AN IMPLEMENTATION OF PROBLEM BASED LEARNING IN HIGH SCHOOL BIOLOGY COURSES

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Approval of the Graduate School of Natural and Applied Sciences.

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I certify that this thesis satisfies all the requirements as a thesis for the degree of Doctor of Philosophy.

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This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Doctor of Philosophy.

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ABSTRACT

THE IMPLEMENATION OF PROBLEM BASED LEARNING IN HIGH SCHOOL BIOLOGY COURSES

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The main purposes of the present study included investigation of the effect of problem based learning on students' academic achievement and performance skills in the unit of human excretory system; and students' perceived motivation and perceived use of learning strategies.

This study was carried out during 2003-2004 fall semester at an Anatolian High School in Ankara. A total of 61 tenth grade students from two biology classes of the same biology teacher were involved in the study. Two classes were randomly assigned as experimental and control groups. Experimental Group was instructed with problem based learning, while control group received

traditionally designed biology instruction. In the experimental group, ill-structured problems based on actual patiens served as a basis for learning the basic science and while dealing with these problems, students did independent study as well as group work. In the control group, instruction was based on teacher explanations and textbooks.

Human Excretory System Achievement Test, Motivated Strategies for Learning Questionnaire were administered as pre-test and post-test to students in both groups to measure students' academic achievement and performance skills in the unit of human excretory system; and students' perceived motivation and perceived use of learning strategies.

Multivariate Analysis of Variance (MANOVA) was used to investigate the effect of problem based learning on the dependent variables of current study. Results revealed that problem based learning improved students' academic achievement, performance skills, intrinsic goal orientation, task value, elaboration strategy use, critical thinking, metacognitive self-regulation, effort regulation and peer learning.

Keywords: Problem Based Learning, Traditionally Designed Biology Instruction, Motivation, Self-Regulation, Metacognition

ÖZ

PROBLEME DAYALI ÖGRENME MODELININ LISE BIYOLOJI DERSLERINDE KULLANILMASI

Sungur, Semra

Doktora, Ortaögretim Fen ve Matematik Alanlari Egitimi Bölümü

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Bu çalismanin amaci probleme dayali ögrenme modelinin lise ögrencilerinin bosaltim sistemi konusundaki akademik basarilarina, performans becerilerine, biyoloji dersindeki motivasyonlarina, ve ögrenme stratejilerine etkisini incelemektir.

Bu çalisma 2003-2004 ögretim yili sonbahar döneminde Ankara iline bagli bir Anadolu Lisesinde gerçeklesmistir. Çalismada ayni biyoloji ögretmeninin egitim verdigi iki ayri siniftaki 61 lise ikinci sinif ögrencisi yer almistir. Siniflar deneysel grup ve kontrol grup olmak üzere rastgele seçilmistir.

Deney grubunda dersler probleme dayali ögrenme modeli dogrultusunda islenirken, kontrol grubunda geleneksel biyoloji ögretim yöntemi kullanilmistir. Deney grubunda, bir hastanin durumunu ortaya koyan iyi yapilandirilmamis problemler ilgili konularin ögrenilmesi için temel olusturmus ve ögrenciler bu problemlere çözümler üretirken gruplar halinde ve ayni zamanda bireysel olarak da çalismislardir. Kontrol grubunda ise dersler ögretmenin açiklamalari ve ders kitaplarina dayali olarak islenmistir.

Bu çalismada Insanda Bosaltim Sistemi Basari Testi ve Ögrenmede Güdüsel Stratejiler Anketi ögrencilerin akademik bilgilerini, üst düzey ögrenme yeteneklerini, performans becerilerini, biyoloji dersindeki motivasyonlarini, ve ögrenme stratejilerini belirleyebilmek için her iki gruba da uygulanmistir. Probleme Dayali Ögrenme Modelinin çalismada yer alan bagimli degiskenler etkisini incelemek için çok yönlü varyans analizi (MANOVA) kullanilmistir. Sonuçlar probleme dayali ögrenme modelinin ögrencilerin akademik basarilarina, performans becerilerine, içsel degeri de kapsayan motivasyon bilesenlerine, ve bilisötesi kendi kendini ayarlama becerilerine etkisi oldugunu göstermistir.

Anahtar Sözcükler: Probleme Dayali Ögrenme Modeli, Geleneksel Biyoloji Ögretim Yöntemi, Motivasyon, Kendi Kendini Ayarlama Becerileri, Bilisötesi Becerileri

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PBL	: Problem Based Learning.
TDBI	: Traditionally Designed Biology Instruction.
HESAT	: Human Excretory System Achievement Test.
MSLQ	: Motivated Strategies for Learning Questionnaire.
LSI	: Learning Style Inventory.
AA	: Academic Achievement
PS	: Performance Skills
IGO	: Intrinsic Goal Orientation
EGO	: Extrinsic Goal Orientation
TV	: Task Value
CLB	: Control of Learning Beliefs
SELP	: Self-Efficacy for Learning and Performance
TA	: Test Anxiety
R	: Rehearsal
E	: Elaboration
O	: Organization
CT	: Critical Thinking.
MSR	: Metacognitive Self-Regulation

TSE	: Time and Study Environment
EF	: Effort Regulation
PL	: Peer Learning
HS	: Help Seeking
MANOVA	: Multivariate Analysis of Variance.
ANOVA	: Analysis of Variance.
Λ	: Multivariate Test Statistic
η^2	: Effect Size Measure

CHAPTER 1

INTRODUCTION

We live in a dynamic society in which social, political, technological conditions are changing continuously. So, educators should analyze and evaluate the trends to decide on appropriate curricula and instructional methods to make students ready for the real life situations. Today, it is recognized that every teacher, every student, every person must be empowered to wonder, to suggest possible explanations, to propose ways to test personal or class hunches, to collect and interpret data obtained, to communicate the process and results to others (Yager, 2000). Actually, in today's world people who can think, solve problems, and make decisions based on evidence and reasoning are needed. Accordingly, the goals of today's science education includes providing students with a rich classroom environment where they experience the richness and excitement of knowing about and understanding natural world, and use appropriate scientific processes and principles in making personal decisions. Problem based learning (PBL) involving the use of real or simulated problems can produce changes in knowledge, skills or attitudes necessary for making wise decisions on the problems (Rangachari & Crankshaw, 1996).

Problem Based Learning is a curriculum development and delivery system that recognizes the need to develop problem solving skills as well as the necessity of helping students to acquire necessary knowledge and skills. Indeed, PBL was first introduced in medical schools, which rigorously test the knowledge base of graduates and it is most comprehensively and enthusiastically used in medical schools (Heckmann, Bleh, Dütsch, Lang, Neundörfer, 2003; Alleyne, Shirley, Bennet, Addae, Walrond, Wests & Pereire, 2002; Musal, Abacioglu, Dicle, Akalin, Sarioglu, & Esen, 2002; Macpherson, Jones, Whitehouse, O'Neill, 2001; Smits, Verbeek, deBuisonje, 2001; Rivarola & Garcia, 2000; Doig & Werner; 2000; Miller & Schwartz, 2000; Deretchin & Contant, 1999; Rivarola, Bergesse, Garcia, & Fernandez, 1997; Rosing, 1997; Harris, Güner, Arbogast, Salati, Shumway, Connors, & Beattie, 1997; Jervis & Morris ,1996; Clayton, 1992).

Moreover, there are studies in the literature which aimed to describe how problem-based learning can be adapted for use in elementary and high school settings (Cakir, 2002; Nowak, 2001; Gordon, Rogers, Comfort, Gavula, & McGee, 2001; McBroom & McBroom, 2001; Kaptan & Korkmaz, 2001; Achilles & Hoover,1996; Krynock & Robb, 1996; Ardmbula-Greenfield, 1996; Sage, 1996; Gallagher, Stepien, Sher, & Workman, 1995; Savoie & Hughes 1994; Stepien & Gallagher, 1993; West, 1992). In these studies, it was stated that PBL helps make students apprentice scientists, using realistic, ill-structured problems and sharing their thoughts. Actually, PBL utilizes real world problems, not

hypothetical case studies with neat, convergent outcomes. It is in the process of dealing with actual problems that students learn both content and critical thinking skills. However, the traditional curriculum does not sufficiently foster thinking and critical analysis. Passive learning is promoted to the detriment of intellectual stimulation and motivation. Students are considered as empty vessels to be filled with isolated bits of knowledge. Nevertheless, in the implementation of PBL, the basic assumption is that students' prior knowledge has influence on what they will learn and meaningful and long-lasting learning occurs when knowledge is constructed by the students (Rivarola & Garcia, 2000). It was reported that for dealing with problems effectively, an extensive knowledge base was necessary (Bereiter & Scardamalia, 1993; Gick, 1986). Moreover, Tanner, Keedy and Gallis (1995) indicated that PBL encourages understanding of new knowledge activating students' prior knowledge. What is more, Grave, Schmidt, and Boshuizen (2001) suggested that problem based learning that involves tutorial group discussion promotes better integration of new knowledge to existing knowledge structure enhancing retention. In fact a meta-analysis carried out by Dochy, Segers, Bossche, and Gijbels (2003) showed that students in the PBL has slightly less knowledge, but remember more of the acquired knowledge. A similar finding was found in the study carried out by Nowak (2001) in the K-12 setting. Results of that study revealed that students in a teacher directed classroom learn factual content at a higher rate than students in PBL classrooms. Students instructed by PBL, however, have better retention. Furthermore, the findings indicate that students instructed with problem based learning exhibit

more favourable attitude toward the course than students who received traditional instruction (Tanner et al., 1995; Smith, Powell & Wood, 1995; Bernstein, Tipping, Bercovitz, & Skinner, 1995; Smith & Murphy, 1998). In general, PBL is found to be an effective model for addressing varied learning styles, improve general classroom behavior and achievement, and make learning experiences more exciting (Achilles & Hoover,1996; Krynock & Robb, 1996; Gordon, et al., 2001; McBroom & McBroom, 2001; Cakir, 2002).

What is more, PBL is identified as one of the strategies facilitating the development of self-regulated learning skills which make students metacognitively, motivationally, and behaviourally active participants in their own learning (Galand, Bentein, Bourgeois, & Frenay, 2003; Karabulut, 2002; Paris & Paris, 2001). Self-regulated learning skills, which involves active student participation in the learning process, are essential for development of independent, life-long learners (Dahlgren, 2000). These are important skills because the need for learning does not cease after graduation from school (Rosing, 1997). Today, the world of work is more complex than in the past, and requires intellectual adaptability and ability to manage knowledge without involvement of teachers (Hurd, 2000). However, there are few studies done to provide empirical evidence concerning the effectiveness of PBL on self-regulation (Galand, et al., 2003; Lohman & Finkelstein, 2000; Blumberg & Michael, 1992). Thus, there is need for more researches to be conducted for this purpose.

In accordance with the findings in the literature, main purposes of the present study are to investigate the effect of PBL on students' academic achievement and performance skills; and different facets of self-regulated learning including motivation and learning strategies. In the literature there is no experimental study that explicitly investigated the effectiveness of problem-based learning on these variables in the high school level. The articles mainly focused on the description of how problem-based learning could be implemented in science classrooms and how students and teachers perceive PBL. Accordingly, the findings of current study can have many important implications in instruction, when the appropriateness of problem-based learning to the new biology curriculum implemented countrywide since 1998 is considered. Depending on the results, further researches can be conducted using problems with varying difficulty, with different group sizes, and at different grade levels. The effect of nature of concepts under investigation and duration of implementation of problem-based learning on the success of problem-based learning with respect to the students' understanding and retention can be investigated. Moreover, effectiveness of problem-based learning on students' understanding concepts in physical sciences can be determined.

CHAPTER 2

REVIEW OF LITERATURE

If asked, most educators would agree that one basic goal of education is the development of students who are effective problem solvers for the Information Literacy Age. However, critical thinking and problem solving skills are not typically emphasized in the classrooms. Most of the teachers' questions are at the recall or simple comprehension level. Questions that promote synthesis and evaluative skills of thinking are rarely asked. Teacher is considered as primary source of information (http://score.rims.k12.ca.us/problearn.html; Rosing, 1997; Smith et al, 1995).

In Problem Based Learning environments, students act as professionals and are confronted with problems that requires clearly defining an ill-structured problem, developing hypotheses, accessing, analyzing, utilizing data from different sources, revising initial hypothesis as the data collected developing and justifying solutions based on evidence and reasoning (Gallagher & Stephian, 1995; Barrows, 1986). So a student in a problem-based classroom learns while

dealing with ill- structured problems, is responsible for seeking, accessing his or her own learning material, develop skills to communicate acquired knowledge to other students and teacher (Rosing, 1997). This is the manner in which decision making in a variety of life situations occurs. In this way, as Hoffman & Ritchie (1997) stated, problem-based learning can promote the transfer of knowledge and skills gained in the school to daily-life. Actually, students with such skills are well prepared for professions which rarely have a supervisor who has time, inclination, or knowledge to tell them what to do. They are also well prepared for the explosion of knowledge which gluts the world today.

However, cultural change is required to implement PBL. Students used to being instructed with more traditional teaching methods, which features the teacher as disseminator of knowledge, will experience culture shock of a sort. Students will wish to know what is expected from them. Although preparing a rubric with a teacher may be helpful in overcoming fears, there is initial suspicion of the new approach (http://score.rims.k12.ca.us/problearn.html)

Students must also learn to be part of the group. In fact, for the success of the PBL program every group member should be encouraged to participate as fully as possible by other group members. Moreover, the group members must be open with each other. They have to admit their deficiencies, share their ideas, and make the group benefit from their knowledge and experience they might have gained from self-study taking place outside the small group setting. In addition,

each member of a group has to be sensitive to the needs and feelings of others in the group. In the early stages of the group work, it might be difficult to adapt to these expected behaviors and group members may feel uncomfortable, but with familiarity, it becomes an enjoyable exercise (Curry, 2002).

