, Montreal, Canada. On-line at

Mills, J. E., & Treagust, D. F. (2003). Engineering education. Is problem-based or project-based learning the answer. *Australasian journal of engineering education*, *3*(2), 2-16.

Mioduser, D., & Betzer, N. (2008). The contribution of Project-based-learning to high-achievers' acquisition of technological knowledge and skills. *International Journal of Technology and Design Education*, *18*(1), 59-77.

Morgan, J. R., Moon, A. M., & Barroso, L. R. (2013). Engineering better projects. In *STEM Project-Based Learning* (pp. 29-39). SensePublishers.

Nilsen, H., & Purao, S. (2005). Balancing objectivist and constructivist pedagogies for teaching emerging technologies: Evidence from a Scandinavian case study. *Journal of Information Systems Education*, *16*(3), 281.

Palmer, S., and W. Hall. (2011). "An Evaluation of a Project-based Learning Initiative in Engineering Education." *European Journal of Engineering Education* 36 (4): 357–365.

Pramling, I. (1983). *The Child's Conception of Learning. Goteborg Studies in Educational Sciences 46*. ACTA Universitatis Gothoburgensis, Box 5096, S-402 22, Goteborg, Sweden (no price quoted)

Prince, M., and R. Felder. 2006. "Inductive Teaching and Learning Methods: Definitions, Comparisons, and Research Bases." *Journal of Engineering Education* 95 (2): 123–138.

Purdie, N. M. and J. Hattie (2002). "Assessing students' conceptions of learning." *Australian Journal of Educational and Developmental Psychology* **2**: 17-32.

Raelin, J. (2006). Does action learning promote collaborative leadership? *Academy of Management Learning & Education*, *5*(2), 152-168.

Resnick, L. B. (1989). Introduction. In L. B. Resnick (Ed.), Knowing, learning, and instruction: Essays in honor of Robert Glaser (pp. 1–24). Hillsdale, NJ: Erlbaum.

Resnik, M., & Ocko, S. (1990). Constructionist learning. LEGO/LOGO: Learning through and about design. Boston: MIT Media Laboratory.76 Int J Technol Des Educ (2007) 18:59–77

Rivet, A., & Krajcik, J. (2004). Achieving standards in urban systemic reform: An example of a sixth grade project-based science curriculum. Journal of Research in Science Teaching 41(7), 669–692.

Rossini, P. A., & Yam, L. H. (2010). Implementing a project-based learning approach in an introductory property course.

Sandberg, J. (1994). *Human Competence at Work (PhD* (Doctoral dissertation, Thesis), University of Gothenburg.

Sandbergh, J. (1997). Are phenomenographic results reliable? *Higher Education Research & Development*, *16*(2), 203-212.

Sa¨ ljo¨ , R. (1979). Learning about learning. Higher Education, 8, 443–451.

Savery, J. R., & Duffy, T. M. (1995). Problem based learning: An industrial model and its constructivist framework. Educational Technology, September–October, 31–37.

Sheppard, S., Macatangay, K., Colby, A., & Sullivan, W. M. (2009). Educating engineers: designing for the future of the field. San Francisco, CA: Jossey-Bass.

Sjöström, B., & Dahlgren, L. O. (2002). Applying phenomenography in nursing research. *Journal of advanced nursing*, *40*(3), 339-345.

Slunt, K. M., & Giancarlo, L. C. (2004). Student centered: A comparison of two different methods of instruction. *Journal of Chemical Education*, *81*(7), 985-988.

Stamouli, I., & Huggard, M. (2007). Phenomenography as a tool for understanding our students. In *International Symposium for Engineering Education* (pp. 181-186).

Terrón-López, M. et al, (2016): Implementation of a project-based engineering school: increasing student motivation and relevant learning, European Journal of Engineering Education, DOI: 10.1080/03043797.2016.1209462

Thomas, J. W. (2000). A review of research on project-based learning. San Rafael, CA: Autodesk Foundation.

Tsai, C.-C. (2004). Conceptions of learning science among high school students in Taiwan: A phenomenographic analysis. *International Journal of Science Education*, *26*, 1733–1750.

Trigwell, K. (2000). A phenomenographic interview on phenomenography. In J. Bowden & E. Walsh (Eds.), *Phenomenography* (pp. 62–82). Melbourne: RMIT University Press.

Tsai, C. C., & Kuo, P. C. (2008). Cram school students' conceptions of learning and learning science in Taiwan. *International Journal of Science Education*, *30*(3), 353-375.

Tseng, K. H., Chang, C. C., Lou, S. J., & Chen, W. P. (2013). Attitudes towards science, technology, engineering and mathematics (STEM) in a project-based learning (PjBL) environment. *International Journal of Technology and Design Education*, *23*(1), 87-102.

Tuncay, N., & Ekizoğlu, N. (2010). Bridging achievement gaps by "free" project based learning. *Procedia-Social and Behavioral Sciences*, *2*(2), 5664-5669.

