AN ANALYSIS OF THE PROBLEM-BASED INSTRUCTION IN ENGINEERING EDUCATION

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ABSTRACT

AN ANALYSIS OF THE PROBLEM-BASED INSTRUCTION IN ENGINEERING EDUCATION

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The main aim of this study was to analyze the implementation of problem-based instruction in electrical-electronics engineering education from the perspectives of tutors and students. Secondary aim of the study was to compare engineering students' motivation and their use of learning strategies who received their first year curriculum in problem-based learning (PBL) format, in comparison to those who received their curriculum in a conventional lecture format. A multi-method research design that incorporated case study and causal comparative designs were employed in this study. Fourteen electrical-electronics engineering students and four tutors working as instructors at this department were selected for the case study. Observations, interviews, and document analysis were used to collect qualitative data. For the causal comparative study, Motivated Strategies for Learning Questionnaire was administered to 452 freshman engineering students twice as a pre-test and after a three months period as a post-test. Multivariate Analyses of Covariance was used to compare the two groups on the dependent variables of the current study.

The findings of the case study indicated students' and tutors' perceptions and opinions about the implementation of PBL, its strengths and weaknesses, factors affecting tutors' and students' performance and their improvement suggestions.

The results of the causal comparative study indicated that there was a significant difference between the two groups in favor of the group receiving PBL curriculum with respect to students' extrinsic goal orientation and test anxiety; their use of elaboration strategy; their management of effort regulation, and time and study environment.

Keywords: Physics education, problem-based learning, motivation, learning strategies.

ÖZ

MÜHENDİSLİK EĞİTİMİNDE PROBLEME DAYALI ÖĞRETİMİN ANALİZİ

Ateş, Özlem
Doktora, Orta Öğretim Fen ve Matematik Alanları Eğitimi Bölümü
Supervisor: Assist. Prof. Dr. Ali Eryılmaz

Şubat 2009, 193 sayfa

Bu çalışmanın temel amacı elektrik-elektronik mühendisliğinde uygulanan probleme dayalı öğretimin incelenmesidir. Çalışmanın ikinci amacı ise probleme dayalı öğretim ve geleneksel öğretim gören mühendislik eğitimi birinci sınıf öğrencilerini motivasyon ve öğrenme tekniklerini kullanmaları açısından karşılaştırmaktır. Çalışmada, nedensel karşılaştırma ve örnek olay çalışmasını içeren çok metotlu araştırma yöntemi kullanılmıştır. Örnek olay çalışması için elektrik-elektronik mühendisliğinde öğrenim görmekte olan 14 öğrenci ve bu bölümde ders veren 4 akademisyen seçilmiştir. Nitel veriler görüşme, gözlem ve doküman analizi yöntemleriyle toplanmıştır. Nedensel karşılaştırma çalışması, 452 mühendislik öğrencisine Öğrenmede Güdüsel Stratejiler Anketi ön test ve üç aylık bir süreç sonunda da son test olarak uygulanmıştır. Çalışmada yer alan iki grubu bağımlı değişkenler açısından karşılaştırmak için çok yönlü kovaryans analizi (MANCOVA) kullanılmıştır.

Örnek olay çalışmasının sonucunda öğrenci ve akademisyenlerin probleme dayalı öğrenmenin uygulanması, probleme dayalı öğrenmenin güçlü ve zayıf yönleri, öğrenci ve akademisyenlerin performanslarına etki eden faktörler, problem ve eksikliklerin giderilmesine yönelik çözüm önerileri ile ilgili görüş ve algıları

incelenmiştir. Bu bulgulara gözlem ve doküman analizlerinin sonuçları da eklenmiştir.

Nedensel karşılaştırma çalışmasının sonuçları incelendiğinde test kaygısı, dışsal hedefe yönelme, elaborasyon, çaba harcama ve zaman yönetimi açısından probleme dayalı öğrenim gören öğrencilerin lehine anlamlı bir fark ortaya çıkmıştır.

Anahtar Kelimeler: Fizik Eğitimi, probleme dayalı öğrenme, motivasyon, öğrenme stratejileri.

To my parents

Halil and Nesibe Hardal

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

SYMBOLS

PBL:	Problem-Based Learning
DEU:	Dokuz Eylul University
EEED:	Electrical-Electronics Engineering Department
GPA:	Grade Point Average
THS:	Type of High Schools
OP:	Order of Preference at the Student Selection Exam
REPT:	Repeat a class
MSLQ:	Motivated Strategies for Learning Questionnaire
PDÖ:	Probleme Dayalı Öğrenme
IGO:	Intrinsic Goal Orientation
EGO:	Extrinsic Goal Orientation
TV:	Task Value
CLB:	Control of Learning Beliefs
SE:	Self-Efficacy for Learning and Performance
TA:	Text Anxiety
REH:	Rehearsal
ELA:	Elaboration
ORG:	Organization
CRT:	Critical Thinking
MSR:	Metacognitive Self-Regulation
TS:	Time and Study Environment
EF:	Effort Regulation
PL:	Peer Learning
HS:	Help Seeking
SELS:	Students' Selection Examination
MOT:	Methods of Teaching

MANCOVA:	Multivariate Analysis of Covariance
ANCOVA:	Analysis of Covariance
SPSS:	Statistical Package Program for Social Sciences
GOF:	Goodness of Fit
GFI:	Goodness of Fit Index
RMR:	Root-Mean-Square Residual
RMSEA:	Root-Mean-Square Error of Approximation
CG:	Conventional Group
PG:	Problem-Based Learning Group
MRC:	Multiple Regression Correlation
df:	Degrees of Freedom
N:	Sample Size

CHAPTER 1

INTRODUCTION

One of the greatest challenges in education is finding methods of making learning meaningful for students. One way to meet this challenge is to actively involve students in learning and allowing them to experience the construction of knowledge. Students can best learn the importance of material when each lesson helps them internalize their individual understanding (Strain & Pearce, 2001).

Problem-based learning (PBL) is a learner-centered instructional format requiring students to participate actively in their own learning by researching and working through a series of real-life problems to arrive at a best solution (Arambula-Greenfield, 1996). Since its beginning, PBL has become widespread in the education of doctors and has been adapted in curricula in a variety of disciplines and educational settings from elementary schools to graduate business education (Graziano, 2003).

Despite the many variations of PBL that have evolved and various domains it has been implemented, a basic definition of PBL was needed to serve as a basis of comparison with other educational methods (Dochy, Segers Van den Bossche & Gijbels, 2003). Therefore, Barrows (as cited in Gijbels, Dochy, Van den Bossche & Segers, 2005) stated the six core characteristics of PBL such as:

> 1) learning is student-centered, 2) learning occurs in small student groups, 3) a tutor is present as a facilitator or guide, 4) authentic problems are presented at the beginning of the learning sequence, before any preparation or study has occurred, 5) the problems encountered are used as tools to achieve the required knowledge and the problem-solving skills necessary to eventually solve the problems, 6) new information is acquired through self-directed learning (pp. 29-30).

Although PBL is often acclaimed in terms such as “active, constructive, self-directed and student-centered,” (Bernstein et al., 1995; Dolmans, et al., 2005;

Mann & Kaufman, 1995) conventional teaching or lecture approaches are characterized as "didactic and directive", emphasizing recall of theoretical knowledge (Mann & Kaufman, 1995). When the lecture approach is used, many students do not have the proper understanding of some fundamental concepts. Studies have shown that the lecture approach associated with most textbooks leaves students as passive learners of facts and is an ineffective way to teach. Students become accustomed to receiving knowledge rather than helping to generate it by this way (McDermott, 1990; Weaver, 1998). Unlike conventional instruction, which is often teacher-centered, problem-based instruction normally occurs within an environment that is based on the learner that is facilitated by the teacher (Al-Arfaj, 1999).

Some researchers claim that PBL is consistent with the instructional principles of constructivism (Hollingshed, 2004; Savery & Duffy 1995) due to its common characteristics. Hollingshed (2004) states those characteristics as follows: students-centered inquiry, teachers acting as a guide, use of open-ended questions, teachers as a member of the learning community, and interwoven assessment with teaching. Moreover, Savery and Duffy (1995) state that the instructional principles of constructivism are realized when the PBL is implemented appropriately.

In order to implement PBL appropriately, the existing curricula should be usually restructured and some changes should be promoted in the teaching-learning process as well as in the roles of teachers, students, and teaching-learning environment (Riberio & Mizukami, 2005). A PBL classroom looks different from a conventional teacher-centered classroom because student activity is the norm. In PBL, ill-structured real life problems are used as a stimulus for learning. Whether for gathering information or drawing conclusions, students work in groups, confer with others, do labs, create physical displays, consult resources outside the classroom, and take responsibility for their own learning. Through teacher-who is called tutor or facilitator- coaching, students learn knowledge that applies to their real lives making them more willing to learn. Due to the fact that the information comes in the form of an interesting problem and students construct knowledge

logically, PBL seems more engaging to students and they retain the information by this way (Krynock & Robb, 1999). Assessment is another component of the PBL that differs from conventional curricular designs. Since the PBL is student-centered, and self-directed learning is emphasized in it, developments of effective assessment techniques are crucial. Alternative assessment which can help bridge the gap between instruction and assessment may be necessarily a better measure for an alternative pedagogy, such as PBL (Major & Palmer, 2001). Some signs of a movement in this direction exist. Some studies have been investigating PBL outcomes (Gijbels et al., 2005; Major & Palmer, 2001; Miller, 2000). Teamwork or presentation skills can be given as examples of those outcomes.

Based on the gaps of conventional medical training, PBL firstly designed for medical students at McMaster University. However in time, some other medical schools around the world began to adapt PBL. Today, most medical schools especially in US are implementing or planning to implement PBL in their curricula to a greater or lesser extent. Therefore, in literature, there are lots of studies related with the effectiveness of PBL in medical education (Barrows, 1986; Camp, 1996).

There have been eight systematic reviews or meta-analyses (Albanese & Mitchell, 1993; Berkson, 1993; Colliver, 2000b; Dochy et al., 2003; Gijbels et al., 2005; Prince 2004; Smits, Verbeek, & Buisonje, 2002; Vernon & Blake, 1993) related with the effectiveness or outcomes of PBL compared with the conventional instruction in medical education from different points of view. Summarizing those reviews or meta analyses shows some important points to us. The studies conducted in the literature in 1993 does not show large differences in favor of PBL students as compared with their counterparts in conventional instruction on knowledge assessed through conventional measures (e.g. national licencing examinations). PBL students performed a little better or worse than conventional students. Moreover, the studies of Albanese and Mitchell (1993) and Vernon and Blake (1993) suggested effects of PBL on students' skills, satisfaction and clinical performance. However Berkson (1993) found that PBL and conventional curricula

are indistinguishable. In his review, Colliver (2000a) focused on the size of the effect of PBL interventions and questioned whether the effect size is consistent with the strength of the claims and the costs of such a major curriculum intervention such as PBL. As a result of their study (Smits et al., 2002) there was limited evidence that PBL increased doctors' knowledge and performance but moderate evidence they had higher satisfaction with PBL. Later, Dochy et al. (2003) reported positive effect of PBL on the skills (knowledge application) of students and a negative effect of PBL on the knowledge base of the students. Prince (2004) emphasized that student in PBL curriculum have more positive attitudes, deeper approach to learning and more retention period compared to their conventional counterparts. Lastly Gijbels et al. (2005) conducted a meta-analysis related with the effectiveness of PBL from the angle of assessment and concluded that the effect of the PBL is larger when understanding of the principles that link concepts was the subject of assessment.

Norman and Schmidt (2000) stated that previous research on PBL caused small effects and inconclusive findings due to the fact that PBL interventions are inadequately grounded in theory. The authors claimed that studies treating PBL as a single intervention and examining the usual outcomes would arrive at a conclusion of minimal difference between PBL students and their conventional counterparts. Having lots of characteristics, different implementations, complex interactions among treatment components and unexplained variables also caused to diffuse the predicted effects (Norman & Schmidt, 2000). Moreover, Albanese (2000) commented that students' being accustomed to conventional learning environments as another cause of delays for exploring the effects of PBL. We can infer from those studies of medical education, that "readers might be feeling lost by being confronted with these confounding, sometimes contradictory, and apparently inconclusive findings" (Mamede, Schmidt, & Norman, 2006, p. 404).

In the past few decades, in addition to medical education, PBL has been implemented in higher education such as nursing, economics, pharmacy, dentistry, physiotherapy, architecture, business, law, engineering, social work, and science

towards PBL (Barrows, 1986; Camp, 1996; Dahlgren et al., 1998; Fergusson, 2003; Perrenet et al., 2000; Polanco et al., 2004; Ribeiro, & Mizukami, 2005). In higher education, engineering is one of the popular disciplines that PBL has been used as a teaching strategy (Denayer et al., 2003; Guzelis, 2006; Hadgraft, 1999; Perrenet et al., 2000; Polanco et al., 2004; Ribeiro & Mizukami, 2005; Said et al., 2005). Some of the institutions reported that they adapted PBL for their entire curriculum and some adapted it as a partial strategy.

Analyzing the most of the prior studies in literature, neglecting investigation of the actual learning process, and mostly focusing on quantitative experimental design is seen as an important weakness of those prior studies. Those studies do not clearly involve whether the educational approach being described is actually PBL. Even if an implementation is a true PBL based on its core principles, PBL curriculum vary along some dimensions. Since the dimensions and implementations of this multifaceted approach are not clearly reported in most of the studies, the educational outcomes may not give confidence to the readers. Therefore, there is a need for process-oriented studies as well as outcome-oriented studies (not only statistical meta analysis and quantitative reviews but also narrative studies) reporting educational interventions, their reason for calling their implementation as PBL based on some criteria or principles, and what really happens in the PBL environment in a more detailed way (Charlin, Mann & Hansen, 1998; Dolmans 2003; Lee, 2004).

In literature, there are some studies aiming to define PBL interventions and investigate components of PBL environment in terms of students' and tutors' opinions or perceptions. The main purposes for some of those studies are given as follows: investigating attitudes and opinions of tutors in PBL curriculum as compared to a conventional medical curriculum (Vernon, 1995; Vernon & Hosokawa 1996) investigating tutors' opinions about the relative benefits of PBL and tutors' level of satisfaction and the difficulties the tutors face with (Kaufman & Holmes, 1996); analyzing teachers' experience of the planning and implementation of PBL (Dahlgren, Castensson & Dahlgren, 1998); comparing

attitudes of a sample of students attending PBL courses and students attending conventional courses (Kaufman & Mann, 1996); investigating perceptions of students' abilities to be self-directed learners changing over time (Ryan, 1993); assessing the level of interest, enthusiasm and personal satisfaction of the students experiencing PBL (Barman, Jaafar, & Naing, 2006); investigating students' perceptions of PBL process (Hollinshed, 2004); investigating opinions of students and tutors about the effectiveness of PBL (Musal, Taskiran, & Kelson, 2003); evaluating problem-based instructional approach (Ribeiro & Mizukami, 2005). However, the vast majority of those studies are investigated in medical education and very few of those studies provide detailed and rich descriptions about what happens in the PBL environment and what are the students' and tutors' (basic components of PBL) perceptions related with the implementation of PBL.

1.1 Purpose of the Study

The main purpose of this study is to analyze the implementation of problem-based instruction in electrical-electronics engineering education from the perspectives of tutors and students. While achieving this purpose, it is aimed to report implementation of PBL in detail and identify students' and tutors' perceptions about PBL and its essential components, their roles, strengths and weaknesses of PBL, factors affecting their performance during PBL tutorials and improvement suggestions of them about problem-based instruction.

In the related literature, some researchers report that PBL promotes students' self-regulated learning (including the motivation and use of learning strategies). Therefore, this study also aimed to compare engineering students' motivation and their use of learning strategies who received their first year curriculum in PBL format, in comparison to those who received their curriculum in a conventional lecture format. Here, the goal is to determine if a statistically significant difference in the scores of motivation and use of learning strategies exist between the groups.

1.2 The Main Problems

The following problems and sub-problems have been used to guide the analysis of the phenomena:

1. How do tutors and students perceive PBL and their roles?
2. How PBL is implemented into PBL tutorials?
   - How tutors act in PBL tutorials?
   - How students act in PBL tutorials?
   - How students are assessed during PBL tutorials?
3. What are tutors' and students' perceptions about the strengths/benefits of problem-based instruction?
4. What are tutors' and students' perceptions about the weaknesses of problem-based instruction?
   - What are tutors' and students' perceptions about the problems encountered in problem-based instruction?
5. What are tutors' and students' perceptions about the factors affecting their performance during PBL tutorials?
6. What are the improvement suggestions of the tutors and students about problem-based instruction?
7. What is the effect of PBL on freshman engineering students' motivation (intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performance, text anxiety) scores?
8. What is the effect of PBL on freshman engineering students' scores for the use of learning strategies (rehearsal, elaboration, organization, critical thinking, metacognitive self-regulation, time and study environment, effort regulation, peer learning, help seeking)?

1.3 Significance of the Study

In literature, the debate still continues related with the various implementation of PBL, insufficient information about the implementation of

PBL, uncertainty about the outcomes of those implementations, how tutors' and students' characteristics effect the tutorial group function and the insufficient number of detailed studies in the disciplines other than the medical education.

Engineering is one of the disciplines that PBL has been adapting to its curriculum based on the gaps of conventional instruction. Educating prospective engineers requires more holistic approach than simply teaching the principles and practices of the profession. Engineering instruction should bridge the gap between theory and practice. Moreover, engineering students need some skills such as problem solving, collaborative, communication and self-directed learning skills (Perrenet et al., 2000) that is why engineering departments has been implementing PBL in their curriculum. Therefore, it is important to analyze this instructional method and learning environment in terms of its contributions to engineering education.

This study analyzes the implementation of problem-based instruction in engineering education and investigates the effect of PBL on freshman engineering students' motivation and their use of learning strategies. The findings of this study can provide a light for the developers of university curriculum either in evaluating their program or preparing a PBL curriculum. Therefore, students' and tutors' feedback is very important for curriculum revision studies. This information can help decision makers to develop better-designed materials and make further progress in the curriculum design. Moreover, this study provides detailed information about the implementation process of PBL. It helps us to visualize how tutors and students in PBL tutorials are interpreted and practiced it. Therefore, analyzing the problem-based instruction and taking the ideas of students and tutors who are the basic components of it seems to be of fundamental importance to contribute implementations.

This study also helps to identify the practical problems experienced by tutors and students during implementations. When taken into consideration, the results of this study can help to overview their weaknesses and fix them to improve their performance and instructional practices.

Finally, research in this area may increase the instructors' awareness of the pedagogical alternatives of teacher-centered instruction and may contribute to students' understanding in a better way.

1.4 Definitions of Terms

The definitions of commonly used terms within the scope of this study were introduced so as to assist the reader in understanding this study.

Problem-Based Learning: It is an instructional format requiring students to participate actively in their own learning by researching and working through a series of real-life problems to arrive at a best solution (Arambula-Greenfield, 1996).

PBL Session/Tutorial: The process in which students first encounter a problem, work through the problem and finally learn from the problem with the guidance of the tutor.

Self-Directed Learning: A process in which individuals take the initiative, with or without the help from others, in diagnosing their learning needs, formulating goals, identifying human and material resources, choosing and implementing appropriate learning strategies, and evaluating learning outcomes (Knowles as cited in Loyens, Magda, & Pikers, 2008, p.411).

Collaboration: An element of PBL that includes resource identification, peer support, acknowledgement, continued reinforcement of existing knowledge, and assistance and assurance in integrating and synthesizing new information (Lambros, as cited in Hollingshed, 2004).

Intrinsic Goal Orientation: The degree to which students perceive themselves to be participating in a task for such reasons: challenge, curiosity, or mastery (Pintrich, et al., 1991).

Extrinsic Goal Orientation: The degree to which students perceive themselves to be participating in a task for such reasons: grades, rewards, performance, evaluation by others, and competition (Pintrich, et al., 1991).

Task Value: Students' evaluation of the how interesting, how important, and how useful the task is (Pintrich, et al., 1991).

Control of Learning Beliefs: Students' beliefs about thinking that their efforts to learn will result in positive outcomes (Pintrich, et al., 1991).

Self Efficacy for Learning and Performance: Self appraisal of students' ability to master a task (Pintrich, et al., 1991).

Text Anxiety: Students' negative taughts disrupting performance as well as affective and physiological aspects of anxiety (Pintrich, et al., 1991).

Rehearsal: Reciting or naming items from a list to be learned which is best used for simple tasks and activation of information in working memory (Pintrich, et al., 1991).

Elaboration: Storing information into long-term memory by building internal connections between items to be learned by using paraphrasing, summarizing, creating analogies, and generative note-taking which help the students integrate and connect new information with prior knowledge (Pintrich, et al., 1991).

Organization: Selecting appropriate information and constructing connections among the information to be learned (Pintrich, et al., 1991).

Critical Thinking: The degrees to apply previous knowledge to new situations in order to solve problems, reach decisions, or make critical evaluations (Pintrich, et al., 1991).

Metacognitive Self Regulation: Involvement of some processes such as planning, monitoring, and regulating (Pintrich, et al., 1991).

Time and Study Environment: Students' skills for managing and regulating their time, as well as their study environment (Pintrich, et al., 1991).

Effort Regulation: Students' ability to control their effort and attention even in the face of difficulties and uninteresting tasks (Pintrich, et al., 1991).

Peer Learning: Students' collaboration with peers (Pintrich, et al., 1991).

Help Seeking: Asking for support of peers and instructors (Pintrich, et al., 1991).

CHAPTER 2

REVIEW OF LITERATURE

2.1 Definitions of Problem-Based Learning

PBL has been defined in various ways in literature (Albanese & Mitchell, 1993; An, 2006; Arambula-Greenfield, 1996; Barrows & Tamblyn, 1980; Gijbels et al., 2005; Vernon & Blake, 1993). One of the most common definitions of PBL is:

> "Problem-based learning results from the process of working toward the understanding or resolution of a problem. The problem is encountered first in the learning process and serves as a focus or stimulus for the application of problem solving or reasoning skills as well as for the search for or study of knowledge needed to understand the mechanism responsible for the problem and how it might be resolved" (Barrows & Tamblyn as cited in Hesterberg, 2005, p.4).

Albanese and Michell (1993) gave one of the much quoted definitions of PBL as "an instructional method characterized by the use of patient problems as a context for students to learn problem-solving skills and acquire knowledge about the basic and clinical sciences" (p.53). Vernon and Blake (1993) defined PBL as "a method of learning (or teaching) that emphasizes 1) the study of clinical cases, either real or hypothetical, 2) small discussion groups, 3) collaborative independent study, 4) hypothetico-deductive reasoning, and 5) a style of faculty direction that concentrates on group process rather than giving information" (p. 550). Arambula-Greenfield, (1996) have defined PBL as an instructional format requiring students to participate actively in their own learning by researching and working through a series of real-life problems to arrive at a best solution.

Somewhat later, An (2006) defined PBL as "a learner-centered instructional approach that aims to help learners acquire both domain-specific knowledge and domain independent knowledge, such as problem solving,

metacognitive, reasoning, critical thinking, self-directed learning, communication and teamwork skills, by using a problem as the starting point of, and stimulus for, learning in a collaborative learning environment" (p.7).

2.2 Theoretical Framework of Problem-Based Learning

Some authors such as Schmidt (1983, 1993), Brooks and Brooks (1993), Savery and Dufy (1995), Driscoll (as cited in Cisneros, 2003) and Hollinshed (2004) maintained that the theoretical bases of PBL can be explained by using cognitivism, constructivism and their derived theories. Driscoll (as cited in Cisneros, 2003) summarized the characteristics of constructivism as follows. First, it assumes that knowledge is constructed by learner. Second, its goals include critical thinking, self-regulation and reflection. Third, its conditions for learning include complex and relevant learning environments, social negotiation, multiple methods of learning, ownership in learning, and self-awareness of knowledge construction. Fourth, its methods of instruction are varied and include problem-based learning, collaborative learning and problem scaffolding. Savery and Duffy (1995) claimed that PBL is consistent with the instructional principles of constructivism. They supported their claim with the following eight instructional principles of PBL deriving from constructivism such as: 1) anchor all learning activities to a larger task or problem; 2) support the learner in developing ownership for the overall problem or task; 3) design an authentic task; 4) design the task and the learning environment to reflect the complexity of the environment; 5) give the learner ownership of the process used to develop a solution; 6) design the learning environment to support and challenge the learner's thinking; 7) encourage testing ideas against alternative views and alternative contexts; 8) provide opportunity for and support reflection on both the content learned and the learning process. The authors pointed out that all of these instructional principles are realized when the PBL is appropriately used.

Hollingshed, (2004) reported that constructivism shares characteristics of the PBL approach. Those characteristics are stated as follows: "students-centered

inquiry, teachers' act as a guide, use of open-ended questions, teachers' are a member of the learning community, and assessment is interwoven with teaching" (p. 17).

2.3 Characteristics of Problem-Based Learning

Some researchers described the characteristics of PBL curriculum or PBL process as number of steps. For example, Barrows (as cited in Krivel-Zacks, 2001) outlined following eight essential characteristics that should be included in an authentic PBL curriculum in addition to his six core characteristics of PBL mentioned before:

- PBL must be student-centered with a small group orientation
- The cases in PBL should include real life problems
- Tutor facilitates and develop problem-solving skills
- Self-directed learning skills should be developed
- Collaboration should be included
- Curriculum need to be integrated
- Curriculum should provide students with opportunities for reflection.
- Assessment should be student centered. Peer and self assessment opportunities should be provided.

Moreover, Schmidt (1983) described the PBL process into seven systematic steps: 1) clarifying and agreeing on working definitions of unclear terms/concepts; 2) defining the problem(s), agreeing which phenomena require explanation; 3) analyzing components, implications, suggested explanations (through brainstorming) and developing working hypothesis; 4) discussing, evaluating and arranging the possible explanations and working hypotheses; 5) generating and prioritizing learning objectives; 6) going away and researching these objectives between tutorials; 7) reporting back to the next tutorial, synthesizing a comprehensive explanation of the phenomena and reapplying synthesized newly acquired information to the problem(s).

To sum up the PBL process, it begins with an authentic, ill-structured problem that is presented to a small group of students. The group size is mostly four to seven students. After tutor who is serving as a facilitator presents the problem, students try to determine what they know about the problem and what they need to know to solve the problem. While students collaborate and communicate within the group to define their existing knowledge and knowledge needed to solve the problem, they experience with self-directed learning skills. Students formulate their learning needs as questions. Until the next session, they study independently and return to the group to discuss, share and synthesize their acquired knowledge. They need social interaction and collaboration skills to solve the problem. Every module/tutorial is concluded with an evaluation part which allows the processes of problem-solving, interaction, and learning. The tutor guides the students by formulating necessary questions. This cycle repeats until a satisfactory solution is achieved (Barrows as cited in LeJeune, 2002; Dahlgren et al., 1998; Nowak, 2001).

Charlin, Mann and Hansen (1998) proposed to categorize educational activities as PBL and non-PBL according to three core principles such as: the problem should act as a stimulus for learning, educational approach should not be an isolated instructional technique and approach should be student-centered. Even based on those core principles, the researchers emphasized multiple adaptations of PBL that vary considerably along some selected dimensions: 1) the person or group who selects the problem; 2) the purpose of the problem; 3) nature of the educational objectives and control over their selection; 4) the nature of the task; 5) the presentation of the problem; 6) format of the problem; 7) the processes students follow; 8) resources utilized and how they are identified, 9) the role of the tutor. The researchers discuss that practices vary for each of those dimensions within the three core principles stated above.

2.3.1 Role of the Problem

The problem is the central part of PBL. Instead of being organized by topics and disciplines, the curriculum is organized around problems that are relevant to desired learning objectives. A real problem is used as a motivational context to drive learning and as a stimulus for authentic activity (Barrows, 1986; Savery & Duffy, 1995). Research suggests that PBL is most effective when students encounter an ill-structured or ill-defined problem (i.e. the type of problem most often faced by students outside of school). Ill-structured problems have several characteristics. First, the information that is readily available to the students is not sufficient to solve the problem. Second, a single, correct way for solving the problem is not apparent or does not exist. Third, the nature of the problem may change as the new information is gathered and students attempt to solve it. Forth, student will never be completely sure that they have made the correct selection of solution options (Gallagher et al., 1995; Nowak, 2001).

2.3.2 Role of the Tutor/Facilitator

In PBL, rather than providing information during a lecture, the tutor monitors and assesses each group and student's progress. He/she acts as a coach, facilitator, co-investigator who presents the problem; guide students to develop problem solving and higher order thinking skills; models learning behavior; provides necessary resources and encourages students to consider alternative perspective. Moreover, he/she helps students to become independent learners, formulate problems, and explore alternatives to develop thinking skills within the context of the problem being solved and to evaluate the learning process (Barrows, 1986; Carl-Williamson, 2003; Nowak, 2001; Rangachari & Crankshaw, 1996; Riberio & Mizukami, 2005; Savery & Duffy, 1995).

Some researchers emphasize the importance of tutors and effectiveness of their roles in PBL tutorials. They discuss some topics such as how much direction to give, level of content expertise and pedagogical knowledge, when/how frequently intervene to the discussion, how to assess students etc. They also give

some suggestions related with tutor's role and its effectiveness (Gilkison, 2003; Silver & Wilkerson, 1991; Wilkerson & Maxwell, 1998). Kalaian and Mullen (1996) indicated that effect of teacher is very important on learning especially at the start of the implementation of PBL.

2.3.3 Role of the Student

During PBL, students working in small groups facilitated by a tutor should have ownership of the problem and take responsibility for their learning to solve a problem. With the ownership of a problem, students actively engage in learning and attempt to solve ill-structured, real world problems. They formulate hypotheses to reach a solution and extract a number of learning issues from the hypotheses. Students research specific learning issues first individually, as self-directed learners, and then explore all the identified learning issues collaboratively by sharing their perspectives and information they gained and applying it to resolve the problem, and lastly evaluate their own contribution and their peers' (Barrows, 1986; Fergusson, 2003; LeJeune, 2002; Riberio & Mizukami, 2005; Savery & Duffy, 1995).

2.3.4 Problem-Based Learning and Assessment

Assessment procedures that have been used in conventional curricular designs, such as multiple choice tests or written examinations, may not be enough to assess and analyze the outcomes of PBL since the objectives of PBL are different in many ways from conventional curricular designs. Therefore, there is a need to determine a meaningful assessment system for PBL using assessment criteria that are commonly used in PBL (Miller, 2000). Practical examinations, concept maps, peer assessment, self assessment, tutor assessment, exhibitions, oral presentations, portfolios, personal reflections and reports can be given examples of some evaluation techniques to be used in PBL. Those measures might be much more authentic to a problem-solving setting than a conventional measure such as standardized multiple-choice or true false tests (Major & Palmer 2001).

2.3.5 Self-Directed Learning Skills

There are many different views and explanations of a complex and multi-dimensional concept of self-directed learning throughout the literature. Therefore, it is difficult to arrive at a single definition. Dahlgren et al. (1998) defines self-directed learning as students themselves taking responsibility for their learning. Considering the real-life situations in a problem, students have to be aware of what knowledge gaps they need to cover, and what information they have to gather to answer the questions given in the problem. Therefore, students can integrate aspects from different knowledge areas, as they relate to the problem they wish to solve (Dahlgren et al., 1998).

Moreover, LeJeune (2002) explains self-directed learning into four components:

1. psychological/personal characteristics component for the individuals' readiness for self-directed learning, 2. skills or capabilities component for conducting one's own learning projects, 3. performance/behaviors component for applying those skills to the self-directed learning activities, and 4. motivation component for the particular learning project. The author states that PBL methods give students opportunity to better develop their self-directed learning skills since some activities used in PBL require some skills also used in self-directed learning.

According to Hmelo-Silver (2004), students should have following characteristics to improve self-directed learning skills. "Learners firstly must have a metacognitive awareness of what they do and do not understand. Second, they must be able to set learning goals, identifying what they need to learn more about for the task they are engaged in. Third, they must be able to plan their learning and select appropriate learning strategies…. Finally, as they implement their plan, learners must be able to monitor and evaluate whether or not their goals have been attained" (pp.240-241).

2.4 Background of Problem-Based Learning

Originally designed for medical students, PBL began with the Faculty of Medicine at McMaster University in Canada in the mid 1960's. PBL was emerged from the need to reduce medical students' memorizing and recalling facts; apply information learned in the classroom to real-life; facilitate problem-solving and generalization skills; develop self directed learning, team and interpersonal skills; perform clinical reasoning skill; manage patients more effectively and efficiently as a result of PBL training and develop a desire to continue learning (Barrows, 1986; Hollingshed, 2004; Krivel-Zacks, 2001). Therefore, based on the gaps of conventional medical training, the founders of PBL proposed a curriculum centered on students and on problems (Ntyonga-Pono, 2006).

In time, in addition to medical science, PBL has spread globally in all forms of undergraduate institutions including nursing, economics, pharmacy, dentistry, physiotherapy, architecture, business, law, engineering, social work, and science as well as in elementary and secondary education (Camp, 1996; Dahlgren et al., 1998; Fergusson, 2003; Perrenet et al., 2000; Polanco et al., 2004; Ribeiro, & Mizukami, 2005).

Although PBL was originally implemented in the whole curriculum, it became possible to see some institutions adopting the approach as a partial strategy, such as hybrid PBL, course-by-course models, etc. (Major & Palmer, 2001).

2.5 Problem-Based Learning in Medical Education

There have been eight systematic reviews or meta-analyses (Albanese & Mitchell, 1993; Berkson, 1993; Colliver, 2000b; Dochy et al., 2003; Gijbels et al., 2005; Prince 2004; Smits, Verbeek, & Buisonje, 2002; Vernon & Blake, 1993) related with the effectiveness or outcomes of problem-based learning compared with the conventional instruction in medical education from different points of view. Most of those studies, with one or two exceptions, include PBL studies in the health education professions. Three of those reviews (Albanese & Mitchell

1993; Berkson, 1993; Vernon & Blake, 1993) were published in the same year and same journal.

Albanese and Mitchell (1993) conducted a meta-analysis to address PBL and its learning outcomes. They searched the medical education literature from 1972 to 1992. The results of this study mainly indicated that 1) as compared to conventional instruction, students found PBL more nurturing and enjoyable, 2) on clinical examinations and faculty evaluations, PBL graduates performed as well, and sometimes better than students who received conventional instruction, 3) on basic sciences examinations, PBL students rarely scored lower and judged themselves as less prepared as compared with their counterparts in conventional instruction, 4) in terms of reasoning process, PBL graduates tended to engage in backward reasoning rather than the forward reasoning that experts engage in and there appeared to be gaps in their cognitive knowledge base that could affect practice outcomes, 5) with class size larger than 100, the costs of PBL may slow its implementation in schools.

Vernon and Blake (1993) conducted five separate meta-analyses on 35 studies from 1970 to 1992 representing 19 institutions. They discussed the results of the analyses separately for four general outcome area such as program evaluation (student and faculty attitudes, student mood, and class attention), academic achievement (tests, academic problems and attrition), academic process (approaches to learning and resource use), and clinical functioning (performance tests and ratings, humanism and clinical knowledge). Results showed that PBL students scored significantly higher on attitudes and opinions measures about their programs and on measures of clinical performance. No significant difference was found between groups on miscellaneous tests of factual knowledge and clinical knowledge. However, on the National Board of Medical Examiners Part I examination, conventionally instructed students performed significantly higher than their PBL counterparts. The researchers comment that this might be due to significant heterogeneity among the tests. Less frequently reported studies supported the superiority of the PBL approach over more conventional methods.

Those studies pointed out a greater degree of independent study and more emphasis on understanding less emphasis on rote learning and memorization in PBL programs; better clinical performance by the PBL students; higher scores in skills (in relating to patients, empathy, patient-centered orientation, comfort with emotions, communication skills and data collection) as compared to their conventional counterparts. However, the researchers note that in many of the studies, variables related to clinical performance and skills were not well-defined and methods of measurement were inadequately described or validated. They emphasized that this limitations restrict the conclusions.

In the same year (1993), Berkson also conducted a meta analysis in the medical literature published before 1992. She discussed whether PBL curricula teach problem solving, impart knowledge, enhance motivation or promote self-directed learning skills better than conventional curricula. Moreover, she criticized the satisfaction of participants (student and faculty) in PBL and financial cost of PBL. The results showed that the products of PBL (knowledge acquisition, problem solving, motivation and self-directed learning) and conventional curricula are indistinguishable. Moreover, PBL can be stressful for both students and faculty and appeared to be unreasonably expensive. Although those three reviews are the most well known ones, they are criticized by their difficulty to interpret since the review methods are not reported clearly and approaches differ between the reviews (Newman, 2003).

Colliver (2000b) conducted a review of a medical education related with the effectiveness of PBL for knowledge acquisition and clinical performance. Starting with the three reviews published in 1993 (mentioned above), he reviewed the 29 medical research papers published from 1992 through 1998 comparing students in a PBL curriculum with students in conventional curriculum. Different from the previous reviews mentioned above, he also investigated some randomized studies. He summarized each study design, outcome measures, effect sizes and other informations relevant to the research conclusion. He claims that a large effect of d=0.8 or even d=1.0 would seem to be reasonable level of effectiveness to be

expected for an educational/instructional method like PBL. As a result of his review no convincing evidence was reported that PBL improves knowledge base and clinical performance. Colliver states that "PBL may provide a more challenging, motivating, and enjoyable approach to medical education, but its educational effectiveness compared with conventional methods remains to be seen (p.266). However, Albanese (2000) opposed Colliver's (2000b) claim. According to him, expecting students-selected for success in medical schools- to do better in a PBL curriculum is unreasonable. Moreover, he noted the effect size of many commonly used and accepted medical procedures and therapies reported in the literature as below medium effect size (d = 0.5) value. Lastly he argued that knowledge acquisition and clinical skills may not be improved by PBL but it enhances the work environment for students and faculty which is the worthwhile goal in and of itself.

Smits et al. (2002) conducted a systematic review to find out if there is evidence that PBL in continuing medical education is effective. They searched controlled studies in continuing medical education from 1974 to 2000. The results of this study showed limited evidence that PBL increases participants' knowledge and performance and patients' health. Moreover, there was moderate evidence that doctors had higher satisfaction with PBL. Smits et al. (2002) state that "in order to deduce that one educational intervention is more effective, the content, process, and influencing variables in both interventions must be clearly stated" (p.155). He points out that in three of the six studies reviewed, the information on the educational interventions can be rated as completely absent, poor, and reasonable.