Apart from students, teachers also experience major adjustments in the PBL. They should appreciate the key elements of PBL and be ready to guide their students through their initial challenges. They should learn to facilitate, rather than direct, student learning (Rangachari & Crankshaw, 1996). Some authors suggest that the teacher must remain silent to encourage student thinking and discussion but intervention should occur if process loses direction (Wilkerson & Maxwell, 1988; Pansini-Murrel, 1996). However, it is generally agreed that more intervention by the teacher is required for the students novel to PBL (Haith-Cooper, 2000). As Kalain and Mullen (1996) indicated, effect of teacher is very important on learning especially at the start of the implementation of PBL. Actually, the role of the teacher is central to the success of problem-based learning (Maudsley, 1999). In general, teacher is expected to be patient. He/she should give students ample opportunity to get on track on their own. When providing guidance, he/she should do so by asking open, very general questions which will stimulate students to probe deeper into a topic, or redirect themselves. Also, teacher should insist that students take and maintain control of the discussion and he/she should foster critical thinking (Curry, 1998)

Therefore, in the PBL the emphasis is on learning, not on teaching. The responsibility for learning lies with the student, not the facilitator. The group sessions serve to clarify learning issues, and provide perspective. Facilitators should be non-directive, and intervene only to extent it is necessary (Curry, 1998).

2.1 Theoretical Base of Problem-Based Learning: Constructivism

Studies in the field of education have triggered an array of theories with their educational assumptions, applications, and approaches. These learning theories articulate the way in which knowledge is acquired, skill and activities emphasized, the role of the students and the teacher differently. For example, the behaviorist theory claims that learning is the conditioning of observable behavior shaped by selective reinforcement of individual's response to events (stimuli) that occur in the environment. Thus, in this tradition the teacher has the primary responsibility to transfer the fixed world of the knowledge directly to students who are passive in the classroom. On the other hand, cognitive theory emphasizes the role of thinking in the learning process in which students are actively involved. According to this view, students' past knowledge before instruction has a great influence on what they learn during instruction. In fact, Ausubel said that learning new knowledge will be meaningful to degree that the student can relate it to the ideas that she already understands. Also, Piaget described three phases through which meaningful learning occurs. These are

assimilation, acommodation, and equilibrium. Assimilation is a cognitive process in which new experience is fitted into existing schemes. However accommodation is a cognitive process in which existing schemes is revised or changed due to new experience. Equilibrium occurs when cognitive stability is created through assimilation and accommodation. Therefore, equilibrium allows better understanding of experiences because what students already know is consistent with new experience when equilibrium is reached. Nevertheless, for equilibrium to be reached there must be disequilibrium which is the discrepancy between existing schemes and new experience. Disequilibrium leads students to find equilibrium. Thus, a student's schemes undergo changes. Depending on his studies, Piaget believed that children's cognitive development was affected by heredity and environmental experience. Thus, students should be given the freedom to understand and construct meaning at their own pace through challenging personal experiences as they develop through individual developmental process and peer interactions and social negotiation should be encouraged in the classroom. Moreover, Vygotsky, who is contemporary of Piaget, emphasized the role of social and cultural influences on the learning process. However, he stressed the effect of instruction on cognitive development more than Piaget. Constructivism which evolved from cognitive and developmental perspective of Piaget, interactional and cultural emphasiz of Vygotsky, and works and philosophies of others, reflects a shift from a teacher-centered approach based on behaviorism to a student-centered approach based on cognitive theory. Therefore, in constructivist theory, emphasis is placed on the

students rather than the teacher. It is the student who constructs his/her own knowledge with the guidance of the teacher so knowledge is not something to be transferred to but is a process of construction and reconstruction. Table 2.1.1 summarizes the basic features of constructivist classrooms (Brooks and Brooks, 1993):

Table 2.1.1 Constructivist Classrooms

Basic Features of Constructivist Classrooms
Learning not teaching is emphasized.
Learner autonomy and initiative are encouraged.
Cognitive terminology such as “classify”, “analyze”, “predict” is extensively used.
Student inquiry is supported by asking open ended, probing questions.
Wait time is provided after asking questions.
Students’ initial responses are elaborated.
Interaction with other students and teacher is encouraged.
Students’ understanding of concepts is inquired before teacher mentions scientific explanations of the concepts.
Instructional strategies, content are altered depending on students’ responses.
Students are provided with experiences that pose contradictions to their initial thoughts and then they are encouraged to discuss their ideas.
Knowledge is constructed in individual’s cognitive structure through social collaboration and experience.

Based on the features of constructivist classrooms Savery and Duffy (1995) claimed that PBL is consistent with the principles of constructivism. They supported their claim with the following statements:

1. Understanding is in our interactions with the environment: According to the authors this is the core concept of constructivism and we cannot talk about what is learned separately from how it is learned, as if a variety of

experiences all lead to the same understanding. Rather, what we understand is a function of the content, context, the activity of the learner.

2. Cognitive conflict or puzzlement is the stimulus for learning and determines the organization and nature of what is learned: When in a learning environment, learner has a goal for learning. The goal is not only the stimulus for learning, but also it is a main factor in determining what the learned attends to, what prior experience the learner brings to bear in constructing and understanding, and, basically, what understanding is eventually constructed. For Piaget it is the need for accommodation when current experience cannot be fitted into existing scheme.

3. Knowledge evolves through social negotiation and through the evaluation of the viability of individual understanding: Since we can test our own understanding and examine the understanding of others, cooperative groups are important. Other people are the greatest source for alternative opinions to challenge our current opinions and thus to serve as a puzzlement that stimulates the new learning.

In fact, PBL approach allows students interact with their environment, with their peers and in a typical PBL class, students work in groups cooperatively which allows evolvement of knowledge through social negation. Moreover, ill-structured problems posed to them lead students to apply their newly constructed

knowledge and to take alternative point of views and strategies into consideration (Curry, 2002; Nowak, 2001; Walton& Matthews, 1989)

Furthermore, Savery and Duffy (1995) outlined eight instructional principles derived from constructivism and consistent with the PBL. These principles were as follows: First, anchor all learning activities to a larger task or problem. Second, support the learner in developing ownership for the overall problem or task. Third, design an authentic task. Fourth, design the task and the learning environment to reflect the complexity of the environment hey should be able to function in. Fifth, give the learner the ownership of the process used to develop a solution. Sixth, design the learning environment to support and challenge the learner's thinking. Seventh, encourage testing ideas against alternative views and alternative contexts. Eighth, provide opportunity for and support reflection on both the content learned and the learning process. They claimed that all eight of these instructional principles are realized when the PBL is appropriately used. They pointed out that in the PBL the focus is on learners as constructors of knowledge in a context similar to the context in which they would use that knowledge. They are encouraged to think both critically and creatively and to monitor their own understanding. Social negotiation of meaning is an important aspect of group process. The learners have the ownership of the problem and all of the learning occurs as a result of consideration of the problem. Facilitation is focused on metacognitive process.

2.2 Research on the Implementation of Problem-Based Learning in Medical Education

Problem-based learning has had a major impact on thinking and practice in medical education for the past 30 to 40 years. The PBL approach has been based on active learning in small groups, with clinical problems used as the stimulus for learning and it has been evaluated in medical literature for its ability to incorporate realistic experiences in the classroom.

There are some studies which analyzed previous studies to determine whether the expected benefits of PBL were detected. Albanese and Mitchell (1993) categorized and listed the quantitative results of the studies, Vernon and Blake (1993) synthesized the results with a meta-analysis, and Berkson (1993) used a traditional, narrative approach. Nevertheless, a common picture emerges, showing little or no effect on student achievement. Albanese and Mitchell (1993) recommended that caution be exercised in making comprehensive, curriculum-wide conversions to PBL." Berkson (1993) concluded that "the graduate of PBL is not distinguishable from his or her traditional counterpart. The experience of PBL can be stressful for student and faculty. And implementation of PBL may be unrealistically costly." Surprisingly, Vernon and Blake (1993) concluded that "the results generally support the superiority of the PBL approach over more traditional methods. In relation to clinical knowledge, Vernon and Blake (1993) in their meta-analysis reported that weighted mean effect size for NBME II

(National Board Medical Examine) performance was positive but quite small, d = +.08, indicating that PBL students were about one tenth of a standard deviation above standard students. The PBL students were reported to be significantly superior with respect to clinical performance, but the weighted mean effect size was small, d = +.28, about one fourth of a standard deviation. Roughly, this means that about 10% more of the PBL students were above the standard students' mean compared with the standard students. Even the effect for student satisfaction was only moderate—a weighted mean effect size of d = +0.55. Moreover, the meta-analysis carried out by Dochy et al, (2003) showed that students in the PBL has slightly less knowledge, but remember more of the acquired knowledge and apply it more efficiently.

According to Delva, Woodhouse, Hains, Birtwhistle, Knapper, and Kirby (2000), there are two potential reasons for why PBL appears not to meet the expectations. Firstly, PBL may not be enough to alter the learning process and outcomes if students cannot adopt appropriate learning strategies. Secondly, the tests used may not be sufficient to indicate the learning outcomes of PBL and insensitive to the nature of changes in learning. A similar explanation to the later was provided by Vernon & Blake (1993). Furthermore, it was reported that although problem-based learning tends to reduce the initial levels of learning, it fosters retention (Yip & Ghafarian, 2000; Arambula-Greenfield, 1996; Farnworth, 1994). What is more, it was indicated that for dealing with problems

effectively, an extensive knowledge base is necessary (Bereiter & Scardamalia, 1993; Gick, 1986).

Apart from these, the findings of the studies in general revealed that PBL increases students' attitude toward the course indicated by increase interest to the course, and opinions of students about the advantages of PBL (Smith & Murphy, 1998; Bernstein, Tipping, Bercovitz, & Skinner, 1995; Smith, Powell & Wood, 1995;Tanner, Keedy & Galis, 1995). Moreover, the PBL creates an environment in which students actively participate in the learning process, take responsibility for their own learning, and become better learners in terms of time management skills, ability to define topics, ability to access different resources, and ability evaluate validity of these resources (Karabulut, 2002)

2.3 Research on the Implementation of Problem-Based Learning in Elementary and Secondary Education

The studies mentioned so far were done in the field of medical education. There are not so much studies in the field of science education investigating the effectiveness of PBL. The articles published mainly described how PBL can be implemented in science classrooms (Kaptan & Korkmaz, 2001; Arambula-Greenfield, 1996; Gallagher et al., 1995; Sage, 1996; Savoie & Hughes, 1994; Stepien & Gallagher, 1993; West, 1992). In these articles, the rationale for PBL and its integration to science lessons were mentioned. Apart from these studies,

Krynock and Robb (1996) conducted a research in which there were three distinct eight grade classes of science referred to as standard, PBL, and gifted. There were two standard classes with a total of 50 students who had above average to below average intelligence. Those students were instructed with lecture and laboratory methods. Total number of students in two PBL classes was 54. They had average intelligence and worked on a problem introduced to them related to the genetics. The gifted class of above average intelligence students spent a great deal more time studying the genetics. The hand-made test results and standardized test results displayed as group means indicated that gifted students outperformed. However, the fact that they spent more time studying genetics should be taken into consideration while analyzing the results. Accordingly, the authors concluded that PBL does increase higher-level thinking skills by requiring students to think about a problem critically and analyze data to find out solution. Also, they reported that responses of students revealed that they tend to work better in group and are able to do better research on a topic. But, there was no inferential statistics done to statistically analyze the data, just group means were given as descriptive statistics.

In addition, McBroom and McBroom (2001) investigated the effect of the PBL on secondary school students' knowledge level, attitude, and self-confidence in molecular genetics unit. Students in the experimental group were given a problem to examine the effects of genetic similarity on weed control on campus. To find a reasonable solution to the problem the students had to learn the

necessary techniques and concepts appropriate for the task. On the other hand students in the control group were received traditional lecture-based instruction. Two groups were instructed by the same teacher. Before and after the treatment, a survey was administered to both groups to measure students' knowledge level. The survey required students to asses their knowledge on twenty concepts and techniques on a numerical scale of one to four. In addition, they were required to define these techniques allowing the teacher to rate what they knew and compare that to their self-assessment. Based on the instructor assessment no statistically significant difference was found between control and experimental groups before the treatment with respect to knowledge level. However, after the treatment the experimental group gained 28.3 % in the instructor assessment while the control group gained 4.75 %. Independent t-test carried out showed that at the end of the treatment students in the experimental group scored significantly higher than the control group (t= 4.94, df=8, p<0.005). Moreover, self-assessment data revealed that students completed the PBL experience with a more positive attitude and an obvious gain in self-confidence. The researchers of the study suggested that PBL may be applicable to any subject matter in any classroom.

Moreover, in the study carried out by Gordon et al., (2001), effect of PBL on urban minority middle-school students" achievement was examined. Academic performance at the school where the research was conducted fell in the lowest 25th percentile for the school district. Participants of the study were students of two classrooms at each of 6th, 7th, and 8th grade levels: while forming

the experimental group, each grade level was divided into seven groups of eight to ten students each. The control group consisted of two similar classrooms at each grade level. PBL activities constituted only two percent of the curriculum schedule. All the problems written were interdisciplinary and aimed at exploring health science issues, and carriers in the health professions, to develop students' self-directed leaning skills, and to help development of critical thinking. During PBL group process students discussed on the problem and recorded the process under the headings of data, analysis, hypothesis, and learning issues. The students searched for information in line with the learning issues identified in the library, from experts, local community, and internet. In the classroom, students shared their findings with each other and discussed the implications of their findings. They used the information they gathered to better understand the problem and to propose solutions. In the end, groups prepared a concept map of their findings. Teacher assessed the concept maps. Apart from this, students made a self-assessment regarding what they learned and what can be done to improve the group process. A survey competed by eighty-eight students revealed positive perceptions of PBL. In general, students valued the student centered nature of PBL, the information seeking, the high levels of challenge, the group work, and personal relevance of the material. Similarly, teachers thought that PBL helped students develop interpersonal skills, critical thinking, information seeking. In addition, it was reported that PBL increased science performance of low-income minority middle school students.