Uljens, M. (1996). On the philosophical foundations of phenomenography. In G. Dall'Alba & B. Hasselgren (Eds.), *Reflections on phenomenography: Toward a methodology* (Gothenburg Studies in Educational Sciences No. 109). Gothenburg: Acta Universitatis Gothoburgensis.

Vernon, D. T., & Blake, R. L. (1993). Does problem-based learning work? A meta-analysis of evaluation research. Academic Medicine, 68(7), 550–563.

Williams, M., & Linn, M. (2003). WISE Inquiry in fifth grade biology. Research in Science Education, 32 (4), 415–436.

Williams, A., & Williams, J. (1997). Problem-based learning: An appropriate methodology for technology education. Research in Science & Technological Education, 15(1), 91 103.

Wright, G. B. (2011). Student-centered learning in higher education. *International Journal of Teaching and Learning in Higher Education*, *23*(1), 92-97.

Zhou, C. (2012). “Integrating Creativity Training into Problem and Project-based Learning Curriculum in Engineering Education.” *European Journal of Engineering Education* 37 (5): 488–499.

APPENDICES

Appendix A, Participant Information Statement

(1) What is the study about

This study aim to describe the qualitative variation in the way a group of Engineering students experienced PBL approach in there domain. It would like to explore your understanding of PBL the ways you think about it and how often you experience it in your engineering class setting.

(2) Who is carrying out the study?

This study is being conducted by M.sc TE student of the Department of Technical and Vocational Education (TVE), Islamic University of Technology, a subsidiary organ of the Organisation of Islamic Cooperation (OIC), under the supervision of Dr. Shahadat Hossain Khan, Assistant Professor Technical and Vocational Education (TVE) Department; Islamic University of Technology (IUT) .

(3) What does the study involve?

This study involves interview and you will be invited at a time suitable for you. The interview will take place in any convenient place to you, and it will focus on your experience and understanding regarding PBL in your engineering class setting.

(4) How much time will the study take?

The interview will take 40-50 minutes.

(5) Can I withdraw from the study?

Yes. Being in this study is completely voluntary you are not under any obligation to consent and - if you do consent - you can withdraw at any time without affecting your relationship with Islamic University of Technology, and without having to give a reason. If you decide to withdraw from the study, please inform Ibrahim Adamu (telephone: +8801736729128, Email: ibrahimadamumaga@gmail.com).

(6) Will anyone else know the results?

All aspects of the study, including results, will be strictly confidential and only the researcher will have access to information about participants. A report of the study will be prepared and submit to the IUT for partial fulfilments for the award of masters of Science in Technical Education in Electrical and Electronic Engineering. It is important to note that Individual participants will not be identifiable in such reports.

(7) Will the study benefit me?

While there are no direct benefits to the participants, as there is no reward or reimbursement for participation in this study, but there may be indirect benefits in terms of the findings of this study contributing for improving current pedagogical techniques in engineering education of Bangladesh.

(8) Can I tell other people about the study?

Yes.

(9) What if I require further information about the study or my involvement in it?

When you have read this information, the researchers will discuss it with you further and answer any questions you may have. If you would like to know more at any stage, please feel free to contact: Ibrahim Adamu (telephone: +8801736729128, Email: ibrahimadamumaga@gmail.com). Or Dr. Shahadat Hossain Khan (telephone: +8801798470248, email: shkhants@gmail.com).

Ibrahim Adamu ID No: 153607 M.Sc. TE student Technical and Vocational Education (TVE) Department; Islamic University of Technology (IUT) Room: 211, South Hall, IUT campus, Board Bazar, Gazipur-1704, Bangladesh Email: ibrahimadamumaga@gmail.com Mobile:+8801736729128/ +2347033848133	Dr. Shahadat Hossain Khan Chief Researcher Assistant Professor Technical and Vocational Education (TVE) Department; Islamic University of Technology (IUT) Room: 302 Academic Building 1, IUT campus, Board Bazar, Gazipur-1704 Bangladesh Email: shkhants@gmail.com Web: http://www.iutoic-dhaka.edu Mobile:+8801798470248

This information sheet is for you to keep

Appendix B: Participant Consent Form

Ibrahim Adamu ID No. 153607 M.Sc. TE student Technical and Vocational Education (TVE) Department; Islamic University of Technology (IUT) Room: 211, South Hall, IUT campus, Board Bazar, Gazipur-1704, Bangladesh Email: ibrahimadamumaga@gmail.com Mobile:+8801736729128/ +2347033848133	Dr. Shahadat Hossain Khan Chief Researcher Assistant Professor Technical and Vocational Education (TVE) Department; Islamic University of Technology (IUT) Room: 302 Academic Building 1, IUT campus, Board Bazar, Gazipur-1704 Bangladesh Email: shkhants@gmail.com Web: http://www.iutoic-dhaka.edu Mobile:+8801798470248

I, ...[PRINT NAME], give consent to my participation in the research project

TITLE: **Students' Experience on Project Based Learning (PBL) in Engineering Education of Bangladesh (Case study)**

In giving my consent I acknowledge that:

1. The procedures required for the project and the time involved have been explained to me and any questions I have about the project have been answered to my satisfaction.