One of the most recent meta-analyses by Dochy et al. (2003) included 43 empirical studies on PBL in tertiary education conducted in real-life classrooms (to maximize ecological validity). The main aims of this meta-analysis were: 1) to address the main effects of PBL on knowledge and skills outcomes and 2) to address potential moderators of the effect of PBL. The results of the first part of the study suggested that there is a robust positive effect of PBL on the skills (knowledge application) of students. However, PBL has a negative effect on the

knowledge base of the students when compared with the knowledge of students in conventional learning settings. Seven of the studies resulted a significant positive effect while 14 of found a significant negative effect. For the second part of this study, some moderators (year of study, retention period, study design) of PBL effect were investigated. The most remarkable result of the moderator analysis indicated that "students in PBL have slightly less knowledge, but remember more of the acquired knowledge …..the positive effect of PBL on the skills of students seems immediate and lasting" (p. 549).

Prince (2004) distinguished the different types of active learning that are most frequently mentioned in engineering literature. Moreover, he examined the core element of each method (active learning, collaborative learning, cooperative learning, and problem-based learning) and provided suggestions for the reader trying to draw quick conclusions on the effectiveness of active learning. Prince (2004) emphasized two common problems in literature analyzing the effectiveness of PBL. Firstly, there are many different implementations of PBL in literature, some differ from each other and some have common elements which make difficult to interpret the literature. Therefore he claimed that when analyzing the effectiveness of any instructional method, the results of the studies can be misleading and confusion may occur unless the reader and author take care to specify what is being examined. Secondly, some studies lack how the authors measure and interpret 'what works'. He suggested that "assessing 'what works' requires looking at a broad range of learning outcomes, interpreting data carefully, quantifying the magnitude of any reported improvement and having some idea of what constitutes a 'significant' improvement" (p.225). Moreover, he mentioned the difficulty of assessing higher level learning outcomes (ability to solve open-ended problems, engage in life-long learning etc.). He claimed that it is difficult to obtain data for these outcomes as compared to ones for standard measures of academic achievement such as test scores. By reviewing all previous meta-analyses and reviews he concluded that while no statistically significant effect was found for enhancing academic achievement as measured by exams, there is

evidence that PBL develops more positive student attitudes, fosters a deeper approach to learning and helps student retain knowledge longer than conventional instruction.

Gijbels et al. (2005) claimed that one characteristic should be added to the six characteristics in Barrow's PBL core model: that is "it is essential to PBL that student to learn by analyzing and solving representative problems" (p.32). Therefore, the researchers gave emphasis to the need of valid assessment systems in order to evaluate students' problem-solving competencies in PBL assessment environments. After the reviews and meta-analyses which overviewed the effect of PBL implementation compared with conventional education methods, Gijbels et al. conducted a meta-analysis investigating the effects of PBL when the assessment of its main goals focuses on a) understanding of concepts, b) understanding of the principles that link concepts, and c) linking of concepts and principles to conditions and procedures for application. According to the results drawn from the analysis of forty empirical and quasi-experimental studies, the effect of the PBL is larger when understanding of the principles that link concepts was the subject of assessment. In only eight of the 40 studies, assessment focused on the third level of the knowledge structure (linking of concepts and principles to conditions and procedures for application). The researchers interpreted those results and suggested to pay more attention to the third level of the knowledge structure both during the learning activities that take place and during students' assessment in PBL provided PBL aims to educate better problem solvers.

Newman (2003) conducted a pilot systematic review with international group of teachers and researchers. The major objective of this pilot review was to establish the evidence provided by prior reviews about the effectiveness of PBL. High quality experimental or quasi experimental design studies focusing post-school education included in this review. While assessing studies whether they met the criteria or not, a lack of detailed information (about the design, preparation or implementation process of interventions etc.) in those studies is reported by the author. 15 studies out of 91 met the inclusion criteria and those studies were ones

reporting outcomes particularly in multiple-choice format. The result of the pilot study established that there are gaps in existing reviews causing a lack of robust evidence in terms of the effectiveness of PBL.

2.6 Problems Encountered in Problem-Based Instruction

Treating PBL as one single variable without contextual information, neglecting investigation of the actual learning process, and only focusing on quantitative experimental design are some of the problems about those prior studies (Lee, 2004). Norman and Schmidt (2000) stated that studies treating PBL as a single intervention and examining the usual cognitive and critical outcomes will arrive at a conclusion of minimal difference. Similarly, Dolmans (2003) stated that "research in which the intervention under study is treated as a single variable all too often leads to inconclusive results, with some studies reporting positive findings, some negative findings and some zero findings" (p. 1129). As she emphasizes, focusing our research only on the effectiveness of educational interventions, is not enough for conclusive results. Her suggestions for bridging the gap between educational research and educational practice are as follows: The researchers should 1) pay attention to why and under which conditions an intervention is effective or not; 2) conduct process-oriented studies as well as outcome-oriented studies; 3) include studies that investigate the effects of interaction on the effectiveness of a particular intervention; 4) carry out not only statistical meta-analysis and quantitative reviews, but also narrative reviews; 5) should improve methodological quality of our studies; 6) should report educational interventions in a more detail way; 7) make use of triangulation of data.

Dolmans et al. (2005) pointed out that poor implementation of PBL causes some problems (too well-structured problems, too directive tutors and dysfunctional tutorial groups) in educational practice. They emphasized that with too well-structured problems, PBL doesn't stimulate students' towards constructive learning and with too directive (dominant) or too passive tutors the learning process is hindered. In a typical dysfunctional tutorial group, activation of

prior knowledge does not take place, connections between new ideas and other ideas are not made, and some students in the groups are well-prepared for the sessions but others prepare and involve less. Therefore, those authors argued that the implementation problems can be solved with 1) more complex, open-ended, ill-defined problems activating students' prior knowledge, 2) tutors as being a facilitator in PBL knowing when and how to intervene, 3) tutors evaluating the functioning of their group regularly, 4) the better integration of learning and assessment implying more self-assessment, peer-assessment, group assessment etc.

2.7 Problem-Based Learning in Engineering Education

In literature, it is also possible to find examples of implementation of PBL in higher education. PBL has been used in teaching of diverse disciplines including engineering (Denayer et al., 2003; Guzelis, 2006; Hadgraft, 1999; Ribeiro, & Mizukami, 2005; Perrenet et al., 2000; Polanco et al., 2004; Said et al., 2005).

University of Manchester (UK), University College London (UK), University of British Colombia (Canada), University of Aalborg (Denmark), University of Samford (USA), University of Maastricht (Netherlands), University of Linköping (Sweden) University of Newcastle (Australia), University of Delaware (USA) and University of Dokuz Eylul (Turkey) reported to have implemented PBL in their engineering curriculum. Moreover, University of Malaya (Malaysia) reported their planned program to implement a hybrid-PBL approach within their electrical engineering department.

Polanco et al. (2004) reported the results of a curricular program based on PBL, directed to second-year engineering students. This program called "Principia Project" was formed to solve some problems (low retention knowledge, inability to transfer basic knowledge to real-life engineering situations, lack of mathematical reasoning, lack of students' motivation toward science mathematics, students' meaninglessness of learning) noted in especially conventional mathematics and basic science courses. In this PBL program, the contents of physics, mathematics and computer science courses brought together in order to

help engineering students to develop a mathematical and science culture facing them with various situations where successful proposals for physical and mathematical concepts are required. Students are assigned to permanent teams and mainly three types of PBL activities: solution of exercises, solution of complex problems, and development of projects are formed. For solution of exercises activity, students temporarily leave their teams and form a new team to solve small-scale problems. This activity concludes when the students return to their permanent teams and share the knowledge they gained. In the solution of complex problems activity, students confront large-scale problems working in their basic teams. By integrating knowledge in various disciplines and use of technology, they solve exercises forming part of the solution of more complex problems.

Polanco et al. (2004) evaluated the effects of the "Principia Project" on the students' academic achievement with three data sources: pre-test post test scores on the Mechanical Baseline Test and Force Concept Inventory; students' grade point average (GPA); and students' grades in advanced engineering courses (Mechanics, Electrical Circuits I, Digital Systems, Probability and Statistics, Oral Communication). The Mechanical Baseline Test and Force Concept Inventory were administered to the students enrolled in the PBL curriculum and the conventional curriculum at the beginning of the first semester as pre-tests and at the end of the fourth semester as post-tests. Analysis showed that there was a significant difference in the Mechanical Baseline Test scores of the two groups in favor of the PBL students. However, no significant difference was found between the groups in terms of the Force Concept Inventory. With respect to the second source of data, results showed that PBL students' GPA was significantly higher than conventional curriculum students. Lastly, PBL students got significantly higher than conventional curriculum students on two of the five lessons which are Probability and Statistics and Oral Communication.

Influenced by the Maastricht, Eindhoven University of Technology has been using PBL as a partial strategy for the Mechanical and Biomedical engineering departments. Eindhoven formed a Mechanical Engineering program

including courses, case studies and projects. The first, second and third year curriculum consists of some compulsory courses dealing with the main concepts of mechanical engineering and four parallel courses (mathematics, physics, mechanics dynamics, knowledge of materials and chemistry) every term. Lectures focusing mainly on the outlines of a these course and guided private studies are organized in the morning. Definitions, concepts and theories are given by the lecturers and they point out to the students what is expected from them for the private study. Two hours guided private study which is offered for every course each week is directly related with the lectures in the first and second year. During the guided private study, students practice the concepts and theories under the expert supervision of a lecturer. In the afternoon, students work in groups on case studies and actively cooperate on multidisciplinary design problem which is called design-based learning. A case includes five groups meeting in almost 3 weeks with a total workload of 30 hours. Groups are moderately directed by tutors and mostly conclude the cases with a presentation, a group report, a debate or a contest. In the third year, students have project work with smaller groups and larger tasks. The fourth and fifth year involve specialization in mechanical engineering. Compared to Mechanical Engineering, the Biomedical Engineering is more research directed. Greater emphasis is placed on project work with a variety of related labs in the third year of Biomedical Engineering. Those project works are used as a preparation for research projects of the final two years (Perrenet et al., 2000).

PBL approach has been reported to be an ideal tool for teaching engineering in the University of Malaya. PBL was perceived useful in developing the relevant transferable skills (critical thinking skills, communication skills and analytical skills etc.) expected of an engineer. Therefore, it was planned to implement it within the department of Electrical Engineering. In the first year curriculum, PBL content is planned to be minimal (10%) since the students' level of mathematics and physics is limited. Those subjects such as engineering mathematics, circuit theory and electromagnetic theory was planned to be taught in

a classical framework. In the next years, since the students' knowledge base in electrical engineering would increase, the number of courses to be taught with PBL approach are planned to be increased (40%) even more in the third (60%) and fourth year (90%) (Said et al., 2005). The authors suggested implementing a hybrid-PBL approach within the Department of Electrical Engineering and renewing the academic advisor approach in order to study the effectiveness of PBL in an organized manner.

The current approach at the University of Aalborg is a hybrid of problem-based and project-based learning, with the projects being more about acquiring knowledge than applying it. The main goal in the first year is to give students a general competence in project work and an awareness of general problem-solving method, while in the rest of the curriculum the focus shifts to more specific technical and scientific learning objectives, with the project work being mainly a mechanism for achieving those goals. Another institutional implementation of problem/project-based learning was initiated in 2000 by the engineering school of University of Louvain in Belgium, with both week-long problems and semester-long projects being routinely assigned to student teams in the first two years of engineering curriculum.

PBL was implemented in a specific part of the undergraduate electronic engineering program in the University College London. In the third year Communication Systems II lesson, students worked in small groups of five or six through a succession of four problem briefs, which ranges from two to four weeks duration. There were facilitation sessions lasting two or three hours a week. Students were assessed through portfolio which consisted problem solutions as a group work and an individual narrative requiring a reflective evaluation of the process, challenges, and key skills achievements. Moreover, students were interrogated orally on their technical knowledge that was intended to acquire during the course (Mitchell & Smith, 2008).

A public university in Brazil mentioned their implementation of PBL in their administration course of postgraduate engineering curriculum. PBL was

implemented to the self tutored groups of four or five facilitated by one tutor during 15 weeks. During this period, 12 problems were presented. The students' roles (leader, spokesperson, scribe etc.) changed every week. The problem which was presented in the second half of the weekly meeting was followed by group discussions. During those discussions, the tutor helped the team and answered related questions. Groups present their results through seminars, posters, dramatization, and mid-term. After discussion of those results, teams assessed the problem, instructional process, and member's weekly performance (Riberio & Mizukami, 2005).

Savin-Baden (2008) examined the different forms of PBL in the content of engineering education. She mentions seven different forms of PBL curricula that are varied across both disciplines and cultures in terms of length and design. She explains that those curricula were commonly represented as three years programs since this length is common to many undergraduate programs worldwide. Mode 1 is called a "single module approach" in which PBL is implemented in one or two module in one year of a program. Mode 2 is called "problem-based learning on a shoestring" in which PBL may be used in many models throughout the curriculum. That is, PBL or lecture-based learning may be implemented in any of those three years. Mode 3 is called "the funnel approach" the curriculum of which enables students to be funneled away from a lecture-based learning approach towards a PBL approach. In the first year of this approach, students receive lectures and tutorials and they attend lecture-led seminars. Problem-solving learning is used in the second year. Students are expected to discover the answer of problems that are rooted in the information supplied to them through lectures, workshops, and seminars. In the third year, cohesive framework is used consisting problems that are build upon one another. Mode 4 which is called "the foundational approach" is based on the assumption that some knowledge needs to be taught to the students before they can begin to solve problems. Therefore, lectures, tutorials, and laboratory are provided to the students to understand the necessary knowledge in the first year and they utilize PBL in the second and third years of the program.

Mode 5 is called “the two-strand approach” in which PBL is seen as the crucial component of the curriculum using other learning methods simultaneously. Mode 6 is called “patchwork problem-based learning” of which the curriculum is designed using PBL consisting concurrently run modules instead of consecutive ones. Last mode is “the integrated approach” in which the curriculum is integrated so that all the problems are sequential and are linked both to one another and across disciplinary boundaries.

2.8 Problem-Based Learning in Dokuz Eylul University Engineering Education

In Turkey, Faculty of Medicine of the Dokuz Eylul University (DEU) has changed its curriculum from conventional to problem-based learning for the first time in 1997. Being influenced by that development the Engineering Faculty has started to change its undergraduate education. Guzelis (2006) - the dean of engineering faculty- pointed out that poor problem solving skills, lacking of communication and team working skills, poor link between any course and real engineering world in conventional education system can be stated as another factors that motivated those departments to adopt PBL.

In 2002, departments of Electrical and Electronics, Geophysics, and Geological Engineering and in 2003, Mining Engineering department have adopted problem-based active learning system. The system is staged in a modular based. Guzelis (2006) stated that “this has been in accordance with the new vision of DEU which aims to educate students as enterprising, creative, innovative and proficient graduates who will contribute to their community and will serve as good citizens in a universal sense.” (p.67)

At first, departments had designed modules as units of integrated learning objectives from the disciplines of mathematics, physics, chemistry, computer basics, and engineering sciences. For freshman engineering curricula, curriculum design committee (consisting instructors from mathematics, basic sciences and engineering sciences) constructed 14 clusters of learning objectives from mathematics, physics and chemistry. Three of the departments took the clusters as

basis and then integrated with engineering learning objectives for redesigning freshman engineering modules. One department spread those mathematics and basic science learning objectives over the entire modules of four years. However, after having three years of experience, freshman engineering PBL curriculum has been planned to be common for all engineering programs identifying physics, mathematics, and computer basics as common disciplines. Now, scenarios are written by the collaboration of physics, mathematics and computer basics instructors based on a real physics problems (Guzelis, 2006).

Moreover, in the newly planned PBL curricula, project-based learning takes place as a co-strategy for the freshman and senior engineering education. In the freshman year, all modules of both semesters consist two hours of project-oriented learning (POL) sessions. Teams of 3–4 students work together and take feedbacks from the instructors during the semester and present their projects at the end of the semester. However, in the senior year, all modules are organized around four-week long real design problems or projects in which the students are confronted with the complexity of a real engineering project. In addition to these projects, students are assigned an individual graduation projects in the senior year. Students are expected to create their own original solutions by deciding on the model, the materials, and the methods of implementation (Guzelis, 2006; Kuntalp et al., 2002).

A typical PBL session consists of 8–9 students meeting with a tutor to discuss a problem. It takes place in the PBL rooms and includes 3–4 sessions during a two or three week period. As a central part of the educational system, PBL sessions take 2–4 hours providing a learning environment where students attempt to define and then solve a real life problem introduced with a motivating scenario. Most of the educational activities such as presentations, laboratories, scientific consultation hours, engineering orientation, and discussions are structured around the scenarios as a complementary to PBL sessions. Students have active roles and instructors act as a facilitator in PBL sessions. At the end of those sessions students are asked to find what they know, what they need to know

and determine necessary learning objectives to cover until the next session. Moreover, students evaluate their tutors and tutors evaluate students by means of written forms at the end of each PBL module (Guzelis, 2006).

Several methods are being used for evaluation of the curriculum. Within the semesters examinations (consisting mostly essay type questions or multiple choice tests) are held on the last day of the modules. At the end of semesters, term exams take place. The scores of module-end and semester-end exams are part of the comprehensive assessment of the curriculum. Besides those examinations, tutors' evaluation of students in PBL sessions based on their performance and laboratory works are also taken into account during the assessments. Therefore, semester grade is calculated adding the 30% of the end-term score to the 70% of the semester score. Class grade is formed by calculating 50% of each semester's score. Students whose class scores are higher than 70, are exempted from the relevant module's end-of-the-year exam. Students whose class scores are below 50 are unsuccessful and should take the same module once more. In order to calculate final class score, 50% of the end-of-the–year exam results and 50% of the class scores are added together. The students complete the class successfully if their final class scores are at least 70 out of 100.

2.9 Faculty Opinions and Perceptions about Problem-Based Learning

Vernon (1995) investigated the attitudes and opinions of PBL tutors as compared to a conventional medical curriculum. The respondents evaluated PBL more positively than conventional methods. According to the tutor reports, students in PBL medical curriculum had a higher level of student interest, general principles, reasoning and clinical preparation as compared to students from a conventional medical school. However, factual knowledge in basic science of PBL students was lower than that of conventional medical students. In a later study Vernon and Hosokawa (1996) compared the attitudes and opinions of faculty who did not participate in a new PBL curriculum with those who did participate. Participants were significantly more positive and judged the new PBL curriculum

to be superior in the areas of students' interest, clinical preparation and medical reasoning. However, teaching of factual knowledge in the basic science and efficiency of learning was rated lowest.

Kaufman and Holmes (1996) examined teacher and student perceptions during the first 2 years of a complete transition from a conventional to a PBL curriculum at Dalhousie University. Teaching staff who had tutored in the two pre-clinical years (n = 88) completed a questionnaire at the end of the 1993-94 academic year, and student assessments of their tutors were collated for all nine units (n = 597). Seven research questions were addressed in the study which examined the faculty, student and administrative aspects of tutoring. The results showed that faculty tutors rated PBL more highly than conventional medical school methods on eight of the nine items. Teaching staff were very satisfied with their tutoring experience, but expressed a need for further training in group facilitation, questioning, handling 'difficult' situations and evaluating students. They reported that their workload outside tutorials was cut almost in half in their second year of tutoring. Students expected a tutor to be a skilled group facilitator who would guide them in their learning, while helping to maintain a positive group climate. They did not want the tutor to teach the content as they perceived the task of learning to be their responsibility. Several major administrative factors (changing tutorial group composition and tutor every 8-10 weeks; team tutoring; end-of-unit exam) are mentioned that affected tutors' and students' perceptions of tutorials.

Dahlgren, Castensson and Dahlgren (1998) evaluated the implementation of PBL in environmental education from the teachers' perspective. The main aims of the study were to "describe and analyze teachers' experience of the planning and implementation of PBL; their ways of experiencing the meaning of PBL; and their ways of experiencing the teacher's role as a tutor in PBL" (p.440). The researchers made interviews with seven teachers at the end of the second year of a project called 'Problem-Based Learning in Environmental Science.' The results of this study showed that the teachers were prepared for the PBL sessions, positive

toward the project and understand the essence of PBL. Teachers were divided into two groups in terms of their perspectives such as “learning perspective” and “teaching perspective.” The focus of teachers having learning perspective is on the students’ learning process. They reported that students take responsibility for their learning, use a deep approach to learning, acquire an attitude and a way of studying, and develop their learning skills and personality. However, teachers having learning perspective noted that they have difficulties in finding assessment criteria. The focus of teachers having teaching perspective is on the methodological teaching aspects of PBL. They reported that teaching methods used in PBL is explained as more flexible and pleasant as compared to conventional lectures. As a disadvantage of PBL, teachers having teaching perspective expressed their fear about controlling the students’ factual knowledge. Teachers’ perspectives about their roles as tutors in PBL were classified as “supportive” and “directive.” Supportive tutors perceived the process as stimulating and challenging whereas directive tutors perceived themselves as resources and ready to answer students’ all questions.

2.10 Student Opinions and Perceptions about Problem-Based Learning

According to the Vernon and Blake’s (1993) meta-analysis of studies that compare PBL with conventional methods of medical education, PBL students scored significantly higher on attitudes and opinions measures about their programs and on measures of clinical performance.

Kaufman and Mann (1996) compared attitudes of a sample of students attending PBL courses and students attending conventional courses in a medical school. They used a questionnaire including evaluation, academic enthusiasm, goal direction, authoritarianism, breadth of interest, student interaction, enjoyment and satisfaction with curriculum, social factors, and intellectual maturity subscales. The findings of the study indicated that PBL students reported significantly more positive attitudes than conventional students on the scales of academic enthusiasm;

authoritarianism and more positive attitudes towards curriculum. There were no significant differences between groups on the remainder of the subscales.

Ryan (1993) conducted a study with 35 nursing students in a professional course implementing problem-based learning. Students were asked to complete questionnaires to assess perceptions of their abilities to be self-directed learners changing over time and the importance they placed on self-directed learning. The results indicated an increase in perceived ability and a perceived rating of importance.

In their study, Barman, Jaafar and Naing, (2006) assess the level of interest, enthusiasm and personal satisfaction of the students experiencing PBL in the School of Medical Sciences and the School of Dental Sciences. All those students participating in PBL between 1998 and 2003 were surveyed in 2003. Majority of the students (more than 65% of them) were the opinion that: PBL sessions to be interesting and beneficial in achieving learning objectives. Students utilize the available learning resources that are enough according to them. Some of students study harder to prepare themselves to participate in discussions. PBL allows in-depth understanding and provides group interaction skills.

Hollinshed (2004) investigated students' perceptions of PBL process within an introductory computer application course. The purpose of the study were to investigate the issues students encounter, type of interaction occurs between students and instructors, perceptions of students about the most and least useful things occur in PBL environment. A qualitative case-study research was used in the study. Sample of the study consisted of 19 participants. Observations, reflection papers and questionnaires were used for data collection. The results of the study indicated that collaboration was indicated as the most useful component in PBL by the students. Moreover, the interaction between the instructor and the students was found positive. Besides, students indicated that attendance, locating proper resources, and relating to group and group members as the major issues they faced during PBL process.

Musal, Taskiran, and Kelson, (2003) made a study in order to determine how the students and tutors view the effectiveness of PBL at Dokuz Eylul University Faculty of Medicine. A questionnaire that consists of some PBL outcomes (reasoning skills, problem-solving skills, communication skills, self-directed learning, assessment skills, intrinsic motivation etc.) was distributed to faculty members who had actively participated to modules since the beginning of the PBL curriculum. Same questionnaire was distributed to first, second and third year students. 130 tutors and 346 students responded the questionnaire. Results showed that no significant difference was found between those students. In order to examine the effectiveness of PBL, the tutors and students rated clinical reasoning skills, communication skills and problem solving skills highly. However, the lowest point rated by both groups was acquisition of basic science knowledge. The tutor ratings except the "gaining basic science knowledge" item were significantly higher than student ratings. Basic science tutors rated all items higher and the items (problem solving skills, gaining basic science knowledge, and intrinsic motivation of student) significantly higher than the clinical science tutors. Moreover, the questionnaire includes open ended questions taking students' and tutors' opinions and suggestions about the PBL curriculum. Improvement in library facilities and computer lab are suggested by the students. They noted the importance of tutors' motivation and providing them to the limits of their knowledge. Whereas, the tutors noted the importance of detailed tutor guides and education on PBL philosophy and method. They suggested a course with participation of all tutors in weekly tutor meetings related with advanced tutoring skills.

In the study of Riberio and Mizukami (2005) (mentioned in 2.6) qualitative research design was used focusing on how postgraduate engineering students evaluate problem-based instructional approach. Students were asked to evaluate the instructional method, its advantages and disadvantages, give their idea on some of its features, and give improvement suggestions. Participant observation and end-of-term questionnaire were used to collect data. The students' evaluations

showed that PBL instruction was satisfactory and motivating. It made the class more dynamic provided students how to search for knowledge and work in teams and have promoted communication skills. Whereas, increased workload for students, feeling of pressure for participation it placed on more introverted students, feeling insecure in understanding the proposed problems especially who have no prior knowledge about the topic in the problem are given as the disadvantages of the instructional method. The students explained that planning phase was considered to be fundamental since it gives direction to the teamwork. Moreover, group work was one of the most valued characteristic of the instructional method. Students reported that group work provides the participation of all students gathering different perceptions and points of view. However, time and distance arrangement for group work was evaluated as a difficulty for the group members living at distant areas.

Mitchell and Smith (2008) (mentioned in 2.6) conducted a case study to investigate the implementation of PBL in electronic engineering. The results of the study were given based on the interview and observation notes. The study showed that the students spend more time to find new information to find a solution to a problem but less time to identify how the problem related to their prior experience. The authors explained that students were poor at linking their previous learning to solve the problem. Moreover, the authors emphasized that students needed direction and more support since they were accustomed to conventional teaching. Besides, they reported how this kind of authentic form of assessment- in particular the narrative- was found a difficult and unpleasant task by students. Finally, it was reported that inter-group communications occurred in a great deal.

Canavan (2008) summarized the findings from an evaluation of PBL carried out at three UK universities over a three year period. A mixed-method approach including expert reviews, focus groups and semi-structured interviews, discussions etc. was used while varying out the evaluation. The author stated that students were engaged in a deep and reflective learning environment and almost benefitted from the development of skills such as problem solving, time and task

management, group work, negotiating and communication skills. However, he added that lots of the students reported the inconsistency between the methods of learning employed during PBL activity and the conventional end of year examination as being largely responsible for the resistance of them to PBL. The relationship was noted between the methods of assessment used and the degree of anxiety expressed by the students. Moreover, the results of an attitudinal questionnaire showed that although PBL demanded more of students' time as compared with conventionally taught courses, it required a greater degree of responsibility on their part. The author concluded that students perceived positively the reasoning behind the methodologies adopted in spite of exhibiting uncertainty, insecurity, frustration, and grade-anxiety.

In summary, researches show that there are some weaknesses in most of the prior studies in literature due to many different implementations, neglecting investigation of the actual learning process, not clearly reporting the implementation and learning environment, and only focusing on quantitative experimental designs making them difficult to interpret and causing distrust about educational outcomes (Charlin, Mann & Hansen, 1998; Dolmans 2003; Lee, 2004). Researchers emphasize the need for detailed and rich descriptions about what happens in the PBL environment. While supplying this need, since the students and tutors have a central role in PBL, it is also important to take their opinions or perceptions related with the implementations. Therefore, this study aimed to analyze the implementation of problem-based instruction in electrical-electronics engineering education from the perspectives of tutors and students.

2.11 Problem-Based Learning and Self-Regulated Learning

Self-regulation is a "self-directive process by which learners transform their mental abilities into academic skills" (Zimmerman, 2002, p.65). Social learning psychologists view the self-regulatory process in terms of three cyclical phases namely forethought phase, performance phase, and self-reflection phase. The processes and beliefs that occur before efforts to learn form the forethought phase.

Students' goal setting and strategic planning; their self-efficacy beliefs, outcome expectations, intrinsic interest/value, and learning goal orientation are the parts of this phase. The performance phase refers to processes occuring during behavioral implementation such as self control and self observation. Lastly, the self-reflection phase refers to processes occuring after each learning effort such as self-judgement and self-reaction. Therefore, self regulated learners' ability to monitor their behavior in terms of their goals and self-reflect on their increasing effectiveness enhance their self-satisfaction and motivation to improve their methods of learning. (Zimmerman, 2002). Similarly, Pintrich (as cited in Fergusson, 2003) explained the main characteristics of self-regulated learners as follows: to actively control available resources, to control their cognitive learning strategies or study skills, and ability to control and change their motivational beliefs in order to improve their learning. To sum up, Zimmerman (as cited in Loyens, Magda, & Rikers, 2008, p. 417) described learners as self-regulated considering "the degree that they are metacognitively, motivationally, and behaviorally active participants in their own learning process."

Paris and Paris (2001) stated that PBL promotes self-regulated learning since it places the responsibility on students "to find information, to coordinate actions and people, to reach goals, and to monitor understanding" (p. 94). Moreover, Evenson and Hmelo (as cited in Galand, Bentein, Bourgeois, & Frenay 2003) explained that PBL is assumed to foster students' motivation and self regulation. Therefore, considering the findings of the literature, this study also aimed to investigate the effect of PBL on different dimensions of students' self-regulated learning such as motivation and use of learning strategies.

2.12 Summary of the Related Literature

- There are lots of studies related with the effectiveness of PBL in medical education. For example, there have been eight systematic reviews or meta-analyses (Albanese & Mitchell, 1993; Berkson, 1993; Colliver, 2000b; Dochy et al., 2003; Gijbels et al., 2005; Prince 2004; Smits, Verbeek, &

Buisonje, 2002; Vernon & Blake, 1993) related with the effectiveness or outcomes of PBL compared with the conventional instruction in medical education from different points of view.

- There are some criticisms (Norman & Schmidt, 2000) about those prior studies such as: treating PBL as a single intervention without contextual information and examining the usual outcomes cause inconclusive findings or minimal difference between PBL students and their conventional counterparts.
- In addition to medical science, PBL has been implemented in all forms of undergraduate institutions including nursing, economics, pharmacy, dentistry, physiotherapy, architecture, business, law, engineering, social work, and science as well as in elementary and secondary education (Camp, 1996; Dahlgren et al., 1998; Fergusson, 2003; Perrenet et al., 2000; Polanco et al., 2004; Ribeiro, & Mizukami, 2005).
- In higher education, engineering is one of the popular disciplines that PBL has been used as a teaching strategy (Denayer et al., 2003; Guzelis, 2006; Hadgraft, 1999; Perrenet et al., 2000; Polanco et al., 2004; Ribeiro & Mizukami, 2005; Said et al., 2005). It has been observed that different forms of PBL are implemented in the content of engineering education. Savin-Baden (2008) examined seven different forms of PBL curricula that are varied across both disciplines and cultures in terms of length and design.
- Recently researchers have started to deal with what happens in the PBL learning environment, students' and facilitators' perceptions, thoughts and feelings. Instead of testing the effectiveness of PBL as compared to conventional curriculum on outcome measurement, they are focusing on fundamental issues and potential factors that may contribute to effectiveness. There are some studies aiming to define PBL interventions and investigate components of PBL environment in terms of investigating attitudes and opinions of tutors/students in PBL curriulum (Barman, Jaafar,

& Naing, 2006; Dahlgren, Castensson & Dahlgren, 1998; Hollinshed, 2004; Kaufman & Holmes, 1996; Kaufman & Mann, 1996; Ribeiro & Mizukami, 2005; Ryan, 1993).

- Researchers (Charlin, Mann & Hansen, 1998; Dolmans 2003; Lee, 2004) claimed that there are some weaknesses in most of the prior studies such as lots of different implementations of PBL, neglecting investigation of the actual learning process, not clearly reporting the implementation and learning environment, and mostly focusing on quantitative experimental designs. Therefore, researchers emphasize the need for detailed and rich descriptions about what happens in PBL environments and what are the outcomes of PBL implementations in certain settings and conditions.

CHAPTER 3

METHODOLOGY

3.1 Research Design

The main purpose of this study is to analyze the implementation of problem-based instruction in electrical-electronics engineering education from the perspectives of tutors and students. While achieving this purpose, it is aimed to report implementation of PBL in detail identifying students' and tutors' perceptions about PBL and its essential components; their roles; strengths and weaknesses of PBL; factors affecting their performance during PBL tutorials and improvement suggestions of them about problem-based instruction. Moreover, this study also aimed to compare freshman engineering students' motivation and their use of learning strategies who received their first year curriculum in PBL format, in comparison to those who received their curriculum in a conventional lecture format. Therefore, this study adopted a multi-method research design incorporating case study and causal comparative designs.

3.1.1 Case Study Design

Merriam (1998) stated that qualitative research based on the case study design is an appropriate way to provide a "holistic description and analysis of a single instance, phenomenon, or social unit" (p.27). Similarly Yin (2003) described case study as follows: "case study is used in many situations to contribute to our knowledge of individual, group, organizational, social, political, and related phenomena (p.1). Case study is well suited when the "researchers are interested in insight, discovery, and interpretation rather than hypothesis testing" (Yin 2003, p. 29).

Based on the characteristics listed above, case study design was used in this study in order to identify and analyze problem-based instruction in its natural

setting providing detailed and rich descriptions through the perceptions of students and tutors related with the essential components of the problem based instruction, implementation of it, their roles, strengths and weaknesses of PBL, factors affecting their performance during PBL tutorials and improvement suggestions of them about problem-based instruction. Therefore, the answers of the first six research questions are investigated through case study design.

3.1.2 Causal Comparative Design

In order to investigate the effectiveness of problem-based instruction on freshman engineering students' motivation and their use of learning strategies, causal comparative design was used in this study. Fraenkel and Wallen (1996, p.341) state that causal comparative study is used "to investigate the possibility of a causal relationship among variables that cannot be manipulated. In DEU, Faculty of Engineering, the departments of Electrical-Electronics, Geophysics, Geological and Mining Engineering have been implementing PBL for 6-7 years while the other engineering departments implementing conventional curriculum. Therefore, no manipulation or assignment of individuals occurred in this study.

3.2 Participants of the Study

3.2.1 Participants for the Case Study

The study was conducted in DEU, Faculty of Engineering during the spring semester of the 2006-2007 academic year. The faculty has 11 engineering departments (Mechanical, Computer, Electrical-Electronics, Industrial, Civil, Geological, Geophysical, Mining, Metallurgical and Materials, Environmental, Textiles Engineering) consisting nearly 200 faculty members and lecturers, 226 research assistants, 127 administrative personnel and 4,100 undergraduate students (Guzelis, 2006). The departments of Electrical-Electronics, Geophysics, and Geological Engineering have been establishing PBL since 2002 and Mining Engineering since 2003.

In order to identify students' and tutors' perceptions about problem-based instruction, the Electrical-Electronics Engineering Department (EEED) was considered a natural setting for tutors and students. The researcher's own work as a research assistant in this department gave her access to the participants easily. Therefore, being familiar with the site helped the researcher to be comfortable and provided the participants share their thoughts more willingly and fully with the researcher. This is the most important reason why this site was chosen for the case study.

The students and tutors of the EEED were the participants of the case study. There were 22 tutors and 284 undergraduate students (91 freshmen, 55 sophomores, 88 juniors, and 51 seniors) in this department in the 2006-2007 academic year. The students were aged between 18 and 25 years. 6% of the students were female whereas 94% were male (Table 3.1). The tutors' experience in teaching profession at DEU, EEED was between 1 and 15 years. 36% of the tutors were female whereas 64% were male (Table 3.2).

Table 3.1 Student Characteristics for the EEED

Characteristic	Dimension	Frequency (n=284)	Percent
Gender	Female	17	6
	Male	267	94
Age	18-19	10	4
	20-21	123	43
	22-23	128	45
	24-25	23	8

Table 3.2 Tutor Characteristics for the EEED

Characteristic	Dimension	Frequency (n=22)	Percent
Gender	Female	8	36
	Male	14	64
Age	30-39	9	41

Table 3.2 (Continued)

	40-49	11	50
	50-59	2	9
Teaching experience at EEED	1-5	3	14
	6-10	14	63
	11-15	5	23

The sample for this qualitative part of the study originated from this population. Out of those participants, interviews were held with 4 tutors and 14 students ranged from freshman to senior.

Participants in this research were chosen using the purposeful sampling technique. In purposeful technique, the researcher purposefully selects participants to maximize information. Patton (2002) quotes:

> "The logic and power of purposeful sampling lie in selecting information-rich cases for study in depth. Information-rich cases are those from which one can learn a great deal about issues of central importance to the purpose of the inquiry, thus the term purposeful sampling" (p. 230).

In order to maximize the possibility of analyzing the research questions, two types of purposeful sampling were used for selecting cases in this study. Criterion sampling involves the cases that meet some predetermined criterion of importance (Patton, 2002). The researcher used criterion sampling to select tutors that meet some predetermined criteria. The criteria for the selection of tutors were as follows:

- The tutor should have an experience in conducting PBL tutorials from the beginning of PBL implementation.
- The tutor should also have an experience in conventional teaching profession before the PBL implementation has started.
- The tutor should be willing to take part in the study.
- The tutor should accept the researcher as an observer in his/her PBL module.

Three tutors (Murat, Filiz, and Zeynep) that met those criteria were selected. Interviews were conducted with those tutors and freshman modules of the two tutors, sophomore module of the one and senior module of the other was selected to observe. Moreover, after the study has begun, the researcher decided to add one more tutor called Alper, although he did not meet the first criteria. He was included to the study to enrich it due to the fact that he was both guiding the freshman PBL sessions in EEED and lecturing freshman physics courses at some other engineering departments in a conventional way. Therefore, the researcher conducted an interview with him and observed one of his freshman modules.

Intensity sampling involves selecting cases that are information-rich manifesting the phenomena of interest intensely but not extremely (Patton, 2002). Moreover, 14 students having high, low or medium cumulative grade points and volunteer to interview about the instructional method from each grade level were selected to participate in interviews. Patton (2002) states that "There are no rules for sample size in qualitative inquiry. Sample size depends on what you want to know, the purpose of the inquiry, what's at stake, what will be useful, what will have credibility, and what can be done with available time and resources" (p.244).