In the study carried out by Achilles and Hoover (1996), PBL was implemented in three middle schools (6th, 7th, 8th grade), and one high school (9th grade). Based on the feedback provided by the teachers participated in the study researchers reported that PBL was an effective model for addressing varied learning styles, improved general classroom behavior and achievement, and made learning experiences more exciting. In addition, this model encouraged life skills such as communication, mutual respect, teamwork, and responsibility.

What is more, Cakir (2002) investigated the effects of case-based instruction, learning styles, and gender on students' performance skills, higher order thinking skills, attitude toward biology, and academic knowledge in the unit of nervous system. Seventy four 10th grade students from two different classes were involved in the study. One class was assigned as experimental group while other was assigned as control group. Students in the control group received traditional lecture-based instruction. Some reading assignments were given to the students. In the experimental group, a unit plant prepared in accordance with case-based learning was implemented. The unit plan included cases related to the nervous system. During implementation students worked in groups and made group discussion. During group discussions, students in each group shared the information they acquired from different resources with each other. At the end, each group prepared a single report and shared their reports with other groups during whole class discussion. Results of the study indicated that case-based learning had statistically significant effect on students' performance skills, and

academic knowledge whereas it had no effect on students' higher order thinking skills and attitude toward biology. Students' performance skills such as organizing and integrating ideas were measured by essay type questions whereas students' academic knowledge was measured by multiple-choice type questions written at the knowledge level in Bloom's taxonomy. Students in the experimental group tended to perform better on these questions.

In addition, in his study, Nowak (2001) aimed at specifically addressing whether or not students learn as much via PBL as they do in traditional classroom settings. In line with this purpose, two eight grade gifted and talented science classes were compared. Results showed that students in a teacher-centered classroom learn factual knowledge at a higher rate than students learning via a PBL approach. Students in the PBL group, however, had better retention. Interview analysis indicated that students favor learning via PBL, but many students suggested that teacher directed lessons should have been integrated into a PBL unit so that they could benefit more than an exclusively PBL-based curriculum.

In summary, PBL as an instructional method appear to improve interpersonal skills, critical thinking, information seeking, communication, mutual respect, teamwork and students involved in PBL tend to have more positive attitude toward the course and better performance on the tests. What is more, it was proposed that some aspects of the PBL such as the responsibility on

the students to identify knowledge deficiencies, to find information, to critique the resources used, to coordinate actions and people, to realize goals, to monitor understanding, and debriefing contribute to the development of self-regulated learning (Galand et al., 2003; Karabulut, 2002; Paris & Paris, 2001).

2.3 Self-Regulation in Academic Learning

In today's world, rapid technological and social changes and developments require individuals to have skills necessary for acquiring knowledge, using and applying it in novel situations, keeping that knowledge updated, working cooperatively, using time efficiently and being better problem solvers. Accordingly, during the past 30 years, the nature of instruction has been changed considerably (Paris & Paris, 2001) and effective study skills which will help students be an active member of the society that involves intellectual adaptability and ability to manage knowledge began to be considered as necessary for academic success in the schools. Study skills are classified as cognitive, metacognitive, and affective processes by Hattie, Biggs, and Purdie (1996), after examining more than 1400 articles. Cognitive processes emphasize task-related skills like note-taking. Metacognitive processes emphasize planing and monitoring one's learning and being aware of which strategies are suitable for use across academic tasks. Affective processes emphasize motivation, self-efficacy, and students' attributions for success and failure. Metacognitive, motivational, behavioural, and environmental processes used to enhance

academic achievement formed multidimensional criteria to define the self-regulation of academic learning (Zimmerman & Rismerberg, 1997). In general, students are described as self-regulated to the degree they are metacognitively, motivationally, and behaviourally active participants in their own learning (Zimmerman, 1989). Self- regulated students set goals effectively, plan and use strategies to achieve their goals, manage resources and monitor their progress. They are self-efficacious about the ir abilities to master a learning task. From this perspective, the value of self-regulation in schools is readily obvious. Students who can initiate learning tasks, set their own goals, decide on appropriate strategies for the realization of the goals, and then monitor and evaluate their own progress are likely to achieve at higher levels than students who relies on teachers for performing these same functions (Risemberg & Zimmerman, 1992).

Self-regulation is viewed as interaction of personal, behavioural, and environmental triadic and at the same time cyclic processes (Bandure, 1986 as cited in Zimmerman, 2000). Personal processes involve students' knowledge, metacognitive processes, goals and affect. Behavioral processes involve self-observation, self-judgement, and self-reaction. Environmental processes involve enactive outcomes, modelling, and verbal persuasuion (Zimmerman, 1989). From a social cognitive perspective,these self-regulatory processes and accompanying beliefs fall into three cyclical phases: forethought, performance or volitional control and self-reflection (Zimmerman, 2000; 2002).

Forethought Phase includes two distinctive but closely linked categories: task analysis and self-motivational beliefs. A key form task analysis is the goal setting which refers to deciding upon specific outcomes of learning or performance. Research indicated that self-regulated learners set more specific, challenging and proximal goals (Shu-Shen, 2002; Zimmerman, & Risemberg, 1997). A second form of task analysis is strategic planing. For a skill to be mastered or performed optimally, students need methods which are appropriate for the task and the setting. Self-regulated learners appear to continuously adjust their goals and choices of strategies in response to changing intrapersonal, interpersonal and contextual conditions. However, self-regulatory skills are of little value, if students fail to motivate themselves to use them. A number of self-motivational beliefs forms a base for forethought processes of goal setting and strategic planing. These self-motivational beliefs are self-efficacy, outcome expectations, intrinsic interest/value, and goal orientation (Zimmerman, 2000). Self-efficacy refers to students' beliefs about their capability to learn or perform effectively while outcome expectations refer to students' beliefs about the ultimate end of performance. Research findings in the literature revealed that students with a higher sense of self efficacy are tend to use more cognitive and metacognitive strategieis and persist in difficult or uninteresting task (Neber, Schommer-Aikins, 2002; Shu-Shen, 2002; Dembo and Eaton, 2000; Pintrich, Roese, & De Groot, 1994; Pintich and DeGroot, 1990). Intrinsic interest/value and goal orientation essentially concerns students' reasons for doing a task. (Zimmerman, 2000; 2002; VanderStoep, Pintrich, & Fagerlin, 1996; Pintich &

DeGroot, 1990). Two general goal orientations that can be adapted towards learning are suggested by the goal orientation research; a learning goal orientation where the students give importance to developing new skills, and thus mastery and learning of the material, and a performance or ability orientation where the students focus on their ability and performance in relation to other students (Wolsters, Yu, & Pintrich, 1996). Educational research showed that learning goal orientation and the beliefs that task is interesting and important are positively related to reports of cognitive, metacognitive, and self-regulatory strategies like elaboration, organization, planning, monitoring, and regulating learning (Neber, & Schommer-Aikins, 2002; Pintrich, Roese, & De Groot, 1994; Pintich & DeGroot, 1990; Ames & Archer, 1988; Meece, Blumenfeld, & Hoyle, 1988; Nolen, 1988).

Performance/volitional Control Phase includes self-control and self-observation. Self-control refers to organization and use of specific method or strategies that were selected during the forethought phase. Among self-control methods, imagery, self-instruction, attention focusing, and task strategies are the ones that have been studied up to date. Imagery is forming of mental pictures. For instance, while learning the Spanish word pan for "bread" , an English-peaking student form an image of a bread pan or self-instruct using the phrase "bread pan". So self-instruction is overtly or covertly describing how to proceed as one works on a task. Attention focusing is to improve one's concentration and task strategies promote learning by reducing task to its essential pars and

reorganizing the parts meaningfully. The second type of performance/volitional control involves self-observation. Self-recording and self-experimentation are common self-observation techniques. For example, a student who self-records his/her time use may realize that when he/she studied alone, he/she completed his/her homework more quickly. Then he/she could perform a self-experiment to see whether his/her friend was an asset or liability (Zimmerman, 2000; 2002; Schunk & Zimmerman, 1997).

Self-Reflection Phase includes self-judgement and self-reaction. Self-judgement is self-evaluation of one's performance and attributing causal significance to the results. Self-evaluative and attributional judgements are closely related to two key forms of self-reactions: self-satisfaction and adaptive/defensive responses. An increase in self-satisfaction leads to increase in motivation. Adaptive responses involve adjustments made to increase the learning This view of self-regulation is cyclical in that self-reflections from past efforts to learn affect subsequent forethought processes. For instance, self-dissatisfaction may lead to lower self-efficacy and decreased effort to learn (Zimmerman, 2000; 2002; Schunk & Zimmerman, 1997).

From social cognitive perspective, social and physical environment is considered as a source for self-enhancing forethought, performance or volitional control and self-reflection. Modeling and instruction serve as a primary vehicle to through which self-regulatory skills can be thought (Zimmerman, 2000; 2002;

Schunk & Zimmerman, 1997). According to Perry, VandeKamp, Mercer, and Nordby (2002) students can and do engage in self-regulated learning in classrooms where they are provided with opportunities to participate in complex, open-ended activities, make choices that have an influence on their learning, and evaluate themselves and others. Moreover, they reported that instrumental support provided by teachers through questioning, clarifying, correcting, elaborating, modelling and creating an environment in which students can support one another through collaborating, sharing, ideas, and problem solving led students to demonstrate attitudes and actions expected from independent, academically effective learners: metacognition, intrinsic motivation and strategic action. Moreover, Paris and Paris (2001) suggested that problem-based learning which places the responsibility on the students to find information, to coordinate actions and people, to realize goals and to monitor understanding can be utilized by the teachers to support the development of self-regulated learning. In line with the research findings in the literature, current study aimed at investigating effect of problem-based learning on different facets of students' self-regulated learning such as motivation and learning strategies.

In summary, Problem based learning involving the use of real or simulated problems can produce changes in knowledge, skills or attitudes necessary for making wise decisions on the problems that can be faced in daily life (Rangachari &Crankshaw, 1996). In the present study, the effect of problem-based learning on students' academic achievement and performance skills in

excretory system unit, and students' perceived motivation, and perceived use of learning strategies in biology was investigated. There are no studies in the literature which explicitly investigated the effect of PBL on all of the variables included in this study. The experimental studies carried out in the elementary and high school level mainly aimed at determining whether or not PBL had influence on students' achievement. However, since initiating learning tasks, setting goals, deciding on appropriate strategies for the realization of the goals, and then monitoring and evaluating the progress are important skills which help students be an active member of the society that involves intellectual adaptability and ability to manage knowledge, in the present study effect of PBL on students' such self-regulatory skills was investigated as well as their academic achievement and performance skills

Considering the fact that there are not so much studies regarding the implementation of problem-based learning in the field of science education, the current study can add valuable information to science education in relation to curriculum development and teacher education. And it can lead to new searches as indicated in introduction section.

CHAPTER 3

PROBLEMS AND HYPOTHESES

This chapter presents main problems and sub-problems of the current study and the hypotheses tested in Chapter 5.

3.1 Main Problem

1. What is the effect of problem based learning and gender on students' academic achievement and performance skills in the unit of human excretory system?

2. What is the effect of problem based learning and gender on students' perceived motivation (Intrinsic Goal Orientation, Extrinsic Goal Orientation, Task Value, Control of Learning Beliefs, Self-Efficacy for Learning and Performance, Test Anxiety)?

3. What is the effect of problem based learning and gender on students' perceived use of learning strategies (Rehearsal,

Elaboration, Organization, Critical Thinking, Metacognitive Self-Regulation, Time and Study Environment, Effort Regulation, Peer Learning, Help Seeking)?

3.2. Sub-Problems

1. Is there a significant population mean difference between the groups exposed to problem based learning and traditionally designed biology instruction with respect to students' academic achievement and performance skills in the unit of human excretory system?

2. Is there a significant population mean difference between boys and girls with respect to students' academic achievement and performance skills in the unit of human excretory system?

3. Is there any interaction between treatment and gender with respect to students' academic achievement and performance skills in the unit of human excretory system?

4. Is there a significant population mean difference between the groups exposed to problem based learning and traditionally designed biology instruction with respect to students' perceived

motivation (Intrinsic Goal Orientation, Extrinsic Goal Orientation, Task Value, Control of Learning Beliefs, Self-Efficacy for Learning and Performance, Test Anxiety)?

5. Is there a significant population mean difference between boys and girls with respect to students' perceived motivation (Intrinsic Goal Orientation, Extrinsic Goal Orientation, Task Value, Control of Learning Beliefs, Self-Efficacy for Learning and Performance, Test Anxiety)?

6. Is there any interaction between treatment and gender with respect to students' perceived motivation (Intrinsic Goal Orientation, Extrinsic Goal Orientation, Task Value, Control of Learning Beliefs, Self-Efficacy for Learning and Performance, Test Anxiety)?

7. Is there a significant population mean difference between the groups exposed to problem based learning and traditionally designed biology instruction with respect to students' perceived use of learning strategies (Rehearsal, Elaboration, Organization, Critical Thinking, Metacognitive Self-Regulation, Time and Study Environment, Effort Regulation, Peer Learning, Help Seeking)?