2. I have read the Participant Information Statement and have been given the opportunity to discuss the information and my involvement in the project with the researcher.

3. I understand that being in this study is completely voluntary – I am not under any obligation to consent.

4. I understand that my involvement is strictly confidential. I understand that any research data gathered from the results of the study may be published however no information about me will be used in any way that is identifiable.

5. I understand that I can withdraw from the study at any time, without affecting my relationship with the researcher(s) or polytechnic institution now or in the future.

6. I understand that I can stop the interview at any time if I do not wish to continue, the audio recording will be erased and the information provided will not be included in the study.

7. I consent to:

- Audio-recording YES ☐ NO ☐
- Receiving Feedback YES ☐ NO ☐

If you answered YES to the "Receiving Feedback" question, please provide your details i.e. mailing address, email address.

Feedback Option

Address: ____

____

Email: ____

……………………………………………………………………

Signature

………………………… ……………………………………………

Please PRINT name

……………………………………………………………………

Date

Appendix C: Interview Schedules

PART ONE: Introduction

I sincerely thank you for accepting to participate on this study the interview schedule will take about 40 to 50 minutes of your today's time.

Before I start this interview I will like to give you some overview of what I am trying to achieve. I am conducting a research on **Project based learning** (PBL). My aim is to describe the qualitative variation in the way a group of Engineering students experienced the PBL approach in there domain. In this interview with you I would like to explore your understanding of PBL the ways you think about it and how often you experience it in your engineering class setting. I have prepared several key questions to ask you in two areas PBL itself, and how often you experience it's in your engineering setting, Depending on your responses, these questions may be followed up by other questions.

Please allow me to give brief introduction on the concept PBL: it is a technique, strategy, approach or method which aimed at bringing practical experiences into the classroom. PBL give opportunity for students to investigate questions, propose assumption and explanations, discuss their ideas, and challenge the ideas of others, to come out with new knowledge/idea. It can be Theoretical or practical knowledge but must be relevant to their field of study and that are similar to what scientists, engineers, mathematicians, writers, and historians do.

For instance a teacher may explain a concept, method or technique of some things in the class/lab he may ask students to design or come out with a new technique within a specific period of time that they thing is more suitable to their environment and justify their outcome. In this scenario, Learners decide how to approach a problem. Students will review relevant literature of within and across the discipline to come up with the new technique and convince a teacher that this technique or method is suitable to the present situation. The teachers role is only to guide and advice the students, students are judged by how much they've learn, communicate and convince the teacher. This task can be assign to individual or a group of students.

However, as we agreed when I first contacted you, I will be recording the interview on audiotape as it will be transcribed along with others in the study and I am assuring you that, the information you give will be used purposively for this study only and your identity will remain confidential. Is that still alright with you?

Yes.

Alright, let’s go.

PART TWO: differences of students’ understanding on PBL in engineering education (What aspect).

1. What do you understand by PBL? (otherwise as an Engineering Student, what is your thinking on the concept of PBL)

   Probes:

   I. Why do you think this?

   II. Can you explain more with relevant example?

   III. Can you cite more examples?

2. What type of learning experience acquired in a PBL class? (What type of knowledge acquired in PBL class)

   Probes:

   I. Why do you think this?

   II. Can you explain more with relevant example?

3. What type of teaching strategies/ techniques will lead to PBL?

   Probes:

   I. Give some reason why do you think like that?

   II. Can you explain more with relevant example?

PART TWO: To identify Qualitative different ways of experiencing PBL in there study (How aspect).

1. How often do you experience PBL in your engineering class setting?

   Probes:

   I. Can you give more examples?

2. How do you expect to learn engineering concept in the class room as well as laboratory/workshop? (Which strategies, techniques, method do you expect will be suitable in learning engineering concept)

Probes:

I. Why do you think this?

II. What are the benefit of using this strategies to engineering students?

3. How does your engineering teachers teach you in the class room and laboratory?

   Probes:

   I. Why do you think your teachers are using such strategy?

   II. Do you thing such strategy/method is helpful to engineering students and how?

4. What are the advantages and disadvantages of PBL based on your understanding?

Closing of the interview:

Before we finish is there anything that you would like to share with me about your experience on PBL which you have not been mentioned?

Thank you and God bless.

Ibrahim Adamu (153607)

Appendix D: Table A: Showing the process of developing the final outcome space

Categories	Version I	Version II	Version III	Version IV
A	Understanding, acquisition and use of knowledge	Linking PBL with student understanding of engineering concept	Knowledge acquisition and retention	Understanding of Engineering Concept
B	Collaborative learning style	Collaborative learning style	Classroom interaction	Enhancing Networked Learning
C	Students centered learning	Students engagement in learning process	Student's involvement in learning	Changing Conceptual Development
D	Application of knowledge in to practice	Linking PBL learning style with real world of work.	Linking PBL to the real world of work.	Linking Knowledge to the real practice.