The following sections begin with brief descriptions of the participants (tutors and students) of this study. Age, gender and academic background of the participants are presented in those sections.

3.2.1.1 Descriptions of the Tutors

Murat is a 38-year old full time faculty member (an assistant professor) at the DEU, EEED. He has been working as a faculty at EEED since 1993.

Filiz is a 40-year old full time faculty member (an assistant professor) at the DEU, EEED. She has been working as a faculty at EEED since 2000.

Zeynep is a 40-year old full time faculty member (an associate professor) at the DEU Faculty, EEED. She has been working as a faculty at EEED since 2000.

These three tutors had their doctoral degree in the field of electrical-engineering education. They have been attending to the PBL tutorial sessions and presentations of undergraduate students for approximately seven years. They also give lectures to graduate students in conventional way. These teachers has worked in preparation of curriculum and regulation in the process of transition to PBL and attended trainings on PBL at the School of Medicine. After this period, they have been preparing scenarios and guiding PBL sessions.

Alper is a 34-year old lecturer at DEU, Faculty of Engineering and Faculty of Education. He has a doctoral degree in physics education department and working at DEU since 2004. Alper has been giving lectures to some departments of Engineering and Education Faculties in conventional way and attending to the PBL sessions and presentations at the EEED for four years. When he came to this university he didn't take part at the preparation stage of PBL curriculum as PBL had been already started to be implemented. However, he takes part in scenario writing, laboratory practices and project lessons.

All the tutors were experienced in both the conventional and PBL curriculum. Therefore, they were able to compare the two.

3.2.1.2 Descriptions of the Students

The participants of this case study also include 14 students at EEED from different grade levels and having different academic successes. In this and the following chapters, there are some abbreviations used to describe the students interviewed, and the grade level of those students. For example, A1 refers to a freshman student, and E3 refers to the junior student.

G1 is a 20-year old first grade student. He was graduated from a Science High School. EEED was his ninth preference at the Student Selection Exam. He is one of the most successful students among the first graders with a high grade point average (GPA).

M1 is a 20-year old student. He was graduated from an Anatolian High School. EEED was his fourth preference at the Student Selection Exam. At the

time of conducting interview with him, he was repeating his first grade. His GPA was below the average at that semester.

C1 is a 20-year old first grade student. She was graduated from an Anatolian High School. EEED was her third preference at the Student Selection Exam. She has been repeating her first grade at the time of conducting interview with her. Her GPA was on average at that semester.

L1 is a 20-year old first grade student. He was graduated from an Anatolian High School. EEED was his fourth preference at the Student Selection Exam. He has been repeating his first grade at the time of conducting interview with him. His GPA was below the average at that semester.

A1 is a 21-year old first grade student. He was graduated from Science High School. EEED was his second preference at the Student Selection Exam. He has been repeating his first grade at the time of conducting interview with him. His GPA was on average at that semester.

S2 is a 21-year old second grade student. He was graduated from Super High School. EEED was his second preference at the Student Selection Exam. He is one of the most successful students among the second graders with a high GPA.

R2 is a 21-year old second grade student. He was graduated from a Science High School. EEED was his third preference at the Student Selection Exam. His GPA was below the average at that semester.

T2 is a 21-year old second grade student. He was graduated from an Anatolian High School. EEED was his third preference at the Student Selection Exam. He has been repeating his first grade at the time of conducting interview with him. His GPA was below the average at that semester.

S3 is a 22-year old third grade student. He was graduated from Anatolian High School. EEED was his second preference at the Student Selection Exam. He is one of the most successful students among the third graders with a high GPA.

H3 is a 22-year old third grader. He was graduated from an Anatolian High School. EEED was his second preference at the Student Selection Exam. He had

repeated his second grade once. His GPA was below average at the time of conducting interview.

M4 is a 22-year old forth grader. He was graduated from an Anatolian High School. EEED was his third preference at the Student Selection Exam. His GPA was below average at the time of conducting interview.

A4 is a 23-year old forth grader. He was graduated from an Anatolian High School. EEED was his third preference at the Student Selection Exam. His GPA was above average at the time of conducting interview.

D4 is a 24-year old forth grader. He was graduated from an Anatolian High School. EEED was his second preference at the Student Selection Exam. His GPA was below average at the time of conducting interview.

E4 is a 23-year old forth grader. He was graduated from an Anatolian High School. EEED was his 17th preference at the Student Selection Exam. His GPA was on average at the time of conducting interview.

Those 14 students' age, gender, grade level, GPA, type of high schools they are graduated from (THS), their order of preference at the Student Selection Exam (OP), and the information about whether they repeated their class or not (REPT) are summarized at the Table 3.3.

Table 3.3 Descriptions of the Students

Students	Age	Gender	GPA	THS	OP	REPT
G1	20	Male	High average	Science High School	9	no
M1	20	Male	Below average	Anatolian High School	4	yes
C1	20	Female	On average	Anatolian High School	3	yes
L1	20	Male	Below average	Anatolian High School	4	yes
A1	21	Male	On average	Science High School	2	yes
S2	21	Male	High average	Super High School	2	no
R2	21	Male	Below average	Science High School	3	no
T2	21	Male	Below average	Anatolian High School	3	yes
S3	22	Male	High average	Anatolian High School	2	no
H3	22	Male	Below average	Anatolian High School	2	no
M4	22	Male	On average	Anatolian High School	3	no
A4	23	Male	Above average	Anatolian High School	3	no
D4	24	Male	Below average	Anatolian High School	2	no
E4	23	Male	On average	Anatolian High School	17	no

3.2.2 Participants for the Causal Comparative Study

In order to compare motivation and use of learning strategies of freshman engineering students, nine engineering departments of the Faculty of Engineering took place for this study. In this faculty, there were approximately 700 freshman students at 11 engineering departments in the 2006-2007 spring semester. The sample for this causal comparative part of the study originated from this population. Four engineering departments of the Faculty of Engineering have been implementing PBL since 2002 or 2003, while the other seven departments implementing conventional lecture-based instructional method. Since the freshman curriculum (basically mathematics and physics) of all engineering departments are common, the researcher used purposive sampling while choosing the departments implementing conventional curriculum. While choosing those departments, their Student Selection Examination score criteria for accepting students to their department was taken into account. Those scores were tried to be matched with the criteria of the departments implementing PBL. Therefore, except for the students of two engineering departments (Industrial and Mechanical), the freshman students of four departments implementing PBL and five departments implementing lecture-based instructional methods constituted the participants of this causal comparative study.

There were a total of 452 freshman students from nine engineering departments took the Motivated Strategies for Learning Questionnaire (MSLQ) for this causal comparative study. There were 98 female and 354 male students in the study. The student sample ranged in age from 17 to 28 with a mean age of 20 (SD=1.3). Distribution of ages, gender, departments, order of preference, and student selection exam points of the students who took the MSLQ are given in Table 3.4.

Table 3.4 Student Characteristics for the Causal Comparative Study

Characteristic	Dimension	Frequency	Percent
Gender	Female	98	22
	Male	354	78
Age in years	17-18	35	8
	19-20	252	56
	21-22	144	32
	23-28	17	4
Engineering Department	Electrical-Electronics	67	15
	Geophysics	39	9
	Geological	60	13
	Mining	55	12
	Metallurgical and Materials	33	7
	Computer	47	10
	Textiles	31	7
	Civil	76	17
	Environmental	44	10
Student Selection Exam Scores	< 290	39	9
	291-310	158	35
	311-330	64	14
	331-350	80	18
	>350	98	22
Order of Preference to Department	1-3	74	16
	4-6	115	25
	7-8	64	14
	≥ 9	183	40

3.3 Context

Although the implementation of PBL in the Faculty of Engineering is described in 2.7, this section gives extra information about the implementation of PBL in EEED.

Freshman curriculum of EEED consists of six modules in the fall semester and five in the spring semester. Sophomore curriculum consists of six modules in each of the semester. In the junior curriculum, there are six and seven modules in the fall and spring semesters respectively. Lastly senior curriculum consists of four modules in the fall and three in the spring semester. Except the modules of the senior curriculum all modules consists either three or four PBL sessions depending

on their duration. In the senior curriculum, all modules consist of four or five PBL sessions that are organized around four-week long real design problems or projects.

PBL tutorials of freshman, sophomore, and junior electrical-electronics curriculum take place in PBL building. The building has 120 PBL rooms but 45 of those rooms are reserved for the Faculty of Engineering. However, the PBL sessions of senior program take place within the EEED which has 10 PBL rooms.

Apart from PBL sessions, there are presentations, laboratories, scientific consultation hours, and module discussions in a PBL module. To be a sample, the topical outline of a three weeks long freshman module and its weekly schedule is given in Appendix A and B respectively. Presentations take important place in students' weekly schedules. There are two classes in EEED in which the presentations are done. The need for extra classes is compensated from the classes of other engineering departments. Students are given presentations conventionally about the topical outline determined before for each module. Moreover, for every module, there is two hour long consultation hours every week in which students can ask any questions about the modules (presentations, scenarios etc.) to the tutors who guide them during the PBL sessions. Besides, students participate in laboratories related with physics, computer, electronic, programming etc. At the last week of the module, students take module exam and then participate into discussion hours to discuss and evaluate the scenario/module as a whole.

The tutors in EEED have different area of specialization such as biomedical engineering, circuits and systems, electrical machines, electromagnetic waves, microwaves, signal processing, power electronics, and telecommunication in which they have doctoral degrees or have been making researches theoretically and practically. Those tutors participate in the modules as a facilitator. Although it changes as the number of the students change, in freshman, sophomore, junior and senior modules, students are mostly divided into 10, 6, 9 and 4 groups respectively meaning that much of tutors are needed to guide those groups. Therefore, since there is not much tutors in the department, tutors may guide the modules the topic

of which is not directly related with his/her area of specialization. To be a sample, for the freshman module-weekly schedule of which was given previously- 10 tutors were responsible for guiding 10 tutorials each consisting of 9-10 students. Those tutors were all electrical-electronics engineers but only two of them were a content expert of the subject of that module. In fact, one or two content experts about the topic of each module prepare scenarios and are chosen to be responsible for each module. Those tutors guide one of the PBL sessions, do presentations, and participate to the discussion hours and scientific consultations of their PBL groups. Other PBL sessions are guided by the remaining tutors whose area of specialization may differ.

Since the scenarios of freshman engineering modules are prepared mostly by the instructors from mathematics, basic sciences and engineering sciences, presentations are also done by them. For example, Physics presentations were done by a lecturer from the Physics Education Department, Linear Algebra and Calculus presentations by a lecturer from Mathematics Education Department, Materials presentations by an instructor from the Metallurgical and Materials Engineering department, Algorithms & Programming presentations by an instructor from the EEED. Moreover, physics laboratories were guided at the Physics Department by the research assistants/lecturers of this department or those of Physics Education Department. Lastly, PC laboratories were guided by the research assistants/lecturers of the EEED.

At the end of the last PBL session, an evaluation form is distributed to each student to evaluate their tutors. Students are expected to fill it and reach them to the chair of the department. Then, the chair shares the results of those evaluations to the tutors. Similarly, “student evaluation form” (given in Appendix C) is distributed to the tutors. They are expected to fill those forms for each student in their group while giving session grades.

In this study, PBL sessions of four tutors during their five modules were observed. The module guided by Filiz was a two week long module. She prepared the scenario, did the presentations and was responsible for the exam discussion and

consultation hours of that module. The module guided by Alper was a three week long module. He took part in preparing the scenario, did the presentations and was responsible for the exam discussion and consultation hours of that module. The module guided by Murat was a two weeks long module. He prepared the scenario, did the presentations and was responsible for the exam discussion and consultation hours of that module. The first module guided by Zeynep was a three week long module. She did not prepare the module or took part in preparing it. She was only responsible for guiding it. All the tutors were the content experts about the subject of those mentioned modules. However, the second module guided by Zeynep which was a two week long module, was not related with her area of specialization. She was only responsible for guiding it.

3.4 Data Sources

This study involves a wide range of data on people experiencing PBL and conventional instruction. Observations, interviews, document analysis, and the MSLQ were utilized as data gathering instruments to analyze the problem-based instruction in engineering education. In this part, those data sources are explained in detail.

3.4.1 Observations

"Observation entails the systematic noting and recording of events, behaviors, and artifacts (objects) in the social setting chosen for study… Through observation, the researcher documents and describes complex actions and interactions" (Marshall & Rossman, 1999, p.107). According to Patton (2002), qualitative methods using observations have been considered as one of the appropriate methods of data gathering. In this study, five PBL modules of selected tutors from the curriculum of freshman and junior engineering were observed. Those modules each of which have three or four sessions within two or three weeks ranging from six to ten hours and belong to different grade levels were

selected on conditions that both tutor of those modules accepted the researcher as an observer and a schedule of one module did not overlap with another.

The data related with observations were collected through non-participating observation during March and June 2007 for the three modules and November 2007 for one module. For each observation, the researcher noted the date of the observation, the physical appearance of the place, the students' and tutors' activities, phrases, keywords, their interactions, and her ideas about the events took place and their expressions. She tried to quote some of the exact words of participants and took some notes in order to refresh her memory when typing those field notes into computer at the same evening or the day after the observation.

An observation checklist (given in Appendix D) was developed as a guide in order to better report how frequent some PBL characteristics (in terms of tutors' roles, students' roles, PBL session process, and assessment) occurred during tutorials. During observations, the researcher took notes related with the participants' actions/interactions and the PBL process, and then she filled one observation checklist for each module by considering the average of all observed sessions and added her comments. Taking notes became easier when there were pre-prepared headings showing the main points to be observed. This checklist was derived from both the studies in the literature and the reports of Faculty of Engineering emphasizing the basic characteristics of PBL and their goals while implementing it. All the observed sessions were rated according to the observation checklist.

3.4.2 Interviews

The semi-structured interviews were conducted with tutors and students to answer the first six research questions. Interviews were conducted both to support the observations and provide the means to analyze the problem-based instruction in engineering education. Review of the literature, and pre observations of the researcher formed the questions for the interviews. The interviews were based on a person-to-person semi-structured protocol one for students (given in Appendix E)

and one for tutors (given in Appendix F). Yes/No questions and open-ended questions were used in order to gather data. Both of the interview guides have common open-ended questions focusing on the perceptions of participants. However, the Yes /No questions of those guides differ from each other in terms of participants' backgrounds or experiences. For example, while the students were asked whether they have an experience with PBL before coming to this university or not; the tutors were asked their teaching experience with PBL in EEED and their first impressions about it. Moreover, only the tutors were asked to compare PBL with conventional curriculum using a 5-point Likert scale (1=much more in conventional curriculum, 2=a little bit more in conventional curriculum, 3=both are the same, 4=a little bit more in PBL, 5=much more in PBL) of fifteen statements in different aspects of students' motivation and their use of learning strategies.

The interviews lasting from 40-60 minutes were conducted once with each participant (4 tutors and 14 students). The interviews were held in Turkish and all of the interviews were audio-recorded. The interviews were transcribed and coded by the researcher.

The student interview was piloted on two undergraduate and one graduate student whereas tutor interview was piloted on a research assistant having seven years experience at EEED. Before the piloting started, those students and research assistant were explained that they may ask for comprehension of the items. The interviewees did not ask for any clarification. However, the researcher realized that some of the questions were not asked in a logical sequence. Therefore, the researcher changed the order of some questions and added some alternative questions to the guides. Moreover, the researcher also continued to make some revisions (adding alternative questions or probes, integrating some questions etc.) after conducting interviews with tutors by taking into consideration of their answers.

3.4.3 Document Analysis

Patton (2002) points out that "records, documents, artifacts, and archives… constitute a particularly rich source of information about many organizations and programs (p. 293). Similarly, Bogdan and Biklen (1998) state that documents refer to such materials (photographs, films, videos etc.) can be used as supplemental information as a part of a case study. In this study, some documents, reports, and records were selected according to their relevance to the research questions and analyzed both as a part of the triangulation of data and to increase the understanding of the instructional practice and participants' perspectives. Those documents and reports were selected since some of them give information about the implementation of PBL in the EEED or some about the students' or tutors' ideas about this implementation process.

For example, in the EEED, evaluation forms used by students to evaluate their tutors guiding them during PBL sessions are recorded regularly. With this form, tutors are evaluated in terms of their motivation, contribution to the learning process, contribution to the development of critical thinking, contribution to the development of self-directed learning skills, contribution to the development of communication skills, and contribution to the development of assessment skills. Students mark the numbers ranging between 1 having the meaning of "incompetent" and 5 having the meaning of "excellent".

Moreover, the students fill module questionnaires (given in Appendix I) every term evaluating the all modules they are involved in. This questionnaire consists two sections namely "general consideration" and "evaluation of program outcomes". Students mark the numbers between 1 and 5 (1: very poor, 2: poor, 3: average, 4: good, 5: excellent) or NA indicating not applicable.

The results of those questionnaires and evaluation forms are reported in the "self-evaluation report" prepared for the Engineering Evaluation Institution in 2006. This self-evaluation report also included the detailed information about the curriculum that was being implemented in the Faculty of Engineering. Therefore, the researcher analyzed this report in order to increase the understanding of the

instructional practice and students' evaluations of their tutors, modules and PBL processes. For example, the self-evaluation report gives some descriptive statistics about students' evaluation of the modules in 2005-2006. It is reported that 41 freshman students (52% of the whole freshman students), 56 sophomore students (57%), 25 junior students (48%), and 20 senior students (57%) filled the questionnaire for all modules.

Apart from this, the researcher reached the module questionnaires filled by 59 freshman (65%), 39 sophomore (72%), 82 junior (93%), and 31 senior (61%) engineering students in 2006-2007. The researcher analyzed the results descriptively and reported those as additional data sources while answering the related research questions.

Lastly, every academic year, one student delegate is chosen from each grade level. In the spring semester, the delegate of sophomore students from the EEED prepared a questionnaire about the implementation of PBL in this department and conducted it to volunteer sophomore and junior engineering students. 65% (36 out of 55) sophomore and 55% (48 out of 88) junior engineering students participated in this questionnaire. There were some questions related with some research questions of this study such as (Are you satisfied with the PBL scenarios? Do you think that the PBL sessions are effective? What are the characteristics of a good PBL scenario? What are the characteristics of a good PBL tutor?).

All of those reports, documents, records, and the results of the questionnaires mentioned above were used for document analysis.

3.4.4 Motivated Strategies for Learning Questionnaire

Developed by Pintrich, et al. (1991), MSLQ is a self-report instrument designed to assess college students' motivational orientations and their use of learning strategies for a college course. MSLQ consists 81 items that use a seven point Likert scale ranging from "not at all true of me" to "very true of me". MSLQ consists two sections namely, motivation and learning strategies.

Sungur (2004) translated and adapted MSLQ into Turkish for high school students. Therefore, the researcher adapted this version of MSLQ into two forms: the first form (MSLQ-I) (given in Appendix G) for freshman engineering students having conventional curriculum and the second form (MSLQ-II) (given in Appendix H) for freshman engineering students having problem-based instruction.

The motivation section consists of 31 items under six scales such as Intrinsic Goal Orientation, Extrinsic Goal Orientation, Task Value, Control of Learning Beliefs, Self- Efficacy for Learning and Performance and Text Anxiety (Table 3.5) assessing students' goals and value beliefs for a course, their beliefs about their skill to succeed in a course, and their anxiety about test in a course (Pintrich, et al., 1991).

Table 3.5 Item Numbers of the MSLQ Motivation Scales

Scale	Item Numbers
Intrinsic Goal Orientation	1-16-22-24
Extrinsic Goal Orientation	7-11-13-30
Task Value	4-10-17-23-26-27
Control of Learning Beliefs	2-9-18-25
Self- Efficacy for Learning and Performance	5-6-12-15-20-21-29-31
Text Anxiety	3-8-14-19-28

The learning strategy section consists of 31 items regarding students' use of different cognitive (Rehearsal, Elaboration, Organization, Critical Thinking) and metacognitive strategies (Metacognitive Self Regulation) and 19 items concerning student management of different resources (Time and Study Environment, Effort Regulation, Peer Learning, Help Seeking) (Table 3.6) (Pintrich, et al., 1991). There are eight reversed items (33, 37, 40, 52, 57, 60, 77, and 80) in the learning strategies part. Those items were reversed before an individual's score was computed. For example, the student scoring one for reversed items received a score of seven. Therefore, one became seven, two became six, three became five,

four remained four, five became three, six became two, and seven became one for those reversed items (Pintrich, et al., 1991).

Table 3.6 Item Numbers of the MSLQ Learning Strategies Scales

Scale	Item Numbers
Rehearsal	39-46-59-72
Elaboration	53-62-64-67-69-81
Organization	32-42-49-63
Critical Thinking	38-47-51-66-71
Metacognitive Self Regulation	33-36-41-44-54-55-56-57-61-76-78-79
Time and Study Environment	35-43-52-65-70-73-77-80
Effort Regulation	37-48-60-74
Peer Learning	34-45-50
Help Seeking	40-58-68-75

Scales are constructed by taking the mean of the items that make up that scale. For example, an individual score for the Intrinsic Goal Orientation scale-having four items- was computed by summing the four items and taking the average. Therefore, students' scores for each scale range from 1 to 7.

3.5 Procedure

At the beginning of the study, a detailed review of the literature search was carried out. After determining the keyword list, Educational Resources Information Center (ERIC), International Dissertation Abstracts (DAI), Social Science Citation Index (SSCI), Ebscohost, Science Direct and Internet (Google) were searched systematically. Previous studies made in Turkey were also searched from the YOK, Hacettepe Eğitim Dergisi, Eğitim ve Bilim and Çağdaş Eğitim Dergisi. Photocopies of obtainable documents were taken from METU library, library of Bilkent University and TUBİTAK Ulakbim.

The researcher, who was working as a researcher temporarily in the EEED, made the purpose of the study clear to the chair of the department. After getting

preliminary approval from him, the necessary permission was taken from the dean of the faculty. Then, parallel to the related literature survey; history of PBL in this faculty, implementation process, and students' and tutors' opinions were examined through informal observations or interviews with students and tutors in this department. Subsequent to those, data sources related with the research questions and appropriate samples of data were identified. Table 3.7 shows the link between the data sources and research questions.

Table 3.7 Linking Data Sources to the Research Questions

Research Questions	Data Sources
1. How do tutors and students perceive PBL and their roles?	• Interviews • Document Analysis
2. How PBL is implemented into PBL tutorials?	• Observations • Interviews
3. What are tutors' and students' perceptions about the strengths of problem-based instruction?	• Interviews • Document Analysis
4. What are tutors' and students' perceptions about the weaknesses of problem-based instruction?	• Interviews • Document Analysis • Observations
5. What are tutors' and students' perceptions about the factors affecting their performance during PBL tutorials?	• Interview • Observations
6. What are the improvement suggestions of the tutors and students about problem-based instruction?	• Interviews • Document Analysis
7. What is the effect of PBL on freshman engineering students' motivation (intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performance, text anxiety) scores?	• MSLQ • Interviews • Observations
8. What is the effect of PBL on freshman engineering students' scores for the use of learning strategies (rehearsal, elaboration, organization, critical thinking, metacognitive self-regulation, time and study environment, effort regulation, peer learning, help seeking)?	• MSLQ • Interviews • Observations

Interviews, observations, document analysis, MSLQ-I and MSLQ-II constituted the data sources of this study through which both qualitative and quantitative data were gathered. The language of the data sources were Turkish considering the possible differences in the English proficiency levels of the participants.

The researcher started to collect quantitative data in February 2007. The MSLQ-I or MSLQ-II were administered to the freshman students of nine engineering departments as a pretest at the beginning of the spring semester and a posttest at the end of this semester. The researcher was present while administering the questionnaire in whole groups in order to handle with any kind of problems that might arise. 40 minutes were allocated for the administration of the both forms of the MSLQ. During the collection of data, no problem was encountered. Although it is emphasized on the explanation part of the MSLQ-I, the researcher warned all the freshman students implementing conventional curriculum to fill the questionnaire by taking into account the mathematics and physics lessons due to the fact that scenarios are written based on a real physics problems with the major collaboration of mathematics in the departments implementing PBL.

A good case study investigator should be able to pose and ask good questions; be a good listener having ability to assimilate new information without bias; be adaptive and flexible seeing newly encountered situations as opportunities, not threats; be unbiased by preconceived notions; have a firm grasp of the issues being studied (Yin, 2003). The researcher in this study attempted to improve those skills.

After the third week of the spring semester, the interview to be held with students was piloted on two undergraduate students and a graduate student. The tutor interview was piloted with an experienced research assistant. Therefore, the researcher started to conduct semi-structured interviews with students on March. The researcher conducted the interviews during students' free time in her room. Although, the researcher informally talked with some of the participant students

about PBL when they required, one formal interview was conducted with each participant during the spring semester.

The researcher started to make observations on April since the four modules (two modules of the tutor Zeynep, one module of the tutors Murat and Filiz) which those tutors accepted the researcher as an observer started at that month. During the observations, the researcher wrote field notes that described what she had observed, what the students and tutor had discuss, what events occurred during the sessions of the modules and any other notable information about the sessions. Moreover, the researcher noted nonverbal communication and recorded her interpretations as side notes. For each module the researcher filled the observation checklist and took noted about it. Therefore, during April and May, the researcher observed four PBL modules with the observation time ranging from 6 to 10 hours for each module. However, the module of the tutor Alper was observed at the following fall semester on November. This tutor was guiding few modules and only the ones of freshman students. Therefore, the module on this time was more suitable both for him and the researcher to observe.

In fact, the researcher planned to observe one module of each tutors before the study began. However, the tutor Zeynep mentioned her concern about directing a module which is not related with her area of specialization or which necessitates to be prepared a lot to understand. Therefore, she recommended the researcher to observe her two modules one of which is related with her area of specialization and the other not.

Following the observation of each module, the researcher conducted semi-structured interviews with tutors during their free times and in their rooms. Before starting the interview, the researcher explained the aim of the interview and the approximate time needed to complete the interview. Each interview took about 40 to 60 minutes and was recorded with a tape recorder in order to take notes and not to miss any points said by the interviewees. Semi-structured interviews with a list of questions were performed and any emerging questions were asked when clarification was needed. After conducting the interviews the researcher

transcribed them. Moreover, during two semesters, some students aware of the study visited the researcher and explained their ideas about PBL. Those spontaneous informal interviews with students provided the researcher a deeper understanding and insight into details of the instruction.

Throughout the study, the researcher searched some documents, reports or studies in order to constitute additional source information. As Patton (2002) states "these kinds of documents provide the evaluator with information about many things that cannot be observed" (p. 293). Therefore, the researcher used evaluation forms of student to their tutors, results of questionnaires related with each module, the report of the Engineering Evaluation Institution, and a questionnaire applied by a student delegate were used for document analysis.

Given these conditions, the data for this study were completely gathered by November 2007. The timeline of the study is viewed in Table 3.8.

Table 3.8 Timeline of the Study

Parts of the Study	2006 October-November	2006-2007 December-January	2007 February-March	2007 April-May	2007 June-July	2007-2008 August-March	2008 April-December
Literature Review	X	X	X	X	X	X	
Preliminary Analysis of Implementation	X	X					
Development of Data Sources		X	X	X			
Piloting of Data Sources			X				
Administration of MSLQ			X		X		
Making Observations			X	X	X	X	
Conducting Interviews			X	X	X	X	
Data Analysis					X	X	X
Results and Conclusions						X	X

3.6 Data Analysis Methods

In this study, two main sources of data existed: qualitative data (audio recordings of interviews, field notes and document analysis) and quantitative data (pre-test and post-test scores for the scales of the MSLQ-I and MSLQ-II) depending of the nature of research questions and the data sources. Qualitative data analysis was carried out to identify perceptions of students and tutors related with the implementation of problem-based instruction in engineering education. On the other hand, quantitative data analysis was carried out to investigate the effect of PBL on freshman engineering students' motivation and their use of learning strategies.

3.6.1 Qualitative Data Analysis

Bogdan and Biklen (1998, p. 157) defines qualitative data analysis as "working with data, organizing them, breaking them into manageable units, synthesizing them, searching for patterns, discovering what is important and what is to be learned, and deciding what you will tell others". Patton states that "case data consist of all the information one has about each case: interview data, observations, the documentary data…" (2002, p. 449). In this study, multiple source of information was used to provide a comprehensive perspective on problem-based instruction. Observations, interviews and document analysis were used as data sources. Therefore, as a preliminary task, the researcher organized this data set.

"Developing some manageable classification or coding scheme is" stated as the first step of qualitative analysis (Patton, 2002, p. 463). Bogdan and Biklen (1998) explained that the most general information on the setting, topic or subjects" can be sorted under codes. In this study, coding schemes was used to gain a more detailed perspective about what was occurring based on the purpose of the study. These coding schemes helped to analyze the transcripts of the participants. Marshall and Rossman (2006) advised to use of preliminary research questions or related literature developed earlier as guidelines for data analysis.

Therefore, the researcher formed preliminary code list (given in Appendix J) based on the research questions: understanding of PBL, implementation of PBL, strengths of PBL, weaknesses of PBL, and improvement suggestions for PBL.

After observations, the researcher typed field notes at the same evening or the day after the observation. The researcher used thick description in order to describe the PBL sessions. While approaching data analysis, the researcher scanned the gathered data and looked for words or phrases representing the preliminary coding categories of the data. Therefore, the researcher-based on the field notes- began initial coding and investigated themes emerged from that coding. She used the same approach while analyzing the interviews. In fact, the analysis of this study began while the researcher was still collecting data and continued after leaving the field by identifying categories and subcategories. After categorizing the data, the researcher used a word-processing to combine the interview, observation and document analysis notes to a file in order to see clearly where the themes triangulated with data sources.

Each data sources were coded by the researcher. The categories/sub categories having similar names or meanings were combined and those unsupported ones having not enough information were eliminated. Moreover, some sub categories were added. Therefore, recoding the data and organization of the themes formed the final version of the code list (given in Appendix K).

3.6.2 Quantitative Data Analysis

The quantitative data were collected by the MSLQ-I and MSLQ-II which were used to investigate the effect of PBL on freshman engineering students' motivation and their use of learning strategies. There are 35 variables involved in this study, which were categorized as dependent and independent. The dependent variables in this study are the posttest scores of intrinsic goal orientation (IGO), extrinsic goal orientation (EGO), task value (TV), control of learning beliefs (CLB), self-efficacy for learning and performance (SE), and test anxiety (TA) in the motivation section of MSLQ; rehearsal (REH), elaboration (ELA),

organization (ORG), critical thinking (CRT), metacognitive self-regulation (MSR), time and study environment (TS), effort regulation (EF), peer learning (PL), and help seeking (HS) in the learning strategies section of MSLQ. Therefore, there are 15 dependent variables, namely students' motivation and learning strategies.

The independent variables in this study are methods of teaching (MOT), students' age, gender, Selection Examination score (SELS), order of preference to their department (OP) in the Student Selection Examination, and students' pretest scores for the motivation scales and learning strategy scales. Among these, MOT is the group membership and the remaining is used as covariates to match two groups statistically.

The data obtained in the study were analyzed by using descriptive and inferential statistics. For descriptive statistics, the mean, median, mode, standard deviation, skewness and kurtosis of the dependent variables were presented according to the MOT. For inferential statistics, statistical technique named multivariate analysis of covariance (MANCOVA) was used.

The following null hypotheses were tested by using MANCOVA:

1. There is no significant difference between freshman engineering students receiving their curriculum in problem-based instruction and those receiving in conventional instruction on their post-motivation scores (PSTIGO, PSTEGO, PSTTV, PSTCLB, PSTSE, PSTTA) when their age, gender, SELS, OP, and pre-motivation scores are statistically controlled.
2. There is no significant difference between freshman engineering students receiving their curriculum in problem-based instruction and those receiving in conventional instruction on their post-learning strategy scores (PSTREH, PSTELA, PSTORG, PSTCRT, PSTMSR, PSTTS, STEF, PSTPL, PSTHS) when their age, gender, SELS, OP, and pre-learning strategy scores are statistically controlled.

The statistical analyses of this study were performed by using statistical package program for social sciences (SPSS). During analyses, the probability of rejecting true null hypothesis (probability of making Type 1-error) was set to .05

as a priori to our hypothesis testing because it is mostly used value in educational studies.

3.7 Trustworthiness of the Qualitative Study

Lincoln and Guba stated the main question addressed by trustworthiness as "how can an inquirer persuade his or her audiences that the research findings of an inquiry are worth paying attention to?" (p. 290, as cited in Yürük, 2005). Those researchers (1986 as cited in Patton 2002) suggested that establishment of trustworthiness includes the combination of credibility, transferability, dependability and confirmability. Credibility corresponds to internal validity, transferability corresponds to external validity, dependability corresponds to reliability, and confirmability corresponds to objectivity in qualitative research.

3.7.1 Credibility

Patton (2002) states that "any research strategy ultimately needs "credibility" to be useful. No credible research advocates biased distortion of data to serve the researcher's vested interests and prejudices" (p.51). In order to increase the quality and credibility of the qualitative analysis, the researcher used the strategies such as explanation of triangulation, keeping methods and data in context and credibility of the researcher.

3.7.1.1 Triangulation

Merriam (1998, p. 207) defines triangulation as "… using multiple investigators, multiple sources of data, or multiple methods to confirm emerging findings". Triangulation both strengthens a study by providing diverse ways of looking at the same phenomenon and adds credibility by strengthening confidence in whatever conditions are drawn (Patton, 2002). Denzin (1978 as cited in Patton, 2002) categorizes triangulation types as four such as data triangulation, investigator triangulation, theory triangulation and methodological triangulation. Data triangulation involves comparing and cross-checking the consistency of

information get by qualitative methods. Investigator or analyst triangulation involves multiple investigators or analysts providing a check on bias in data collection. Methodological triangulation involves multiple research methods to study a problem or program. Theory triangulation involves multiple theories and perspectives to interpret a single set of data (Patton, 2002). Data triangulation, methodological triangulation and investigator triangulation were used in this study to increase the validity of the information. Data from observations, interviews, and documents were gathered to cross-validation and data triangulation. Document analysis provided the researcher an additional data to triangulate the results of interviews and observations. Moreover, methodological triangulation was achieved by combining qualitative and quantitative methods to answer some research questions. Lastly, in order to achieve investigator triangulation, a colleague who is familiar with the nature of this study and has an experience in PBL coded 10% of the randomly selected transcripts independently by using the developed coding scheme. The percentage of agreement (inter-coder reliability) was calculated as 93.65%. In order to eliminate the disagreements, the transcripts were reexamined up to reach consensus on the conflicted codes.

3.7.1.2 Keeping Methods and Data in Context

Patton (2002) states that "keeping findings in context is a cardinal principle of qualitative analysis" (p.563). Since the qualitative findings are highly context and case dependent, the researcher attempted to report both methods and results in their proper contexts in order to avoid over generalize from purposeful sampling.

3.7.1.3 Credibility of the Researcher

The researcher may "report any personal and professional information that may have affected data collection, analysis, and interpretation- either negatively or positively- in the minds of users of the findings" (Patton, 2002, p.566) in order to establish investigator credibility. At the time of this study being conducted, the researcher was a research assistant in the faculty of education but temporarily

working in EEED. Since the branch of the researcher is not engineering but an education, the participants explained their thoughts and ideas without being under pressure. Moreover, they accepted her as an evaluator of PBL instruction, and respected and valued her goal.

3.7.2 Transferability

Transferability corresponds to external validity in quantitative research referring the degree to which the results of qualitative research can be transferred or applied to other situations (Lincoln & Guba as cited in An, 2006). The researcher provided a thick description of the program, inquiry process, the learning environment and the participants in order for readers to determine whether the findings are transferable to their own settings. Therefore, it will be the responsibility of the reader to determine the extent to which the findings of this study will transfer to other programs of participants.

3.7.3 Dependability

Dependability corresponds to reliability in quantitative research where the main idea is to provide consistency between the interpretation of the data and the work the researcher has done. In this study, the researcher explained the research process, data sources and data analysis in detail to demonstrate the consistency of the findings and interpretations with the process of the study therefore to establish dependability.

3.7.4 Confirmability

Confirmability corresponds to objectivity in qualitative research, where the researcher “does not set out to prove a particular perspective or manipulate the data to arrive at predisposed truths” (Patton, 20002, p. 51). In this study, as a first step, the researcher described the procedures (data collection sequences, data processing etc.) clearly so that they could be easily followed. Moreover, member checks were done by sharing the data constructions with two of the participants in

order to verify developing data constructions occurred as a result of data collection. However, the interpretations and conclusions derived from the data were not reviewed by any examiner limiting the objectivity of the study.

3.8 Validity and Reliability Issues of the Causal Comparative Study

The MSLQ-I was piloted using 173 freshman students. 14 (8.1%), of the students were attending biology education, 28 (16.2%) of the students were attending mathematics education, 24 (13.9%) were attending civil engineering, 66 (38.2%) were attending industrial engineering, and 41 (23.7%) were attending mechanical engineering departments. 82.7% of the students were male and 17.3% of the students were female. The MSLQ-II was piloted using 162 undergraduate electrical-electronics engineering students. 8.4% of the students were freshman, 24.7% were sophomore, 50.6% were junior, and 16.3% were senior engineering students. 91.6% of the students were male and 8.4% of the students were female. After the MSLQ-I and MSLQ-II were administered, the data was entered into SPSS and then LISREL was used for the confirmatory factor analysis.

The researcher tested the motivation items by confirmatory factor analysis to see how well they fitted to those six latent factors. Pintrich, et al. (1991) reported following goodness of fit (GOF) statistics for the English version of the MSLQ (MSLQ-ENG): the ratio of chi-square to degrees of freedom (χ^2/df = 3.49), the goodness of fit index (GFI = 0.77), and the root-mean-square residual (RMR = 0.07). When the fit statistics for the adapted versions of the MSLQ in Turkish were examined, it was found that χ2/df = 2.03, GFI = 0.76, RMSEA (root-mean-square error of approximation) = 0.077 and RMR = 0.085 for the MSLQ-I, χ2/df = 1.83, GFI = 0.76, RMSEA = 0.072 and RMR = 0.1 for the MSLQ-II.