8. Is there a significant population mean difference between boys and girls with respect to students' perceived use of learning strategies (Rehearsal, Elaboration, Organization, Critical Thinking, Metacognitive Self-Regulation, Time and Study Environment, Effort Regulation, Peer Learning, Help Seeking)?

9. Is there any interaction between treatment and gender with respect to students' perceived use of learning strategies (Rehearsal, Elaboration, Organization, Critical Thinking, Metacognitive Self-Regulation, Time and Study Environment, Effort Regulation, Peer Learning, Help Seeking)?

3.3. Hypotheses

1. There is no statistically significant mean difference between the groups exposed to problem based learning and traditionally designed biology instruction with respect to academic achievement and performance skills in the unit of human excretory system in the population of all the 10th grade Anatolian High School students in Ankara .

2. There is no statistically significant mean difference between the boys and girls with respect to academic achievement and

performance skills in the unit of human excretory system in the population of all the 10th grade Anatolian High School students in Ankara .

3. There is no interaction between treatment and gender with respect to academic achievement and performance skills in the unit of human excretory system in the population of all the 10th grade Anatolian High School students in Ankara.

4. There is no statistically significant mean difference between the groups exposed to problem based learning and traditionally designed biology instruction with respect to students' perceived motivation (Intrinsic Goal Orientation, Extrinsic Goal Orientation, Task Value, Control of Learning Beliefs, Self-Efficacy for Learning and Performance, Test Anxiety) in the population of all the 10th grade Anatolian High School students in Ankara.

5. There is no statistically significant mean difference between boys and girls with respect to students' perceived motivation (Intrinsic Goal Orientation, Extrinsic Goal Orientation, Task Value, Control of Learning Beliefs, Self-Efficacy for Learning and Performance, Test Anxiety) in the population of all the 10th grade Anatolian High School students in Ankara.

6. There is no interaction between treatment and gender with respect to students' perceived motivation (Intrinsic Goal Orientation, Extrinsic Goal Orientation, Task Value, Control of Learning Beliefs, Self-Efficacy for Learning and Performance, Test Anxiety) in the population of all the 10th grade Anatolian High School students in Ankara.

7. There is no statistically significant mean difference between the groups exposed to problem based learning and traditionally designed biology instruction with respect to students' perceived use of learning strategies (Rehearsal, Elaboration, Organization, Critical Thinking, Metacognitive Self-Regulation, Time and Study Environment, Effort Regulation, Peer Learning, Help Seeking) in the population of all the 10th grade Anatolian High School students in Ankara.

8. There is no statistically significant mean difference between boys and girls with respect to students' perceived use of learning strategies (Rehearsal, Elaboration, Organization, Critical Thinking, Metacognitive Self-Regulation, Time and Study Environment, Effort Regulation, Peer Learning, Help Seeking) in

the population of all the 10th grade Anatolian High School students in Ankara.

9. There is no interaction between treatment and gender with respect to students' perceived use of learning strategies (Rehearsal, Elaboration, Organization, Critical Thinking, Metacognitive Self-Regulation, Time and Study Environment, Effort Regulation, Peer Learning, Help Seeking) in the population of all the 10th grade Anatolian High School students in Ankara.

CHAPTER 4

DESIGN OF THE STUDY

This chapter presents definiton of variables, sample of the study, instruments used, decription of the treatment, expression of methods to analyze data, and assumptions, and limitations.

4.1 The Experimental Design

In this study, the static-group comparison design was used (Fraenkel & Wallen, 1996). Table 4.1 shows the research design of the study.

Table 4.1 Research Design of the Study

Groups	Before Treatment	Treatment	After Treatment
EG	HESAT MSLQ	PBL	HESAT MSLQ
CG	HESAT MSLQ	TDBI	HESAT MSLQ

In this table, EG represents the experimental group instructed by problem-based instruction. CG represents the control group receiving traditionally designed biology instruction. HESAT is the Human Excretory System Achievement Test and MSLQ is the Motivated Strategies for Learning Questionnaire. PBL represents Problem Based Learning while TDBI is the Traditionally Designed Biology Instruction.

In this study, HESAT was administered to experimental and control groups before the instruction to determine whether there was a significant mean difference between two groups with respect to previous academic achievement and performance skills in the unit of excretory system. Before the instruction, two groups were also compared concerning previous motivation, cognitive and metacognitive strategy use, and resource management strategy use based on the scores obtained from MSLQ. After the instruction, HESAT and MSLQ were again administered to both groups to determine the effect of problem based learning on students' academic achievement and performance skills in the unit of excretory system and students' motivation, and learning strategies , respectively.

4.2 Definition of Variables

1. Academic Achievement: The performance of students on the Human Excretory System Achievement Test developed by the researcher

2. Performance Skills: The performance of students on the essay type item which aimed at measuring skills such as ability to use of relevant information in addressing the problem, articulate uncertainties, organize concepts, and interpret information in the Human Excretory System Achievement Test developed by the researcher.

3. Motivation: Students' goals and value beliefs for biology, their beliefs about their skill to succeed in biology, and their anxiety about tests in biology measured by corresponding scales (Intrinsic Goal Orientation, Extrinsic Goal Orientation, Task Value, Control of Learning Beliefs, Self-Efficacy for Learning and Performance, Test Anxiety) of the Motivated Strategies for Learning Questionnaire developed by Pintrich, Garcia, & McKeachie (1991).

4. Learning Strategies: Students' use of different cognitive and metacognitive strategies. (Rehearsal, Elaboration, Organization, Critical Thinking, Metacognitive Self-Regulation), and students' management of different resources (Time and Study Environment, Effort Regulation, Peer Learning, Help Seeking) measured by the Motivated Strategies for Learning Questionnaire developed by Pintrich, et al,. (1991).

5. Traditionally Designed Biology Instruction: the instruction based on teacher explanation and textbooks. The primary underlying principle is that

knowledge resides with the teacher and that it is the teacher's responsibility to transfer that knowledge as fact to students.

6. Problem-based learning: the instructional strategy with the following distinct characteristics

Reliance on problems to drive the curriculum – through problems, students learn how to use an iterative process of assessing what they know, identifying what they need to know, gathering information, and collaborating on the evaluation of hypotheses ideas based on the data they collected

The problems are ill-structured - there is no a single, correct solution, and as students attempt to deal with the problem, the nature and definition of the problem may change.

Students solve the problems - teachers serve as facilitators and students are only given guidelines for how to approach problems Students take responsibility for what is learned and how (Stepian & Gallagher 1993).

4.3 Subjects of the Study

Target population of the study is all the 10th grade students in Ankara. Accessible population of the study is all the 10 grade students attending Anatolian

High Schools in Ankara. Accordingly, the subjects of this study consisted of 61 tenth grade students (n=39 boys and n=22 girls) instructed by the same biology teacher in an Anatolian High School in Ankara in 2003-2004 fall semester. Two instructional methods (PBL and TDBI) were randomly assigned to the experimental and the control groups. Number of students in the experimental group was 30 while that of in the control group was 31. The mean age of the students in the experimental group and control group was 16 and 16.6, respectively. The biology grade of the students in both groups was comparable: 4.6 over 5 in the experimental group and 4.7 over 5 in the control group. Table 4.3.1 shows demographic information regarding the mother educational level (MEL), father educational level (FEL), mother work status (MWS), father work status (FWS) as indicators of socioeconomic status of students in the experimental and control groups. As it can be deduced from the table, majority of the parents in both groups had the university degree and they were employed. However, percentage of employed fathers in both groups was around 90 while that of mothers was 50.What is more, information collected regarding the number of books at home as another indicator of the socioeconomic status indicated that most of the students (around 65 %) in both groups had more than 200 books besides their course books at their homes In the experimental group 3.6 % of students had 0-25 books at their homes whereas there were no students in the control group having less than 26 books.

Table 4.3.1 . Sample Characteristics

	EG (%)		CG (%)	
Educational Level	MEL	FEL	MEL	FEL
Primary School	3.6	3.6	7.1	7.1
Junior High School	10.7	0	0	0
High School	28.6	17.9	28.6	7.1
University	42.9	67.9	50	71.4
MS	14.3	7.1	14.3	10.7
PhD	0	3.6	0	3.6
Work Status	MWS	FWS	MWS	FWS
Unemployed	46.4	10.7	46.4	3.6
Employed	53.6	89.3	53.6	96.4

Moreover, regarding sample characteristics, students' learning styles were also determined by administering the Learning Style Inventory developed by Kolb (1985). The information about students' learning styles is presented in Table 4.3.2

Table 4.3.2 Students' Learning Styles

	EG		CG	
Learning Style	Frequency	Percent	Frequency	Percent
Converger	6	20	7	22.6
Diverger	2	6.7	4	12.9
Assimilator	17	56.7	18	58.1
Accomodator	5	16.7	1	3.2

As the table shows, majority of the students participated in the study had assimilator learning style. Next predominant learning style in both groups was converger learning style. A few students had accommodator learning style.

4.4 Variables

4.4.1 Independent Variables

The independent variable in this study was treatment

4.4.2 Dependent Variables

The dependent variables in this study were students' academic achievement and performance skills in the unit of excretory system measured by HESAT and students' intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performance, test anxiety, rehearsal, elaboration, organization, critical thinking, metacognitive self-regulation, time and study environment, effort regulation, peer learning, and help seeking measured by the MSLQ. In the MSLQ, intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performance, and test anxiety were included in the motivation section, whereas rehearsal, elaboration, organization, critical thinking, metacognitive self-regulation, time and study environment, effort regulation, peer learning, and help seeking were included in the learning strategies section. So, since the number of variables in each section is high, for the sake of simplicity, in the current study, names of the sections were frequently mentioned as the

dependent variables, namely, students' motivation, and learning strategies. In fact, there were 18 dependent variables in the present study.

4.5 Instruments

4.5.1 Human Excretory System Achievement Test (HESAT)

This test was developed by the researcher. There were 25 multiple choice items with one correct answer and three distracters, and one essay type item in the test.

During the development stage of the test, instructional objectives related to human excretory system were stated (see Appendix A) depending on national curriculum and biology textbooks. This step was carried out to define the content of the test. While constructing the test a few items were selected and adapted from a website; (www.borg.com/~lubehawk/hexcrsys.htm) and a book (Ryan & Wang, 2002).The test covered the topics related to the structure and function of the human excretory system and its relation to other organ systems

Each item in the Human Excretory System Achievement Test (see Appendix B) was examined by a group of experts in the field of science education, biological sciences and by biology teachers regarding content validity and format. HESAT was piloted by administering it to 60 eleventh grade students

in the Anatolian High School where the study was carried out. Final form of the test was administered to experimental group and control group before and after instruction to measure students' academic achievement and performance skills. Multiple choice items aimed at determining students' ability to integrate their knowledge on different topics in biology and on different subject areas such as chemistry as well their ability to recall some definitions and facts. Essay type item was prepared to measure students' performance skills such as ability to use of relevant information in addressing the problem, articulate uncertainties, organize concepts, and interpret information. The skills measured by this item was in proper alignment with the problem based learning approach requiring students to deal with an ill-structured problem similar to ones they faced with in the classroom. To achieve acceptable levels of inter-rater consistency, a rubric, which is adapted from the one developed by Lynch and Wolcott (2003), was used for the essay type item (see Appendix C). This essay type item was scored by two raters using the rubric. Correlation between two different scores was high (r= 0.94) indicating inter-rater consistency for the item. In addition, reliability of the multiple choice part of the test was found to be 0.70

4.5.2 Motivated Strategies for Learning Questionnaire (MSLQ)

It is a self-report questionnaire developed by Pintrich, Garcia, & McKeachie (1991). Students rate themselves on a seven point Likert scale from "not at all true of me" to very true of me" concerning different aspects of their

learning namely, motivation in learning, confidence in gaining success, test anxiety, and ability in using various learning strategies. (see Appendix D). The MSLQ was translated and adapted into Turkish by the researcher of the current study. Translated version of the questionnaire (see Appendix E) was examined by three instructors from faculty of education and an instructor from the basic English department who academically carries out research on translation. In line with the suggestions, Turkish version of the questionnaire was revised and adapted into Turkish. This form of the questionnaire was piloted using 319 tenth and 169 eleventh grade students enrolled in state schools (n=177), Anatolian high schools (n=273), and private schools (n=38) which are located in different regions of Ankara. Of the students who responded to the demographic questions 58.1 % were males (n=254) and 41.9 % were females (n=183). Mean age of the students was 16.59. Their mean biology grade was 4.06. The questionnaire was administered to entire classes at one time. Students were advised to complete the questionnaire in its entirety, not to discuss their responses with others near them, to be as sincere as possible. Students were reminded that their responses will be kept confidential. After questionnaires were completed, data were first entered into SPSS, then for the confirmatory factor analysis LISREL was used.

There are essentially two sections to the MSLQ, a motivation section, and a learning strategies section. In the English version of the questionnaire, motivation section consists of 31 items that assess students' goals and value beliefs for a course, their beliefs about their skill to succeed in a course, and their

anxiety about tests in a course. The 31 motivation items were tested to see how well they fit six latent factors: Intrinsic Goal Orientation, Extrinsic Goal Orientation, Task Value, Control of Learning Beliefs, Self-Efficacy for Learning and Performance, Test Anxiety. In the Turkish version, these dimensions were tested by Confirmatory Factor Analysis using LISREL. Several fit statistics were provided for the English version of the questionnaire: the chi-squared to degrees of freedom ratio ($\chi 2/df = 3.49$); the goodness of fit index (GFI = 0.77); and the root mean residual (RMR = 0.07). Pintrich, Garcia, & McKeachie (1991) claimed that although the goodness of fit indices are not within acceptable limits, they are quite reasonable values, because motivational attitudes may differ depending upon course characteristics, teacher demands, and individual student characteristics. So, they proposed that overall the models show sound structures. When the fit statistics for the Turkish version were examined, it was found that $\chi 2/df = 5.3$, GFI = 0.77, and RMR = 0.11. These values appeared to be reasonable when the fit indices for English version are considered. However, it should be noted that the values for both English and Turkish version do not indicate a good fit.

Lambda-ksi estimates for the latent factors for both version of the questionnaire are presented in Table 4.5.2.1. Lambda-ksi estimates are analogous to factor loadings in an exploratory factor analysis, and values of 0.8 or higher indicate well-defined constructs. Table 4.5.2.2 shows Phi values which are estimates for the covariances between the latent constructs.

Table 4.5.2.1 Lambda ksi Estimates for Motivation

	Indicator	English Version LX estimate	Turkish Version LX estimate
Intrinsic Goal Orientation	q1	0.64	0.55
	q16	0.69	0.61
	q22	0.66	0.74
	q24	0.55	0.74
Extrinsic Goal Orientation	q7	0.71	0.86
	q11	0.58	0.82
	q13	0.48	0.15
	q30	0.44	0.14
Task Value	q4	0.57	0.54
	q10	0.64	0.73
	q17	0.88	0.84
	q23	0.86	0.83
	q26	0.88	0.80
	q27	0.84	0.84
Control Beliefs about Learning	q2	0.57	0.80
	q9	0.38	0.28
	q18	0.84	0.86
	q25	0.47	0.44
Self-Efficacy for Learning	q5	0.83	0.73
	q6	0..70	0.72
	q12	0.63	0.71
	q15	0.71	0.73
	q20	0.86	0.74
	q21	0.89	0.79
	q29	0.77	0.77
	q31	0.87	0.73
Test Anxiety	q3	0.60	0.33
	q8	0.42	0.48
	q14	0.62	0.67
	q19	0.88	0.57
	q28	0.76	0.61

Table 4.5.2.2 displays the estimates for the covariances between the latent constructs. In this table IGO, EGO, TV, CLB, SELP, TA represents Intrinsic Goal Orientation, Extrinsic Goal Orientation, Task Value, Control of Learning Beliefs, Self-Efficacy for Learning and Performance, Test Anxiety, respectively. ENG is the English version, TUR is the Turkish version.

Table 4.5.2.2 Phi Estimates

		IGO	EGO	TV	CLB	SELP
EGO	(ENG)	0.27				
	(TUR)	-0.39				
TVe	(ENG)	0.83	0.24			
	(TUR)	0.90	-0.40			
CLB	(ENG)	0.54	0.18	0.45		
	(TUR)	0.47	-0.01	0.49		
SELP	(ENG)	0.69	0.26	0.55	0.66	
	(TUR)	0.61	-0.18	0.63	0.68	
TA	(ENG)	-0.18	0.22	-0.17	-0.26	-0.39
	(TUR)	-0.01	0.33	-0.09	-0.11	-0.29

Table 4.5.2.3 presents the Cronbach's alphas for English Version and Turkish Version of the questionnaire.

Table 4.5.2.3 Reliability Coefficients

	IGO	EGO	TV	CLB	SELP	TA
ENG	0.74	0.62	0.90	0.68	0.93	0.80
TUR	0.73	0.54	0.87	0.62	0.89	0.62

The learning strategy section of the Motivated Strategies for Learning Questionnaire includes 31 items regarding students' use of different cognitive and metacognitive strategies, namely, Rehearsal, Elaboration, Organization, Critical Thinking, Metacognitive Self-Regulation and 19 items concerning student management of different resources, namely, Time and Study Environment, Effort Regulation, Peer Learning, Help Seeking. Therefore, there are 9 scales constituting this part of the questionnaire. In the Turkish version, these scales were tested by Confirmatory Factor Analysis using LISREL as it was done previously for the motivation scales. Fit statistics for the English version of the

questionnaire: was as follows: $\chi 2/df = 2.26$; GFI = 0.78); and RMR = 0.08. Pintrich, et al., (1991) reported that although the goodness of fit indices are not stellar, overall, the model shows sound structures and one can reasonably claim factor validity for the scales given the fact that deployment of the various learning strategies may differ depending upon course characteristics, teacher demands, and individual student characteristics.. When the fit statistics for the Turkish version were examined, it was found that $\chi 2/df = 4.5$, GFI = 0.71, and RMR = 0.08. These values were similar to that of English version of the questionnaire. Considering the fact that reliability of the dimensions and fit indices of Turkish version are comparable with original version, it was decided that Turkish version will be used without modification. In Turkish version, $\chi 2/df$ value was below 5 which is the sign of good fit. In addition, some of the fit statistics not mentioned so far such as RMSEA indicated good fit having the value of 0.08 which is below 0.1. Also, RMR value was the same as the English version of the questionnaire. The only deviation was in GFI. As Pintrich, Garcia, & McKeachie (1991) pointed out, the fit statistics found appear to be reasonable values given the fact that students' motivation, strategy use may differ depending on course characteristics, teacher characteristics, and individual characteristics. Lambda-ksi estimates for the latent factors for both version of the questionnaire, and Phi estimates are presented in Table 4.5.2.4 and 4.5.2.5 respectively.

Table 4.5.2.4 Lambda ksi Estimates for Learning Strategies

	Indicator	English Version LX estimate	Turkish Version LX estimate
Rehearsal	q39	0.62	0.70
	q46	0.63	0.73
	q59	0.56	0.60
	q72	0.58	0.64
Elaboration	q53	0.60	0.71
	q62	0.60	0.54
	q64	0.74	0.78
	q67	0.42	0.63
	q69	0.71	0.78
	q81	0.65	0.53
Organization	q32	0.57	0.55
	q42	0.55	0.75
	q49	0.45	0.52
	q63	0.75	0.81
Critical Thinking	q38	0.49	0.62
	q47	0.76	0.69
	q51	0.66	0.73
	q66	0.74	0.69
	q71	0.67	0.78
Metacognitive Self-Regulation	q33	0.40	0.42
	q36	0.44	0.64
	q41	0.47	0.61
	q44	0.54	0.51
	q54	0.53	0.48
	q55	0.58	0.69
	q56	0.43	0.53
	q57	0.35	0.01
	q61	0.60	0.69
	q76	0.61	0.71
	q78	0.55	0.70
	q79	0.50	0.61
Time and Study Environment	q35	0.52	0.58
	q43	0.81	0.75
	q52	0.52	0.33
	q65	0.56	0.36
	q70	0.64	0.68
	q73	0.37	0.70
	q77	0.48	0.44
	q80	0.40	0.55
Effort Regulation	q37	0.53	0.60
	q48	0.65	0.42
	q60	0.52	0.59
	q74	0.74	0.74
Peer Learning	q34	0.54	0.59
	q35	0.82	0.58
	q50	0.84	0.73
Help Seeking	q40	0.20	0.23

Table 4.5.2.4 continued

q58	0.17	0.34
q68	0.90	0.77
q75	0.79	0.77

Table 4.5.2.5 shows the estimates for the covariances between the latent constructs. In this table R, E, O, CT, MSR, TSE, ER, PL, HS represents Rehearsal, Elaboration, Organization, Critical Thinking, Metacognitive Self-Regulation, Time and Study Environment, Effort Regulation, Peer Learning, Help Seeking, respectively.

Table 4.5.2.5 Phi Estimates

		R	E	O	CT	MSR	TSE	ER	PL
E	(ENG)	0.46							
	(TUR)	0.81							
O	(ENG)	0.71	0.65						
	(TUR)	0.99	0.82						
CT	(ENG)	0.27	0.76	0.48					
	(TUR)	0.58	0.86	0.59					
MSR	(ENG)	0.58	0.85	0.75	0.73				
	(TUR)	0.92	0.88	0.90	0.76				
TSE	(ENG)	0.55	0.57	0.59	0.41	0.76			
	(TUR)	0.73	0.75	0.74	0.63	0.84			
ER	(ENG)	0.45	0.59	0.48	0.38	0.78	0.95		
	(TUR)	0.61	0.61	0.62	0.50	0.76	0.88		
PL	(ENG)	0.28	0.19	0.28	0.28	0.23	0.13	0.07	
	(TUR)	0.51	0.62	0.50	0.60	0.58	0.43	0.29	
HS	(ENG)	0.31	0.23	0.28	0.14	0.27	0.20	0.19	0.70
	(TUR)	0.50	0.48	0.45	0.38	0.52	0.39	0.22	0.79

Table 4.5.2.6 presents the Cronbach's alphas for English Version and Turkish Version of the questionnaire.

Table 4.5.2.6 Reliability Coefficients

	R	E	O	CT	MSR	TSE	ER	PL	HS
ENG	0.69	0.76	0.64	0.80	0.79	0.76	0.69	0.76	0.52
TUR	0.73	0.78	0.71	0.81	0.81	0.73	0.62	0.61	0.57

The Turkish version of the MSLQ was used in the current study to investigate the effect of PBL on students' motivation, and learning strategies

4.5.3 Learning Style Inventory (LSI)

It is a 12-item inventory developed by Kolb (1985) to evaluate the way students learn and how they deal with ideas and day-to day situations in their lives. Kolb's model is based on the idea that learners use the following four learning modes: a) concrete experience b) reflective observation c) abstract conceptualization, and d) active experimentation But no single mode entirely describes one's learning style. This because each person's learning style is a combination of the four basic modes. In fact, Kolb's model identifies two dimensions of learning, processing and perception. Processing dimension is characterized by a continuum of experiences from concrete experience (doing) to reflective observation (watching). Perception dimension is characterized by a continuum of experiences from active experimentation (feeling/sensing) to abstract conceptualization (thinking). By combining these two opposing dimensions Kolb defined four general learning styles: Accommodator, Diverger, Converger, and Assimilator. Accommodators perceive concretely, and process actively. Divergers perceive concretely and process reflectively. Convergers

perceive abstractly and process actively. Assimilators perceive abstractly and process reflectively.

This inventory was translated and adapted into Turkish by Askar and Akkoyunlu (1993). The reliability of the each sub-scale corresponding to each learning mode was 0.58, 0.70, 0.71, and 0.65, respectively. In the current study, it was administered to students to determine their learning styles as part of the information regarding sample characteristics. Also, results were used to form heterogeneous groups in the experimental group to maximize the interaction among students with different learning styles.

4.5.4 Peer Evaluation Form

It is the evaluation form used in the Problem Based Learning Pathway at the College of Medicine, at the Ohio State University to evaluate the students' participation in their small groups. It was translated into Turkish by the researcher and translated statements were examined by an instructor from faculty of education and an instructor from the Basic English Department. Moreover, students' opinions about clarity of the statements were sought for before the treatment begins. After the treatment, students in the experimental group evaluated each other with respect to participation, preparation, interpersonal skills, and contribution to group progress. In this way, it was expected that students become aware of to what extent they behaved as intended individually and as a group. Results of the peer evaluation were not used in the statistical analysis.

4.6 Treatment (PBL vs. TDBI)

This study was carried out over 5 weeks during 2003-2004 fall semester at an Anatolian School in Ankara. A total of 61 students from two biology classes of the same teacher were involved in the study. One of the classes was assigned as the experimental group and other as the control group. Experimental group was instructed by problem-based learning. Control group received traditionally designed biology instruction. The topics related to human excretory system were covered as part of regular classroom curriculum in the biology course. The classroom instruction was four 45-minute sessions per week.

The traditionally designed biology instruction involved lessons with lecture/questioning methods to teach concepts. Teaching strategies relied on teacher explanation and textbooks. The students studied the textbooks on their own before the class hour. The teacher structured the entire class as a unit, wrote notes on the chalkboard about definition of concepts and drew figures of structures related to the human excretory system. For example, at the beginning of the lesson the teacher drew structure of the excretory system on the board and she labelled the important structures such as kidney, ureter, urinary bladder, and urethra on the figure by herself without interacting with students. Then she asked students what might be role of the excretory system. Students mainly mentioned about role of the excretory system in the elimination of waste products. After listening to a few students' responses, she listed functions of the human excretory

system. Next, she drew structure of the kidney and again labelled the important kidney structures. After that she started to talk about nephron as a functional unit of the kidneys and urine formation. The teacher stated that basic processes in the urine formation are filtration and reabsorption. Before, explaining what filtration and reabsorption were she drew the nephron structure on the board and labelled the important parts such as Bowman's capsule, glomerulus, proximal convoluted tubule, loop of henle, distal convoluted tubule, and collecting tubule. Then, she asked students whether they had any idea about these structures. Some students tried to explain structures and their role on the urine formation but the information they presented was mainly based on their textbooks. After listening to students, teacher made a definition of filtration and reabsorption and mentioned about the sites where these two basic processes occur. A two-class hour lecture ended with stating this brief information. Teacher asked students to study filtration and absorption before coming to next class hour. At the beginning of next class hour, the teacher wanted students to tell what they learned in the previous lesson. Students recalled and summarized what were mentioned in the previous lesson. At the same time, they talked about filtration and reabsorption as far as they learned from their textbooks. Then teacher started to give detailed information about these processes and their role in the urine formation. After that she mentioned about role of the excretory system in homeostasis. She emphasized relation between the excretory system and other organ systems. She talked about two hormones, aldosterone and ADH, and their importance in the regulation of water and inorganic-ion balance. She, finally, stated that to keep excretory system healthy,

to prevent kidney stones, people should drink plenty of water, if any pain or difficulty occurs during urination, or there is blood in the urine, one should immediately see a doctor. In this way, in the control group, lecture on the human excretory system was completed and it took four-class hours to complete. In general, in the control group, where the traditionally designed biology instruction was used, the primary underlying principle was that knowledge resides with the teacher and that it is the teacher's responsibility to transfer that knowledge as fact to students.