The researcher also tested the learning strategy items by confirmatory factor analysis to see how well they fitted to those nine latent factors. The GOF statistics reported by Pintrich, et al. (1991) for the MSLQ-ENG was as follows: χ^2/df = 2.26, GFI = 0.78 and RMR = 0.08. When the GOF statistics for the adapted version of MSLQ in Turkish were examined, it was found that χ2/df =

1.88, GFI = 0.67, RMSEA (Root Mean Square Error of Approximation) = 0.072 and RMR = 0.09 for the MSLQ-I, $\chi 2/df$ = 1.98, GFI = 0.64, RMSEA = 0.078 and RMR = 0.098 for the MSLQ-II.

In fact, Kelloway (1998) reported that the $\chi 2/df$ ratios of less than 5 indicate a good fit to the data. Moreover, values less than 0.05 for RMR (Kelloway, 1998), values below 0.1 for RMSEA (Steiger, as cited in Kelloway, 1998), and the values exceeding 0.9 for GFI are interpreted as indicating a good fit to the data. When compared with those GOF criteria and the fit indices of the MSLQ-ENG, the fit indices of Turkish versions of MSLQ used in this study seem quite reasonable. Pintrich, et al. (1991) pointed out that the MSLQ has been applied to a broad range of courses and subject domains which may cause to difference in the motivational attitudes and deployment of the various learning strategies depending upon course characteristics, teacher demands, and individual student characteristics. Therefore, the authors stated that although the fit indices are not perfect-but quite reasonable- and one can claim factor validity for the MSLQ scales.

The reliability of the MSLQ-I and MSLQ-II was measured by using Cronbach's alpha coefficient. The Cronbach's alphas of the each sub-scale corresponding to motivation and learning strategies sections for MSLQ-ENG, MSLQ-I, and MSLQ-II are presented in Table 3.9 and Table 3.10 respectively. The Cronbach's alphas of the whole motivation section for MSLQ-I and MSLQ-II are 0.87 and 0.86 respectively. Similarly, the Cronbach's alphas of the whole learning strategies section for MSLQ-I and MSLQ-II are 0.93 and 0.91 respectively which represented a high reliability.

Table 3.9 Reliability Coefficients of Motivation Sections

	IGO	EGO	TV	CLB	SE	TA
MSLQ-ENG	0.74	0.62	0.90	0.68	0.93	0.80
MSLQ-I	0.59	0.69	0.81	0.66	0.88	0.71
MSLQ-II	0.71	0.62	0.84	0.73	0.83	0.68

Table 3.10 Reliability Coefficients of Learning Strategies Sections

	REH	ELA	ORG	CRT	MSR	TS	EF	PL	HS
MSLQ-ENG	0.69	0.76	0.64	0.80	0.79	0.76	0.69	0.76	0.52
MSLQ-I	0.74	0.74	0.72	0.76	0.74	0.72	0.65	0.56	0.50
MSLQ-II	0.66	0.81	0.69	0.78	0.69	0.67	0.58	0.54	0.57

3.9 Limitations of the Study

- Data collection and analysis were done mainly by the researcher. This is one of the limitations of this study as for the other qualitative researches.
- The external validity of the study was limited since purposeful sampling was used. Therefore, generalizations derived from this study are confined to similar groups and settings.
- The number of the participants in the group of tutors with whom the semi-structured interviews were hold was limited to four. The increased number of the sample as well as conducting unstructured interviews rather than semi-structured ones might provide more in-depth and multi-faceted data with the consideration of diverse perspectives and points of view.
- During observations, behaviors/actions of the participants might be unexpectedly influenced by the researcher's (observer's) presence.
- The qualitative part of this study was limited to the electrical-electronics engineering students and tutors. The differences that might stem from the backgrounds of the students and the tutors might cause different results.

CHAPTER 4

RESULTS

The central focus of this study was to analyze the problem-based instruction in engineering education. The research questions which guided the collection and analysis of data provided a framework for the presentation of the findings of this study into seven major sections. Based on the observation notes, interview notes and document analysis, the results of qualitative part of this study are given in the first six sections addressing the first six research questions. In those sections, participants' perceptions about their PBL experience and/or the results of observations and document analysis are described under the headings such as Question 1: Understanding of PBL and its Essential Components, Question 2: Implementation of PBL into PBL Sessions; Question 3: Strengths of PBL; Question 4: Weaknesses of PBL and Difficulties with PBL; Question 5: Factors Affecting Performance of Tutors and Students during PBL Tutorials; and Question 6: Improvement Suggestions for PBL. When reporting the parts related with the perceptions of the participants, firstly the perceptions of the students and then the perceptions of the tutors were mentioned under related headings. Moreover, for those parts, the findings of the observations or document analysis were not given under separate subheadings but reported in related parts.

In order to answer the seventh and eighth research questions, the MSLQ was administered to the freshman students of nine engineering departments as a pretest at the beginning of the spring semester and a posttest at the end of this semester. The results of the quantitative part of this study addressing the last two research questions are examined and reported in the seventh section under the heading of Questions 7 and 8: Effectiveness of PBL on Motivation and Learning Strategies.

4.1 Question 1: Understanding of PBL and its Essential Components

While reporting the results of the first research question which considers the students' and tutors' perceptions about PBL and its essential components, data gathered from interviews and documents were used.

Before mentioning their perceptions about PBL and its essential components, students were asked when they learned that PBL is implemented in their department, what they were told about it and what their first impressions were. Three of the students (S3, A1, and C1) said that before they pick the options for OSS, they were aware that PBL is implemented in their department and they picked it on purpose. For example, S3 stated as follows:

> I saw it on the brochure of Dokuz Eylul University. There was some information about PBL but not in detail. It mentioned about the problem based solutions and student centered system. When I came here I met a teacher and learned from him. When I picked my option, I knew that PBL is implemented here. I was conscious. I thought it was good but people said that it was difficult. There was a rumor that most students failed and it is said to be a difficult but at the same time enjoyable and helpful. These were the things I heard before I involved in this system.

Although S3 mentioned his positive impressions, the other two students emphasized how their impressions have changed in time due to the problems they faced. For instance, A1 mentioned that although he explored PBL before coming to university and made his choice willingly, he realized that the results of his exploration and knowledge about PBL do not correspond with the system implemented at the university due to some problems he faced with.

Other students learned about PBL either from the orientation program that the engineering faculty arranged or from the students at the upper classes after coming to the university. While two of them (G1 and T2) didn't have positive or negative impressions, the others stated that their first impressions were positive. G1 expressed his first impression as neutral since he was of the opinion that it was up to the student to be successful no matter the system is conventional or problem based. However, A4 pointed out his positive feelings as follows:

> As a first impression, it motivated me because it was different from the conventional education that we got used to. I was enthusiastic about it when I first heard about it and am

still so. I am still hopeful about the general situation. I still support the idea that it motivates the students.

When the students were asked what they understand from the term PBL and its essential components, they all stated that it is a student centered system and it promotes students take responsibility for their own learning. For example, the second grade student (S2) to express the aim of the system stated:

> The system continuously promotes you to do research. In the first session of a module, you face a lot of unknown subjects and you search for them. You try to learn about them. Gradually you digest them. The goal is to provide you with the basic knowledge and then form a sound basis with the help of the information the teachers provide.

Another student (M4) stated an analogy his tutor made about PBL tutorials. He stated:

> The idea is that: We sent you to a city; you will get lost there and try to find your way on your own. In the end, when you find your way, you will understand it better because you will find it by yourself.

In addition, H3 explained what he understands from PBL as "finding the solutions for the problems you face by yourself." He added to idea by saying:

> Before PBL, because of Turkey's educational system we used to take information in capsules but here we have to do something to acquire it. It means it is student centered. Tutors are not expected to do so many things.

Moreover, other students mentioned how PBL tutorials process and what are the roles of tutors and students in PBL environment. They all stated that students should do research, be curious and eager to learn and be prepared for modules, whereas tutors should guide the discussions and lead students to the right way without intervening so much while finding solutions of the problems. To express the process of a PBL tutorial and the roles of a tutor, A4 stated:

> For example we come to the PBL room on Monday. We are given a problem in scenario. We do not know anything. We learn about the subject, do research, follow the scenario then we determine our own way and we learn through time. As far as I understand, the goal of PBL is to enable students find solutions for the problems by themselves through brain storming. The function of the tutor is to guide the discussion without intervening so much. When the students go far beyond the answers, the tutor guides them. She/he should lead them to the right way theoretically as well.

Besides, M1 justified the role of a tutor and expressed that the tutors guide the students to find the solutions on their own to the maximum level in the sessions and guide them on the way to solution when they fail to solve.

The results of the questionnaire conducted by the delegate of sophomore students confirmed the fact that some students were aware of the roles of tutors in problem-based instruction. When the students were asked to choose the tutor who was guiding the PBL sessions best and the reasons of choosing him/her, 36% of the students mentioned guiding skills of the tutors as a reason for choosing them. They noted such characteristics of a PBL tutor: intervene the discussions when necessary, give daily life examples, ask critical thinking questions, make the topic interesting, be prepared for the sessions etc. However, few students (15%) assumed "giving information" or "teaching the topics" as reasons for choosing the best PBL tutor, although those reasons are not the characteristics of a tutor having good facilitating skills.

Before mentioning their perceptions about PBL and its essential components, the tutors were asked such questions: how they were prepared to this new curriculum, whether they took trainings before it was started to be implemented, which type of missions they performed during this preparation process and up to now, and how were their first impressions. The tutors (except Alper) stated that they and the rector (a tutor of the Faculty of Medicine) came together once a week during nearly a year before the PBL was started to be implemented in their department. During those meetings, they discussed about what is active learning and PBL and their theoretical background. Sometimes, other tutors from the Faculty of Medicine participated to those discussions to give trainings and told their experiences. They also took trainings at the Faculty of Medicine for three days about how to prepare scenarios. During those trainings, they observed a sample PBL session that was being implemented for medical students. However, they had no chance to apply a pilot study in their department. The tutors stated that they searched individually the literature and investigated the implementation of PBL at some engineering departments of other countries. After

the PBL was accepted to be implemented, tutors planned the four year program together. Moreover, they did not participate any other training after that time. The new tutors (e.g. Alper) started to guide sessions without having any trainings. All the tutors (except Alper) explained that they have been preparing scenarios, facilitating tutorial sessions, making presentations since PBL was started to be implemented in their department. Their experience also involved module directorship, semester directorship and curriculum development.

When asked their first impressions about PBL, the tutors all mentioned their feelings of doubt about the applicability of the PBL in their department. Filiz stated that she questioned whether the system was applicable or not in their department at the meetings before PBL was started to be implemented. She said that the most important reason of this was the inadequate number of tutors. However, she stated that she adapted the system with high motivation and good impression. She expressed her feeling as follows:

> The most obvious problem with conventional education seemed to be the lack of students' motivation. No matter how hard the teacher tried in conventional education, the outcome was not positive since the students were passive or we thought in that way. We thought that PBL will produce higher motivation. As a student who graduated from conventional system I have always thought that there is a lack of practical activity. That is why I had positive attitudes towards PBL when it was started to be implemented.

After the meetings and the training he took, Murat stated that PBL attracted him but he had some question marks in his mind about whether the students can adapt the system or not and to what extent can the students apply it. Nevertheless, he expressed that his thoughts were positive.

Alper, as a physics teacher who has been giving lectures only to the freshman engineering students for four years said: "I thought it was a good method but it was hard to apply in these conditions. I just felt confused. I thought that the system was applicable of course if people want to apply."

Zeynep was the most pessimistic tutor compared to the others. She expressed her feelings about the applicability of PBL saying "As a first impression, I thought that the implementation of PBL will not answer the purpose

of it in our department. I never hesitated to express my feelings about this during discussions."

When the tutors were asked what they understand from the term PBL and its essential components, firstly they mentioned the features that the students should have. As a common opinion, all tutors emphasized that students should be curious, eager to learn, take it serious, do search so take responsibility for their own learning. For example, Filiz and Alper expressed that the students should study hard with a high motivation, should be curious, question the things they learn, study beforehand for the sessions, and even activate the tutor due to the fact that they want to learn.

Moreover, Murat added his opinions about the importance of guidance in PBL and stated:

> In PBL, the students decide on what to learn by themselves. This is their responsibility but at the same time they need to be guided. Our students have the needed qualities for PBL. If they have the capacity to come this department, it means that they are curious and successful. However, they need to be guided well.

Differently, Zeynep emphasized that being curious and eager to learn are not only the features that the students should have in PBL. She believed that those features are needed no matter the system is conventional or problem based.

Tutors also mentioned the features that tutors should have. They all expressed that while guiding students, tutors have great roles in PBL. Those roles were stated as follows: Tutors should be master of their subject, ask the right questions, keep the discussions alive, prevent the students from wandering away from the subject, and intervene discussions when necessary while reaching the learning objectives. Murat added to this idea saying:

> "The role of the tutor is not to give a problem to his/her students and ask them to search for it and explain it. When you do that it fails in some part or another. Because, the students do not learn in that way. You have to guide them. Tutor should be concerned with the system and competent. They should believe in the system."

Lastly, the tutors mentioned the features that a scenario, which is the other important element of PBL, should carry. They stated that scenarios should be

taken from real life situations, attractive, fluent and well organized integrating the subjects to be covered.

4.2 Question 2: Implementation of PBL into PBL Tutorials

While reporting the results of the second research question which considers the implementation of PBL into PBL tutorials, data gathered from observations and interviews were used.

During the observation of five PBL tutorials, the researcher constantly recorded notes regarding how PBL tutorial process, how students and tutors acted during tutorial sessions, how tutors assess the students and how students assess themselves. Although the frequency of observed behaviors changed in those modules, the researcher identified following specific stages in all PBL tutorials:

- Student copy of the scenarios was delivered to each student.
- Students read the problem in turns, each one reading a part.
- Students tried to identify the main points of the problem.
- Students discussed the terms in the problem.
- In order to find the answer of the questions, students brainstormed and tried to make links with their previous knowledge or what they saw at the lab or presentations.
- Students shared results, tried to explain one another, made calculations, drawed or graphed the related parts on the writing board or the related parts of the session papers.
- Students shared the roles such as director for explaining the problem or secretary for writing on the board/solving problem.
- The tutor asked some questions to direct students toward unclear or unraised parts of the problem. He/she did this either to supplement their understanding, or to focus their attention to the related part.
- Tutor encouraged students to explore possibilities, find alternative solutions, and collaborate with other students.

- Tutor checked the tutor copy of the handout given for the scenario while students were reading or discussing the problem.
- Tutor checked whether the learning objectives were reached or not. Because, sometimes students reached them all, sometimes not. At the end of the session, students listed those learning objectives. Those parts that were not raised by students were given as homework.
- Until the next session, students were expected to work individually or as a group to search the unclear parts raised in the first session to reach specified learning objectives on using various resources (library, books, internet etc.).
- In the next sessions, students read the next stages of the scenario; they applied the result of their research to the problem and tried to explain the points rose during the first session. In these sessions, students were expected to discuss much since they had time to search and discuss the objectives.
- Tutor checked student's understandings and assessed students' performance.
- Students and tutors gave feedback mostly at the end of the last tutorial session.

As a result of the observations, the researcher filled the observation checklist (Table 4.1). When we look at the observation checklist, it can be seen that the frequency of PBL characteristics changed during some tutorials. The researcher explained those similarities and differences between the five observed PBL tutorials under the subheadings of "tutors' actions in PBL tutorials" and "students' actions in PBL tutorials" in the next pages.

Table 4.1 Observation Checklist

Element	PBL Characteristics / Criteria	Rating of Modules Evidenced*				
		Murat's Tutorial	Filiz's Tutorial	Zeynep's Tutorial I	Zeynep's Tutorial II	Alper's Tutorial
Students						
	Actively participate in group learning	S	S	S	S	S
	Identify their learning needs/ what needs to be learned and how	F	F	F	F	F
	Work collaborately with each other to solve the problem they define	S	S	S	S	S
	Collect and analyze the information	F	F	F	F	F
	Develop strategies to enable and direct own learning, critical thinking	S	S	S	S	S
	Well-prepared for sessions	S	S	S	S	S
	Take responsibility for own learning	S	S	S	S	S
	Skillful in communicating with peers	F	F	F	F	F
	Demonstrate effective group skills (shows respect and sensitivity for others, helps to resolve conflicts, intervenes appropriately)	F	F	F	F	F
Tutors						
	Facilitate, coach, guide of group processes	F	F	F	F	F
	Guide to additional resources	S	S	S	S	S
	Learner, as well	S	S	S	S	S
	Provide information about what is needed * Negative criteria	N	S	S	S	N
	Provide necessary resources	S	S	S	S	S
	Intervene group process	S	F	F	S	S
	Assess students' progress	F	F	F	F	F
PBL Session						
	Is a student-centered process	F	F	F	F	F
	Consists a learning group small in size (6-10)	A	A	A	A	A
	Allows collaboration	F	S	S	S	S
	Begins with the problem encounter	A	A	A	A	A
	Allows students to identify what needs to be known to reach a better solution	F	F	F	F	F
	Ends with analysis and reflection of what was learned	F	F	F	F	F
Assessment						
	Occurs often (is on going- embedded)	F	F	F	F	F
	Involves problem solving skills and self-directed learning skills	F	S	S	F	F

** Always: A Frequently: F Sometimes: S Never: N*

4.2.1 Tutors' Actions in PBL Tutorials

The tutors generally acted as a coach/facilitator and guided students. They asked some questions to direct students toward unclear or unraised parts of the problem. They generally did this either to supplement students' understanding, or to focus their attention to the related parts.

For instance, Zeynep and two students at her module-I quoted:

Zeynep: What would you do if you were the woman at the scenario?

Student1: I would control the magnetic field of the medium.

Zeynep: What are the factors affecting the magnetic field of a medium?

Student2: Temperature, electric field and humidity.

Zeynep: What changes if the medium is too hot or humid?

By asking those questions she re-focused students' attention on the problem also checked students' understanding and encouraged them to explore possibilities and alternative solutions.

When the group was quiet or confused, the tutors generally asked some questions to re-focus the debate. This manner of the tutors allowed students to see if they were on the right track or not. The following are a few statements the researcher took while observing the sessions. "Students were confused on how to proceed. There were lots of questions and ideas of students being discussed. Tutor was attempting to guide the group in the right direction without saying how to proceed or telling the answer."(in the session of Murat)

During the Murat's second PBL session observed, the students were allowed to have control over their own learning environment. Students went over their previous knowledge and learning objectives of the previous session, discussed the content of the problem, and came up with some learning objectives on their own. For example, the tutor asked the previous learning objectives and the students discussed the situations for the fatal effect of electric current. Since the topic of the scenario seemed interesting for the students and related with everyday life, the tutor asked some daily life questions to deepen reflection and to direct students to some unraised parts. Tutor quoted: "why man and woman differ while resisting to the electric current? How much the parts of your body resist to the

electric current?" Tutor waited long enough to let students discuss freely. During the group discussion, there was a minimal interference from Murat. He did not interrupt the students' discussions and waited until the end of the group discussion. He gave the unclear parts as homework for the students to search until the last session.

The observation notes revealed that all tutors paid attention to the students' discussion. They were attentive to what was being discussed during the sessions. They were able to observe the expected outcomes and determine whether they were met or not. They helped the students to realize which learning issues they needed to improve.

Although the tutors who are content experts (especially Filiz and Zeynep in her module I) usually asked very important questions to re-focus students' discussions, check their previous knowledge or explore alternative solutions, they intervened the group discussions more frequently than the others. In fact, that much of intervene is not an expected PBL behavior. Sometimes Filiz gave the answer of the questions just after students' comments. Similarly, in her module I, Zeynep did not hesitate to lecture the students if they were confused about an issue or deviate from the subject. For example, during the second session, the students had some difficulties understanding the meaning of the μ. She waited a bit for students to discuss about this topic and then explained features of ferromagnetic, paramagnetic, diamagnetic substances, meaning of μ and Biot-Savart Law approximately for ten minutes.

While interviewing with her, Zeynep confirmed this stating as follows:

> Normally, the role of the tutors should be just to guide of group processes not to teach something; keep the discussion alive and prevent the students form wandering away from the subject. However, I am not sure whether we can do this or not. For my part, I never give this kind of guidance if I am content expert of the module I am guiding. I explain what students do not understand as a result of their requests. That is to say, I am not doing a work that is appropriate to its definition.

The same situation was observed during the module of Filiz too. Both students and tutor were pleased since the tutor was expert of the module subject.

The followings are the statements of Filiz and two students that the researcher took while observing the sessions:

> Student1: Both this group and you were fine during this module.
>
> Filiz: Yes, it is true but sometimes, I can not hold my tongue. I do what I should not do. I talk a lot and explain so many things. In fact, I should sit silently. This is basic problem of us.
>
> Student2: This module was fine due to the fact that you were our tutor. I believe that I learned the subject well thanks to you. We did not have difficulty due to the advantage of your guidance. I was happy and believed that I would be able to learn the subject when I learned that you were our tutor for this module.

During observations, it was noted that tutors acted also as learners in some occasions. They did not hesitate to tell that they do not know the answer of some questions. For example, when a student asked the question (how much current flow through source electrode?) that Murat did not know the answer of it, he said: "search, learn and then tell us the answer of this question." Similarly, Filiz-for the value of a constant they can't remember- stated: "I don't know the exact value. It may be in between… interval but let's search and learn together."

It was observed that most of the sessions ended with analysis and reflection of what was learned. For example, at the end of the second session, Murat asked the students about the learning objectives they had for that session. One of the students summarized the objectives. Then, tutor asked the students whether they had found an answer for their questions or not. Lastly, tutor asked students to search the issues that need further exploration for the next session. Moreover, some modules (especially the first grade ones) consisted of drawing/filling concept maps or flow charts at the end of the scenario papers. For example, in the kinematics module, Alper asked students to draw a concept map of the things they learnt in that module showing the nature of the relationship. By this way, students summarized what they learned in that module and showed the relationships of topics with each other.

Through the observations, students and tutors gave feedback about the scenario, group dynamic, themselves, assessment and the tutor mostly at the end of

the last session or whenever they want. The followings are statements the researcher took while observing the sessions.

Alper and two students quoted:

Student1: The scenario was based on only one example. There should be more examples. We only did calculations which were boring for us. However, my friends were very successful.

Student2: There are some unfair ways of assessment. One tutor sticks to the assessment criteria and we get low grades whereas another tutor finishes the session in 30-40 minutes and give high grades.

Alper: How was the scenario in terms of its physics?

Student2: We did lots of practice and learned well.

Student1: It was instructive for a student who does not know the subject but easy for us since we had already known the subject.

Alper: In PBL, students study and search the learning objectives and the sessions continue on the basis of those. PBL is totally unlike conventional system. Therefore, the module papers won't teach you. You will study what you don't know.

Filiz and one of the students quoted:

Student1: Learning something together is enjoyable as usual. We make team work and our team spirit develops. Why we do not do team work in exams? (tutor and students laugh together)

Filiz: You will not do group work everytime in your daily lives. We should evaluate your individual performance one way or another. Do not be so reactive to be evaluated and exams. You even would have that many exams in conventional system.

During each session, it was observed that tutors gave grades or put some marks near to the students' name on the student list according to their participation and explanations to the questions they asked.

4.2.2 Students' Actions in PBL Tutorials

During the sessions, students participated in the discussions freely and shared their results comfortably. The followings are the statements that the researcher took while observing the sessions.

When a student asks a question the others are trying to answer this question. When a student is drawing something on the board, the others are making comments and helping

each other. One of the students is explaining something to his friend sitting next to him and they are discussing the topic. (from Zeynep's Tutorial)

In order to answer the question, the students usually tell their ideas without waiting the guidance of the tutors. They are motivating themselves within the group." (from Filiz's Tutorial)

However, not all the students participated in those processes. I noted that certain students seemed to answer most of the thing or tried to put forward an idea, whereas others listen and did not speak. Out of 8-10 students, generally 3-4 students were trying to participate in the discussions. Since the students were graded according to their participation, tutor asked them to participate and tried to involve them by asking some questions. Some students presented the results of their research and shared their ideas with others. However, some students expressed the difficulty they had in understanding some parts. At those times, either peers gave some explanations or tutor gave some clues. On the other hand, some students still did not participate in the discussions.

There was collaboration between some of the students. They were making effort to ensure that all are in the same page of the scenario and same issue. Some students were checking each other to make sure that they were on the right track. Generally, there was a consensus within the group. The followings are the statements the researcher took while observing one of the sessions of Alper's tutorial: "One of the group members is fifteen minutes late to the session but other group members especially the ones sitting next to him are explaining what he missed and discussing some parts."

During the observations, it was obvious that the students discussed the problem on their own and they had the control while continuing the scenario unless they have gone too far of subject. For example, while observing Murat's tutorial, the researcher noted that students completed a scenario page and then moved to the next one without receiving approval to continue or asking the tutor if there was anything else on that page they needed to emphasize.

In the second or third sessions, some students were well-prepared for the sessions and shared their ideas and knowledge, presented the results of their

research but some were not. When the tutors asked them whether they reached the learning objectives or not, it was obvious that some of the students have not checked those or even think about them. During his last session, Murat said: "I think that you are not attaching enough importance to this module thinking that the subject of it is easy. It seems that you are trying to learn from me here instead of making self study.

4.3 Question 3: Strengths of PBL

While reporting the results of the third research question which considers the students' and tutors' perceptions about the strengths of PBL, data gathered from interviews and documents were used.

During interviews, students mentioned various strengths of PBL for the purposes of themselves. Table 4.2 shows students' perceptions about the strengths of PBL according to their grade level.

Table 4.2 Strengths of PBL

Strengths / Grade	First Grade (N=5)	Second Grade (N=3)	Third Grade (N=2)	Fourth Grade (N=4)	Total (N=14)
Gaining engineer's viewpoint & self confidence	3	2	2	3	10 (71%)
Improvement of communication skills	4	1	2	2	9 (64%)
Improvement of problem solving skills	3	2	2	2	8 (57%)
Improvement of self-directed learning skills	1	2	1	2	6 (43%)
Improvement of critical thinking skills	2	1	1	1	5 (36%)
Increase of collaboration skills	2	1	1	1	5 (36%)
Learning to prepare scientific reports & projects	2	2	0	0	4 (29%)
Other (3 items)	3	1	0	3	7 (50%)

The primary strength of PBL that the 71% of the students mentioned for their purposes was that they gained engineers' viewpoint and therefore self

confidence due to PBL tutorials. For example, A4 mentioned that their practice for future career improved their self confidence and stated:

> PBL is a good method because if you are really going to be an engineer you have to conduct a problem based study. In worklife you can encounter a problem that you don't know anything about. The implementations in here are like that. When the students face a problem they don't know anything about it. Then they try to learn about the subject and come up with solutions. It provides you self confidence that you are able to handle it even if you have no idea about it.

Another student (T2) added to this idea by stating:

> It provides me self confidence to learn even when I have no idea about any subject. I think there will be similar situations in the worklife. The boss will assign us tasks or projects. As engineers we will be able to produce some things without knowledge. At least we will start our work life getting used to such things.

Moreover, students mentioned that they gain some important skills with the help of PBL which are: communication skills (64%), problem solving skills (57%), self-directed learning skills (43%), critical thinking skills (36%), collaboration skills (36%), and scientific report preparation skills (29%). Some examples of those statements are given in below.

> (S3) This system provides you with problem solving skills. It leads people to group work. It taught me to make collaboration in a group work. In conventional education I wouldn't have the interaction with all these 80 people. Because, in each module we meet different people and at least we have an eye contact. Everyone knows each other. In this respect people do not have troubles. I have learned how to learn. I had troubles in the beginning. I did not use to understand what I read. I used to need a teacher's help and say that the teacher would give the essence part of the subject but now I can find out the important parts by myself.
>
> (G1) I can say that this system is important for the ones who are going to be engineers. It provides you with the autonomy for self study. Furthermore, you learn how to prepare a report. You find out what you need to know and what you don't. When compared to the conventional method, we learn better ways of expressing ourselves.
>
> (S2) I usually ask questions such as "… what happens if I do it like this" to myself. I do the simulations on computer to learn better and in detail… I try to gain different point of views for different questions that I may face with… We have really learned how to do research. I can say that this system here teaches the students how to become an engineer.

(A1) Practically thanks to PBL, everybody gains the ability to communicate with others and express themselves better in social contexts.

Besides, three students (first, second and fourth grade) stated that PBL improved active participation due to its practical applications, two students (first and fourth grade) regarded tutors' openness to discussions and students' freedom to tell their complaints as a strength of PBL, and two students (first and fourth grade) mentioned that PBL improved students' level of interest to the lessons.

Improvement for some skills of students due to PBL is confirmed by the self-evaluation report prepared by the EEED. It is emphasized that PBL and project-based learning that is used as a co-strategy for the freshman and senior engineering education can be assumed as highly effective while achieving the seventh program outcome (ability to communicate effectively in both oral and written fashion- Item number 30 of the module questionnaire given in Appendix I) Moreover, for the seventeenth outcome (a possession of leadership properties, self confidence, the flavor of enterprise, and an ability to work in teams-Item number 40) it is pointed out that the tutors and students found that the level of modules achieving this outcome as pretty adequate with the ratings above 3.5 (1: very poor, 2: poor, 3: average, 4: good, 5: excellent) (Self Evaluation Report, 2006).

When investigating students' average ratings for program outcomes in the 2006-2007 spring semester, the researcher gathered the ratings of students from each grade level for all modules. Figures 4.1 and 4.2 show the averages for students' evaluation of the seventh program outcome related with communication skills and seventeenth outcome related with leadership, self confidence, and group work skills according to their grade level respectively. The results indicated that average ratings of the students from all grade levels were 3.7 for both program outcomes. However, as grade level increased, students' average ratings for those program outcomes also increased.

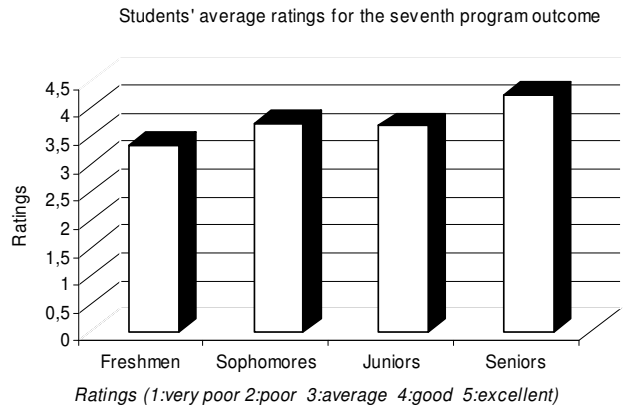

Figure 4.1 Students' Evaluation of the 7 th Program Outcome

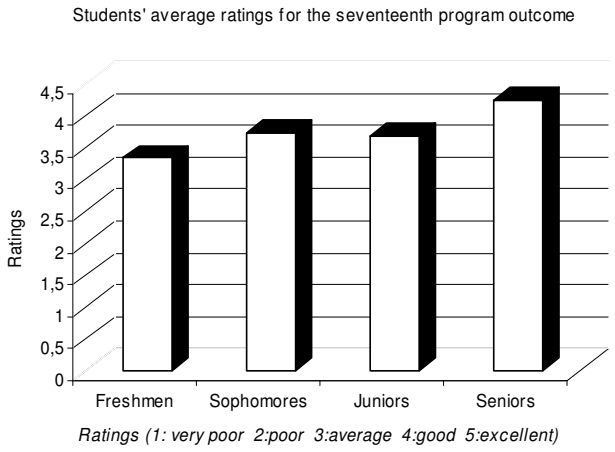

Figure 4.2 Students' Evaluation of the 17 th Program Outcome

When asked about the strengths of PBL, three of the tutors (Filiz, Zeynep, and Murat) stated that PBL promoted engineering viewpoint, communications skills, feeling of self confidence, and problem solving skills of the students. But they emphasized that this improvement is observed more among the senior students thanks to some project-based modules. This improvement in some skills

(communication, self-confidence, and leadership) as the students' grade level increases is also seen in the figures given in the previous page.

Murat stated his opinions about those strengths as follows:

> Especially those senior students are very good at expressing themselves. They are enterprising and open minded on approaching a problem. It is an advantage to be able to discuss with the tutor face to face in a class consisting of 6-8 students instead of the ones consisting of 70-80. Students graduate from here as good candidates for engineer.

Besides, Filiz gave example of practical trainings. She explained that in practical trainings, some students coming from the other universities have difficulties in how to start the projects while her students start to do it with courage even if they do not understand the project totally. They somehow actualize it.

Moreover, Filiz and Zeynep pointed out that the characters of the students are also effective on students' improvements. Zeynep stated that 20-25% of the students were studying hard in the conventional system and this is still valid in this system. Similarly, Filiz explained her idea saying:

> There are students who behave like what I expect to see in a PBL student and it is because of their own character I think. In conventional education the situation would be the same for them. This motivation has nothing to do with the system. We had such students before and in conventional education as well. But it is certain that the students are more active in this system.

Additionally, Alper expressed that it is very important to have communication skills, self confidence, and ability to study with a group, to be researcher and to have a questioning mind for engineers. He stated that "even if people are not aware of those contributions now, they will see it when they graduate from university indeed."

Alper added that in addition to the contributions of PBL for students, learning about the PBL implementations and doing practice also contributed to him academically.

4.4 Question 4: Weaknesses of PBL and Problems Encountered in PBL

While reporting the results of the fourth research question which considers the students' and tutors' perceptions about the weaknesses of PBL and problems

encountered in it, data gathered from interviews, observations, and documents were used.

Although most of the interviewees found PBL as a satisfactory methodology and mentioned the strengths of PBL, they also mentioned that there are lots of problems at the implementation of PBL in their department making them unsatisfied with the current situation. Statements of the some students and tutors are given respectively as follows:

> In fact, it is a very nice system in terms of its purpose. However, I don't think that it is so much nice in terms of application. (S2)
>
> Everything is nice theoretically but not so in terms of application due to quality of students or tutors' and students' point of views toward PBL etc. (H3)
>
> Students accept the system but think that it does not get better in any case… They complain saying that if this is active learning, we do not want it. (S3)
>
> In fact, we can solve our problems but we should be more serious. We are behaving as if we lost our consciousness. This system is not enjoyable when the tutors and students do not have motivation. Preparing a program does not have any meaning if it is not applied appropriately. (Murat)
>
> An educational institution should defend or claim its instruction but unfortunately we can not do this. I can not say to the students "It is not like you think. We know what we are doing"… the program should have refreshed itself but nothing has changed in PBL since it started to be implemented… This type of PBL implementation is not proper for our department. (Zeynep)

Observations also confirmed that some students seemed unsatisfied with the system. It was observed that although they did not participate in the discussions, they complained a lot about the system. Besides, looking at the observation notes and analyzing the interview notes, it was clear that Zeynep especially in her tutorial II was unsatisfied due to the fact that she was not the content expert of that module topic. For example, it was observed that when she was not sure about the answer of a question, she stated: "I have commented like that but do not trust me. Take notes and ask the tutor who gives presentation." Moreover, while controlling the drawings of students by checking them from the tutor copy, she implied by showing her annoyance that she is not the content expert of that topic.

Since the students and tutors are unsatisfied with some parts of the PBL implementations and have some problems, this sections presents their perceptions about the weaknesses of PBL and difficulties with PBL under the headings of "tutors' weaknesses", "students' weaknesses", "scenarios'/sessions' weaknesses", "assessment weaknesses", "presentation weaknesses", "the problems students encountered in PBL", and "the problems tutors encountered in PBL."

4.4.1 Tutors' Weaknesses

During interviews, students mentioned some weaknesses of tutors while guiding them during PBL tutorials or getting ready for tutorials. Table 4.3 shows students' perceptions about the weaknesses of tutors related with PBL implementations according to their grade level.

Table 4.3 Tutors' Weaknesses

Tutors' Weaknesses / Grade	First Grade (N=5)	Second Grade (N=3)	Third Grade (N=2)	Fourth Grade (N=4)	Total (N=14)
Difference in PBL implementations	4	2	1	2	9 (64%)
Insufficient guidance	3	2	1	1	7 (50%)
Negative attitudes toward PBL	1	2	2	1	6 (43%)
Insufficient preparation	1	2	1	1	5 (36%)
Other (2 items)	1	1	1	1	4 (29%)

The most common complaint of students (64%) was different PBL implementations of the tutors. For example, G1 mentioned that behaviours and attitudes of the tutors are different from one another:

> Sessions of some tutors last 3–4 hours but some others finish in an hour. Tutors differ when applying scenarios. Some tutors assume that everybody knows about the subject. Therefore, the task is handled superficially when students are unwilling to continue or look forward to the end of the session.

Apart from these, some students stated that tutors do not guide them efficiently (50%), have negative attitudes towards PBL (43%), and come to the sessions unprepared (36%). For example, S3 stated that sometimes the tutors do not know the subject well and that is problematic. He emphasized that some of the tutors try to clarify the subject even if they don't know about it; some others may look forward to the end of the session on the contrary.

S2 added to this idea by stating:

> Some teachers guide effectively but some do not. Some do not answer any question. They do not do much thing to motivate or activate the students. Not all the tutors are content experts. Some of them are experts and some are not. While some support PBL, I don't think that some of them care about it at all. I know that some do not like the sessions. Some of them may skip the subject by saying that he/she does not know the subject or some may explain well. Some of them really have the guiding skills that a tutor should have and implement those skills.

Although some students regarded insufficient guidance as weaknesses of the tutors, two of the students claimed that having unequal content expertise is not tutors' weakness but their problem. They argued that insufficient guidance may occur due to insufficient number of tutors and different majors of them. A4 stated:

> It is not surprising that some tutors have insufficient knowledge in some subjects because each of them has different area of specialization. As the module director or the content experts can not facilitate the sessions of all groups, it is normal that tutors may differ.

M1 added to this idea and stated:

> In my opinion there is not so much that the tutors can do. For example we have the magnetic module. Two of the tutors in this department are the experts of magnetic while the others are not. Suppose that we fail to go further at one stage. As our tutor is not the master of the area how he can guide us is another concern.

Besides, two students (second and fourth grade) mentioned insufficiency of tutors for motivating students and two students (first and third grade) mentioned lack of communication between tutors and students as other weaknesses of tutors.

However, students' evaluation of their tutors was not compatible with their complaints about tutors. Tutor evaluation forms for 22 modules that were filled by 529 students (with a response rate of 35%) at the end of each module were investigated. Students' rated their tutors who guided them during PBL sessions for

such dimensions: tutors' motivation, tutors contribution to the learning process, tutors' contribution to the development of critical thinking skills, tutors' contribution to the development of self directed learning skills, tutors' contribution to the development of communication skills, and tutors' contribution to the development of assessment skills. The mean of those ratings were varied between 4.6 and 4.7 (1: very poor and 5: excellent).