In the experimental group, before implementing the problem based learning, five groups were formed. There were 6 students in each group. Groups were formed so that interaction among students with different learning styles, academic performance, and gender was optimized. In line with this idea, learning style inventory was administered to students; and information regarding their biology grade in previous year and gender were collected. Based on the findings, it was determined that there should be 2 girls in each group and of 2 girls one should be with converger learning style. Because there were just 10 girls in the experimental group and 5 of them had converger learning style. Boys were assigned to groups first based on their previous grades, then on their learning styles. Since most of the boys had assimilator type learning style (n=14), heterogeneity of the groups could be maximized based on their grades.

After groups were formed, training of students and the teacher started in the first week of the study. For this purpose, the handbooks prepared for the students (see appendix F) and the teacher (see Appendix G) were distributed by the researcher. The only difference between the student handbook and the teacher handbook was that role of the teacher was explained in more detailed manner in the teacher handbook. Considering the fact that students might not read what was written on the handbooks, the researcher explained what the PBL was and described a typical PBL class emphasizing the roles of students and teacher in detail. Then, students were informed about the groups with which they would work starting with next class hours and they were reminded that they can refer to the handbook to remember what were expected from them as a PBL student and how a typical PBL session looks like. Explanation of the PBL took two class hours. Next class hour was cancelled due to general physics exam. On the final class hour of the week, Human Excretory System Achievement Test was given to students as pre-test. The MSLQ was administered to students as pre-test almost a month ago not to make students bored with repeated administrations of the instruments in a relatively short period of time as both pre-test and post-test. .

In the second week of the study, respiratory system unit was started to be covered in line with problem based learning. The reason why the PBL was started to be implemented before the excretory system unit was to make students familiar with the PBL and their expected roles. As a first step in the implementation of the PBL, some volunteer roles such as scriber, reader, doctor, and patient were

assigned to students in each group. Reader was responsible for reading aloud the case information distributed over pages. Scribe served to write the facts, ideas, hypotheses, and learning issues on a sheet with these headings prepared by the researcher. The doctor interviewed the patient and patient answered the doctor's questions based on the case information. The cases used in this study were written by the director of Problem Based Learning pathway at College of Medicine and Public Health, at the Ohio State University, a nephrologist, an emergency room doctor at the same university and the researcher. The case about the respiratory system (see Appendix H) was based upon an actual patient. The information about the patient was distributed over seven pages and presented one at a time. When the case was started, first page was distributed to all students. Second page was given only to the student who would role play a patient. On the first page there was information about age, gender, and chief complaint of the patient: The patient was a 68-year-old male brought in Emergency Room complaining of high fever, productive cough, and fatigue. The reader in each group read the information given and the scribe summarized it on the sheet. Students started to discuss about the possible organ systems involved and associated diseases. Meanwhile, the researcher randomly selected one of the five groups and observed their group work thoroughly. At the same time, the researcher circulated among the groups and acted both as a student and a teacher to make the teacher and students familiar with their roles whenever it was needed. In the group that the researcher observed, one student told that the patient might be suffering from AIDS because in the case of AIDS, one's immune system is very weak and thus he/she is more likely to feel

tired and have an infectious disease causing fever. However, most of the students thought that the symptoms seemed to be related to the respiratory system. In fact, some students said that he might be suffering from bronchitis or lung cancer. Other students mentioned that he might have just a flue and since he is old the symptoms may be appearing more seriously than expected. After discussing about the possible organ systems and diseases, they tried to identify the questions to be asked to patient to get further information. The questions were related to family history, medical history, social history, and history of present illness. For example, students decided to ask the following questions: When did symptoms start? Does he smoke? Is there a pain while breathing? Did he receive or donate blood? What is his job? Under which conditions does he work? Does he have a chronic disease? Apart from asking these questions, they decided to have chest X-ray, laboratory test results, specifically, white blood cells, and listen to breathing sounds. Scribe listed these general elements of history on the sheet. Next, student who would act as the doctor started to interview the patient. Patient answered the questions based on the information given on the second page. If something not mentioned on the page was asked, the patient said I don't know or the teacher answered saying yes or no. For instance, one of the questions was whether he received or donated blood. They asked this question, because they thought that if he was AIDS this could be due to the un-sterilized needle used during blood transfer. Answer of this question was not available on the second page and the teacher said no; he didn't receive or donate blood. Scribe wrote the information obtained from the interview. Then second page was distributed to all students and

reader read the page. Based on the new information provided, students revised their previous ideas and decided that the disease he might not be suffering from flue because he had a productive cough with initially rust-colored, then purulent sputum. They said that if it was a simple flue, there wouldn't be purulent sputum. Since he had a history of smoking for the past 40 years, and had an increasing shortness of breath, students thought that his illness was most probably related to the respiratory system. They identified stages of tuberculosis, diseases associated with the respirator system as learning issues. Scribe summarized all these under the heading of ideas/hypotheses and learning issues. Then, facilitator gave third page to all students and reader read it. Teacher asked which of the diagnosis was/were not possible based on the physical exam results? Students concluded that the patient might be suffering from a respiratory disease such as bronchitis or lung cancer since lungs had decreased breath sounds with wheezes and crackles throughout all lung fields. In addition, they found heart rate to be high as well as breathing rate. Since they couldn't be sure about the normal breathing rate, they identified it as one of the learning issues. When there was 10 minutes left, the teacher asked students whether they wanted to continue to discuss or to evaluate their performance orally. Students wanted to evaluate their performance. Each student expressed his/her opinions. In general, they thought that their progress on the case was good. The teacher and the researcher gave advice on determination of learning issues and said that they shouldn't be too specific or too general. While deciding on the learning issues, they can think of the book chapters. Moreover, they advised that students should focus on the underlying basic science

rather than making diagnosis. What is more, researcher reminded students that they can bring any books or materials to the class to help them work efficiently during group process. Also, they can go to school library and make use of the different resources including written, electronic or human resources. After that, the two-class hour group session ended. Next session started with a patient presentation. The student making patient presentation called presenter in each group was selected by lottery. Presenter summarized previous sessions' work by describing relevant case data. She also mentioned about her opinion of the problem, based on the findings and knowledge she acquired from independent study before the session. In this way, presenter provided a link between previous session and next session. Students continued to discuss on the case. The presenter of group which the researcher observed mentioned that there can be inflammation in the patient's lungs because he had purulent sputum, decreased breath sounds, and high breathing rate. Based on her research on respiratory system diseases, she said that he can be suffering from bronchitis or pneumonia. Other students in the group agreed with her. After this group discussion, presenter of each group shared the ideas generated as result of his/her independent study and group work to whole class. In this way, groups interacted with each other and it was ensured that all the groups were at the same point, agreed upon the learning issues to study. In fact, discussion among groups revealed that all the groups had learning issues related to respiratory system and the ideas, hypotheses generated were similar. After the whole class discussion, students in the groups tried to guess what might be the laboratory test results. Most of the students thought that if there was an

inflammation, number of white blood cells in the blood had to be more than normal. Also, they expected abnormal levels of blood gases since the role of respiratory system is to provide gas exchange between the body and air. After discussing on the possible diseases and test results, they requested fourth page. Reader read the page. The laboratory test results were as they expected. They suggested that low pCO_2, and pO_2 levels indicated interference in gas exchange in the lungs most probably due to an inflammation. They indicated that high white blood cell count supported their claim. Next, they wanted to see chest X-ray results. The teacher gave the fifth page. Information presented on this page was in agreement with their thoughts and to be able sure about the inflammation students suggested to take a tissue sample from the lungs and culture it. The researcher asked them what might be the alternative to this approach and wanted them to review what they knew about the patient. Students reviewed what they knew, the ideas/ hypotheses they generated and one of the students realised that the patient had purulent sputum so his sputum can be cultured instead of taking tissue sample. Other students agreed with him. Then, the teacher gave them sixth page. The information provided made students sure that there was an inflammation of the patient's lungs. Since students as tent graders were not expected to make a diagnosis and propose a treatment, seventh and last page of the case was distributed afterwards. The reader read the page and students decided to learn about respiratory system until next class hour. Finally, students briefly evaluated their performance. In general, they found their performance good but wanted the teacher and the researcher to be more active.

In the third week, a student from each group selected by lottery explained what he/she learned about the respiratory system during out-of-class searches. They mostly, talked about function of the respiratory system and suggested that the teacher should tell them what to study because it was difficult for them to decide on what to study and what was important to learn. In line with their suggestions, the teacher and the researcher decided that at the end of the case about the excretory system, keywords which can guide students while studying would be given. Since it was realized that students had difficulty in what to study and it was the first time that they were involved in such a student-centred class, the teacher made a summary of important points, and answered students' questions about the respiratory system. However, this was not something like transfer of knowledge from the teacher to the students but sharing of ideas and knowledge between the teacher and the students since students studied, made search about the respiratory system before coming to the class. They did so, because, presented with a problem, students needed to find information to fill in missing gaps. The researcher and the teacher agreed on following the same strategy for the excretory system unit allowing better understanding of the related topics by exchange of ideas and knowledge. The respiratory system unit was completed at the end of two-class hour. Before the break, a work sheet on which there was a figure showing interrelationships among organ system (see Appendix I)was distributed to students. Students were asked to write an essay explaining these relationships until next class hour. The purpose of giving this worksheet to students was to prepare them to the problem related to the excretory system:

Students did not learn about the excretory system before. So, they would learn about this system for the first time as a result of the PBL. If they had no idea about a topic, it wouldn't be appropriate to introduce a problem related to that topic. Students were expected to read about the excretory system and use the knowledge they gained to be able to write their essays. They already knew about other organ systems. So, when they had a general idea about the excretory system, it would be easier for them to deal with the problem and use their knowledge about physiology to propose solutions and to make interpretations. Next class hour, they brought their essays and shared the information they gained with each other. They discussed their ideas. Two of the students' essays about the relationships among organ systems were presented in Appendix J.

In the fourth week, the case related to the excretory system was introduced to students. Students worked in their previous groups and the volunteer roles were assigned to them. The researcher again randomly selected one of the five groups to observe thoroughly, and at the same time she completed the treatment verification checklist (see Appendix K) prepared by herself to determine to what extent the treatment was made as intended in the class. The case (see Appendix L) was based upon an actual patient. The information about the patient was distributed over seven pages and presented one at a time. When the case was started, first page was distributed to all students. Second page was given only to the student who would role play a patient. On the first page there was brief information about the patient: The patient was a 37-year-old male brought to the

Emergency Department 9 hours following an automobile accident. He was brought to the hospital by people who had witnessed the accident, because they were concerned that he was injured more severely than he looks. He was complaining of a severe abdominal pain. The reader in each group read the information given and the scribe summarized it on the sheet. Students started to discuss about the possible organ systems that might be affected by the accident. Most of the students thought that the patient might have an injury in the abdominal region and there can be an internal bleeding. They stated that some organs in the abdomen can be seriously affected. Some other students claimed that ribs of the patient may have been broken. Another idea arisen from the group was that he might have hit his head and there can be injury in the head. Students played around their ideas thoroughly and decided that chest X-ray, brain tomography, blood tests should be ordered in order to test their ideas and to be sure about the site of injury. Also, they wanted to measure the patient's blood pressure, heart rate. At this point, the teacher asked why they wanted to measure the blood pressure and heart rate. One of the students said that if there is an internal bleeding, blood pressure has to be low, because volume of the blood circulating will be low. So, if we find that blood pressure is low, it might support our claim that he might be suffering from an internal bleeding. Another student added to this statement that if there is an internal bleeding the patient might appear weak, because cells cannot get enough oxygen and glucose necessary for their activities. As a result of this discussion students determined internal bleeding and trauma as learning issues. Then students tired to decide on which questions to

ask to the patient to get further information. They identified just the following question: how did accident happen? Other groups identified some other question such as whether he was wearing seat belt, whether he drank alcohol, whether he hit his abdomen during accident, whether he had an external bleeding, and whether he had a chronic disease. After deciding on the questions, student who would act as the doctor started the interview. At this point, the teacher reminded the groups that it is better to interview with the patient's wife because she has no injury and can better answer the questions than the patient himself. Thus, the student who would role play the patient, role played patient's wife. Patient's wife answered the question based on the information given on the second page. Scribe summarized the information provided under the heading of what we know. This information was about how accident happened. When the teacher circulating among the groups realized that there was just one question generated by this group, she asked students to review what they know and the ideas they generated and try to decide on what they need to know, thus what additional questions can be asked? One of the students said that we can ask whether he was taking any medications or suffering from any disease. This information is important because some of the symptoms that might be observed can be due to the medication or the disease making situation more complicated. For example, as far as I know if someone has diabetes bleeding time increases so if he has internal bleeding, the situation may become worse due to diabetes. In addition to this idea, the student who expected the patient to appear weak, tired suggested that appearance of the patient can be checked. Other students agreed with them and the questions about