When asked about their weaknesses, the tutors Murat, Alper and Zeynep complained that tutors differ in their PBL implementations, some of the tutors come to the sessions unprepared, and some do not make enough effort to give better guidance. For example, while making interview with him, Alper expressed his thoughts as follows:

> As far as I can observe, the biggest problem is the insufficient knowledge of the tutor about the module subject. Some tutors are of the opinion that it is enough to read the scenario without analyzing it. Sometimes PBL sessions takes just 15 minutes. Tutor may be reluctantly gives the lecture and may not care about whether the students search and study or not.

Murat agreed to this idea and stated:

> I think the tutors just have a look at the copies of the scenarios in the evening before the module starts. They do not study for it intensely. It becomes obvious when we look at the module hours. There is no session that lasts for more than 45 minutes. The problems of the scenarios should be solved in sessions indeed but some tutors just give the problems to students as an assignment.

The same tutor added that tutors do not discuss about the modules/scenarios enough before implementing them. According to him, when they have a problem about the module they can only talk about it after the session anymore.

4.4.2 Students' Weaknesses

During interviews, students mentioned their weaknesses related with the implementation of PBL or necessities of it. Table 4.4 shows students' perceptions about the weaknesses of themselves in PBL according to their grade level.

Table 4.4 Students' Weaknesses

Students' Weaknesses / Grade	First Grade (N=5)	Second Grade (N=3)	Third Grade (N=2)	Fourth Grade (N=4)	Total (N=14)
Insufficient preparation level	3	2	1	0	6(43%)
Students' disinterest about modules, lab etc. / negative attitudes toward PBL	2	2	1	0	5(36%)
Weaknesses of study habits	2	1	1	0	4(29%)
Insufficient knowledge about the system	1	1	1	0	3(21%)
Other (3 items)	1	0	1	0	2(14%)

The primary weakness that the students (43%) mentioned about themselves was their insufficient preparation to the sessions and presentations. C1 stated that students do not prepare the sessions or presentations well and they still could not adapt the PBL system.

36% of the students feel unwilling to attend the sessions, presentations and laboratory practices. S2 stated that most of the students might not care about the sessions and see those sessions as two hours of past time activity making their burden heavier. Another student (T2) stated:

> In my opinion, most of the students don't like PBL. But they do not say they don't like it. They think that it doesn't matter whether it is classical or PBL for them as long as they have high scores and they can pass the lessons anyhow. That is the way they think. Some of our friends including me speak just for the sake of participating, because participation will be evaluated. It is better than not participating.

29% of the students reported that they fail to develop regular studying habits. For example, G1 stated:

> It is certain that the students do not fulfill the requirements. As students, we never study enough. The system challenges the student but not so much. Some students think that they come to the presentations anyhow, so they don't need to study at all. They exactly think like that. They are of the opinion that they already participate in the presentations so they think it is enough for exams. Here students delay studying till the last minute and they do not understand much. Sometimes we cover subjects in two weeks time that we were supposed to covered in one and a half month in conventional system. Therefore, students have problems when they delay their studies till the last minute.

Except those, 21% of the students taught that they do not have sufficient information about PBL and that shows why they fail. G1 reported that if a student does not know about the system when he comes here, he may lose his motivation to study because he is disappointed. R2 added:

> We come to the sessions unprepared and there are lots of students who do not know that we should be prepared. Usually we have PBL sessions before taking presentations. The aim is to make the student come prepared, do brainstorming and make them express their opinions. However most of our friends do not have an idea about it because they think that firstly they should have the presentation in the class and then will come to PBL sessions. There emerge some question marks on how much the administration manage to explain the system to the students.

Lastly, a first grade student mentioned students' not enough responsibility for their own learning and insufficiency of tutors for motivating students. Moreover a third grade student mentioned students' tendency to demotivate and give up easily as other weaknesses of them.

The common weakness that the tutors pointed out was that some students do not come to the sessions prepared. Filiz, Alper, and Zeynep stated that some students are not interested in/curious about learning and do not have the required studying habits. For instance, Alper stated:

> Students do not do what they are expected to do in sessions. Instead of learning something in sessions, they are content with what is covered in two hours of presentations just like in the conventional lessons. When they come here on the following week, there is no improvement in most of the students. They say that they reached the learning objectives but it is deceptive. They do not study enough. They just want to solve the questions and go as quickly as possible. I don't think that they make any effort. I haven't met anyone who is curious about the subjects. They reluctantly read the scenario and make discussion.

Besides, Filiz emphasized the big discrepancy between what the students should do and what they do. She complained stating:

> The students do not study in order to learn but in order to pass the exams. They follow the sessions with that opinion. They are only focusing on the exams. May be they are right because they are motivated in that way. Therefore, they do not demonstrate the behaviors that a PBL student is expected to do. There are still some students who are curious and interested but less than I expected. I don't think most of them have enough motivation.

Alper emphasized that the weakness he observed in the freshman students is that they still misperceive the system as the conventional system therefore they can't adapt the new system, at least in the first year. He stated that the students who are accustomed to the conventional system have some objections when they see that the subjects are covered quickly and superficially.

4.4.3 Scenarios' / Sessions' Weaknesses

Interview notes revealed that there are some weaknesses of scenarios and sessions. Table 4.5 shows students' perceptions about the weaknesses related with the preparation of scenarios and while applying scenarios during sessions according to the grade levels of them.

Table 4.5 Scenarios'/Sessions' Weaknesses

Scenarios'/Sessions' Weaknesses / Grade	First Grade (N=5)	Second Grade (N=3)	Third Grade (N=2)	Fourth Grade (N=4)	Total (N=14)
Carelessly/badly prepared scenarios	5	3	2	3	12 (86%)
Difference in scenario applications	4	2	1	2	9 (64%)
Problems in group works	2	1	1	0	4 (29%)
Other (2 items)	1	1	0	0	2 (14%)

During interviews, 86% of the students stated that they faced both well prepared and badly prepared scenarios but almost all of them explained that majority of the scenarios were carelessly prepared. They pointed out the missing parts of the scenarios and the features that the scenarios should have.

H3 found some sessions so difficult that the students could not go further when they have not sufficient input and stated:

> PBL is a good system but some topics of sessions are based on directly formulations or operations. That is we can not make associations. It is the biggest problem, I think.

S2 added this idea stating "… although we made connections with real life in some scenarios, there were also some scenarios in which just the subject was given including very difficult proofs that we could not handle."

As an additional data, the results of the questionnaire that was prepared by the delegate of sophomore students and conducted to sophomore and junior engineering students from the EEED were investigated. The results have shown that 64% of the participant sophomores and 60% of the juniors were not satisfied with the scenarios due to the fact that scenarios lacked authentic and interesting problems, they were not applicable, and the connection of them with the module topics were not proper. Moreover, 92% of the participant sophomores and 90% of the juniors marked "No" for the statement of "I think that the PBL sessions are efficient."

In addition, during interviews, 64 % of the students stated that the scenario had some missing parts at the stage of implementation. They pointed out that tutors do not have a standard style of scenario implementation in sessions. Although PBL hours are designed as 4 hours in the curriculum, students complained that some tutors may finish a scenario in 15 minutes. G1 explained that some tutors cover the subject quickly if they understand that students know the subject, while some others "dwell upon the subject." Moreover, Ed4 stated: "In conventional education, 4 hours period is a normal lesson hour but in here it is a waste of time.

Additionally, 29% of the students mentioned that they had troubles in group work activities during sessions. First grade students (G1 and M1) expressed that there is not much collaboration in group works. According to the G1, this is due to the common belief among the students that the questions "should be solved by the one who knows the best." Moreover, M1 complained about doing most of the group work assignments himself.

Apart from these weaknesses, a second grade student mentioned that two-three weeks long modules cause difficulty on comprehension of concepts of the

modules and a first grade student complained applying common modules with other engineering departments since some unrelated topics were not functioning.

When asked about the weaknesses of the scenarios or the sessions, all of the tutors emphasized the importance of the quality of scenarios for PBL. They stated that although they faced some well prepared scenarios majority of them were carelessly done. They expressed that failing to integrate the subjects in the scenarios is one of the biggest weaknesses. For example Alper pointed out difficulty of writing scenarios saying:

> I think writing scenario is a work of fiction. Nobody here is a scenarist. We can't integrate the subjects well into the scenarios. Probably this is because we have too many subjects. We can't integrate all of them. Sometimes scenario writers make absurd connections just to integrate one subject to another which cause to decrease the fluency of a scenario. This situation prevents scenarios to be good and quality.

Filiz stated that for the scenarios of the first grade, people put their effort and try hard to make them better but starting form the second grade there is no integration within the modules. She also criticized PBL tutorials as follows:

> In the past, each lesson (except the lessons of first grade) was directly turned into a module without being integrated. Therefore, in PBL tutorials, there is not much brain storming and discussion at all since most of the problems are not discussible and have clear and single answers. Because of those scenarios, the PBL tutorials are not efficient.

Moreover, Zeynep mentioned that the same scenarios are implemented every year due to the fact that tutors realize inefficiency of those scenarios and do not want to lose time for writing scenarios especially that of theoretical modules. Therefore, she criticized the scenarios as being artificial and unoriginal.

Observation notes confirmed the tutors' and students' unsatisfaction with the scenarios. While observing the PBL sessions it was noted that students criticized the scenarios while giving feedback about the modules. However, this situation was different for the Murat's tutorial. It was noted that students and tutor seemed more satisfied with the scenario as compared with the students of other observed modules. At the end of the last session-while giving feedback- one of the students emphasized that the module was attractive and funny involving daily life experiences and interesting problems. He added "it seemed that we can not learn

anything from other scenarios but here we learned." In fact, this was the only scenario (see Appendix L for the some part of this scenario) that all the students expressed their satisfaction of it. When it was analyzed, it was noticed that this scenario consisted authentic, real-world questions; was interesting for the students, leaded to discovery of other problems by asking critical thinking questions and encouraged students to brain storm.

Besides, Filiz, Alper, and Zeynep stated that tutors differ while applying scenarios. They complained that the duration of the sessions changes between 15 minutes to two hours. However, Zeynep argued inefficiency and unreality of some PBL tutorials since they are seen four hour long in the program. She explained that students can't discuss any topic for that long period of time this is why most of the tutorials last shorter.

In addition, Murat mentioned the problem in group works. He complained that especially in lower grades, most work is done by the repeat students.

Lastly, Murat and Filiz complained about applying common scenarios in the first grade curriculum with other engineering departments. They stated that there are differences between those departments (giving the example of mining or geophysics engineering departments). They mentioned different contents and different student levels of those departments and suggested to stop applying common scenarios with other first grade engineering departments.

4.4.4 Assessment Weaknesses

During interviews, students mentioned some weaknesses of the assessment procedure. Table 4.6 shows students' perceptions about the weaknesses while assessing students during tutorials, exams or labs according to the grade levels of them.

Table 4.6 Assessment Weaknesses

Assessment Weaknesses / Grade	First Grade (N=5)	Second Grade (N=3)	Third Grade (N=2)	Fourth Grade (N=4)	Total (N=14)
Difference in assessment procedure	5	3	2	3	13 (93%)
Non-functional assessment	3	3	2	2	10 (71%)
Too many and too long exams	3	2	1	1	7 (50%)
Other (2 items)	0	3	0	0	3 (21%)

Almost all the students (93%) stated that there is no standard assessment procedure that the tutors use while evaluating the students, so it differs from tutor to tutor. M4 and H3 stated respectively:

> There is no sound definition of assessment on which criteria is good or bad… One tutor may like your performance while the other may not.
>
> Some teachers are really good at assessment but some are careless. He even does not remember you after the session for example. At the end of the session he grades as he wishes.

Another fourth grade student (D4) found assessment procedure as a waste of time. He pointed out that some tutors' criteria was whether the students spoke or not rather than their contribution to the solution of the problem. He stated that this caused nonsense talks between the students and added: "In third class, after one of us finished talking the other used to start to talk. We used to paraphrase the things the others said only to take good grades."

71% of the students pointed out that session assessments are not done properly due to the difference in assessment procedure. Moreover, some of them mentioned that students/tutor evaluation forms or the questionnaires made for module assessment do not function well. T2 criticized the student/tutor evaluation forms and stated:

> As far as I know, there are five scales in the student evaluation forms. I did not see the tutors filling them but we fill tutor evaluation forms. However, I usually assess them all at the highest scale. Because, I think that if tutors see how I evaluate them, they may give me low marks.

Another second grade student (R2) mentioned his feelings about questionnaires filled by students at the end of each semester considering all modules they covered and stated:

> If the aim of the questionnaire that we fill about the modules is to reveal the problems in the department and to solve them, we do need 40 questions. It can be done by 10 questions without boring the students. To tell the truth, I didn't want to answer 40 questions for six modules and most of us filled these questionnaires carelessly. We filled it considering the performance of the tutor in that module.

Some others (50%) mentioned that they were constantly having exams during final and year-end exams and this affected the quality of education and assessment negatively. S2 stated that it was very difficult to have so many exams- especially in the first grade- in a short time. Another second grade student (T2) added to this idea emphasizing:

> Teachers call the year-end exams at the end of the term as make up exams but I have no friend who managed to get a raise at his cumulative at those make up exams.... In 15 days we take exams in which we are responsible from the whole term. However, you can not study since this time is not enough.

Moreover, three students (second grade) complained about the late announcements of session grades and exam results. They reported that they were learning whether they fulfilled the cumulative requirement to pass the class or not very late and this increased their stress level.

When asked about their opinions, all the tutors stated that there is no standard assessment system that the tutors use in evaluating the students. For instance, Filiz stated that the assessment in the PBL tutorials is very subjective differing from tutor to tutor. She complained about the system saying:

> We have the habit of giving 70 points to anyone who comes to the session. To what extent it is meaningful is another concern. Anyone who does nothing during sessions gets 70. There is a big trouble with the sessions because the assessment is not reliable.

The tutors also criticized the situation of repeating or failing the class. Zeynep emphasized that by this assessment system, students may pass the class without knowing anything from some modules since the average is taken into account while passing or failing the class.

Moreover, the tutors pointed out that final exams, year-end exams and evaluation forms do not function well. Murat criticized the student evaluation form and stated:

> There is a list of criterion that is used to evaluate students but it is nonfunctional. It is too long to fill so it takes too much time. I don't think there left any tutor who pays attention to it. We used to fill that form but now instead of doing this I just write down the mark I have given to the student without filling the form.

Filiz, Zeynep and Murat mentioned that students were constantly having exams during final and year-end exams and this affected the quality of education and assessment negatively. They mentioned that year-end exams are nonsense and non functional since it is impossible for a student who has successive exams for 14 modules in a week to be successful.

Besides, Alper mentioned that the evaluation system (module exams, final exams, year-end exams, laboratories, projects etc.) become too complicated. He added that being unsuccessful from the year-end exams and repeating the whole year instead of repeating one lesson is a waste of time for students.

Additionally Filiz questioned the form of exam questions and stated:

> In module exams, I prepare questions related with the presentations like most people do and just like I do in the conventional system. It is not a problem based exam. We make the same kind of year-end and module exams as the exams of conventional system. For that reason, if you ask whether the system and the form of exams are compatible with each other or not, I'll say no. In the exams, you test the theoretical information mostly. However while grading the lab and project modules, assessment done objectively since there are a lot of criteria (presentation, project, exam grades etc).

4.4.5 Presentation Weaknesses

Interview notes revealed that some weaknesses occur during presentations. Table 4.7 shows students' perceptions about the weaknesses related with the number of presentations, tutors' presentation styles, and the consistency between presentations and sessions according to the grade levels of them.

Table 4.7 Presentation Weaknesses

Presentation Weaknesses / Grade	First Grade (N=5)	Second Grade (N=3)	Third Grade (N=2)	Fourth Grade (N=4)	Total (N=14)
Too much presentations in a limited time	3	3	2	0	8(57%)
Difference in presentation styles	2	2	0	0	4(29%)
Inconsistency between presentations & sessions	1	1	1	0	3(21%)

57% of the students complained about having too many presentations in a very short time. They stated that in these conditions, presentations were not effective and they had to take exams without comprehending the subject. R2 argued that there was an understanding process in human mind in which mind adapt the information and then learn it. He added saying "…having the core of the subject on Wednesdays and Thursdays and taking the exam on Fridays caused problem. It takes time but we take the core of the subject just two days before the exam. It is not comprehensible for everyone I think."

29% of the students stated that presentations differed from tutor to tutor. They criticized some tutors about covering the subjects superficially, not solving problems although some tutors were dwelling upon the subject and receiving feedback.

21% of the students expressed that they encountered some modules in which there were no parallelism between the scenario and presentations. H3 stated:

> Sometimes presentations go fast and sometimes PBL sessions. For instance, presentation can not catch up with the sessions when sessions go fast. In those times, we cover the scenario in the last session before the presentations were covered. There are such disunities.

C1 added to this idea emphasizing the fact that sessions could become so independent from presentations. She thought that their PBL tutorial becomes wasted when an important part related with the session was disregarded during presentations.

Moreover, the results of the investigation of the education program showed that there are 118 hours of presentation in the first term of the first year program whereas it is 58 hours in the last semester of the fourth year program. This may be the explanation of why the senior students did not complained about the excess of the presentation hours.

When asked about the weaknesses of presentations, Murat and Filiz complained that the students are given a lot of presentations in a very short time and this situation reduces the efficiency in PBL. For example Murat expressed his point of view as follows:

> We have more presentations than the other departments implementing PBL. Therefore, they say that our department do not apply PBL but make a lot of presentation. They may be right because we overload the students. We can't explain the all subjects because we cannot catch up with the curriculum. Time restricts us. Think that I was giving a lesson in 14 weeks in conventional system whereas in this system I have to give it in 4 weeks causing to make 28 hours presentation in two weeks.

Filiz explained that the inefficiency of PBL sessions, incapability of students or tutors may cause the tutors to repeat all subjects in presentations. Moreover, Zeynep mentioned that she added extra presentation and problem solving hours to some modules which are difficult for students to understand. According to her, this application is inconsistent with the nature of PBL.

Besides, Alper emphasized how the presentations take the system away from PBL by saying:

> It is very difficult for us to be adapted to such a system quickly since all of the tutors here are accustomed to conventional system so much. Therefore, it is very difficult to adapt a student to a new system without adapting the tutor. I think the conventional presentations make it difficult to implement PBL entirely.

4.4.6 The Problems Students Encountered in PBL

During interviews, students were asked about the problems they encountered due to the shortcomings in PBL implementations. Table 4.8 shows students' problems related with the curriculum load, motivation, time, assessment, administration etc. according to the grade levels of them.

Table 4.8 Students' Difficulties with PBL

Students' difficulties with PBL / Grade	First Grade (N=5)	Second Grade (N=3)	Third Grade (N=2)	Fourth Grade (N=4)	Total (N=14)
Loaded curriculum	4	2	2	2	10 (71%)
Time inadequacy	4	2	2	2	10 (71%)
Taking too many exams / Having too much stress about failing the class	4	2	1	2	9 (64%)
Noting done about their complaints	2	1	1	1	5 (36%)
Other (4 items)	2	1	1	1	5 (36%)

Most of the students mentioned that their stress levels were increased and they were demotivated due to time inadequacy (71%), loaded curriculum (71%) and taking too many exams (64%). S3 pointed out that time inadequacy was the biggest problem with PBL for the students which demotivated them. He stated:

> Although students understand the subjects at the beginning, they give it up thinking that they won't be able to catch up with the tutor because the tutor goes too fast. So, they get lower grades and this makes students study for getting grades not for learning.

S2 added to this idea emphasizing that exams were done so frequently and not everyone could adapt to this situation easily. He pointed out that the possibility of failing the class caused stress on students.

Apart from these, five students (36%) stated that they complained about the defects in the implementations but their complaints were not paid attention. R2 stressed that academicians or administrators were listening their complaints but nothing changed. He added that fourth grade students are of the opinion that even if they complained there would be no solution since they were going to graduate soon. He also added that the fourth grade students were thinking that they had tried hard and nothing had changed. A4 justified this idea by saying:

> We have some problems and we inform the authorities about them. But if nothing changes and two years passes in that way, one feels hopeless and say that if I could live in that way for two years I can do it for the next two years as well. We had lots of demands and discussions but nothing has changed.

S3 added to this idea emphasizing the fact that although the students accepted the system, they think that problems will not get better in any case. He

pointed out that this situation caused people to become sceptic about the system and he explained it as follows:

> Students are not opposed to PBL indeed. In fact, this system here is neither PBL nor conventional. It is a new system and there are many problems. Students tell that they don't want it if this system is PBL. They are very sceptical about it.

Additionally few students mentioned that being accustomed to conventional system, having not enough theoretical background, tutors' not enough guidance are other problems they face with during the implementation of PBL.

When the program of this department was compared with the conventional program of another EEED, it was realized that the program of this department was more loaded. Intensity of hours for those programs becomes nearly equal when the PBL session hours are extracted from the program of this department.

When asked about the problems students encountered due to the shortcomings in PBL implementations, tutors mentioned that students' stress levels were increased and they were demotivated due to time inadequacy, loaded curriculum, taking exams frequently and possibility of failing the class. For instance, according to Filiz, there is a serious psychological pressure on students in this system. She expressed her opinion as follows:

> Students have exams in every 2–3 weeks. The biggest problem of the system is passing or failing the class. Most of the students are distressed because of the possibility of failing. The biggest problem with the system is that. At the same time, the students have some motivation problems. While it was expected that the motivation would increase in that system, motivation of the most students has already reduced except the senior students.

Zeynep added that students are also socially affected when they failed the class. She argued that students diverge from each other due to failing the class.

Filiz and Murat emphasized that the students do not have the opportunity to digest the subjects because of time restriction. Filiz stated that tutors give the same content in conventional education in a whole term but in this system they give it in less than two weeks (because students spare the last few days of the second week for the exams).

Moreover, Murat added to this idea saying:

> In conventional system, the students used to digest what they learn through time because there used to be more time. But in this system, they may not do so. Some parts of the learning goals in a module are given in scenario and some parts are given in presentations. In the presentations, we need to explain the subjects which are hard for students to learn by searching but this time they cannot digest it as time restricts them.

Additionally, Filiz and Zeynep mentioned that tutors whose area of specialization is related with the module's topic mostly stay at the tutorial for hours but others do not. Tutors thought this application unfair especially for students since some of them make use of content experts but others do not. Moreover, they also regarded students' weak theoretical backgrounds as their problems. Filiz stated that most of the freshman students think that their basic science background is insufficient. She emphasized that she also had the same opinion.

Lastly, Zeynep mentioned that students have problems with practical applications since laboratory hours are not effective. She stated time restriction, crowded students and not enough assistants/tutors as reasons of ineffective laboratory hours.

4.4.7 The Problems Tutors Encountered in PBL

During interviews, students were asked the problems that the tutors face because of the deficiency in implementations of PBL. Table 4.9 shows students' perceptions about the problems of tutors according to the grade levels of them.

Table 4.9 Tutors' Difficulties with PBL

Tutors' difficulties with PBL / Grade	First Grade (N=5)	Second Grade (N=3)	Third Grade (N=2)	Fourth Grade (N=4)	Total (N=14)
Increase in workload	2	1	2	2	7 (50%)
Time inadequacy	1	1	2	1	5 (36%)

Half of the students stated that tutors have problems since there are not enough tutors in the department which cause to increase their work load, restrict their time. S3 expressed the problems of tutors by giving an example:

> Within the third class students, if we arrange groups of 9 out of 88 people, this will make a lot of groups and we need many tutors. This causes trouble. If the teacher is not the content expert in the scenario, he is not the one to blame because today it is not possible for everybody to know everything about a subject. Everyone knows about his own profession. Tutor needs too much time and effort to be prepared for modules. There is a problem with that issue.

Besides, the same third grade student emphasized that tutors feel stress to complete their presentations due to time inadequacy. For him, tutors want to catch up with the schedule and think that they should speed up due to the fact that if they can not do it in that hour they would provide students with missing information.

When asked about the problems they encountered in PBL, tutors stated that there is an increase in their work load and they have problems due to the time restrictions. For instance, Murat emphasized that the tutors used to have too much time in the conventional system but this system began to be very tiring for them since their burdens became heavier.

Filiz expressed that she spends too many hours while getting ready for the sessions. Her words were, “it lasts so much, to read and understand the scenarios especially for the ones that are not related to your area of specialization.” Zeynep mentioned that she spends extra time with students when they need extra presentations which make her schedule much busier.

Moreover, tutors emphasized the difficulty of writing scenarios. Filiz emphasized the difficulty of finding appropriate problems for some of the module contents and stated:

> For example electromagnetic module is totally theoretical. We don’t have such a lesson now because it is impossible to give it as a module. There are some subjects that you can’t adapt a problem in it. It is very difficult to give a lesson which is entirely theoretical as practical and explain it to a person who has no idea about it.

Besides, Murat and Alper mentioned their complaints about deficiency in organization. Murat stated his complaints as follows:

> Firstly there is an administrative problem. On paper, there is a clear organization for everything but it is not applied. For example, we should prepare scenarios during summer but we don't prepare. Other than this, there is no control mechanism here. For example there is no control over which topics do the scenarios cover, to what extend can they be applied, does the problem too complex or too simple etc. There are some modules in which the scenarios haven't changed for 4-6 years.

Additionally, Alper complained that the tutors are not trained about the system so they are unaware of it anymore and they learn their roles by themselves.

Lastly, Filiz and Zeynep expressed that complaints of the tutors were not paid attention, so their belief and motivation for PBL was decreased.

4.5 Question 5: Factors Affecting Performance of Tutors and Students during PBL Tutorials

While reporting the results of the fifth research question which considers the students' and tutors' perceptions about the factors affecting their performance during PBL tutorials, data gathered from interviews and observations were used.

4.5.1 Factors Affecting Performance of Tutors

Interview notes revealed that there are some factors affecting performance of tutors. Table 4.10 shows students' perceptions about those factors according to the grade levels of them.

Table 4.10 Factors Affecting Performance of Tutors

Factors Affecting Performance of Tutors / Grade	First Grade (N=5)	Second Grade (N=3)	Third Grade (N=2)	Fourth Grade (N=4)	Total (N=14)
Point of view toward PBL / adaptation of the system	2	3	2	3	10 (71%)
Content expertise	2	2	2	2	8 (57%)
Other (3 items)	0	2	2	0	4 (29%)

Most students (71%) stated that one of the factors that affect the performance of tutors is their point of view towards PBL or their adaptation level of the system. They stressed that while some of the tutors support PBL some do not support which affects their implementations. When asked about these factors, one of the first grade student's (G1) words were,

> The tutor who is adapted to this system always knows how to take what he wants from the student. He guides well, challenges and restricts the student. But the tutor who is not adapted to the system does not care about the students.
>
> S3 justified this by saying: "The tutor who believes in the system tries to implement PBL entirely."

Moreover, 57% of the students stated that the tutors' content expertise also affect their performance during PBL implementations. For instance, D4 explained that there is left nothing to discuss when the tutor is not master of the subject during the sessions. S2 justified this by saying,

> Not all the tutors are masters of the subjects. Some do not lecture well but some do and try hard and know what a tutor is expected to do in the sessions and implement it. Tutors are given the copies of the answers of the questions somehow but if they don't have fundamental knowledge of a subject, students cannot be guided well in my opinion.

Additionally, tutors' number, work load, experience, level of knowledge about their roles in PBL and students' motivation, are considered by few students as other factors affecting performance of tutors.

When asked about the factors affecting their performance all the tutors stated that their content expertise and level of adaptation to PBL affect their performance. For example, Filiz stated:

> Tutors' being content expert is a very important factor. If you are not content expert, it is hard to know whether the discussion wander away from the subject or not and also you feel stress. Moreover, tutor's adaptation level affects their performance and their belief in the system affects their motivation. Guiding a PBL tutorial thinking that it works differ from guiding it thinking as a waste of time.

Zeynep added to those ideas stating that students have a tendency to finish the session quickly without understanding if their tutor is not a content expert. She added that if the tutor is a content expert, she/he can ask motivating question like

"don't you know this? Then let's learn it together" and control the students. Moreover, Zeynep also thinks that tutors' level of adaptation to PBL affects their performance. She gave herself as an example and stated that her belief about the inadequate education given in this system may cause her not to guide students as required.

Murat added "quality of scenario" as another factor affecting performance of tutors. He expressed that if a scenario is bad to understand, tutors may not progress on related subject or if it is too complex, tutors may finish the tutorial in fifteen minutes.

In addition, Alper pointed out that tutors' guidance characteristics needed for PBL also affects their performance. It is important whether he guides well, provide students to discuss with each other, ask proper questions etc. These are all effective.

4.5.2 Factors Affecting Performance of Students

During interviews, students were also asked the factors affecting their performance during PBL implementations. Table 4.11 shows students' perceptions about those factors according to the grade levels of them.

Table 4.11 Factors Affecting Performance of Students

Factors Affecting Performance of Students / Grade	First Grade (N=5)	Second Grade (N=3)	Third Grade (N=2)	Fourth Grade (N=4)	Total (N=14)
Point of view toward PBL / adaptation of the system	3	2	2	2	9 (64%)
Studying habits & time management	2	2	2	2	8 (57%)
Students' motivation and interest	1	1	2	2	6 (43%)
Other (4 items)	2	2	1	1	6 (43%)

Students' point of view towards PBL or their degree of adaptation of the system was considered as an important factor by 64% of the students which affects

their performance. Those students emphasized that most of the students had negative point of views toward PBL or could not adapt the system. For instance M1 stated that students who did not adapt the system had difficulties and did not study. He also gave examples of his friends who quitted the university or repeated the class as a result of this adaptation problem. S3 explained that students being accustomed to conventional system caused negative point of views toward PBL. He also mentioned that some students demotivated easily when got low grades from the first two modules and quitted the university thinking that that they made a wrong choice while choosing their university.

Apart from this, 57% of the students stated that their regular studying habits (level of self-directed learning, self discipline, comprehension etc.) and time management success are among the factors affecting their performance. They addressed that students who cannot schedule their time and who do not study regularly have problems. M1 see himself and most of his friends as students who cannot catch up with the studying tempo of this system and stated that he had the greatest difficulties in that case. H3 also defined himself and other many students in his class as students below the average considering the studying habits and stated:

> Studying habits determines the success of the student. This system necessitates hard and regular study. In a two weeks module, studying is generally left to the second week so we have to study hard for 4-5 days in the second week. But in that circumstance the result is not positive.

Other than those, 43% of the students stated that their motivation and interest towards their branches affect their performance. They think that if a student is interested and motivated, he/she can be more successful. When S2 was asked the affect of this factor on his high performance, he answered,

> I like electronics and try to be interested in it practically. Most of the time I regard it as a joyful subject rather than as a course. I motivate myself in this way. This will be my job eventually. May be we won't use all the things we learn here but understanding the logic here will be my job in the future. I am interested in it and like it because I will be dealing with these things. I think these things have an effect on success.

Additionally, few students addressed that having the fear of failing the class, number of exams, time insufficiency, tutors' success about guidance, quality of scenarios are considered as other factors affecting the performance of students.

When asked about the factors affecting performance of students, all the tutors stated that students' studying habits and motivation were considered as important factors which affect their performance. For instance, Murat pointed out that if students do not study regularly, their motivation decreases and their fear about failing class increases. He added that students' performance also depends on the quality of the scenarios and stated:

> Some scenarios demotivate some students too much. When the students do not wonder the problem, interested in the content or have fun, they do not study at home and search for learning objectives.

Moreover, Zeynep emphasized the contrast between what students do and what they are expected in PBL in terms of their study habits. She thinks that students mostly study according to the exams only for passing the module.

Additionally, Alper pointed out that students' adaptation level of the system is another factor affecting their performance and stated:

> In this system, students have big responsibilities. Students that are not used to take responsibility for their own learning are forced in PBL. Students that do not study even in the conventional system do not like PBL when they should study too much.

4.6 Question 6: Improvement Suggestions for PBL

While reporting the results of the sixth research question which considers the students' and tutors' improvement suggestions for PBL, data gathered from interviews, and documents were used.

4.6.1 Suggestions for Tutors

During interviews, students mentioned their suggestions for the tutors to resolve the problems they encounter in PBL implementations. Most of the students emphasized that teachers should provide them with a better guidance. For this; some students (M4, R2, L1, and G1) explained that the tutors should be trained according to the necessities of PBL. For instance, M4 believed that there were

some who cannot be adapted to the system among tutors this is why the teachers should be trained suitable to PBL.

Moreover, the students (S2, C1, M1, and G1) emphasized that the tutors should gain sufficient information about PBL and carry the needed features that a tutor should carry (such as being able to motivate the students, coming to the sessions prepared etc). During the interview S2 stated:

> Tutor's role is to guide the students. Tutor is very important. If the tutor provides the students with a better guidance students can be easily adapted to the system. Tutor should work harder and consult the director/coordinator of that module about the things they don't know. Apart from this tutors should motivate the students because we take exams every two weeks.

Moreover, M1 justified this by adding:

> Tutors should put more effort on students. They should make the students believe the system and make them like the implementation. They should question why the students do not do their homeworks and why they are not pleased with the system.

When their suggestions were asked, tutors emphasized that they need some features to guide students better. For example, Murat stated that tutors should guide students in an appropriate way even if the scenario is not well prepared. He also added that tutors should press especially the quite students to participate in discussions. Alper pointed out that tutors should know pedagogical knowledge (how to guide students in PBL) as well as content knowledge (master of the subject). He stated: "Tutors should know this work or should be trained theoretically... No one questions whether we know PBL or how to apply it."

Additionally, as those tutors complained about the lack of control mechanisms in their department, they suggested that tutors should organize better among themselves, coordinator system should work better. When he was asked about his suggestions, Murat stated:

> In fact, module directors should introduce each module to the tutors before they are implemented. Moreover, semester coordinators should organize meetings to discuss the modules and evaluate the feedbacks. Those were done during the first two years after PBL was started to be implemented but not done anymore. It would be more efficient to organize those kinds of meetings regularly.

4.6.2 Suggestions for Students

As the students have the opinion that they have some defects in their studying habits their suggestions are generally about these defects. Some students (S2, H3, M1, S3, G1) emphasized that the students should self-discipline their study habits. Moreover, S2 criticized some students for not caring the PBL tutorials and stated:

> They come to the sessions just for passing two hours. I know that I learn a lot in the sessions but if you are not interested you may not learn anything. Students should be more active and more interested.

Additionally, when asked about his suggestions, G1 suggested that the students should control themselves and do whatever they are expected to according to the PBL system. He also added that the information that the tutor gave may not be sufficient for being successful so the students should study by themselves.

Among the tutors, Alper and Murat emphasized that the students should revise their study habits and make an effort to keep up with the system. Murat gave suggestions for a group of students who do not have the proper studying habits and become easily demoralized as follows:

> For example if a student misses a presentation or gets low grade from a module he easily becomes demoralized. If he doesn't like the scenario, he doesn't study. Those kinds of students should self-discipline their study habits and try to adapt to the system.

Moreover, Alper suggested that students should give importance to the scenarios. They should carefully read the scenarios, analyze the problem and determine necessary information, make discussions about with each other and share their opinions etc.)

4.6.3 Suggestions for Scenarios/ Sessions

Students stated that some scenarios are well prepared but some are not and they gave some suggestions for preparing better scenarios. The most common suggestion of students (S3, S2, H3, M1) is that the scenarios should include some authentic and daily life problems. S3 expressed that the students need a real scenario and a real problem the solution of which should be compatible with the

theoretical information given in that module. Another third grade student (H3) justified this by saying: "Scenarios should envision some things in our minds (from daily life or from our previous knowledge etc.)."

Moreover, few students (R2, A1) stated that the subjects of the scenarios should be appropriate for the level of the students and should arouse their interest. A1 stated:

> Scenarios should be more practical and related with our interest more. It should arouse my interest in such a way that I can think about the subject we covered and search for it after the PBL tutorial.

Similarly, the results of the questionnaire that was prepared by the delegate of sophomore students have shown that 46% of the participants marked "scenarios should consist more practicable questions", 73% marked "scenarios should consist authentic problems", 60% marked "scenarios should consist interesting subjects", 52% marked "scenarios should consist questions that are appropriate for brain storming", and 65% marked "scenarios should be compatible with the theoretical subject of modules" as characteristics of a good PBL scenario.

When asked for their suggestions during interviews, Murat and Filiz suggested stopping applying common scenarios with other first grade engineering departments. They advised that either scenarios should be prepared by each department separately or there should be enough contribution from their department during preparation of the scenarios.

Alper and Filiz suggested adding computer, internet connection and books to PBL rooms. Moreover, Alper suggested arranging PBL rooms so that the students are physically closer to each other to see what the others do around the table and mutual interaction can take place.

4.6.4 Suggestions for Assessment

Students stated that some arrangements should be done in the assessment system. When asked about weaknesses/problems in assessment procedure, the students mostly complained about the facts that the assessment process differs from tutor to tutor, some assessments are non-functional and the possibility of

failure causes stress. Before all else, they suggested the assessment system to be standardized. For instance, A4 expressed his feelings as follows:

> The assessments differ from tutor to tutor. Students whose tutor gives high grades feel happy meaning that the others are assessed objectively. This is unfair. For my part, all the students should be assessed in an objective and standardized way.

Another student (C1) pointed out that students find module evaluation questionnaires and tutor evaluation questionnaires sceptical. She added to this idea by suggesting those questionnaires should be seriously taken into consideration and the students should be informed about why those questionnaires are used for and what are their results.

Furthermore, most of the students mentioned their stress due to the possibility of failure and they suggested an arrangement for the assessment system. However, they pointed out that they could not find solution concerning this. S2 and H3 stressed that repeating the module instead of repeating the class may be the solution. However, they added that this is not the proper solution since another problem may occur when it is done in that way.

Apart from these, the students supported that the assessments should include more practical implementations. R2 who complained about the exams that are done in a conventional way suggested that assessments should be based on more practically weighted projects or laboratory studies. G1 justified this by saying:

> We may have exams based on more practically weighted implementations instead of paper based ones. The coefficient of the project and laboratory lessons of the first class should be increased due to the fact that most of us regard these implementations as forced labor.

Tutors offered the idea of summer school as they believed that passing or repeating the class shouldn't be the concern for the assessment system. Apart from this, they stated that tutors have a great role in assessment of the tutorials and this assessment should be done very carefully**.**

Murat stated that exams and laboratory practices measure students' knowledge but grades taken during tutorials show the level of students' participation. Therefore, he suggested assessing students considering how much

they participated to discussions, how much they contributed to solve the problem, and how much they assisted to the discussions.

In addition, Alper criticized that the exams are done in a conventional way and suggested more performance-based assessments for the system. He stated:

> Actually, learning and assessment should be done during tutorials in PBL. An exam with a particular percentage can be held at any time but the high percentage of the assessment should be based on performance. Moreover, tutors should be encouraged to make performance-based assessment and more time should be left for assessment procedure.

4.6.5 Suggestions for Curriculum/Administrative Issues

Students gave suggestions on program and administrative issues as well. Some emphasized that their complaints and problems should be taken into consideration and tutors/administrators should be sensitive about that. One of the third grade students (S3) stated his suggestions as follows:

> I think our complaints are not understood. PBL is a new system therefore they should ask for feedback from students I think. I believe that the tutor should act accordingly and find solution when I give feedback.

Moreover, M4 gave suggestion related with the administrators emphasizing that they should make use of education consultants in order to remove the deficiencies within the system and make necessary corrections.

Some students stated that it is difficult for a student who comes from conventional education to adapt PBL. Therefore, they suggested that necessary informative activities should be done and the adaptation process should be made easier for students. For example, M1 suggested to implement conventional education in the first term of the first year or to provide a transition to make the students get accustomed to the system. He pointed out that by this way students can be adapted to the system and get used to this new environment. Besides, A4 emphasized the difficulty and incomprehensibility of the system for a person who came from the conventional system in high school. He suggested that the students should be informed in detail about the system in order to adapt it.

Additionally, to increase the number of tutors, to improve infrastructure (research laboratories, electronic laboratories etc.) of the department, to supplement curriculum with more practical applications and to integrate some interconnected modules in order to extend the duration of the modules are suggested by some students (T2, R2, S2, S3).

Tutors stated that there are some problems with the current situation and some revisions should be done. Filiz and Murat mentioned that people should study seriously systematically and in a controlled way while making arrangements within the curriculum. Filiz criticized that transition of electrics-electronics curriculum from conventional system to PBL was sudden and too much risky. She also criticized that the lack of integration of subjects within the modules emphasizing the fact that every module in this system corresponds to a lesson of the previous conventional system. She summarized that studies done before implementing PBL was insufficient. Therefore, she suggested a pilot study before implementing changes for the curriculum.

Murat believed that they can solve the problems indeed but they should take it more seriously and there should be certain committees studying systematically while implementing the program. He added that there should be enough professionals (tutor and assistants) to solve this problem so he suggested increasing the number of professionals.

When asked about their suggestions, tutors also expressed their ideas about shifting to the conventional education. Filiz suggested a radical revision within the current system or shifting to a very advanced version of conventional education. She stated:

> I think the first classes should shift to a system which is at least similar to the conventional one. They can have problem solving sessions without having PBL tutorials. They can have recitation or problem solving hours with small groups but in any case they should take lessons from tutors instead of PBL tutorials. Moreover, the system can be project based beginning from the third class. I think the project based part works well. I believe that it should be project based instead of being problem based.

Zeynep agreed the idea of applying problem solving hours especially for the theoretical modules. She pointed out that some topics of some modules such as "electrical safety" are more effective since they are compatible with daily life experiences however theoretical topics should be given in conventional way. She defended that basic courses should be given to the students properly instead of giving it by the current way and stated:

> We should transfer knowledge properly not sloppily. Students should feel the pleasure of taking courses from the university and consider this as a privilege.

Murat mentioned what tutors discussed during academic committees. He stated that tutors suggested extending the duration of modules or making exams more rarely. Moreover he added the idea that some of the interrelated modules may be performed in a conventional way during a semester.

In addition, tutors suggested generalizing project-based studies to the other grades. For instance, Alper expressed that since the students are carrying out projects and gain very important features which are necessary for being an engineer, maintaining this implementation in the second and third class will be beneficial. Murat added to this idea stating "in the second and third classes, it would be better to support problems with little projects. A student who has never carried out a project may get lost when he starts to the upper grade."

4.7 Questions 7 and 8: Effectiveness of PBL on Motivation and Learning Strategies

The results of the seventh and eighth research questions (quantitative data analysis) are explained in two sections. Descriptive statistics associated with the data collected from the administration of the MSLQ-I and MSLQ-II are presented in the first section. The second section presents the inferential statistical data produced from testing two null hypotheses.

4.7.1 Descriptive Statistics

Descriptive statistics related to the students' pretest and posttest scores of the MSLQ Scales for both students receiving their first year curriculum in PBL group (PG) and those who received their curriculum in the conventional lecture group (CG) are presented in Table 4.12 and 4.13 respectively.

Students' scores of the MSLQ scales range from 1 (not at all true of me) to 7 (very true of me). The results presented in those tables show that the pretest and posttest scores of PG were slightly higher than those of the CG both on the MSLQ motivation (IGO, EGO, TV, CLB, SE, TA) and learning strategy scales (REH, ELA, ORG, CRT, MSR, TS, EF, PL, HS). Moreover, as those tables indicates, PG shows a very small mean increases on HS, REH, ORG, CRT, PL, and TA ranging from 0.01 to 0.15 points and CG on REH, HS, PL, and ORG ranging from 0.03 to 0.22 points between the pretest and posttest scores of those scales. It can be seen that there is a slight descending tendency on the other scores of the MSLQ scales between the pretests and posttests.

Table 4.12 Descriptive Statistics for the Pretest Scores of the MSLQ Scales

	N		Mean		Std. Dev.		Skewness		Kurtosis	
	CG	PG	CG	PG	CG	PG	CG	PG	CG	PG
PREIGO	231	221	4.69	4.99	0.98	0.87	-0.37	-0.58	0.47	1.25
PREEGO	231	221	5.37	5.42	0.95	1.11	-0.74	-1.15	0.70	2.16
PRETV	231	221	4.92	5.12	0.96	0.81	-0.76	-0.67	1.67	1.36
PRECLB	231	221	5.12	5.26	0.78	0.93	-0.29	-0.56	0.46	0.71
PRESE	231	221	4.83	5.06	0.84	0.82	-0.24	-0.47	0.39	1.09
PRETA	231	221	4.07	4.19	1.09	1.13	-0.32	-0.18	0.29	-0.11
PREREH	231	221	4.43	4.51	1.10	1.09	-0.30	-0.21	0.53	0.46
PREELA	231	221	4.71	5.06	0.97	0.88	-0.40	-0.19	0.53	-0.28
PREORG	231	221	4.67	4.77	1.06	1.07	-0.33	-0.31	0.69	0.11
PRECRT	231	221	4.24	4.64	1.00	1.01	-0.21	-0.44	0.31	0.50
PREMSR	231	221	4.59	4.70	0.70	0.72	-0.14	0.14	0.70	0.26
PRETS	231	221	4.63	4.72	0.92	0.84	-0.07	-0.13	0.26	0.56
PREEF	231	221	4.42	4.62	1.15	1.06	-0.05	-0.10	0.08	-0.38
PREPL	231	221	3.90	4.28	1.09	1.08	-0.29	0.11	0.18	0.06
PREHS	231	221	4.48	4.77	1.07	1.06	-0.37	-0.72	0.29	1.03

Table 4.13 Descriptive Statistics for the Posttest Scores of the MSLQ Scales

	N		Mean		Std. Dev.		Skewness		Kurtosis	
	CG	PG	CG	PG	CG	PG	CG	PG	CG	PG
PSTIGO	231	221	4.47	4.76	1.14	1.00	-0.24	-0.49	-0.09	0.47
PSTEGO	231	221	4.99	5.27	1.10	1.15	-0.39	-0.88	0.39	0.68
PSTTV	231	221	4.65	4.90	1.10	0.97	-0.39	-0.21	0.07	-0.17
PSTCLB	231	221	5.01	5.04	1.04	1.04	-0.41	-0.49	0.51	0.28
PSTSE	231	221	4.69	4.91	1.03	0.89	-0.31	-0.17	0.37	-0.23
PSTTA	231	221	4.04	4.29	1.12	1.16	-0.02	-0.44	-0.48	0.43
PSTREH	231	221	4.49	4.53	1.19	1.16	-0.14	-0.13	-0.28	-0.23
PSTELA	231	221	4.62	5.02	1.05	0.92	-0.33	-0.10	0.06	-0.58
PSTORG	231	221	4.81	4.85	1.13	1.07	-0.37	-0.25	0.23	0.10
PSTCRT	231	221	4.23	4.65	1.06	1.07	-0.07	-0.26	-0.14	0.13
PSTMSR	231	221	4.53	4.64	0.77	0.76	-0.01	0.06	-0.22	0.10
PSTTS	231	221	4.37	4.56	0.96	0.78	0.01	0.29	0.76	0.33
PSTEF	231	221	4.14	4.43	1.17	1.10	0.25	-0.24	-0.13	0.23
PSTPL	231	221	4.12	4.43	1.18	1.16	-0.25	-0.30	-0.09	0.21
PSTHS	231	221	4.51	4.78	1.08	0.99	-0.43	-0.40	0.51	0.77

Tables given above also present some other basic descriptive statistics like standard deviation, skewness, and kurtosis. The skewness and kurtosis values for this study can be accepted as approximately normal as suggested by George and Mallery (2003). They state that the skewness and kurtosis values between -1 and +1 is considered excellent but values between -2 and +2 is also acceptable. Therefore, the kurtosis values as shown in both Tables can also be accepted as approximately normal.

4.7.2 Inferential Statistics

This section deals with the missing data analysis, determination of the covariates, verification of multivariate analysis of covariance (MANCOVA) assumptions, the statistical model of MANCOVA, the analyses of the hypotheses, and the follow-up analysis

4.7.2.1 Missing Data Analysis

Before starting the inferential statistics, the missing data analysis was carried out.

There were a total of 452 freshman students from nine engineering departments that took the MSLQ as a posttest. However, 63 (13.7%) of the students were absent on the date of pretest. Therefore, one dummy variable was created to represent the independent variables of missing data in the variables of PREIGO, PREEGO, PRETV, PRECLB, PRESE, PRETA, PREREH, PREELA, PREORG, PRECRT, PREMSR, PRETS, PREEF, PREPL, and PREHS. Dummy variable (MISMSLQ) was created to represent these independent variables data (1= missing; 0= present). According to the result of analysis, there was a significant difference between the mean scores of dependent variables (PSTIGO, PSTEGO, PSTTV, PSTCLB, PSTSE, PSTTA, PSTREH, PSTELA, PSTORG, PSTCRT, PSTMSR, PSTTS, PSTEF, PSTPL, and PSTHS) having missing data and those of having no missing data for those 15 independent variables. So, the assigned dummy coded missing data variable (MISMSLQ) was retained as an independent variable, and the whole missing values were replaced with the mean of the entire subjects.

4.7.2.2 Determination of Covariates

Nineteen independent variables; students' age, gender, SELS, OPD, PREIGO, PREEGO, PRETV, PRECLB, PRESE, PRETA, PREREH, PREELA, PREORG, PRECRT, PREMSR, PRETS, PREEF, PREPL, and PREHS were pre-determined as potential confounding factors of the study. To statistically equalize the differences among the experimental and control groups, these variables were included in Block A as covariates. All pre-determined independent variables have been correlated with the dependent variables of PSTIGO, PSTEGO, PSTTV, PSTCLB, PSTSE, PSTTA, PSTREH, PSTELA, PSTORG, PSTCRT, PSTMSR, PSTTS, PSTEF, PSTPL, and PSTHS. Except one of the independent variable (OP), all have significant correlations with at least one of the dependent variables.

Hence; students' age, gender, SELS, PREIGO, PREEGO, PRETV, PRECLB, PRESE, PRETA, PREREH, PREELA, PREORG, PRECRT, PREMSR, PRETS, PREEF, PREPL, and PREHS were determined as covariates for the following inferential analyses.

Although there is significant correlations between the covariates, none of the correlation value is greater than 0.80. So no multicollinearity can be detected among covariates.

4.7.2.3 Assumptions of Multivariate Analysis of Covariance

MANCOVA has the assumptions of normality, homogeneity of regression, equality of variances, multicollinearity and independency of observations. All the variables were tested for all the assumptions.

For the normality assumption, skewness and kurtosis values were used. The values for skewness and kurtosis of dependent variables were given in Section 4.7.1. The skewness and kurtosis value were in approximately acceptable range for a normal distribution.

Homogeneity of regression assumption means that the slope of the regression of a dependent variable on covariates must be constant over different values of group membership. Table 4.14 indicates the results of Multivariate Regression Correlation (MRC) analysis of homogeneity of regression. For this analysis, five new interaction terms were produced. These interaction terms were prepared by multiplying the group membership with the covariates determined. After that, three different blocks were produced. Covariate variables were set to Block A, group membership was set to Block B and interaction terms set to Block C. Then MRC was performed to test the significance of R^2 change using enter method for each dependent variable.

Table 4.14 Results of the MRC Analysis of Homogeneity of Regression

	Change Statistics				
Dependent Variable	R2 Change	F Change	df1	df2	Sig. F Change
PSTIGO	.035	1.27	19	397	.747
PSTEGO	.037	1.25	19	397	.044
PSTTV	.023	.804	19	397	.410
PSTCLB	.021	.572	19	397	.863
PSTSE	.035	1.15	19	397	.040
PSTTA	.016	.547	19	397	.632
PSTREH	.026	.846	19	397	.652
PSTELA	.062	2.32	19	397	.007
PSTORG	.050	1.749	19	397	.014
PSTCRT	.056	1.99	19	397	.015
PSTMSR	.038	1.41	19	397	.116
PSTTS	.047	1.618	19	397	.049
PSTEF	.049	1.70	19	397	.032
PSTPL	.004	2.475	19	397	.250
PSTHS	.064	1.97	19	397	.019

As seen from Table 4.14, for the PSTIGO, PSTTV, PSTCLB, PSTTA, PSTREH, PSTMSR, and PSTPL contribution of Block C is not significant. For example for PSTIGO, (F (19,397) = 1.27, p = .747). However, for the PSTELA, PSTORG, PSTCRT, PSTTS, PSTEF, PSTPL, and PSTHS, contribution of Block C is significant. For example for PSTORG, (F (19,397) = 1.75, p = .014). Therefore, there is significant interaction between some of the covariates and the group membership. This means that the homogeneity of regression assumption is violated.

Moreover, the results of the Box's Test of Equality of Covariance Matrices F(21, 34611) = 1.62, p = 0.035 for the dependent variables of PSTIGO, PSTEGO, PSTTV, PSTCLB, PSTSE, PSTTA and F(45, 73752) = 0.006 for the dependent variables of PSTREH, PSTELA, PSTORG, PSTCRT, PSTMSR, PSTTS, PSTEF, PSTPL, and PSTHS indicated the violation of homogeneity of covariance matrices assumption.

Besides, Levene's Test of Equality was used to determine the equality of variance assumption. Table 4.15 indicates the error variances of the selected dependent variables across groups.

Table 4.15 Levene's Test of Equality of Error Variances

	F	df1	df2	Sig.
PSTIGO	1.724	1	450	0.190
PSTEGO	2.483	1	450	0.116
PSTTV	1.756	1	450	0.186
PSTCLB	0.721	1	450	0.396
PSTSE	1.384	1	450	0.240
PSTTA	0.946	1	450	0.331
PSTREH	0.885	1	450	0.356
PSTELA	2.482	1	450	0.116
PSTORG	2.033	1	450	0.155
PSTCRT	0.109	1	450	0.741
PSTMSR	0.107	1	450	0.744
PSTTS	12.752	1	450	0.000
PSTEF	2.693	1	450	0.102
PSTPL	0.000	1	450	0.995
PSTHS	0.005	1	450	0.943

The results revealed that homogeneity of variance assumption was violated only for the dependent variable of Time and Study Environment. Since some of the assumptions of the MANCOVA were violated, non-parametric data analysis was also performed after conducting the MANCOVA.

4.7.2.4 Multivariate Analysis of Covariance Model

Hypothesis 1:

The first hypothesis was that there is no significant difference between freshman engineering students receiving their curriculum in problem-based instruction and those receiving in conventional instruction on their post-motivation scores (PSTIGO, PSTEGO, PSTTV, PSTCLB, PSTSE, PSTTA) when their age, gender, SELS, OPD, and pre-motivation scores are statistically controlled.

After checking the assumptions, MANCOVA was conducted. Table 4.16 presents the results of MANCOVA for the collective dependent variables of the PSTIGO, PSTEGO, PSTTV, PSTCLB, PSTSE, and PSTTA.

Table 4.16 MANCOVA Results for the Collective Dependent Variables of the PSTIGO, PSTEGO, PSTTV, PSTCLB, PSTSE, and PSTTA

Effect	Wilks' Lambda	F	Hypothesis df	Error df	Sig	Eta Squared	Observed Power
MOT	.969	2.312	6.0	436.0	0.033	0.031	.802

As Table 4.16 shows, the first null hypothesis was rejected since MANCOVA resulted in significant F values for MOT ($F=2.312$, $p<.05$). The significant F value for MOT shows that there was a significant mean difference between the PBL group and conventional lecture groups with respect to with respect to their post-motivation scores. In order to test the effect of PBL on each dependent variable, an analysis of covariance (ANCOVA) was conducted as follow-up tests to the MANCOVA. Table 4.17 indicates the result of the ANCOVA.

Table 4.17 Test of Between-Subjects Effect

Source	Dependent variable	df	F	Sig	Eta Squared	Observed Power
MOT	PSTIGO	1	1.413	0.235	0.03	0.220
	PSTEGO	1	9.140	0.003	0.02	0.855
	PSTTV	1	1.037	0.309	0.002	0.174
	PSTCLB	1	0.546	0.460	0.001	0.114
	PSTSE	1	0.828	0.363	0.002	0.148
	PSTTA	1	4.471	0.035	0.01	0.560

It can be inferred from the Table 4.17 that ($p<.05$) there was a statistically mean difference between the groups with respect to dependent variables of extrinsic goal orientation (EGO) and test anxiety (TA). Therefore, students in the PBL group appeared to perceive themselves to be participating in a task for reasons such as grades, rewards, performance, and evaluation by others etc. more than the students in the conventional group. For instance, for the item number 11 (the most important thing for me right now is improving my overall grade point average, so my main concern in this class is getting a good grade) 80% of the PBL students rated 5, 6, or 7 while the percentage in the conventional group was 67.

Moreover, the results showed that students in the PBL group tend to show more worry and anxiety disrupting their performance than the students in the conventional group. For example, for the item number 8 (When I take a test I think about items on other parts of the test I can't answer) 52% of the PBL students rated 5, 6, or 7 while the percentage in the conventional group was 26. Table 4.18 presents the percentages of ratings for two sample items for the EGO and TA scales.

Table 4.18 Percentages of Responses for Two Items of the EGO and TA Scales

Scale	Item Number	Group	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 (%)	7 (%)
EGO	11	CG	3.5	1.7	10	17.7	26.4	20.8	19.9
	11	PG	3.2	2.3	8.2	6.8	19.1	25.9	34.5
	30	CG	4.3	4.3	18.6	17.7	22.2	16.9	16
	30	PG	5.5	5	10.9	17.7	16.4	23.2	21.4
TA	8	CG	6.9	10	13.9	32.9	16.5	12.1	7.8
	8	PG	9.5	9.1	12.7	16.8	27.3	14.5	10
	19	CG	6.5	13	18.6	23.3	18.2	10	10.4
	19	PG	6.8	10.5	13.6	22.7	21.4	13.2	11.8

Hypothesis 2:

The second hypothesis was that there is no significant difference between freshman engineering students receiving their curriculum in problem-based instruction and those receiving in conventional instruction on their post-learning strategy scores (PSTREH, PSTELA, PSTORG, PSTCRT, PSTMSR, PSTTS, PSTEF, PSTPL, PSTHS) when their age, gender, SELS, OPD, and pre-learning strategy scores are statistically controlled.

Table 4.19 presents the results of MANCOVA for the collective dependent variables of the PSTREH, PSTELA, PSTORG, PSTCRT, PSTMSR, PSTTS, PSTEF, PSTPL, and PSTHS.

Table 4.19 MANCOVA Results for the Collective Dependent Variables of the PSTREH, PSTELA, PSTORG, PSTCRT, PSTMSR, PSTTS, PSTEF, PSTPL, and PSTHS

Effect	Wilks' Lambda	F	Hypothesis df	Error df	Sig	Eta Square	Observed Power
MOT	.950	2.514	9.0	430.0	0.008	0.050	.935

As Table 4.19 shows, the second null hypothesis was rejected since MANCOVA resulted in significant F values for MOT ($F=2.514$, $p<.05$). The significant F value for MOT shows that there was a significant mean difference between the PBL group and conventional lecture groups with respect to their post-learning strategy scores. In order to test the effect of PBL on each dependent variable, ANCOVA was conducted as follow-up tests to the MANCOVA. Table 4.20 indicates the result of the ANCOVA.

Table 4.20 Test of Between-Subjects Effect

Source	Dependent variable	df	F	Sig	Eta Squared	Observed Power
MOT	PSTREH	1	0.156	0.693	0.000	0.068
	PSTELA	1	4.527	0.034	0.010	0.565
	PSTORG	1	1.269	0.261	0.003	0.203
	PSTCRT	1	1.941	0.164	0.004	0.285
	PSTMSR	1	0.007	0.934	0.000	0.051
	PSTTS	1	5.517	0.019	0.012	0.649
	PSTEF	1	4.134	0.043	0.009	0.527
	PSTPL	1	1.601	0.206	0.004	0.243
	PSTHS	1	1.784	0.182	0.004	0.266

It can be inferred from the Table 4.20 that there was a statistically mean difference ($p<.05$) between the groups with respect to dependent variables of elaboration (ELA), effort regulation (EF), and time and study environment (TS). Therefore, students in the PBL group appeared to use elaboration strategies (paraphrasing, summarizing, creating analogies, and generative note-taking) that help the learner integrate and connect new information with prior knowledge) more than the students in the conventional group. For instance, for the item number 81 (I try to apply ideas from course readings in other class activities such as lecture and discussion) 66% of the PBL students rated 5, 6, or 7 while the percentage in the conventional group was 39.4.

Moreover, students in the PBL group tended to control their effort and attention reflecting a commitment to completing their study goals, even when there are distractions and difficulties. For example, for the item number 74 (even when course materials are dull and uninteresting, I manage to keep working until I finish) 70.5% of the PBL students rated 5, 6, or 7 while the percentage in the conventional group was 48.1.

Lastly, students in the PBL group appeared to manage and regulate their time and study environment more than the students in the conventional group. For instance, while 77.3% of students in the PBL group rated 5, 6, or 7 for the item

number 73 (I attend class regularly) the corresponding percentage in the conventional group was 61.5. Table 4.21 presents the percentages of ratings for two sample items for the ELA, ER, and TA scales.

Table 4.21 Percentages of Responses for Two Items of the ELA, ER, and TS Scales

Scale	Item Number	Group	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 (%)	7 (%)
ELA	67	CG	2.2	5.2	10.8	22.1	20.8	21.2	17.7
	67	PG	0.9	2.7	8.6	16.8	25.5	27.3	18.2
	81	CG	8.7	11.7	15.6	24.7	18.2	14.3	6.9
	81	PG	2.3	3.6	9.1	19.1	38.2	14.5	13.2
EF	48	CG	3.0	8.2	18.2	24.2	21.6	16.9	7.8
	48	PG	4.1	5.5	8.2	22.7	23.2	22.3	14.1
	74	CG	4.8	9.5	18.2	19.4	21.6	15.2	11.3
	74	PG	3.2	2.7	7.7	15.9	29.5	27.7	13.2
TS	70	CG	7.8	5.6	13	24.7	21.2	15.2	12.6
	70	PG	2.7	5.0	10.9	18.6	29.1	18.6	15
	73	CG	4.3	6.1	14.3	13.9	19.9	19	22.5
	73	PG	0.5	2.3	5.9	14.1	16.4	25	35.9

The SPSS calculated R^2 as 0.02 for the PSTEGO, 0.01 for the PSTTA, 0.01 for the PSTELA, 0.012 for the PSTTS, and 0.009 for the PSTEF. The observed values of effect size were calculated as 0.02, 0.01, 0.01, 0.01, and 0.009 by using the formula $f^2 = R^2/ (1-R^2)$ for the PSTEGO, PSTTA, PSTELA, PSTTS, and PSTEF respectively. Therefore, follow up results yielded approximately small effect size for those variables meaning that the practical significance of this study is low.

4.7.2.5 Nonparametric Data Analysis

The data was also analyzed by the Mann-Whitney U test for evaluating whether the mean ranks of the two groups (PG and CG) for the PSTEGO, PSTTA,

PSTELA, PSTTS, and PSTEF differ significantly from each other. Table 4.22 present the results of the Mann-Whitney U analysis for those dependent variables.

Table 4.22 The Results of the Mann-Whitney U Analysis for the PSTEGO, PSTTA, PSELA, PSTTS, and PSTEF

	PSTEGO	PSTTA	PSTELA	PSTTS	PSTEF
z	-3.264	-2.476	-3.821	-2.286	-2.804
p	0.001	0.013	0.0	0.022	0.005

The results of the Mann-Whitney U test showed that there is a significant mean rank difference between the PBL group and conventional lecture groups with respect to the dependent variables of PSTEGO, PSTTA, PSTELA, PSTTS, and PSTEF. Therefore, the results of the both MANCOVA and Mann-Whitney U test were significant for the PSTEGO, PSTTA, PSTELA, PSTEF and PSTTS.

4.8 Summary of the Findings

The following findings can be drawn from the results of the current study:

1. Interview notes and document analysis revealed that students and tutors were aware of the common features they should have in a PBL environment. However, during implementations, it was observed that there were some differences between the theory of PBL and its practical applications in terms of students' and tutors' actions.
2. Gaining engineer's viewpoint and self confidence; improvement of communication skills, problem-solving skills, and collaboration skills were commonly mentioned strengths of PBL.
3. Weaknesses of PBL and problems encountered in it were reported under seven sections such as tutors' weaknesses, students' weaknesses, scenarios'/sessions' weaknesses, assessment weaknesses, presentation weaknesses, tutors' problems, and students' problems in PBL.

- Difference in PBL implementations and insufficient preparation were mentioned as tutors' weaknesses.
- Students' insufficient preparation, disinterest toward PBL, weaknesses of study habits, and insufficient knowledge about the PBL system were mentioned as their weaknesses.
- Carelessly prepared scenarios, difference in scenario applications, and problems in group works were mentioned as scenarios' or sessions' weaknesses.
- Difference in assessment procedure, non-functional assessment, and too many/to long exams were mentioned as assessment weaknesses.
- Having too many presentations was commonly mentioned as a weakness of presentations.
- Having loaded curriculum and time inadequacy were commonly mentioned problems of tutors and students.

4. Tutors' point of views toward PBL, adaptation of the system, and content expertise were commonly mentioned as factors affecting their performance. Similarly, students' point of views toward PBL, adaptation of the system, and motivation and interest level were mentioned as factors affecting their performance.
5. PBL improved students' extrinsic goal orientation. That is, students in the PBL group appeared to perceive themselves to be participating in a task for reasons such as grades, rewards, performance, and evaluation by others more than the students in the conventional group.
6. PBL improved students' text anxiety. That is, students in the PBL group tended to show more worry and anxiety disrupting their performance than the students in the conventional group.
7. PBL had no effect on students' intrinsic goal orientation, task value, control of learning values, and self-efficacy for learning and performance.

8. PBL improved students' use of elaboration strategies. That is, students in the PBL group appeared to use elaboration strategies (paraphrasing, summarizing, creating analogies, and generative note-taking) that help the learner integrate and connect new information with prior knowledge more than the students in the conventional group.
9. PBL improved students' management of effort regulation. That is, students in the PBL group tended to control their effort and attention (reflecting a commitment to completing their study goals, even when there are distractions and difficulties) more than the students in the conventional group.
10. PBL improved students' management of time and study environment. That is, students in the PBL group appeared to manage and regulate their time and study environment more than the students in the conventional group.
11. PBL had no effect on students' use of rehearsal, organization, critical thinking, metacognitive self-regulation strategies, and management of peer learning and help seeking.

CHAPTER 5

DISCUSSIONS

This study sought to identify perceptions of engineering students and tutors about PBL, its essential components, strengths and weaknesses of it, factors affecting their performance during PBL tutorials, and improvement suggestions of them about problem-based instruction. This study also aimed to investigate the effectiveness of problem-based learning on freshman engineering students' motivation and their use of learning strategies. Therefore, the study's findings uncovered seven principal elements: (a) Questions 1 and 2: Students' and Tutors' Understanding of PBL and Their Actions in PBL Tutorials, (b) Question 3: Strengths of PBL, (c) Question 4: Weaknesses of PBL and Problems Encountered in PBL, (d) Question 5: Factors Affecting Performance of Students and Tutors during PBL Tutorials, (e) Question 6: Students' and Tutors' Improvement Suggestions for PBL, (f) Questions 7 and 8: Effectiveness of PBL on Motivation and Learning Strategies. Therefore, under those headings, this final chapter evaluates the findings that were reported in the previous chapter in light of the literature. Moreover, implications of the study and recommendations for further studies are presented at the end of this chapter.

5.1 Questions 1 and 2: Students' and Tutors' Understanding of PBL and Their Actions in PBL Tutorials

When asked about understanding of PBL and its essential components, the interviewees mentioned the features the students and tutors should have in PBL. Concerning "student roles in PBL," the interviewees stressed that students should take responsibility for their own learning (do research, be curious and eager to learn, be prepared for modules etc.) and actively participate in discussions.

Concerning “tutor roles in PBL,” the students expressed that tutors should guide the discussions and lead students to the right way without intervening so much while finding solutions of the problems. Similarly, the tutors emphasized the importance of guidance and explained their roles in detail such as being a subject matter expert, keeping the discussion alive, explaining rarely, intervening discussions when necessary, preventing students from wandering away from the subjects etc. These mentioned roles of tutors and students are almost similar to those reported by the literature. (Barrows, 1986; Fergusson, 2003; LeJeune, 2002; Riberio & Mizukami, 2005; Savery & Duffy, 1995).

In this study, although the perceptions of interviewees about the roles of students and tutors in PBL were in agreement with the literature, some differences were observed in their actions during tutorials. During observations, it was noted that tutors gave necessary directions and some hints; asked questions; checked students’ understanding and assessed students’ performance. However, some tutors intervened the discussions more frequently and explained some topics more than the others. Moreover, the observing students’ actions revealed that less than half of them participated in the discussions, discussed the problem, shared their ideas and knowledge and presented the results in each module. Looking at the interview notes, it was clear that the participants were aware of this difference between the theory and practice and they confessed that some of the students and tutors do not behave according to the necessities of PBL.

Interviewees mentioned that those differences between the theory and practice occurred due to some weaknesses or the problems they faced during the implementation of PBL. Those reasons will be discussed in the next sessions.

5.2 Question 3: Strengths of PBL

In the literature, the main strengths of PBL pointed out by the students and tutors were attributed to the fact that it is a satisfactory approach (Albanese & Mitchell, 1993; Kaufman & Holmes, 1996; Riberio & Mizukami, 2005; Vernon & Blake, 1993) that fosters communication skills (Dean et al., 2003; Riberio &

Mizukami, 2005) and self-confidence (Dean et al., 2003); develops problem solving and self-directed learning skills (Hmelo-Silver, 2004) and constructs collaboration (DeGrave et al., 1996).

Some studies (Albanese & Mitchell, 1993; Vernon & Blake, 1993; Riberio & Mizukami, 2005) mentioned students' satisfaction and acceptance level of PBL. In the study of Riberio and Mizukami (2005), the postgraduate engineering students in their study found PBL as a very satisfactory approach. The same was observed by Albanese and Mitchell (1993) and Vernon and Blake (1993). In their studies, many students in PBL environment from medical schools reported that they are more satisfied with their learning and confident in their understanding than those in conventional environment.

This study supports some part of those findings. In this study, most of the students and tutors were satisfied with the PBL instructional method from an overall perspective and accepted the system but unsatisfied with its application. Most of the interviewees stated that their first impressions about PBL were positive and they found PBL as a useful methodology. However, they (especially the repeat and low grades students) mentioned that there are lots of problems at the implementation of PBL in their department making them unsatisfied with the current situation.

In this study, all tutors and 64% of the students mentioned that PBL would foster communication skills. Moreover, 71% of the students and all tutors mentioned that students gained self-confidence due to PBL tutorials. The observation notes also revealed that students seemed very comfortable while mentioning/sharing their ideas or drawing/writing something on the board. This finding is similar to what was reported by Dean et al. (2003) and Riberio and Mizukami (2005) who reported that PBL helped the students in developing communication skills and self-confidence.

Self-directed learning is another skill that PBL focuses on helping students to develop (Hmelo-Silver, 2004; LeJeune, 2002). Hmelo-Silver stated that good self-directed learners can adapt their personal strategies to the situational demands.

Similarly, in a qualitative analysis, Evensen (as cited in Hmelo-Silver, 2004) interviewed medical students from a PBL group. In his study, the students' self-directed learning strategies evolved over time to adapt to the self-directed learning demands of a PBL program. The same was observed in this study especially in successful students (having high cumulative) or students who reported to be adapted to the implementation of PBL in their department. For example one of the successful students (S2) emphasized that he became a confident learner that he could easily learn the topics that were in the book and believed that this is important to become an engineer. He emphasized that he can also learn on his own without attending lectures.

Being a good collaborator is another goal of PBL. Explaining one's ideas, negotiating the actions, coming to an agreement are some parts of collaboration (Hmelo-Silver, 2004). This author stated that in PBL groups, the students should often work together to construct collaborative explanations. In their study, DeGrave et al. (1996) analyzed the verbal communication among group members, and their thinking processes from a videotape of a PBL tutorial group. Although students' attention to collaboration did not appear clearly, the authors noticed students' sensitiveness to collaborative process in PBL curricula. In this study, during observations some of the students also showed their sensitiveness to collaborative process. For example, during sessions, some students were checking each other to make sure that they were on the same issue and making an agreement about the discussions. However, it was observed that some of the students did not participate in the discussions. This may be due to the fact that they seemed unprepared or disinterested during the sessions. During interviews, few students (29%) said that they had troubles in group work activities during sessions. First grade students (G1 and M1) expressed that there is not much collaboration in group works. According to G1, this is due to the common belief among the students that "the questions should be solved by the one who knows the best." Moreover, M1 complained about doing most of the group work assignments by himself. The tutor (Murat) confirmed this idea and stated that in lower grades,

group working does not function well because especially the students who are repeating their class make groups and undertake problem solving themselves. However, he emphasized that collaboration and group work activities functions well especially between upper grade students.

5.3 Question 4: Weaknesses of PBL and Problems Encountered in PBL

In this study, almost all the interviewees (93% of the students and all tutors) stated that the assessment is not effective and functional since there is no standard assessment procedure that the tutors use while evaluating the students during sessions and exams. They also pointed out that evaluation forms do not function. In fact, for all modules, tutors are given student evaluation forms for each students and they are expected to give students' grades by using this form. With this form, students are evaluated in terms of motivation, use of knowledge, producing and developing hypothesis, making inquiry, interpreting, reaching learning objectives, communicating, self learning and use of sources, group work, and assessment. However, during observations it was noted that tutors did not use this form to assess students. They gave grades according to students' participation and explanations to the questions they asked during each session. This was confirmed by looking at the analysis of interview notes. For example, Filiz stated that she used to assess students with this form at first but since it was a waste of time, now she is assessing students considering their general performance. She complained about the subjectivity of this type of assessment. Murat added to this idea expressing that evaluating students by this form is nonfunctional and a waste of time. He also emphasized that he does not think there left any tutor who pays attention to that kind of assessment. The students also found this type of assessment subjective and nonfunctional. For example, S2 thought that PBL session assessments are not done properly since some tutors give fixed points to the students without considering what they did.

Additionally, two tutors (Filiz and Alper) questioned the form of exam questions. They confessed that they are asking conventional questions related with

the presentations not with the module. Moreover, they mentioned that they are making the same kind of year-end and module exams as the ones they were preparing for conventional type exams. Filiz stressed that the system and the form of exams are not compatible with each other. During observations, it was noted that the module exams (except the exam prepared by Murat) consisted essay type or multiple choice questions related with presentations mostly measuring content knowledge. Although the exam prepared by Murat consisted multiple choice and essay type questions, it was related with the module topics and consisted some critical thinking questions. Zeynep stated: "I am asking easier questions when compared with conventional system since we can not give topics theoretically in depth enough during presentations."

These findings are not compatible with what literature says. In the literature, researchers question to assess students by conventional type exams in PBL and state that the assessment of students in PBL should include methods of measuring content knowledge as well as higher order skills such as critical thinking and problem-solving skills Gijbels et al., 2005; Major & Palmer, 2001; Miller, 2000). Moreover, Neville (1999) stated that tutors may be able to evaluate certain aspects of professional behaviors and communication skills but whether they can effectively assess the students' performance or knowledge is questionable. Similarly, Frost (1996) and Kaufmann and Holmes (1996) also criticized the inadequacy in the assessment procedures of studies. Our study supports this statement since the interviewees complained that assessment was not effective and functional.

Students' coming to sessions unprepared and not participating to tutorial sessions were reported as another barrier for the implementation of PBL. In fact, students' actively participation to the learning process is one of the main aims of PBL. However, it seemed that some students could not internalize this role. During observations it was observed that some students only listened to their friends while certain students tend to answer all questions or tried to put forward an idea. The number of students that actively participated in discussions was not more than

three or four. Either the same students participated in all discussions or active students changed in each discussions. That is, there were always some nonparticipating students preferring only listening to the discussions or seeming disinterested about what is going on around. As a result of interviews, some students stated that this weakness occurred due to either students' low level of adaptation to PBL or coming to sessions unprepared. Similarly, the tutors complained that some students come to the sessions unprepared and do not take responsibility for their own learning.