medical history of the patient, and his present condition were asked. Scribe summarized the information provided by the patient's wife under the heading of what we know. Then, the teacher distributed the second page to all students and reader read the page. Students thought that the new information they gathered from the second page supports their claim about internal bleeding: the patient was weak and pale. Students proposed that his rapid breathing can be due to the body's response to compensate for the oxygen deficiency caused by blood loss. One of the students generated another idea: according to her, these symptoms can be due to just shock resulted from the accident. So, the group decided the symptoms of shock as a learning issue. Meanwhile, they continued their idea about the possible trauma in the head. After these discussions they requested the third page from the teacher. The reader read the page, and scribe summarized the information provided on the sheet. A sample sheet filled by a scribe regarding "what we know", "ideas/hypothesis", and "learning issues" is given in Appendix M. Based on the new information, students excluded the trauma and shock possibility. They agreed on the idea that the physical exam results did not indicate any problems in the nervous system. The patient was conscious. According to them, the lethargy, pale, and cool hands and feet with some purple mottling, low blood pressure, high breathing rate, high heart rate and pain in the abdominal region could be caused by internal bleeding. Moreover, they thought that there was no problem in the circulatory system or in the lungs because the physical findings were within normal limits. They mentioned that abnormal physical exam results were the results of internal bleeding: since there was blood loss, to

compensate for the loss and distribute enough oxygen and glucose to cells heart beat increased, to provide more oxygen to the body breathing rate increased. What is more, according to students blood pressure dropped due to the decrease in blood volume caused by internal bleeding. When there was 10 minutes left, the teacher asked students whether they wanted to continue to discuss or to evaluate their performance orally. Students wanted to evaluate their performance. Each student expressed his/her opinions. In general, they thought that they worked in the group well. However, they mentioned about the difficulties they faced with due to the unfamiliarity with some terminology, concepts while making interpretations. For example, they said that they realized they did not know what exactly the systolic and diastolic blood pressures were. They wanted the teacher to be more active and make explanations whenever they needed. The teacher and the researcher advised all groups to make use of different resources instead of directly seeking information from the teacher. Students were reminded that they had to prepare a report in which they discuss and synthesize the ideas/hypotheses generated during the group process and what they learned as a result of independent study until next class hour. Next session started with a patient presentation. The student making patient presentation called presenter in each group was selected by lottery. Presenter summarized previous sessions' work by describing relevant case data. He/she also mentioned about her opinion of the problem, based on the findings and knowledge she acquired from independent study before the session. The presenter of group which the researcher observed mentioned that all the case information provided so far supported their claim that the patient was suffering

from internal bleeding. The reports submitted by two of the five presenters are given in Appendix N. Other students in the group agreed with him. After this group discussion, presenter of each group shared the ideas generated as result of his/her independent study and group work to whole class. In this way, groups interacted with each other and it was ensured that all the groups were at the same point, agreed upon the learning issues to study. In fact, discussion among groups revealed that all the groups had learning issues related to internal bleeding and the ideas, hypotheses generated were similar. After the whole class discussion, the researcher suggested that students in the groups tried to guess what might be the laboratory test results. Because she realized that students behaved as if the purpose was to find a solution to the case problem and they found the solution which was internal bleeding. The researcher said that students' approach to the case was appropriate so far. They approached the problem from different aspects, tried to support their ideas with information they gathered from textbooks, books, and some other resources like their doctor relatives. However, they shouldn't forget that the object of the PBL is not to diagnose the case, but to use it to identify topics for further independent and/or group study to be able to learn the basic underlying science. She mentioned that there is still new information they need to gather and learn to better understand the patient's situation. After this comment, students begin to discuss about the possible test results. One of the students in the group which the researcher observed thoroughly proposed that blood gases may not be within the normal range. The patient's breathing was rapid and shallow and this most probably occurred to compensate for oxygen

deficiency caused by bleeding. So, the oxygen level may still be low in spite of the increased breathing rate. Other students agreed with this student. Then the teacher gave the fourth page. At this point, students were told that the abnormal white blood cell and platelet counts was a normal consequence for this patient so they shouldn't concentrate on these values and try to interpret other results. These abnormal values for white blood cells and platelets were the result of internal bleeding but for a tenth grade student it was not easy to realize this. The values were given because the case reflected a real patient. However, other blood test results could be interpreted by the students based on their previous knowledge and some outside search. After this explanation, students started discussion. They said that low pCO_2 and pO_2 values were as expected and in congruence with their previous ideas and information provided so far. According to them this finding further supported their thoughts about internal bleeding. The teacher asked how they can be sure about internal bleeding. One of the students suggested ordering ultrasound. Then the teacher asked whether everybody agreed with him. After other students told that they agreed, the teacher distributed fifth page. Reader read the page information. Based on the new evidence that there was blood in the abdominal cavity, students became sure that there was and internal bleeding. Meanwhile, students recognized that blood creatinine and BUN values given on the fourth page were slightly above the normal range. So, they started to think about a problem in excretory system because they stated that function of the excretory system was to eliminate waste products such as urea. They identified function and structure of the excretory system as a learning issue. Next, students

asked whether there were some other pages from which they could get additional information about the patient. The teacher gave the sixth page to the students. Based on the information on the sixth page students thought that there was something wrong in the kidneys. Because as time passed, the blood BUN and creatinine levels increased much above normal ranges. Moreover, although there shouldn't be protein, white blood cell, red blood cell in the urine, they began to appear in the urine. Two of the students in the group decided to go to the library to bring books to help them better understand and interpret the results. They brought books related to biology and general health. For example, they searched for the definition of urea and creatinine from the Medicana General Health Encyclopaedia. In addition, they searched for under which circumstances blood urea level increases. They found that in the case of renal failure, urea level increases. Based on these findings, students strongly agreed to study on the excretory system outside the class. To guide students about what to study some keywords such as kidney, nephron, filtration, reabsorption, secretion, creatinine, urea, ADH, and aldosterone were given to students. Since there was no time left, no evaluation of student and group performance could be made at the end of this session.

In the fifth week, first session was started with patient presentation. A presenter from each group was selected by lottery. Presenter summarized previous sessions' work and mentioned about her opinion of the problem, based on the findings and knowledge she acquired from independent study before the session.

Reports written by two of the five presenters were given in Appendix O. After students discussed with each other about their previous work and the information they gathered from outside resources, groups shared their ideas with each other. Students were agreed that there was a problem in filtration due to the decrease in blood pressure caused by blood loss. Moreover, they thought that there can be damage in glomerulus and tubules due to oxygen deficiency. Since most of what the students mentioned were in congruence with the scientific knowledge and not just personal opinions, the teacher did not interrupted the students' discussion. But, to be sure that all students studied the human excretory system in a detailed manner and learned important topics, the teacher wanted students prepare a homework related to structure and function of the human excretory system until next session. At the beginning of next session, homeworks were collected and randomly selected students were asked to explain the human excretory system. The teacher listened to them without intervening. When there was 30 minutes left, the teacher asked students whether there was anything not clear in their minds. A few students said that they had difficulty in understanding the factors affecting glomerular filtration rate. Then the teacher asked who wanted to explain it and allowed the volunteer students explain the glomerular filtration. The teacher made some contributions to them saying about the role of plasma proteins in glomerular filtration. In this way, excretory system unit was completed in line with the PBL in which cases served as a basis for learning the basic science. At the end of the implementation students evaluated each other with respect to participation, preparation, interpersonal skills, and contribution to group progress using peer

evaluation form given in Appendix P. A typical PBL group process can be summarized as follows:

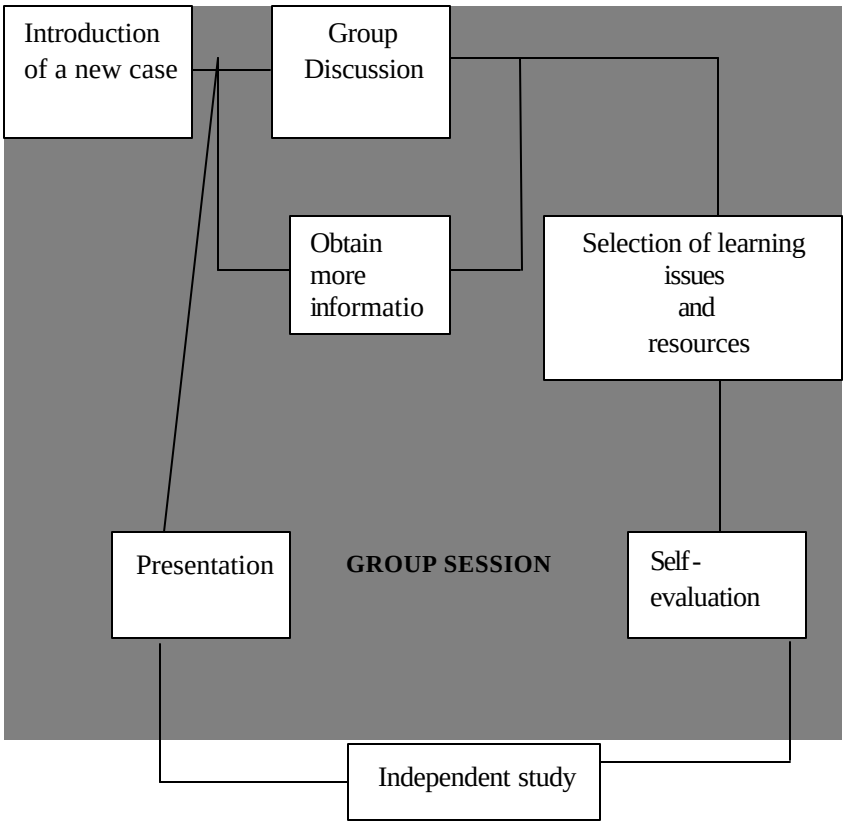

Figure 4.6.1 The PBL Group Process

Therefore, the tutorial group (students and facilitator) was the key element of the problem based learning. Every member of the group had some expected responsibilities for the success of the implementation. Students were supposed to participate actively in the discussion of the group. They had to express their ideas, feelings and share their knowledge and experiences with each other. Apart

from being involved in the group work, each student had to conduct an independent study and evaluate his/her learning at both individual and group levels. In problem based learning, students were supposed to select their own learning issues and decide upon the appropriate depth for study. Other roles students played were volunteer roles which included the doctor, the patient, the reader, the scribe. The doctor interviewed the patient asking the questions determined as a result of group discussion. The reader read the pages providing increasing amount of case information. The scribe wrote the facts, ideas, hypotheses, learning issues identified by the group. The presenter selected by lottery summarized the previous sessions' work by describing relevant case data. In this way, presenter provided a link between previous session and next session. The teacher organized the groups and created a comfortable atmosphere. She distributed the case material at the appropriate time, keeping the group on the track. The teacher ensured that students had the control of the discussion. When guidance was needed, she asked open ended, very general questions. She did not jump in just to break the silence, encouraged critical thinking. Use of the treatment verification checklist prepared by the researcher revealed that most of the expected features of the PBL was observed during the treatment: ill-structured problem was introduced to students. Students always worked in groups, identified learning issues, helped each other, group members showed respect to each other, teacher handed out the case material at appropriate times, encouraged student to student interaction, asked open-ended, non-directive questions, established a relaxing atmosphere, and kept groups on track. Besides these, students

frequently shared relevant information they obtained though individual out-of-class study with each other, evaluated group performance, their own individual performance after each session, the teacher ensured equal participation, and encouraged critical thinking.

After the treatment, in the sixth week, the HESAT and the MSLQ were administered as post-test to measure students' academic achievement and performance skills in the unit of the excretory system and students' motivation and learning strategies, respectively.

4.7 Analysis of Dat a

MANOVA will be usedto investigate the effect of problem based learning on students' academic achievement, performance skills in the unit of human excretory system; and students' motivation and learning strategies.

4.8 Assumptions and Limitations

4.8.1 Assumptions

1. The teacher was not biased during the treatments.
2. Test was administered under standard conditions.

3. Students answered test questions seriously.
4. Students in control and experimental groups did not interact with each other.

4.8.2 Limitations

1. The subjects of this study was limited to 61 tenth grade students at an Anatolian High School in Ankara during 2003-2004 fall semester. Their experiences and expectations may not reflect the typical students enrolled in state or private schools in Ankara or in other parts of the country. Therefore, the results may not be reliable if generalized beyond students enrolled in a similar situation.

2. This study was limited to “human excretory system” unit in biology.

3. Students in the experimental group worked in groups. This might have led to the violation of independency of observations assumption of MANOVA.

4. Fit indices obtained as a result of Confirmatory Factor Analysis were not within acceptable limits. Although they were reasonable values, results should be interpreted cautiously.

CHAPTER 5

RESULTS AND CONCLUSIONS

The results are divided into three sections. In the first section, statistical analysis of the pretest scores on the HESAT and the MSLQ are presented while in the second section, statistical analysis of the hypotheses stated in Chapter 3 based on posttest scores are displayed. In the last section, students' opinions about the problem based learning are given.

5.1 Statistical Analysis of Pretest Scores

Prior to treatment, three separate One-Way Multivariate Analysis of Variance (MANOVAs) were conducted to determine. whether there was a statistically significant mean difference between control and experimental groups with respect to academic achievement and performance skills in the unit of human excretory system and perceived motivation and learning strategies. Statistical analyses were performed at 0.05 significance level using Statistical Package for Social Sciences (SPSS).

Before, interpreting MANOVA outputs, multivariate normality and homogeneity of the variance-covariance matrices assumptions were checked. For multivariate normality assumption, skew ness and kurtosis values for the individual dependent variables were checked. In addition, Box's M test results were also taken into consideration because a significant Box's M statistics can be due to the violation of the multivariate normality assumption. So, Box's M test results can indirectly give an idea about multivariate normality assumption. What is more, homogeneity of the variance-covariance matrices assumption was tested with Box's M statistics.

5.1.1 Statistical Analysis of the Human Excretory System Achievement Test Scores

Of three separate MANOVAs conducted before the treatment, first was performed to determine whether there was statistically significant mean difference between control and experimental groups with respect to academic achievement and performance skills in the unit of human excretory system. Descriptive statistics for the dependent variables of the first MANOVA including skewness and kurtosis values across groups were presented in Table 5.1.1.1 In the table, CG refers to control group, while EG refers to experimental group. Skewness and Kurtosis values in this table can be considered as an indication of a univariate normality for the individual dependent variables across experimental and control groups. What is more, nonsignificant Box's M test

result proposed that multivariate normality was met and variances and covariance among the dependent variables were the same across groups $F(2, 53) = 0.11$, $p = 0.90$. These results revealed that two of the assumptions of MANOVA, multivariate normality, and homogeneity of variance and covariance matrices, were met.