Students' not enough theoretical background/prior knowledge is seen as problem students encountered in PBL. Some students expressed that having limited or not enough prior/theoretical knowledge about the topic given in the problem is a limitation during sessions. Analyzing the interview notes, we can see the M1's and T2's (both students repeated the class and their GPA is below the average) concern about the necessity of prior knowledge. For example, M1 stated that he faced with some subjects in some modules that he never learned. He mentioned that he could not have learned those subjects without tutors' lecturing. In fact, they are reflecting their experience as being educated in a directive learning environment. While adapting to an alternative learning environment such as PBL, students may have this kinds of conflicts and react to this form of learning. The tutors Filiz and Zeynep also taught that first grade students have difficulty in PBL environment since their theoretical background is insufficient.

The amount of time involved in implementing PBL is another concern for both tutors and students. Albanese and Mitchell (1993) in the outcomes of their meta-analysis suggested that students spend more time for studying than do conventional students due to its self-directed nature of PBL. Moreover they indicated that it takes more time (~ 20%) to cover the course content using PBL rather than lecture method of instruction. In this study, this aspect was noted by the many interviewees (71% of the students and all tutors) and mentioned as one of the problems they encountered in PBL. Both the tutors and students complained about lack of time. In fact, since the participants complained about the shortness of

the tutorial sessions or thin attendance to the orientation hours, lesson hours in conventional engineering curriculum becomes matching with the program of PBL curriculum. However, in this curriculum, students needed more time for self study while being prepared for the exams they took every couple of weeks. The tutors also complained about lack of time since they had very busy and mixed weekly schedule.

5.4 Question 5: Factors Affecting Performance of Tutors and Students during PBL Tutorials

In the literature, tutors' content expertise (Neville, 1999; Schmidt et al., 1993; Silver & Wilkerson 1991), adapting to PBL (Khoo 2003), quality of the problems (Barrows, 1986; Savery & Duffy, 1995; Van der Hurk et al., 1999), tutors' training aspects (mastery of the PBL methodology) (Zanolli et al., 2002), and collaboration while discussing the problem (Hmelo-Silver, 2004) are pointed out as the main factors affecting the group function during tutorials.

In their study, Zanolli et al. (2002) examined the perceptions of teachers and students to reveal the most frequent and important problems affecting tutorial group function. They also examined the differences between third and second year medical students regarding their perceptions on the same issue. A questionnaire with 33 items that grouped as seven factors related to tutor performance, feedback, assessment, educational resources, student performance, educational problems and external factors were completed by 30 tutors, 128 second and third year medical students. The results showed that the most important problems that can disturb tutorial session function were related to the behavior of tutors (mainly in training aspects) and students (mainly in problem discussion). Related with the "tutors" factor, participants (students and tutors) agreed that the problems are mainly related to the tutor's mastery of the PBL methodology. Related with the "students" factor, participants emphasized poor learning objectives due to lack of, or inadequate problem exploration in tutorials. Moreover, statistically significant

differences were found between second and third year students' perceptions of different factors.

In this study, although tutors' mastery of the PBL was not stated as a factor affecting their performance, some interviewees (L1, G1, C1, M1, S2, R2, M4, and the tutor Alper) suggested that tutors should be trained according to the necessities of PBL in order to increase their mastery about it. The interviewees considered this mastery as a precondition for adapting to PBL.

Kaufman and Holmes (1996) examined some aspects of tutoring in PBL. The results showed that although the faculty members were very satisfied with their tutoring experience, they expressed a need for further training in group facilitation and evaluating students. Different from the findings of the studies of Zanolli et al. (2002) and Kaufman and Holmes (1996), tutors in this study (except Alper) did not suggest to be trained about PBL in order to increase their mastery about it although they expressed that they have difficulty while writing scenarios and assessing students. This may be due to the fact that the tutors complained a lot about their business and mentioned their annoyance due to unsolved problems of the system. Those may be the reasons of their unwillingness to be trained.

In this study, interviewees mentioned content expertise as another factor affecting performance of tutors. They claimed that tutors who are expert about the scenario subject facilitate effectively students' learning. In this study, two modules of Zeynep were observed. She was content expert in the first module but non-expert in the second one. She expressed that she would be more useful for students in the first module since her area of specialization is related with that module. The observation notes revealed that in her tutorial sessions for module I, she asked questions, encouraged students to explore possibilities and find alternative solutions. Moreover, she intervened group discussions frequently, explained some topics in a directive manner and did not hesitate lecturing when needed. However, in her tutorial sessions for module II, she rarely explained some topics and gave more time to students for their discussions. These findings are similar to the findings reported by Gilkison (2003) and Silver and Wilkerson (1991). Gilkison

(2003) observed two PBL tutorial groups of second year medical students at the University of Liverpool. Tutors' professional background was different. One tutor had a medical background whereas the other had a humanities background. Each tutorial with a scenario over a 2-week period called a module was observed by the researcher. Moreover, the author made interviews with students and tutors after those observations. It was concluded that the medical tutor spoke more frequently, raised students' awareness more often and initiated more topics for discussion than the non-medical tutor. However, non-medical tutor used group facilitation techniques more often expecting students to question each other. Students reported that medical tutors raised their awareness by asking questions and made them think about things they would not otherwise have thought about.

Moreover, in their study, Silver and Wilkerson (1991) observed four PBL tutorials to examine student-tutor interactions. The authors found that tutors who rated themselves as content expert played a more directive role in their tutorials. They spoke more often and for longer periods, provided more direct answers to the students' questions and suggested more discussion topics. They concluded that tutor expertise may endanger the development of students' skills in active and self-directed learning.

Schmidt et al. (1993) and Neville (1999) stated that students (especially first grade students) were more dependent on their tutor's content expertise than advanced students. In fact, novice students beginning the PBL curriculum are unfamiliar with the PBL process and mostly have little prior content knowledge. Therefore, they need guidance and rely heavily on their content expert tutor. Our study supports this finding. Looking at the observation and analyzing the interview notes, it was clear that especially first grade students who repeated their class once generally preferred content experts. They think that content experts would give more direction than they are getting since most of them were accustomed to tutors being directive. During observations, students seemed more satisfied and also expressed their satisfaction when tutors were more directive. Especially those first grade students reported that they have difficulty to adapt PBL and they need more

presentations from content experts. Moreover, tutors suggested shifting to conventional education for some theoretical modules of the first grade curriculum.

In fact, which one (being expert or non-expert) is better for facilitating a PBL tutorial is being debated in the literature. The important criteria for a better guidance in PBL is to what extend do tutors help students to become independent learners, formulate problems, to develop thinking skills, and when/how frequently do they intervene to the discussions. In this study it was obvious that tutors' purpose (especially the tutors Filiz's and Zeynep's) was not behaving according to the necessities of PBL. Their purpose was mostly being more useful for students' understandings. Similarly most of the students preferred to be guided by a content expert to be informed and learn more. Therefore, tutors' expertise levels for a better guidance are still questionable and should be examined and debated more.

In this study, students' level of adaptation of the system or their point of view towards PBL was considered as another important factor affecting their performance. During interviews, 64% of the students emphasized that most of the students had negative point of views toward PBL or could not adapt to the system. They emphasized that one reason of having difficulty to adapt to the system or having negative point of views may be being accustomed to conventional learning settings. For example, S2 stated that students started to be educated in PBL with reactive feelings and therefore have difficulty to adapt to the system. He also added that some students attend to the tutorials just to exist there and get grade but attend to presentations to learn something since the presentations are done in a directive manner.

Moreover, all tutors mentioned that their' level of adaptation to PBL affected their performance. For example, Alper explained: "Since we are accustomed to conventional education so much, it becomes hard to depart from that system and adapt to PBL." This finding is similar to the idea of Ramsden (as cited in Perrenet et al., 2000). He pointed to cultural differences in teaching style. He stated that "faculty in scientific and professional fields are more likely to use

formal, didactic teaching methods and that they are less permissive in their attitudes towards student learning" (p.351).

In a related study, Khoo (2003) examined the implementation of PBL in Asian medical schools and students' perceptions of their experience. The results showed that students and medical schools had positive feelings about adapting to PBL in their curriculum. However, he mentioned that if students behave according to some characteristics of the Asian culture (fear of confrontation with the authority figure of the teacher, low participation in class discussions, lack of motivation to ask questions etc.) they may listen passively to the teacher which make difficult to implement PBL in Asian medical schools. There are some similarities between the mentioned characteristics of Asian students and our students. In Turkey, students entering the universities are familiar with the conventional teacher-centered curriculum. This may be one of the reasons of having difficulties while adapting PBL in our curriculum.

5.5 Question 6: Improvement Suggestions for PBL

The participants suggested some alternatives in order to solve the problems they encountered in PBL and improve the implementation of PBL in their department. Some of those suggestions are in conformity with the studies of Frost (1996), Hmelo-Silver (2004), Kaufman and Holmes (1996), Neville (1999) and Schmidt et al. (1993).

Hmelo-Silver (2004) explained that in engineering curriculum, there are lots of specific subject areas and the problems should be map onto these subject areas with a careful planning. Therefore, he suggested adapting certain aspects of the PBL model according to the developmental level of the learners. He gave example of some students having difficulty to apply metacognitive strategies and suggested to force them to improve their self-directed learning skills. He also suggested adding direct instruction on these adaptations. He stated that "as students are grappling with a problem and confronted with the need for particular kinds of knowledge, a lecture at the right time may be beneficial" (p.260). In the

related studies, Schmidt et al. (1993) and Neville (1999) suggested that students (especially novice students who have little experience of PBL or prior knowledge) need guidance and rely heavily their tutor's content expertise to provide the necessary structure. Moreover, Neville (1999) stated that as students become more experienced in PBL and more knowledgeable, they become more self-sufficient. Therefore, he suggested tutors to become less directive providing less structured learning environment as students become more familiar with PBL. As a result of their study in the department of Electrical Engineering, Said et al. (2005) suggested implementing a hybrid-PBL approach in which the percentage of PBL approach increases and conventional approach decreases as the students' grade level increases.

Although it is questionable to intensely add direct instruction to a student-centered learning environment, tutors and students gave these kinds of suggestions in this study. For example, in our study, some students who reported to be accustomed to conventional learning settings and could not learn without tutor directiveness, had difficulty to adapt PBL and are not satisfied with it. Moreover, some tutors (Filiz, Zeynep) and students (M1, R2, T2, H3) suggested shifting to conventional education especially for some theoretical modules of the first grade curriculum.

In this study, tutors and students complained a lot about the ineffectiveness of the assessment procedure (its conventional type and unfunctionality etc.) and therefore suggested to reorganize it. These suggestions are in accordance with those of Frost (1996) and Kaufman and Holmes (1996). Frost (1996) also suggested the need for reviewing and adapting the assessment procedure. Moreover, Kaufman and Holmes (1996) emphasized the need for tutors' further training in evaluating students**.**

5.6 Questions 7 and 8: Effectiveness of PBL on Motivation and Learning Strategies.

The quantitative results of the study revealed that there was a statistically mean difference between the groups (engineering freshman students who received their first year curriculum in PBL format and who received their curriculum in a conventional lecture format) with respect to the dependent variables related with their extrinsic goal orientation (EGO) and test anxiety (TA), elaboration (ELA), effort regulation (EF), and time and study environment (TS).

Students in the PBL group appeared to perceive themselves to be participating in a task for reasons such as grades, rewards, performance, and/or evaluation by others more than the students in the conventional group. Moreover, students in the PBL group tended to show more worry and anxiety disrupting their performance than the students in the conventional group. These findings were revealed by also the qualitative analysis. During interviews, 64% of the students and all tutors mentioned that students are having too much stress about failing the class due to having too many exams, their loaded curriculum, and time inadequacy. Moreover, some participants emphasized that most of the students are focusing on the exams and studying lessons or participating to the PBL sessions just to have higher grades or pass the exams not due to their curiosity or mastery of a subject. Similar results related with the feeling of anxiety were found in the study performed by Canavan (2008) who summarized the findings of the PBL evaluation carried out at three UK universities. The author reported that grade-anxiety was one of the greatest concern expressed by the students occurred mostly due to the methods of assessment (e.g. end-of-year written examinations).

Regarding learning strategies, students in the PBL group appeared to use elaboration strategies (paraphrasing, summarizing, creating analogies, and generative note-taking) that help the learner integrate and connect new information with prior knowledge. This result may be due to the fact that in PBL, students become familiar with getting information from different sources such as PBL sessions, lectures, laboratories, projects, discussion hours, orientation hours, self

studies etc. which may provide to improve their elaboration strategy for learning. Moreover, the results also showed that the students in the PBL group tended to control their effort and attention reflecting a commitment to completing their study goals, even when there are distractions and difficulties more than the students in the conventional group. These finding was compatible with the findings of the qualitative results of this study. During interviews, 71% of the students and all tutors mentioned that students gain engineer's viewpoint due to PBL interventions. They mention that when the students face a problem, they make an effort to learn and come up with solutions; even they do not know how to handle it.

Lastly, the results of the study also indicated that students in the PBL group appeared to manage and regulate their time and study environment more than the students in the conventional group. This result was also similar with the study performed by Canavan (2008). The author stated that students in three UK universities implementing PBL almost benefitted from the development of time and task management skills. When qualitative results of the current study was investigated, the researcher has observed that students receiving PBL has a more loaded curriculum and the participants were also agreed on students' loaded curriculum and time inadequacy. This may be the reason for being able to regulate their time and study environment better than the students having conventional instruction.

During conducting interviews with tutors, they were asked to compare students having PBL curriculum and conventional curriculum in terms of their motivational orientations and their use of learning strategies (those assessed by the MSLQ). Tutors' average ratings for the EGO, TA, ELA, EF, and TS were either "a little bit more in PBL" or "much more in PBL" as compared with conventional instruction which supports the quantitative findings. However, their ratings for students' control of learning beliefs (CLB), self efficacy (SE), and use of peer learning (PL) were also higher for problem-based instruction which was not supported by the quantitative results. This may be due to the fact that tutors-during interviews- emphasized that students become more adapted to PBL and show some

of its characteristics better especially in higher grades. Since the causal comparative study was conducted with the freshman engineering students, this might be the reason of nonsignificant results on some measures. The freshman students might not be accustomed to PBL enough to show significant mean difference between the students having conventional instruction. Moreover, during interviews, both students and tutors mentioned their concern about the way of PBL implementations in their department and the problems they faced with the system. These may also be the reasons for not showing the expected outcomes.

5.7 Implications and Suggestions for Further Research

The findings of this research point to several implications for practice (in curricular design, tutor training, and students' education) and future research. These implications may be of importance to the tutors, students, and administrators of the related departments in DEU implementing PBL or other departments planning to implement it. Moreover, tutors, students, curriculum designers, administrators and the researchers who are interested in related topics may benefit from the implications mentioned below. Based on the findings of this study and previous studies done on the same topic, following suggestions are offered separately for practice and future research.

5.7.1 Implications for Practice

This study shows that those students (especially novice ones) who are accustomed to conventional learning may feel uncomfortable while fulfilling their roles (doing research, collaboration with students etc.) and have difficulty to adapt PBL. However, in a longer period -as they mature and be more familiar with PBL- they may develop some skills enabling them to adapt to PBL. Similarly, tutors who are unfamiliar with this kind of an unconventional learning environment may feel that PBL is useless and uncertain. Therefore, both tutors and students should not be involved in PBL cursorily until they are familiarized with their roles, benefits of PBL, process and the learning environment thoroughly. In order to do this, they

should be trained in the PBL process. It is necessary to develop a detailed student training/orientation program addressing their roles (how they work in sessions, how to collaborate in sessions, how to improve their study skills etc.). Moreover, tutors training programs should be given more importance and tutors should be trained about their roles/responsibilities (how to guide students, how to write a scenario, how to assess students etc). They should enhance student-centered learning environment by developing their tutorial skills, forming collaborative learning atmosphere, actively working with tutorial groups and be willing to make constructive evaluation of students and their group performance. Therefore, having expertise in group facilitation process as well as content knowledge is necessary for tutors.

Tutors' content expertise was pointed out as the main factor affecting group function in this study. Both tutors and students agreed that expert tutors should guide the sessions. However, it was observed that some tutors intervened too much or informed students in a directive manner. Especially the novice students emphasized their need for more direction. Studies have shown that tutors' facilitative role is open to interpretation. Tutors' degree of giving direction or the content knowledge they are expected to show are widely debated by researchers. We can infer from the literature that tutors' roles should not be the same in all situations. For example, tutors should not always demonstrate their content expertise in tutorials to assist students' learning. They may be sometimes directive while guiding novice students but as students mature, they should balance their natural desire to be directive and behave more participatory and in a less structured way. Therefore, tutor's degree of direction needs to be changed according to the student characteristics, their grade level, their prior knowledge, or the curriculum.

This study shows that the tutors have some problems/weaknesses in terms of assessment, tutorial skills, time inadequacy, disorganization, scenarios, adaptation to the system, etc. They mentioned those issues and complained that their suggestions/complaints were not taken into consideration and the system could not refresh itself. By examining the results of the study, we can say that

tutors are reactive to the operation of the curriculum. Therefore, communication of tutors between themselves and administrators should be improved. There should be regular/continued evaluation of PBL processes at institutions and faculty/teachers need trainings and discuss the program regularly by giving and receiving feedback.

In this study, one tutor expressed that she later realized how they (as a department) were unprepared to implement PBL when they decided to implement it. Another tutor mentioned the deficiency of this transition since they didn't conduct a pilot study. The other two tutors emphasized the disorganization in their department about giving/taking training, planning schedules and discussions. Therefore, careful/successful preparation and planning is needed before PBL starts to be implemented and it should be maintained after it is being implemented. During planning process, there should be close cooperation between members of varying disciplines while planning the course and implementing it.

Qualitative part of this study showed that students having problem-based instruction complained a lot about the assessment procedure of their department. Moreover, according to the results of the quantitative part of this study, students in the PBL group tended to show more worry and text anxiety disrupting their performance than the students in the conventional group. This problem should be taken into consideration by the administrators or curriculum developers while evaluating/revising the assessment procedure.

Curriculum developers of the universities implementing PBL should take into consider the problems/weaknesses mentioned by the tutors and students (participated in this study) about the implementation of PBL in evaluating their curriculum and making necessary revisions to improve their performance and instructional practices.

5.7.2 Suggestions for Future Research

In addition to the implications for practice, the followings are offered for further research.

- The literature says that PBL is more than a simple teaching method. Its outcomes are often complex and difficult to measure. Therefore, its outcomes should be well defined in research reports. Researchers should point which sides of PBL are important for which particular outcomes.
- This study shows that different situations (students' level, their prior knowledge, their motivation etc.) require different tutor features while facilitating students' learning and improve group function. Moreover, there are lots of interrelated factors affecting the results of those features. Therefore, effective PBL tutorials should be investigated well and necessary features of tutors and the learning environments should be specified for all context.
- In literature, there is less evidence as to whether motivation improves during PBL tutorials or whether PBL affect students' use of learning strategies in certain settings and conditions. Based on the findings presented in this study, although the practical significance of this study is low, PBL seem as a suitable alternative to teacher-centered/subject-based learning environments. Therefore, the dimensions of PBL should be reported systematically in the literature in order to improve our understanding of PBL and its effects. By this way, readers will be able to determine whether the outcomes reported are appropriate and whether PBL achieves its educational outcomes. Moreover, it becomes easier and more confident to make comparisons across reported studies in terms of PBL outcomes. Besides, reporting PBL systematically, faculty or educators that are planning to adapt PBL to their curriculum may make well-informed choices about whether to adapt it, how to adapt it in their settings and which outcomes may be achieved as a result of their adaptations.
- There should be further research to examine the outcomes of PBL in other settings since much of the research has been restricted to higher education in medical schools.

- Researches have showed that gap between theory and practice still continues in the implementation of PBL. There should be more studies aiming to eliminate this gap.

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APPENDIX A

TOPICAL OUTLINE OF A MODULE

CALCULUS

- Multiple integrals
    - Triple integrals
    - Triple integrals in cylindrical and spherical coordinates
- Line integrals

LINEAR ALGEBRA

- Vector differential calculus
    - Vector calculus
    - Velocity and acceleration
    - Functions of several variables
    - Gradient of a scalar field
    - Divergence of a vector field
    - Curl of a vector field

PHYSICS (MAGNETOSTATICS)

- Magnetic Field
- Biot-Savart's Law
- Ampere's Law
- Faraday's Law of Induction
- Alternating Currents

PHYSICS LABORATORY

- Faraday's Law of Induction
- Alternating Current Circuits

MATERIALS - Magnetic properties of engineering materials

- Magnetic materials I (current)
    - metallic magnetic materials
    - non-metallic magnetic materials
    - application of magnetic materials in electrical systems
- Magnetic materials II (advanced)
    - superconductors
    - superconductivity and magnetism

ALGORITHMS & PROGRAMMING

- Structures
- Using structures with functions

PROJECT ORIENTED LEARNING

- The rules of the paper presentation.
- The forces in the nature. The observation of the magnetic field and usage for the engineering purposes.

APPENDIX B

WEEKLY SCHEDULE OF A MODULE

Week 1

	Monday	Tuesday	Wednesday	Thursday	Friday
08:30	PBL I. Session	Physics Lab	Consultation	PBL II. Session	Presentation (Physics)
09:30					
10:30			Presentation (Lin.Algebra)		Presentation (Materials)
11:30					
13:00	Presentation (Calculus)	Presentation (Calculus)	Turkish	PC Lab	POL
14:00					
15:00			Atatürk' s Principles	Presentation (Physics)	Eval.
16:00					

Week

08:30	Presentation (Calculus)	Physics Lab	PBL III. Session	PC Lab	Presentation (Physics)
09:30					
10:30				Presentation (Physics)	Presentation (Lin.Algebra)
11:30					
13:00	Presentation (Algorithms & Progr.)	Presentation (Calculus)	Turkish		POL
14:00					
15:00			Atatürk' s Principles		Consultation
16:00					

Week

08:30	Presentation (Calculus)	Physics Lab	PBL IV. Session	PC Lab	Module Exam
09:30					
10:30				Consultation	Discussion
11:30					
13:00	Presentation (Algorithms & Progr.)	Presentation (Calculus)	Turkish	Presentation (Physics)	POL
14:00					
15:00	Presentation (Lin.Algebra)		Atatürk' s Principles		
16:00					

APPENDIX C

EVALUATION FORM FOR STUDENTS

DOKUZ EYLÜL ÜNİVERSİTESİ MÜHENDİSLİK FAKÜLTESİ
MODÜL SONU ÖĞRENCİ ETKİNLİK DEĞERLENDİRME FORMU

Öğrenci Numarası	Eğitim Yönlendiricisinin Adı Soyadı:	Bölüm	Modül Kodu	Grup No
	Öğrenci Adı Soyadı:	BİL ○		
	Tarih :	ÇEV ○		
		ELK ○		
		END ○		
		İNŞ ○		
		JEF ○		
		JEO ○		
		MDN ○		
		MAK ○		
		MMZ ○		
		TEK ○		

Açıklama : Bu formu eğitim yönlendiricisinin öğrenciyi değerlendirmesi içindir. Aşağıda verilen maddelerin her birini 1 ile 5 arası bir puan vererek değerlendiriniz. Bu değerlendirmede: (1) "Yetersiz", (5) "Çok İyi" anlamındadır. Uygun olan puanın dairesini karalayınız. Değerlendirmenizi yaparken belirtilen ölçüleri göz önüne alınız.

Bu formu modül sonunda ilgili koordinatöre teslim etmeniz rica olunur.

Örnek Doldurma

● Doğru

⊗ ◉ ○ ✓ Yanlış

I - MOTİVASYON ① ② ③ ④ ⑤
- Konulara ilgi duyar.
- Oturumlara hevesle katılır.

II - BİLGİ KULLANIMI ① ② ③ ④ ⑤
- Eski bilgilerini kullanır.
- Verilen senaryodan yeni bilgiler üretir.

III - HİPOTEZ ÜRETME VE GELİŞTİRME ① ② ③ ④ ⑤
- Fikir üretmede yaratıcıdır.
- Önerilen fikirleri geliştirir.

IV - SORGULAMA ① ② ③ ④ ⑤
- Veriyi, bilgiyi, savları ve yorumları sorgular.

V - YORUM YAPMA ① ② ③ ④ ⑤
- Verileri doğru yorumlar.
- Çok yönlü düşünür.
- Bilgileri değerlendirir.

VI - ÖĞRENME HEDEFLERİNE ULAŞMA ① ② ③ ④ ⑤
- Bilgileri özetler.
- Hipotezleri eleyerek sonuca ulaşır.
- Nedenleri desteklemek için kanıtlar kullanır.
- Bilgileri ve çıkarımları ilişkilendirir.

VII - İLETİŞİM KURMA ① ② ③ ④ ⑤
- Eğitim araç gereçlerini kullanır.
- Doğru terminoloji kullanır ve telafuz eder.
- Etkin bilgi alış - verişinde bulunur.

VIII - KENDİ KENDİNE ÖĞRENME - KAYNAK KULLANIMI ① ② ③ ④ ⑤
- Farklı kaynakları kullanır. (Basılı, İnternet, Bilimsel Danışma.)
- Kaynaklardaki bilgiyi birleştirir.

IX - GRUP ÇALIŞMASI ① ② ③ ④ ⑤
- Sorumluluk alır.
- Yüklendiği görevini tam yapar.
- Bilgiyi paylaşır.
- Grubu yönlendirir.
- Grup kurallarına uyar.

X - DEĞERLENDİRME ① ② ③ ④ ⑤
- Kendini nesnel değerlendirir.
- Grubu nesnel değerlendirir.
- Senaryoyu nesnel değerlendirir.
- Eğitim yönlendiricisini nesnel değerlendirir.

TOPLAM PUAN	

ÖĞRENCİNİN DEVAM DURUMU		
	Modüldeki oturum sayısı :	⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨
	Katıldığı oturum sayısı :	⓪ ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨

ÖĞRENCİYE İLİŞKİN DÜŞÜNCE VE GÖRÜŞLERİNİZİ LÜTFEN AŞAĞIYA YAZINIZ.

Olumlu özellikleri:

Geliştirmesi gereken yönleri:

Öneriler

APPENDIX D

OBSERVATION CHECKLIST

Element	PBL Characteristics / Criteria	Rating of PBL Tutorials				
		How Frequently Evidenced*				
		Murat's Tutorial	Filiz's Tutorial	Zeynep's Tutorial I	Zeynep's Tutorial II	Alper's Tutorial
Students						
	Actively participate in group learning					
	Identify their learning needs/ what needs to be learned and how					
	Work collaborately with each other to solve the problem they define					
	Collect and analyze the information					
	Develop strategies to enable and direct own learning, critical thinking					
	Well-prepared for sessions					
	Take responsibility for own learning					
	Skillful in communicating with peers					
	Demonstrate effective group skills (shows respect and sensitivity for others, helps to resolve conflicts, intervenes appropriately)					
Tutors						
	Facilitate, coach, guide of group processes					
	Guide to additional resources					
	Learner, as well					
	Provide information about what is needed * Negative criteria					
	Provide necessary resources					
	Intervene group process					
	Assess students' progress					
PBL Session						
	Is a student-centered process					
	Consists a learning group small in size (6-10)					
	Allows collaboration					
	Begins with the problem encounter					
	Allows students to identify what needs to be known to reach a better solution					
	Ends with analysis and reflection of what was learned					
Assessment						
	Occurs often (is on going- embedded)					
	Involves problem solving skills and self-directed learning skills					

** Always: A Frequently: F Sometimes: S Never: N*

APPENDIX E

INTERVIEW GUIDE (for students)

Giriş

İyi günler! Probleme Dayalı Öğrenimin (PDÖ) mühendislik alanında uygulanışı ve öğrencilerin bu konudaki görüş, algı ve önerilerini belirlemeye yönelik bir araştırma yapıyorum. Bu araştırma kapsamında Elektrik Elektronik Mühendisliği bölümündeki öğrencilerle görüşmeler yapıyorum.

- *Bu görüşme süresince vereceğiniz bilgiler sadece bu araştırma için kullanılacak ve çalışmada isminiz kullanılmayacaktır.*
- *Sizin için bir sakıncası yoksa bu görüşmeyi kaydetmek istiyorum. Eğer isterseniz görüşmeyi yazılı metin haline getirdikten sonra size gösterebilirim.*
- *Bu görüşmeye katılmayı kabul edip vakit ayırdığınız için teşekkür ederim.*
- *Görüşmeye başlamadan önce sormak istediğiniz bir soru var mı?*
- *Görüşmemizin yaklaşık 30-40 dakika süreceğini tahmin ediyorum. İzin verirseniz sorulara başlamak istiyorum.*

Sorular

1. Bölüme gelmeden önce PDÖ ile ilgili bir bilginiz var mıydı?
2. PDÖ uygulandığını öğrendiğinizde izleniminiz nasıl oldu?
3. PDÖ denince ne anlıyorsunuz?

   Sonda: Senaryolar, eğitim yönlendiricileri, öğrenciler, sunumlar ve değerlendirme açısından
4. PDÖ bölümünüzde nasıl uygulanıyor?

   Sonda: Eğitim yönlendiricileri açısından

   - Eğitim yönlendiricilerinin PDÖ'deki rolü nedir ?

     Alternatif : İyi bir eğitim yönlendiricisinde olması gereken nitelikler/beceriler sizce nelerdir?
   - Eğitim yönlendiricilerinin performanslarını etkileyen faktörler nelerdir?

Alternatif : Eğitim yönlendiricilerinin verimleri neye göre artıyor ya da azalıyor?

- Eğitim yönlendiricilerinin karşılaştığı sorunlar nelerdir?
- Eğitim yönlendiricilerinde gözlemlediğiniz eksiklikler nelerdir?
- Bu sorunlara/eksikliklere yönelik çözüm önerileriniz nelerdir?

Öğrenciler açısından

- Öğrenci olarak bu sistemdeki rolünüz nedir?
- Öğrencilerin PDÖ' deki performanslarını etkileyen faktörler nelerdir?
- Öğrencilerin bu sistemdeki güçlü yönleri/avantajları nelerdir?

  Alternatif: Bu sistem mühendis eğitiminde nasıl bir etki sağlıyor?
- Öğrencilerin karşılaştığı sorunlar nelerdir?
- Öğrencilerde gözlemlediğiniz eksiklikler nelerdir?
- Bu sorunlara/eksikliklere yönelik çözüm önerileriniz nelerdir?

Senaryolar/ PDÖ Oturumları açısından

- Senaryolar ve/veya oturumlarda karşılaştığınız sorunlar nelerdir?
- Bu sorunlara yönelik çözüm önerileriniz nelerdir?

Değerlendirme açısından

- Bölümünüzde değerlendirme nasıl yapılıyor?
- Kullanılan değerlendirme sisteminin eksikleri nelerdir?
- Bu eksikliklere yönelik çözüm önerileriniz nelerdir?

Sunumlar açısından

- Sunumların PDÖ' ye katkısı nedir?
- Sunumlarda gözlemlediğiniz eksiklikler nelerdir?

- Bu eksiklikler nasıl giderilebilir?

5. PDÖ uygulamalarında çok hoşunuza giden ya da sizi çok rahatsız eden olaylarla karşılaştınız mı? Açıklayınız.
6. PDÖ uygulamalarında yapılması gereken değişiklikler ile ilgili belirtmek istediğiniz başka bir şey var mı? Açıklayınız.
7. PDÖ ile ilgili söylemek istediğiniz başka bir şey var mı?

Teşekkürler.

APPENDIX F

INTERVIEW GUIDE (for tutors)

Giriş

İyi günler! Probleme Dayalı Öğretimin mühendislik alanında uygulanışı ve öğretim elemanlarının bu konudaki görüş, algı ve önerilerini belirlemeye yönelik bir araştırma yapıyorum. Bu araştırma kapsamında Elektrik Elektronik Mühendisliği bölümündeki öğretim elemanlarıyla görüşmeler yapıyorum.

- *Bu görüşme süresince vereceğiniz bilgiler sadece bu araştırma için kullanılacak ve çalışmada isminiz kullanılmayacaktır.*
- *Sizin için bir sakıncası yoksa bu görüşmeyi kaydetmek istiyorum. Eğer isterseniz görüşmeyi yazılı metin haline getirdikten sonra size gösterebilirim.*
- *Bu görüşmeye katılmayı kabul edip vakit ayırdığınız için teşekkür ederim.*
- *Görüşmeye başlamadan önce sormak istediğiniz bir soru var mı?*
- *Görüşmemizin yaklaşık 30-40 dakika süreceğini tahmin ediyorum. İzin verirseniz sorulara başlamak istiyorum.*

Sorular

1. Bölüm PDÖ'ye geçmeden önce klasik sistemde eğitim verdiniz mi? Kaç yıl?
2. PDÖ'ye ne kadar zamandır aşinasınız?
3. Bölümün PDÖ hazırlık süresince rol aldınız mı? / Nasıl bir süreçten geçildi?

   Sonda: PDÖ ile ilgili bir eğitimden geçtiniz mi? Ne kadar sürdü, nasıldı?
4. PDÖ ile ilgili ne tür görevler yürüttünüz/hala yürütmektesiniz? (yönlendirici, senaryo hazırlığı, koordinatörlük vb.)
5. Bölüm PDÖ ye geçerken PDÖ ile ilgili ilk izlenimleriniz nelerdi?
6. PDÖ denince ne anlıyorsunuz?

Sonda: Senaryolar, eğitim yönlendiricileri, öğrenciler, sunumlar ve değerlendirme açısından

7. PDÖ bölümünüzde nasıl uygulanıyor?

Sonda: Eğitim yönlendiricileri açısından

- Eğitim yönlendiricisi olarak bu sistemdeki rolünüz nedir?
  Alternatif : İyi bir eğitim yönlendiricisinde olması gereken nitelikler/beceriler sizce nelerdir?
- Eğitim yönlendiricisi olarak bu sistemdeki güçlü yönleriniz/avantajlarınız nelerdir?
  Alternatif: Bu sistem eğitim yönlendiricilerine ne katıyor?
- Eğitim yönlendiricilerinin performanslarını etkileyen faktörler nelerdir?
  Alternatif : Eğitim yönlendiricilerinin verimleri neye göre artıyor ya da azalıyor?
- Eğitim yönlendiricisi olarak karşılaştığınız sorunlar nelerdir?
- Eğitim yönlendiricilerinde gözlemlediğiniz eksiklikler nelerdir?
- Bu sorunlara/eksikliklere yönelik çözüm önerileriniz nelerdir?

Öğrenciler açısından

- Öğrencilerinizin bu sistemdeki rolleri nedir?
- Öğrencilerin bu sistemdeki güçlü yönleri/avantajları nelerdir?
  Alternatif: Bu sistem mühendis eğitiminde nasıl bir etki sağlıyor?
- Öğrencilerin PDÖ'deki performanslarını etkileyen faktörler nelerdir?
- Öğrencilerin karşılaştığı sorunlar nelerdir?
- Öğrencilerde gözlemlediğiniz eksiklikler nelerdir?

- Bu sorunlara/eksikliklere yönelik çözüm önerileriniz nelerdir?

Senaryolar/PDÖ Oturumları açısından

- Senaryoların hazırlanışı ve işlenişi açısından olumlu yönleri/avantajları nelerdir?
- Senaryoların zayıf yönleri nelerdir?
- Oturumlar sırasında / senaryoların uygulanışında karşılaştığınız sorunlar nelerdir?
- Bu sorunlara yönelik çözüm önerileriniz nelerdir?
- Senaryolarda olması gereken özellikler nelerdir?
- Oturumlar nasıl olmalı? Bir PDÖ sınıfı nasıl olmalı?

Değerlendirme açısından

- Öğrencilerinizi neye göre değerlendiriyorsunuz?
- Kullanılan değerlendirme sistemi öğrencileri iyi ayırt edebiliyor mu?
  Sonda: Öğrencileri hangi özelliklerine göre birbirinden ayırıyor?
- Kullanılan değerlendirme sisteminin güçlü yönleri nelerdir?
- Kullanılan değerlendirme sisteminin eksikleri nelerdir?
- Bu eksikliklere yönelik çözüm önerileriniz nelerdir?
  Alternatif : PDÖ' de değerlendirme nasıl yapılmalıdır? Öğrenciler değerlendirilirken nelere dikkat edilmelidir?

Sunumlar açısından

- Sunumların PDÖ'ye katkısı nedir?
- Sunumlarda gözlemlediğiniz eksiklikler nelerdir?
- Bu eksiklikler nasıl giderilebilir?

8. PDÖ uygulamalarında çok hoşunuza giden ya da sizi çok rahatsız eden olaylarla karşılaştınız mı? Açıklayınız.

9. PDÖ uygulamalarında yapılması gereken değişiklikler ile ilgili belirtmek istediğiniz başka bir şey var mıdır? Açıklayınız.
10. PDÖ ile ilgili söylemek istediğiniz başka bir şey var mı?
11. Klasik eğitim ve PDÖ sistemlerindeki öğrencileri aşağıda verilen değişkenler üzerindenkarşılaştırabilir misiniz?

Aşağıda verilen motivasyon ve öğrenme stratejileri ile ilgili değişkenler açısından probleme dayalı öğrenim (PDÖ) ve klasik eğitim sistemlerini (KES) karşılaştırınız.

1= KES'de büyük ölçüde daha çok mevcut
2= KES'de biraz daha fazla mevcut
3= Her iki sistemde de aynı oranda mevcut
4= PDÖ'de biraz daha fazla mevcut
5= PDÖ'de büyük ölçüde daha çok mevcut

1. Öğrencilerin içsel motivasyonları (Örn: not kaygısı taşımadan konuları iyi öğrenmeye çalışan öğrencilerin içsel motivasyonları yüksektir)	1	2	3	4	5
2. Öğrencilerin dışsal motivasyonları (Örn: daha çok iyi not getirmek için çalışan öğrencilerin dışsal motivasyonları yüksektir)	1	2	3	4	5
3. Öğrencilerin öğrenmeye verdiği önem (öğrencinin ilgisini çeken, kendisi için önemli olduğuna inandığı konuları öğrenmeye çalışması)	1	2	3	4	5
4. Öğrencilerin öğrenmelerini kontrol edebileceklerine olan inançları (Örn: öğrencinin uygun ve yeterli çalışırsa başarılı olabileceğine olan inancı)	1	2	3	4	5
5. Öğrencilerin öz-yeterlik inançları (örn: öğrencinin konular zor olsa bile bu konuları öğrenebileceği inancını taşıması)	1	2	3	4	5
6. Öğrencilerin sınavlarda yaşadıkları telaş/kaygı hissi	1	2	3	4	5
7. Öğrencilerin önemli bilgi ve kavramları tekrar ederek öğrenmeleri	1	2	3	4	5
8. Öğrencilerin farklı kaynaklardan elde ettikleri bilgileri bir araya getirerek ve konular arasında bağlantı kurarak öğrenmeleri	1	2	3	4	5
9. Öğrencilerin konuları organize ederek öğrenmeleri	1	2	3	4	5
10. Öğrencilerin kritik düşünme becerilerini kullanarak öğrenmeleri	1	2	3	4	5
11. Öğrencilerin neyi bilip neyi bilmediklerini belirleyerek öğrenmeleri	1	2	3	4	5
12. Öğrencilerin zaman yönetimi konusundaki becerileri	1	2	3	4	5
13. Öğrencilerin öğrenme konusunda gösterdikleri çaba	1	2	3	4	5
14. Öğrencilerin arkadaşlarıyla birlikte tartışarak çalışmaları	1	2	3	4	5
15. Öğrencilerin anlamakta zorluk çektiği konularda yardım istemeleri	1	2	3	4	5

Teşekkürler.

APPENDIX G

MSLQ-I

MÜHENDİSLİK 1. SINIF ÖĞRENCİLERİ
MOTİVASYON VE ÖĞRENME STRATEJİLERİ ANKETİ

Bu anket, almakta olduğunuz temel alan derslerine (matematik, fizik vb.) karşı tutumunuzu, motivasyonunuzu ve bu derslerde kullandığınız öğrenme stratejileri ve çalışma becerilerini belirlemeye yönelik ifadeler içermektedir. Cevap verirken aşağıda verilen ölçeği göz önüne alınız. Eğer ifadenin sizi tam olarak yansıttığını düşünüyorsanız, 7'yi yuvarlak içine alınız. Eğer ifadenin sizi hiç yansıtmadığını düşünüyorsanız 1'i yuvarlak içine alınız. Bu iki durum dışında ise 1 ve 7 arasında sizi en iyi tanımladığını düşündüğünüz numarayı yuvarlak içine alınız. Unutmayın doğru ya da yanlış cevap yoktur yapmanız gereken sizi en iyi tanımlayacak numarayı yuvarlak içine almanızdır.

1------2------3------4-----5------6------7
beni hiç yansıtmıyor — *beni tam olarak yansıtıyor*

		Beni hiç yansıtmıyor						Beni tam olarak yansıtıyor
1	Derslerde yeni bilgiler öğrenebilmek için büyük bir çaba gerektiren çalışmaları tercih ederim.	1	2	3	4	5	6	7
2	Eğer uygun şekilde çalışırsam, derslerdeki konuları öğrenebilirim.	1	2	3	4	5	6	7
3	Derslerin sınavları sırasında, diğer arkadaşlarıma göre soruları ne kadar iyi yanıtlayıp yanıtlayamadığımı düşünürüm.	1	2	3	4	5	6	7
4	Derste öğrendiklerimi diğer derslerde de kullanabileceğimi düşünüyorum.	1	2	3	4	5	6	7
5	Derslerden çok iyi bir not alacağımı düşünüyorum.	1	2	3	4	5	6	7
6	Derslerle ilgili okumalarda yer alan en zor konuyu bile anlayabileceğimden eminim.	1	2	3	4	5	6	7
7	Beni dersler ile ilgili en memnun eden şey iyi bir not getirmektir.	1	2	3	4	5	6	7
8	Ders sınavları sırasında bir soru üzerinde uğraşırken, aklım sınavın diğer kısımlarında yer alan cevaplayamadığım sorularda olur.	1	2	3	4	5	6	7
9	Derslerdeki konuları öğrenemezsem bu benim hatamdır.	1	2	3	4	5	6	7
10	Derslerdeki konuları öğrenmek benim için önemlidir.	1	2	3	4	5	6	7
11	Genel not ortalamamı yükseltmek, şu an benim için en önemli şeydir. Bu nedenle, derslerdeki temel amacım iyi bir not getirmektir.	1	2	3	4	5	6	7
12	Derslerde öğretilen temel kavramları öğrenebileceğimden eminim.	1	2	3	4	5	6	7
13	Eğer başarabilirsem, derslerde, sınıftaki pek çok öğrenciden daha iyi bir not getirmek isterim.	1	2	3	4	5	6	7
14	Sınavlar sırasında, başarısız olmanın sonuçlarını aklımdan geçiririm.	1	2	3	4	5	6	7
15	Derslerde, öğretim üyelerinin anlattığı en karmaşık konuyu anlayabileceğimden eminim.	1	2	3	4	5	6	7
16	Derslerde, öğrenmesi zor olsa bile, bende merak uyandıran sınıf çalışmalarını tercih ederim.	1	2	3	4	5	6	7
17	Derslerin kapsamında yer alan konular çok ilgimi çekiyor.	1	2	3	4	5	6	7
18	Yeterince sıkı çalışırsam derslerde başarılı olurum.	1	2	3	4	5	6	7
19	Sınavlarda, kendimi mutsuz ve huzursuz hissederim.	1	2	3	4	5	6	7
20	Derslerde verilen ödevleri ve yapılan sınavları en iyi şekilde yapabileceğimden eminim.	1	2	3	4	5	6	7
21	Derslerde çok başarılı olacağımı umuyorum.	1	2	3	4	5	6	7
22	Derslerde beni en çok memnun eden şey, konuları mümkün olduğunca iyi öğrenmeye çalışmaktır.	1	2	3	4	5	6	7
23	Derslerde öğrendiklerimin benim için faydalı olduğunu düşünüyorum.	1	2	3	4	5	6	7
24	Derslerde, iyi bir not getireceğimden emin olmasam bile öğrenmeme olanak sağlayacak ödevleri seçerim.	1	2	3	4	5	6	7
25	Derslerdeki bir konuyu anlayamazsam bu yeterince sıkı çalışmadığım içindir.	1	2	3	4	5	6	7
26	Derslerdeki konulardan hoşlanıyorum.	1	2	3	4	5	6	7
27	Derslerdeki konuları anlamak benim için önemlidir.	1	2	3	4	5	6	7
28	Sınavlarda, kalbimin hızla attığını hissederim.	1	2	3	4	5	6	7
29	Derslerde öğretilen becerileri iyice öğrenebileceğimden eminim.	1	2	3	4	5	6	7
30	Derslerde başarılı olmak istiyorum, çünkü yeteneğimi aileme ve arkadaşlarıma göstermek benim için önemlidir.	1	2	3	4	5	6	7
31	Derslerin zorluğu, öğretim üyeleri ve benim becerilerim göz önüne alındığında, derslerde başarılı olacağımı düşünüyorum.	1	2	3	4	5	6	7
32	Dersler ile ilgili bir şey okurken, düşüncelerimi organize etmek için konuların ana başlıklarını çıkarırım.	1	2	3	4	5	6	7
33	Ders sırasında başka şeyler düşündüğüm için, önemli kısımları sıklıkla kaçırırım.	1	2	3	4	5	6	7
34	Dersler ile ilgili çalışırken, çoğu kez, arkadaşlarıma konuları açıklamaya çalışırım.	1	2	3	4	5	6	7
35	Genelde, ödevlerime rahat konsantre olabileceğim bir yerde çalışırım.	1	2	3	4	5	6	7
36	Dersler ile ilgili bir şey okurken, okuduklarıma odaklanmak için sorular oluştururum.	1	2	3	4	5	6	7
37	Dersler ile ilgili çalışırken kendimi çoğu zaman o kadar isteksiz ya da o kadar sıkılmış hissederim ki, planladıklarımı tamamlamadan çalışmaktan vazgeçerim.	1	2	3	4	5	6	7
38	Derslerle ilgili, duyduklarımı ya da okuduklarımı, ne kadar gerçekçi olduklarına karar vermek için sıklıkla sorgularım.	1	2	3	4	5	6	7

Lütfen Arka Sayfayı Çeviriniz

		Beni hiç yansıtmıyor						Beni tam olarak yansıtıyor
39	Derslere çalışırken, önemli bilgileri içimden defalarca tekrar ederim.	1	2	3	4	5	6	7
40	Derslerdeki bir konuyu anlamakta zorluk çeksem bile hiç kimseden yardım almaksızın kendi kendime çalışırım.	1	2	3	4	5	6	7
41	Dersler ile ilgili bir şeyler okurken bir konuda kafam karışırsa, başa döner ve anlamak için çaba gösteririm.	1	2	3	4	5	6	7
42	Derslere çalışırken, daha önce okuduklarımı ve aldığım notları gözden geçirir ve en önemli noktaları belirlemeye çalışırım.	1	2	3	4	5	6	7
43	Derslere çalışmak için ayırdığım zamanı iyi değerlendirebiliyorum.	1	2	3	4	5	6	7
44	Dersler ile ilgili okumam gereken konuları anlamakta zorlanıyorsam, okuma stratejimi değiştiririm.	1	2	3	4	5	6	7
45	Derslerde verilen ödevleri tamamlamak için sınıftaki diğer öğrencilerle çalışmayı denerim.	1	2	3	4	5	6	7
46	Derslere çalışırken, ilgili okumaları ve aldığım notları defalarca okurum.	1	2	3	4	5	6	7
47	Dersler sırasında veya okuduğum kaynaklarda bir teori, yorum ya da sonuç ifade edilmiş ise, bunları destekleyen bir kanıtın var olup olmadığını sorgulamaya çalışırım.	1	2	3	4	5	6	7
48	Derslerde yaptıklarımızdan hoşlanmasam bile başarılı olabilmek için sıkı çalışırım.	1	2	3	4	5	6	7
49	Derslerle ilgili konuları organize etmek için basit grafik, şema ya da tablolar hazırlarım.	1	2	3	4	5	6	7
50	Derslere çalışırken, konuları sınıftaki arkadaşlarımla tartışmak için sıklıkla zaman ayırırım.	1	2	3	4	5	6	7
51	Derslerde işlenen konuları bir başlangıç noktası olarak görür ve ilgili konular üzerinde kendi fikirlerimi oluşturmaya çalışırım.	1	2	3	4	5	6	7
52	Çalışma planına bağlı kalmak benim için zordur.	1	2	3	4	5	6	7
53	Derslere çalışırken, okuduklarım, dersler ve sınıf içi tartışmalar gibi farklı kaynaklardan edindiğim bilgileri bir araya getiririm.	1	2	3	4	5	6	7
54	Yeni bir konuyu detaylı bir şekilde çalışmaya başlamadan önce çoğu kez konunun nasıl organize edildiğini anlamak için ilk olarak konuyu hızlıca gözden geçiririm.	1	2	3	4	5	6	7
55	Derslerde işlenen konuları anladığımdan emin olabilmek için kendi kendime sorular sorarım.	1	2	3	4	5	6	7
56	Çalışma tarzımı, dersin gerekliliklerine ve öğretim üyesinin öğretme stiline uygun olacak tarzda değiştirmeye çalışırım.	1	2	3	4	5	6	7
57	Genelde derslere gelmeden önce konuyla ilgili bir şeyler okurum fakat okuduklarımı çoğunlukla anlamam.	1	2	3	4	5	6	7
58	Iyi anlamadığım bir konuyu, öğretim üyesinin açıklamasını isterim.	1	2	3	4	5	6	7
59	Derslerdeki önemli kavramları hatırlamak için anahtar kelimeleri ezberlerim	1	2	3	4	5	6	7
60	Eğer bir konu zorsa, ya çalışmaktan vazgeçerim ya da yalnızca kolay kısımlarını çalışırım.	1	2	3	4	5	6	7
61	Derslere çalışırken, konuları sadece okuyup geçmek yerine ne öğrenmem gerektiği konusunda düşünmeye çalışırım.	1	2	3	4	5	6	7
62	Mümkün olduğunca, derslerde öğrendiklerimle diğer derslerde öğrendiklerim arasında bağlantı kurmaya çalışırım.	1	2	3	4	5	6	7
63	Derslere çalışırken notlarımı gözden geçirir ve önemli kavramların bir listesini çıkarırım.	1	2	3	4	5	6	7
64	Dersler için bir şeyler okurken, o anda okuduklarımla daha önceki bilgilerim arasında bağlantı kurmaya çalışırım.	1	2	3	4	5	6	7
65	Ders çalışmak için devamlı kullandığım bir yer (oda vs.) vardır.	1	2	3	4	5	6	7
66	Derslerde öğrendiklerimle ilgili ortaya çıkan fikirlerimi sürekli gözden geçirmeye çalışırım.	1	2	3	4	5	6	7
67	Derslere çalışırken, dersle ilgili okuduklarımı ve derste aldığım notları inceleyerek önemli noktaların özetini çıkarırım.	1	2	3	4	5	6	7
68	Derslerde bir konuyu anlayamazsam, sınıftaki başka bir öğrenciden yardım isterim.	1	2	3	4	5	6	7
69	Derslerle ilgili konuları, ders sırasında öğrendiklerim ve okuduklarım arasında bağlantılar kurarak anlamaya çalışırım.	1	2	3	4	5	6	7
70	Derslerle ilgili okumaları ve verilen ödevleri zamanında yaparım.	1	2	3	4	5	6	7
71	Ders konularıyla ilgili ileri sürülen bir savı ya da varılan bir sonucu her okuduğumda veya duyduğumda olası alternatifler üzerinde düşünürüm.	1	2	3	4	5	6	7
72	Derslerle ilgili önemli kavramların bir listesini çıkarır ve bu listeyi ezberlerim.	1	2	3	4	5	6	7
73	Dersleri düzenli olarak takip ederim.	1	2	3	4	5	6	7
74	Ders konuları çok sıkıcı olsa da, ilgimi çekmese de konu bitene kadar çalışırım.	1	2	3	4	5	6	7
75	Gerektiğinde yardım isteyebileceğim arkadaşlarımı belirlemeye çalışırım.	1	2	3	4	5	6	7
76	Derslere çalışırken, iyi anlamadığım kavramları belirlemeye çalışırım.	1	2	3	4	5	6	7
77	Başka faaliyetlerle uğraştığım için derslere yeterince zaman ayıramıyorum.	1	2	3	4	5	6	7
78	Derslere çalışırken, çalışmalarımı yönlendirebilmek için kendime hedefler belirlerim.	1	2	3	4	5	6	7
79	Ders sırasında not alırken kafam karışırsa, notlarımı dersten sonra düzeltirim.	1	2	3	4	5	6	7
80	Ders sınavlarından önce notlarımı ya da okuduklarımı gözden geçirmek için çok zaman bulamam.	1	2	3	4	5	6	7
81	Derslerde okuduklarımdan edindiğim fikirleri sınıf içi tartışma gibi çeşitli faaliyetlerde kullanmaya çalışırım.	1	2	3	4	5	6	7

APPENDIX H

MSLQ-II

MÜHENDİSLİK 1. SINIF ÖĞRENCİLERİ
MOTİVASYON VE ÖĞRENME STRATEJİLERİ ANKETİ

Bu anket, modüllere karşı tutumunuzu, motivasyonunuzu ve modüllerde kullandığınız öğrenme stratejileri ve çalışma becerilerini belirlemeye yönelik ifadeler içermektedir. Cevap verirken aşağıda verilen ölçeği göz önüne alınız. Eğer ifadenin sizi tam olarak yansıttığını düşünüyorsanız, 7'yi yuvarlak içine alınız. Eğer ifadenin sizi hiç yansıtmadığını düşünüyorsanız 1'i yuvarlak içine alınız. Bu iki durum dışında ise 1 ve 7 arasında sizi en iyi tanımladığını düşündüğünüz numarayı yuvarlak içine alınız. Unutmayın doğru ya da yanlış cevap yoktur yapmanız gereken sizi en iyi tanımlayacak numarayı yuvarlak içine almanızdır.

1------2------3------4-----5------6------7

beni hiç yansıtmıyor — *beni tam olarak yansıtıyor*

		Beni hiç yansıtmıyor						**Beni tam olarak yansıtıyor**
1	Modüllerde yeni bilgiler öğrenebilmek için büyük bir çaba gerektiren çalışmaları tercih ederim.	1	2	3	4	5	6	7
2	Eğer uygun şekilde çalışırsam, modüllerdeki konuları öğrenebilirim.	1	2	3	4	5	6	7
3	Modüllerin sınavları sırasında, diğer arkadaşlarıma göre soruları ne kadar iyi yanıtlayıp yanıtlayamadığımı düşünürüm.	1	2	3	4	5	6	7
4	Bir modülde öğrendiklerimi diğer modüllerde de kullanabileceğimi düşünüyorum.	1	2	3	4	5	6	7
5	Modüllerden çok iyi bir not alacağımı düşünüyorum.	1	2	3	4	5	6	7
6	Modüllerle ilgili okumalarda yer alan en zor konuyu bile anlayabileceğimden eminim.	1	2	3	4	5	6	7
7	Beni modüller ile ilgili en memnun eden şey iyi bir not getirmektir.	1	2	3	4	5	6	7
8	Modül sınavları sırasında bir soru üzerinde uğraşırken, aklım sınavın diğer kısımlarında yer alan cevaplayamadığım sorularda olur.	1	2	3	4	5	6	7
9	Modüllerdeki konuları öğrenemezsem bu benim hatamdır.	1	2	3	4	5	6	7
10	Modüllerdeki konuları öğrenmek benim için önemlidir.	1	2	3	4	5	6	7
11	Genel not ortalamamı yükseltmek şu an benim için en önemli şeydir, bu nedenle, modüllerdeki temel amacım iyi bir not getirmektir.	1	2	3	4	5	6	7
12	Modüllerde öğretilen temel kavramları öğrenebileceğimden eminim.	1	2	3	4	5	6	7
13	Eğer başarabilirsem, modüllerde, sınıftaki pek çok öğrenciden daha iyi bir not getirmek isterim.	1	2	3	4	5	6	7
14	Modül sınavları sırasında, başarısız olmanın sonuçlarını aklımdan geçiririm.	1	2	3	4	5	6	7
15	Öğretim üyelerinin anlattığı en karmaşık konuyu anlayabileceğimden eminim.	1	2	3	4	5	6	7
16	Modüllerde, öğrenmesi zor olsa bile, bende merak uyandıran sınıf çalışmalarını tercih ederim.	1	2	3	4	5	6	7
17	Modüllerin kapsamında yer alan konular çok ilgimi çekiyor.	1	2	3	4	5	6	7
18	Yeterince sıkı çalışırsam modüllerde başarılı olurum.	1	2	3	4	5	6	7
19	Modül sınavlarında, kendimi mutsuz ve huzursuz hissederim.	1	2	3	4	5	6	7
20	Modüllerde verilen ödevleri ve yapılan sınavları en iyi şekilde yapabileceğimden eminim.	1	2	3	4	5	6	7
21	Modüllerde çok başarılı olacağımı umuyorum.	1	2	3	4	5	6	7
22	Modüllerde beni en çok memnun eden şey, konuları mümkün olduğunca iyi öğrenmeye çalışmaktır.	1	2	3	4	5	6	7
23	Modüllerde öğrendiklerimin benim için faydalı olduğunu düşünüyorum.	1	2	3	4	5	6	7
24	Modüllerde, iyi bir not getireceğimden emin olmasam bile öğrenmeme olanak sağlayacak ödevleri seçerim.	1	2	3	4	5	6	7
25	Modüllerdeki bir konuyu anlayamazsam bu yeterince sıkı çalışmadığım içindir.	1	2	3	4	5	6	7
26	Modüllerdeki konulardan hoşlanıyorum.	1	2	3	4	5	6	7
27	Modüllerdeki konuları anlamak benim için önemlidir.	1	2	3	4	5	6	7
28	Modül sınavlarında, kalbimin hızla attığını hissederim.	1	2	3	4	5	6	7
29	Modüllerde öğretilen becerileri iyice öğrenebileceğimden eminim.	1	2	3	4	5	6	7
30	Modüllerde başarılı olmak istiyorum, çünkü yeteneğimi aileme, arkadaşlarıma göstermek benim için önemlidir.	1	2	3	4	5	6	7
31	Modüllerin zorluğu, öğretim üyeleri ve benim becerilerim göz önüne alındığında, modüllerde başarılı olacağımı düşünüyorum.	1	2	3	4	5	6	7
32	Modüller ile ilgili bir şey okurken, düşüncelerimi organize etmek için konuların ana başlıklarını çıkarırım.	1	2	3	4	5	6	7
33	Modül sırasında başka şeyler düşündüğüm için, önemli kısımları sıklıkla kaçırırım.	1	2	3	4	5	6	7
34	Modüller ile ilgili çalışırken, çoğu kez, arkadaşlarıma konuları açıklamaya çalışırım.	1	2	3	4	5	6	7
35	Genelde, ödevlerime rahat konsantre olabileceğim bir yerde çalışırım.	1	2	3	4	5	6	7
36	Modüller ile ilgili bir şey okurken, okuduklarıma odaklanmak için, sorular oluştururum.	1	2	3	4	5	6	7
37	Modüller ile ilgili çalışırken kendimi çoğu zaman o kadar isteksiz ya da o kadar sıkılmış hissederim ki, planladıklarımı tamamlamadan çalışmaktan vazgeçerim.	1	2	3	4	5	6	7
38	Modüllerle ilgili, duyduklarımı ya da okuduklarımı, ne kadar gerçekçi olduklarına karar vermek için sıklıkla sorgularım.	1	2	3	4	5	6	7

Lütfen Arka Sayfayı Çeviriniz

		Beni hiç yansıtmıyor						Beni tam olarak yansıtıyor
39	Modüllere çalışırken, önemli bilgileri içimden defalarca tekrar ederim.	1	2	3	4	5	6	7
40	Modüllerdeki bir konuyu anlamakta zorluk çeksem bile hiç kimseden yardım almaksızın kendi kendime çalışırım.	1	2	3	4	5	6	7
41	Modüller ile ilgili bir şeyler okurken bir konuda kafam karışırsa, başa döner ve anlamak için çaba gösteririm.	1	2	3	4	5	6	7
42	Modüllere çalışırken, daha önce okuduklarımı ve aldığım notları gözden geçirir ve en önemli noktaları belirlemeye çalışırım.	1	2	3	4	5	6	7
43	Modüllere çalışmak için ayırdığım zamanı iyi değerlendirebiliyorum.	1	2	3	4	5	6	7
44	Modüller ile ilgili okumam gereken konuları anlamakta zorlanıyorsam, okuma stratejimi değiştiririm.	1	2	3	4	5	6	7
45	Modüllerde verilen ödevleri tamamlamak için sınıftaki diğer öğrencilerle çalışmayı denerim.	1	2	3	4	5	6	7
46	Modüllere çalışırken, ilgili okumaları ve aldığım notları defalarca okurum.	1	2	3	4	5	6	7
47	Modüller sırasında veya okuduğum kaynaklarda bir teori, yorum ya da sonuç ifade edilmiş ise, bunları destekleyen bir kanıtın var olup olmadığını sorgulamaya çalışırım.	1	2	3	4	5	6	7
48	Modüllerde yaptıklarımızdan hoşlanmasam bile başarılı olabilmek için sıkı çalışırım.	1	2	3	4	5	6	7
49	Modüllerle ilgili konuları organize etmek için basit grafik, şema ya da tablolar hazırlarım.	1	2	3	4	5	6	7
50	Modüllere çalışırken, konuları sınıftaki arkadaşlarımla tartışmak için sıklıkla zaman ayırırım.	1	2	3	4	5	6	7
51	Modüllerde işlenen konuları bir başlangıç noktası olarak görür ve ilgili konular üzerinde kendi fikirlerimi oluşturmaya çalışırım.	1	2	3	4	5	6	7
52	Çalışma planına bağlı kalmak benim için zordur.	1	2	3	4	5	6	7
53	Modüllere çalışırken, okuduklarım, modüller ve sınıf içi tartışmalar gibi farklı kaynaklardan edindiğim bilgileri bir araya getiririm.	1	2	3	4	5	6	7
54	Yeni bir konuyu detaylı bir şekilde çalışmaya başlamadan önce çoğu kez konunun nasıl organize edildiğini anlamak için ilk olarak konuyu hızlıca gözden geçiririm.	1	2	3	4	5	6	7
55	Modüllerde işlenen konuları anladığımdan emin olabilmek için kendi kendime sorular sorarım.	1	2	3	4	5	6	7
56	Çalışma tarzımı, modülün gerekliliklerine ve öğretim üyelerinin öğretme stiline uygun olacak tarzda değiştirmeye çalışırım.	1	2	3	4	5	6	7
57	Sunum ve laboratuarlara gelmeden önce konuyla ilgili bir şeyler okurum fakat okuduklarımı çoğunlukla anlamam.	1	2	3	4	5	6	7
58	İyi anlamadığım bir konuyu, öğretim üyesinin açıklamasını isterim.	1	2	3	4	5	6	7
59	Modüllerdeki önemli kavramları hatırlamak için anahtar kelimeleri ezberlerim	1	2	3	4	5	6	7
60	Eğer bir konu zorsa ya çalışmaktan vazgeçerim ya da yalnızca kolay kısımlarını çalışırım.	1	2	3	4	5	6	7
61	Modüllere çalışırken, konuları sadece okuyup geçmek yerine ne öğrenmem gerektiği konusunda düşünmeye çalışırım.	1	2	3	4	5	6	7
62	Mümkün olduğunca, modüllerde öğrendiklerimle diğer modüllerde öğrendiklerim arasında bağlantı kurmaya çalışırım.	1	2	3	4	5	6	7
63	Modüllere çalışırken notlarımı gözden geçirir ve önemli kavramların bir listesini çıkarırım.	1	2	3	4	5	6	7
64	Modüller için bir şeyler okurken, o anda okuduklarımla daha önceki bilgilerim arasında bağlantı kurmaya çalışırım.	1	2	3	4	5	6	7
65	Çalışmak için devamlı kullandığım bir yer (oda vs.) vardır.	1	2	3	4	5	6	7
66	Modüllerde öğrendiklerimle ilgili ortaya çıkan fikirlerimi sürekli gözden geçirmeye çalışırım.	1	2	3	4	5	6	7
67	Modüllere çalışırken, sunumlarla ilgili okuduklarımı ve sunumlarda aldığım notları inceleyerek önemli noktaların özetini çıkarırım.	1	2	3	4	5	6	7
68	Modüllerde bir konuyu anlayamazsam, sınıftaki başka bir öğrenciden yardım isterim.	1	2	3	4	5	6	7
69	Modüllerle ilgili konuları, modül sırasında öğrendiklerim ve okuduklarım arasında bağlantılar kurarak anlamaya çalışırım.	1	2	3	4	5	6	7
70	Modüllerle ilgili okumaları ve verilen ödevleri zamanında yaparım.	1	2	3	4	5	6	7
71	Modül konularıyla ilgili ileri sürülen bir savı ya da varılan bir sonucu her okuduğumda veya duyduğumda olası alternatifler üzerinde düşünürüm.	1	2	3	4	5	6	7
72	Modüllerle ilgili önemli kavramların bir listesini çıkarır ve bu listeyi ezberlerim.	1	2	3	4	5	6	7
73	Modülleri düzenli olarak takip ederim	1	2	3	4	5	6	7
74	Modül konuları çok sıkıcı olsa da, ilgimi çekmese de konu bitene kadar çalışırım.	1	2	3	4	5	6	7
75	Gerektiğinde yardım isteyebileceğim arkadaşlarımı belirlemeye çalışırım.	1	2	3	4	5	6	7
76	Modüllere çalışırken, iyi anlamadığım kavramları belirlemeye çalışırım.	1	2	3	4	5	6	7
77	Başka faaliyetlerle uğraştığım için modüllere yeterince zaman ayıramıyorum.	1	2	3	4	5	6	7
78	Modüllere çalışırken, çalışmalarımı yönlendirebilmek için kendime hedefler belirlerim.	1	2	3	4	5	6	7
79	Modül sırasında not alırken kafam karışırsa, notlarımı modülden sonra düzeltirim.	1	2	3	4	5	6	7
80	Modül sınavlarından önce notlarımı ya da okuduklarımı gözden geçirmek için çok zaman bulamam.	1	2	3	4	5	6	7
81	Modüllerde okuduklarımdan edindiğim fikirleri sınıf içi tartışma gibi çeşitli faaliyetlerde kullanmaya çalışırım.	1	2	3	4	5	6	7

APPENDIX I

MODULE QUESTIONNAIRE

DOKUZ EYLUL UNIVERSITY

ELECTRICAL AND ELECTRONIC ENGINEERING DEPARTMENT

SURVEY QUESTIONNAIRE FOR MODULES

Dear Student,
This survey is a part of continuous improvement process of electrical and electronic engineering program at DEU. Its purpose is to systematically check the quality of electrical and electronic engineering education and the performance of our graduates as referenced in ABET EC2000 Criteria 2 and 3. Please the mark the number that indicates your opinion for the questions throughout (1-23) and (24-38).
We wish you successful performance in future term(s) and thank you for your help.

Module Code and Name:		EVALUATION					
PART 1: GENERAL CONSIDERATION							
5 : Excellent 3 : Average 1 : Very Poor	4 : Good 2 : Poor NA : Not Applicable	5	4	3	2	1	NA
1.	How satisfied are you with the sources related with the module; textbook, instruction notes, etc.						
2.	Adequacy of module sources and materials						
3.	How satisfied are you with the contents of the module						
4.	The relation between the contents of the module and the time-spend for it						
5.	The relation between the module and modules taken before						
6.	The success of exam questions to measure your knowledge gained from the module						
7.	The relation between the exam grade and your expectation						
8.	Ability of the instructor to use English						
9.	Instructor's afford to teach in English throughout the module						
10.	Level of your English to follow the module						
11.	The adequacy of laboratories related to the module						
12.	The relation between experiments conducted in the lab. And the module contents						
13.	Overall how satisfied are you with the module						
14.	Declaration of module syllabus						
15.	The instructor's level of success for following the module plan						
16.	How satisfied are you with the teaching way of instructor						
17.	Level of encouragement to use library and computer based tools						
18.	Level of effectively use of teaching equipments						
19.	Level of contribution of homework and projects to learning of the module topics						
20.	Level of dialog between you and the instructor						
21.	How easy to reach the instructor during office hours						
22.	Overall, how satisfied are you with the instructor						
23.	How satisfied are you with the teaching assistant						

PART 2: EVALUATION OF PROGRAM OUTCOMES

5 : Excellent 4 : Good 3 : Average 2 : Poor 1 : Very Poor NA : Not Applicable	5	4	3	2	1	NA
24. an ability to apply knowledge of mathematics, science, and engineering principles						
25. an ability to design and conduct experiments in electrical engineering, as well as to analyze and interpret data to reach an appropriate conclusion						
26. an ability to design an electrical system, component, or process to meet desired needs						
27. an ability to function on multi-disciplinary teams						
28. an ability to identify, formulate, and solve electrical engineering problems						
29. an understanding of professional and ethical responsibility						
30. an ability to communicate effectively in both oral and written fashion						
31. the broad education necessary to understand the impact of engineering solutions in a global and societal context						
32. a recognition of the need for, and an ability to engage in life-long learning						
33. a knowledge of contemporary issues and their impact on engineering profession						
34. an ability to use the techniques, skills, and modern engineering tools necessary for electrical engineering practice						
35. a knowledge of applied electronics, computer and information systems to design and analyze complex systems for electrical engineering application						
36. an ability to produce new ideas and/or creative designs						
37. an ability to accomplish project planning, development, execution, controlling, documentation, and evaluation						
38. an ability to follow and adapt to professional developments and social changes in life						
39. an understanding of institutional attachment, responsibility, and a practice of good communication						
40. a possession of leadership properties, self-confidence, the flavor of enterprise, and an ability to work in teams						
41. an implementation of self-assessment of my knowledge and abilities						

APPENDIX J

PRELIMINARY CODE LIST

- Understanding of PBL
  - Purpose/Definition of PBL or PBL process
    - Student-centered
    - Begins with a problem
    - Allows group working
    - Permits self-directed study
  - Scenarios/PBL Tutorials
    - Ill-structured problem
    - Complex, real-world, authentic questions
    - Consisted with learning outcomes
    - Requires team work
  - Tutors
    - Facilitator, coach, guide
    - Interven when necessary
    - Assess students' progress
  - Students
    - Take responsibility for learning
    - Identification of learning needs
    - Collaboration with each other
    - Preparation for sessions
    - Active participation
    - Communication with each other
    - Effective group skills
  - Presentations
  - Assessment
    - On going process
    - Involves problem solving and self-directed learning skills
- Implementation of PBL
  - Scenarios/PBL Tutorials
  - Tutors
  - Students
  - Presentations
  - Assessment
- Strengths and Weaknesses of PBL
  - Scenarios/PBL Tutorials
  - Tutors
  - Students
  - Presentations
  - Assessment
- Improvement Suggestions for PBL

APPENDIX K

FINAL CODE LIST

- Understanding of PBL
  - Purpose/Definition of PBL or PBL process
    - Student-centered
    - Begins with a problem
    - Allows group working
    - Permits self-directed study
  - Scenarios/PBL Tutorials
    - Ill-structured problem
    - Complex, real-world, authentic questions
    - Consisted with learning outcomes
    - Requires team work
  - Tutors
    - Facilitator, coach, guide
    - Intervene when necessary
    - Assess students' progress
  - Students
    - Take responsibility for learning
    - Identification of learning needs
    - Collaboration with each other
    - Preparation for sessions
    - Active participation
    - Communication with each other
    - Effective group skills
  - Presentations
  - Assessment
    - On going process
    - Conducted by tutor, peer, self
    - Involves problem solving and self-directed learning skills

- Factors Affecting Performance of Tutors
  - Point of view toward PBL
  - Adaptation of the system
  - Content expertise / Preparation level
  - Number of tutors
  - Workload of tutors
  - Experience of tutors
  - Level of knowledge about PBL (tutors' role) / guiding characteristics
  - Motivation

- Factors Affecting Performance of Students
  - Point of view toward PBL

- Adaptation of the system
- Studying habits & time management skills
- Motivation and interest
- Having a fear of failing the class
- Number of exams
- Time insufficiency
- Quality of scenarios
- Success about quidance

Weaknesses of PBL

- Tutors' Weaknesses
  - Difference in PBL applications
  - Insufficient guidance
  - Negative attitudes toward PBL
  - Insufficient preparation
  - Lack of communication between students and tutors
  - Insufficiency for motivating students
  - Disorganization
- Students' Weaknesses
  - Insufficient preparation
  - Students' disinterest about modules/labs
  - Negative attitude towards PBL
  - Weakness of study habits
  - Insufficient knowledge about the PBL system
  - Not enough responsibility for learning
  - Tendency to demotivate and give up easily
- Scenarios/Sessions Weaknesses
  - Carelessly/badly prepared scenarios
  - Difference in scenario applications
  - Problems in group works
  - Modules lasting short time
  - Application of common modules
- Assessment Weaknesses
  - Difference in assessment procedure
  - Non-functional assessment
  - Too many and too long exams
  - Late announcements of the exams/gradings
- Presentation Weaknesses
  - Too much presentation in a limited time
  - Difference in presentation styles
  - In consistency between presentations and sessions

Strengths of PBL

- Advantages of Students
- Gaining engineers' point of view (train for business life)

- Improvement of communication skills (self explanation)
- Improvement of self-directed learning skills
- Improvement of problem-solving skills
- Improvement of self confidence
- Improvement of critical thinking skills
- Improvement of motivation
- Increase of effective group / collaboration skills
- Learning to prepare scientific reports & projects
- Active participation
- Tutors' openness to discussions
- Improvement of students' level of interest to lessons

Difficulties with PBL

- Problems of Tutors
  - Increase in workload
  - Time inadequacy
  - Insufficient number of tutors
  - Difficulty on writing scenarios
  - Disorganization
- Problems of Students
  - Loaded curriculum
  - Time inadequacy
  - Taking exams frequently (too many exams)
  - Having too much stress (about failing the class,
  - Nothing done about their complaints
  - Being accustomed to conventional sytem
  - Not enough theoretical background
  - Not enough guidance

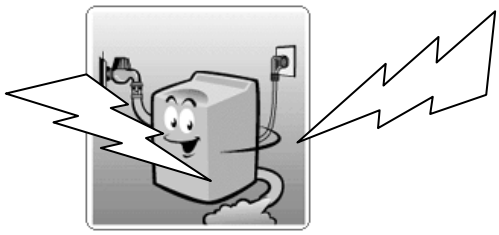
Improvement Suggestions for PBL

- Suggestions for Students
- Suggestions for Tutors
- Suggestions for Scenarios/Sessions
- Suggestions for Assessment
- Suggestions for Curriculum/Administrative Issues

APPENDIX L

A PART OF A SCENARIO

STAGE 1



You have a washing machine. You realize that, when you touch the metal case covering the machine, you are slightly shocked by electricity.

Have you ever faced with a similar problem? Where?

Which reasons can cause this problem?

Try to explain the mechanisms of reasons you gave above.

Which information is required to find the exact reason of this problem?

STAGE 2

You think that your washing machine is not brand new. But in your former house, it had worked fine. After moving to this new house, this problem has appeared. You remember that, while installing the machine, you had to connect two-wire cable to mains of your home because of lack of any additional outlet in your bathroom.

Summarize the new information.

Review your hypotheses in the light of the new information.

What do you know about the electrical connection of light bulbs, switches and outlets in your home? Sketch a diagram.

CURRICULUM VITAE

PERSONAL INFORMATION

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EDUCATION

Degree	Institution	Year of Graduation
Ph.D	Middle East Technical University, Department of Secondary Science and Mathematics Education Dissertation Title: An Analysis of the Problem Based Instruction in Engineering Education	In progress
M.S.	Middle East Technical University, Department of Secondary Science and Mathematics Education Dissertation Title: The Effects of Hands-on Activities on Ninth Grade Students' Achievement and Attitudes Towards Physics	January, 2003
B.S.	Middle East Technical University, Faculty of Education, Department of Science Education	February, 2000

PROFESSIONAL EXPERIENCE

Research Assistant	Dokuz Eylul University, Secondary Science and Mathematics Education	2008-
	Dokuz Eylul University, Electrical-Electronics Engineering	2006-2008
	Middle East Technical University, Secondary Science and Mathematics Education	2000-2006

PUBLICATIONS

Conferences

International:

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4. ve 5. sınıf "Tüm Dersler" kitabı. Koza Yayınevi.

6. ve 7. sınıf “Fen ve Teknoloji” ders, öğrenci çalışma ve öğretmen kitapları. Koza Yayınevi.

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