Table 5.1.1.1 Descriptive Statistics with respect to Academic Achievement (AA), and Performance Skills (PS).

	N		Mean		Std. Dev		Skewness		Kurtosis	
	CG	EG	CG	EG	CG	EG	CG	EG	CG	EG
AA	28	28	5.68	6.04	2.83	3.32	0.21	-0.05	0.13	-0.69
PS	28	28	0.96	1.00	0.69	0.61	0.05	0.00	-0.76	0.01

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Having met the assumptions, MANOVA was run to investigate whether there was a significant mean difference between groups with respect to collective dependent variables of academic achievement (AA) and performance skills (PS) before the treatment. MANOVA results were displayed in Table 5.1.1.2.

Table 5.1.1.2 MANOVA results with respect to collective dependent variables of AA and PS.

Source	Wilks'Lambda	*F*	Significance (*p*)
Treatment	0.99	0.11	0.90

The results given in the table above indicated that there was no statistically significant mean difference between students in the experimental and the control group with respect to collective dependent variables of academic achievement and performance skills before the treatment.

5.1.2 Statistical Analysis of the Motivated Strategies for Learning Questionnaire Scores

Second and third MANOVAs were conducted to investigate whether there was a statistically significant mean difference between experimental and control groups with respects to students' motivation and learning strategies before the treatment, respectively. More specifically, second MANOVA was run to determine whether there was a statistically significant mean difference between students in the experimental and the control group with respect to motivation collective dependent variables of students' Intrinsic Goal Orientation (IGO), Extrinsic Goal Orientation (EGO), Task Value (TV), Control of Learning Beliefs (CLB), Self-Efficacy for Learning and Performance (SELP), Test Anxiety (TA), and third MANOVA was run to investigate whether there was statistically significant mean difference between students in the experimental and the control group with respect to collective dependent variables of Rehearsal (R), Elaboration (E), Organization (O), Critical Thinking (CT), Metacognitive Self-Regulation (MSR), Time and Study Environment (TSE), Effort Regulation (ER), Peer Learning (PL), Help Seeking (HS) before the treatment. Descriptive

statistics for the dependent variables of second MANOVA are presented in Table 5.1.2.1.

Table 5.1.2.1 Descriptive Statistics with respect to IGO, EGO, TV, CLB, SELP, TA.

	N		Mean		Std. Dev		Skewness		Kurtosis	
	CG	EG	CG	EG	CG	EG	CG	EG	CG	EG
IGO	31	30	3.69	3,79	1.28	1.11	-0.08	-0.13	-0.07	-1.13
EGO	31	30	4.69	4.86	1.50	1.40	0.26	-0.21	-1.31	-0.39
TV	31	30	4.29	4.14	1.20	0.10	-0.17	-0.22	-0.91	-0.47
CLB	31	30	4.63	4.83	1.03	1.40	0.16	0.01	-0.03	-0.95
SELP	31	30	3.99	4.07	1.15	1.43	0.29	0.35	-0.80	-0.84
TA	31	30	3.38	3.54	1.61	1.44	-0.05	0.63	-0.85	-0.23

Table 5.1.2.2 shows descriptive statistics for the dependent variables of third MANOVA

Table 5.1.2.2 Descriptive Statistics with respect to R, E, O, CT, MSR, TSE, ER, PL, HS

	N		Mean		Std. Dev		Skewness		Kurtosis	
	CG	EG	CG	EG	CG	EG	CG	EG	CG	EG
R	31	30	3.90	4.20	1.27	1.16	0.23	-0.25	-0.25	0.07
E	31	30	4.09	4.00	1.33	1.10	-0.54	-0.09	-0.21	-0.99
O	31	30	4.31	4.23	1.55	1.29	-0.34	-0.02	-0.71	-0.92
CT	31	30	3.46	3.64	1.32	1.25	0.22	0.77	-0.84	0.16
MSR	31	30	4.06	4.27	1.14	1.11	0.27	0.26	-0.49	-0.39
TSE	31	30	4.04	4.36	1.13	1.05	0.40	0.73	-0.13	0.05
ER	31	30	3.90	3.94	1.43	1.29	-0.11	0.15	-0.55	-0.18
PL	31	30	3.04	2.90	1.29	1.51	0.16	0.55	-0.99	-0.03
HS	31	30	4.35	4.14	1.52	1.63	-0.39	0.01	-0.93	-1.05

As it can be deduced from the tables, skewness and kurtosis values were tolerable for all the dependent variables of two analyses indicating univariate normality. In addition, nonsignificant Box'M test results both for the second and third MANOVAs were the sign of a multivariate normality and homogeneity of variance and covariance matrices, F (21, 12772) = 1.19, p = 0.24 and F (45, 11409) = 0.90, p = 0.67, respectively. .

Having met assumptions of MANOVA, second and third MANOVAs were interpreted. Results were displayed in Table 5.1.2.3 and Table 5.1.2.4 respectively.

Table 5.1.2.3 MANOVA results with respect to collective dependent variables of IGO, EGO, TV, CLB, SELP, TA,

Source	Wilks'Lambda	F	Significance (p)
Treatment	0.88	1.21	0.32

Results revealed that there was no statistically significant mean difference between students in the experimental and the control group with respect to collective dependent variables of IGO, EGO, TV, CLB, SELP, TA. before the treatment so, students in two groups were similar regarding their motivation in biology prior to treatment. The same result was found concerning use of learning strategies (Table 5.1.2.4). There were no statistically significant mean difference between students in experimental and the control group with

respect to collective dependent variables of R, E, O, CT, MSR, TSE, ER, PL, HS before the treatment.

Table 5.1.2.4 MANOVA results with respect to collective dependent variables of R, E, O, CT, MSR, TSE, ER, PL, HS

Source	Wilks'Lambda	*F*	Significance (*p*)
Treatment	0.91	0.56	0.82

As it can be inferred from the findings, students in the experimental and control groups were similar with respect to academic achievement, performance skills, motivation and leaning strategies prior to treatment. Following section presents the results concerning the effect of problem based learning on these variables.

5.2 Statistical Analysis of Posttest Scores

Statistical analysis of the hypotheses stated in Chapter 3 based on posttest scores are given below:

Hypothesis 1:

The first hypothesis was that there is no statistically significant mean difference between the groups exposed to problem based learning and traditionally designed biology instruction with respect to academic achievement

and performance skills in the unit of human excretory system in the population of all the 10th grade Anatolian School students in Ankara

Hypothesis 2:

There is no statistically significant mean difference between the boys and girls with respect to academic achievement and performance skills in the unit of human excretory system in the population of all the 10th grade Anatolian High School students in Ankara .

Hypothesis 3:

There is no interaction between treatment and gender with respect to academic achievement and performance skills in the unit of human excretory system in the population of all the 10th grade Anatolian High School students in Ankara.

These hypotheses was tested by running two-way MANOVA where the treatment and gender were independent variable and academic achievement (AA) and performance skills (PS) were dependent variables. Descriptive statistics for the dependent variables across the experimental (n=30) and control groups (n=29) and gender (38 boys and 21 girls) were displayed in Table 5.2.1

Table 5.2.1. Descriptive Statistics with respect to AA and PS

	Mean		Std. Dev		Skewness		Kurtosis	
	CG	EG	CG	EG	CG	EG	CG	EG
AA	17.75	21.03	2.43	1.81	0.56	-0.42	0.32	-0.48
PS	1.49	2.39	0.68	0.95	1.36	0.14	1.20	-0.53
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
AA	19.61	19.10	1.66	1.35	-0.47	0.79	-1.11	0.20
PS	1.89	2.11	0.68	0.95	0.88	0.22	-0.07	-1.02

Table 5.2. 1 showed that experimental group had the higher mean score on academic achievement and performance skills Moreover, skewness and kurtosis values displayed in the table can be considered as tolerable values indicating a univariate normality for the individual dependent variables across experimental and control groups. In general, a high positive kurtosis value indicates an abnormally 'peaky' distribution, while a high negative kurtosis value indicates abnormally flat distribution. In a symmetric distribution, the value of kurtosis and skewness is zero. Accordingly, the skewness and kurtosis values for the AA and PS can be considered as a sign of univariate normality, which may be an indication of multivariate normality. However, significant Box's Test result suggested that that homogeneity of variance and covariance matrices assumption was not met $F(9, 12126) = 2.24$, $p = 0.02$. Results of Levene's Test performed to check whether each dependent variable has the same variance across groups were presented in Table 5.2.2

Table 5.2.2 Levene's Test of Equality of Error Variances

	F	df1	df2	*p*
AA	4.06	3	55	0.01
PS	2.97	3	55	0.04

The results revealed that homogeneity of variance assumption was not met for all dependent measures. Therefore, while interpreting results, these findings should be taken into consideration. After checking the assumptions, two-way MANOVA was conducted. Results of the analysis were shown in Table 5.2.3

Table 5.2.3 MANOVA results with respect to collective dependent variables of AA and PS

Source	Wilks' Lambda	Hypothesis df	Error df	Multivariate *F*	Sig. (*p*)	Eta-Squared	Observed Power
Treatment	0.45	2	54	33.57	0.000	0.55	1.00
Gender	0.95	2	54	1.43	0.249	0.05	0.29
Treatment* Gender	0.89	2	54	3.23	0.051	0.11	0.59

The findings showed that there was a significant mean difference between the experimental and the control groups with respect to collective dependent variables. The multivariate η^2 based on Wilk's Λ was strong, 0.55, implying that the magnitude of the difference between the groups was not small. In fact, this value indicated 55 % of multivariate variance of the dependent variables was associated with the treatment What is more, power, which is the probability of detecting a significant effect when the effect truly does exist in nature, was found to be 1. These findings implied that the difference found between the experimental and control groups arouse from the treatment effect and this difference had practical value. On the other hand, it was found that there was no significant mean difference between boys and girls with respect to

collective dependent variables and there was no interaction between treatment and gender. .

In order to determine the effect of the treatment on each dependent variables running univariate ANOVA's were run. Table 5.2.4 displays the results of univariate ANOVAs

Table 5.2.4. Follow-Up Pairwise Comparisons

Source	Dependent Variable	df	*F*	Significance (*p*)	Eta-Squared	Observed Power
Treatment	AA	1	57.72	0.000	0.512	1.000
	PS	1	24.06	0.000	0.304	0.998

As it can be inferred from the table, the univariate ANOVAs for the dependent variables of academic achievement and performance skills were significant ($p<0.05$) indicating that there was a statistically significant mean difference between the groups with respect to these two variables. When the mean scores given in Table 5.2.1 were examined, students in the experimental group outperformed on the test. Students' academic achievement was measured by the items written at knowledge level as well as at the comprehension level and beyond in Bloom's Taxonomy. Results indicated that although it appeared that students in the experimental and control groups had similar responses on the items requiring simple recall, students in the experimental group could better integrate and organize the knowledge on different topics in biology and on different subject areas such as chemistry. For example, almost all of students in

the experimental (100 %) and control groups (96.6 %) answered the item 8 correctly which required them to remember the definition of tubular reabsorption as on of the basic renal processes. However, when the percentages of correct responses to item 19 asking students to determine which basic renal processes occur for any molecule X that is freely filtered at the glomerulus, if the clearance of X is less than that of creatinine, it was realized that students in the control group had difficulty in using their knowledge on basic renal processes and inferring the consequences of these processes. In fact, only 44.8 % of students in the control group answered this question correctly, while the corresponding percentage was 90 in the experimental group. Similar striking differences were apparent between the experimental and the control groups on majority of the items measuring their ability to integrate and organize knowledge. For instance, item 18 asking students to combine their knowledge on excretory system, circulatory system, endocrine system and homeostasis required them to identify the factor leading to an increase in urine volume. To be able to answer this question student had to realize the relationship between the blood volume, plasma osmotic pressure, and glomerular filtration rate. Moreover they had to recognize the role of ADH in the regulation of fluid balance in the body acting on tubular cells. Also, students had to infer that a decrease in sodium reabsorption, ultimately, leads a decrease in extra-cellular blood volume increasing volume of urine formation. 48.3 % of students in the control group responded to this item correctly making the connections among their knowledge on different biological concepts. On the other hand, percentage of students who answered this item

correctly in the experimental group was 93.3 indicating that experimental group students were more successful in integrating knowledge. What is more, students responses to essay type item (item no: 26) revealed that students in the experimental group could better use relevant information in addressing the problems, interpret of information, and use the principles to judge objectively. In this item, a case based on a patient was given to students and they were asked to write a comprehensive essay in the light of questions provided to them to explain the patient's situation. 65.5 % percent of students wrote their essays just listing the case information, and they ended their essays with one sentence indicating that patient was suffering from an illness related to excretory system. These students' responses were scored as 1. Because, they just presented the information but did not make interpretation. They proceeded as if the purpose was to find out the single, correct answer. They did not provide any information or evidence that supports their claim about the patient. However, percentage of students in the experimental group who approached the problem this way and thus received 1 was 23.3. Experimental group students, in general, could better identify what they know and its relation to patient's case. They could make better interpretations based on evidences. Accordingly, they first mentioned about what they knew about the patient on their essays and based on the patient's complaints and laboratory test results they indicated that most probably there is something wrong in his kidneys. They supported their claim giving information about the functions of kidneys. Then they tried to explain the symptoms in relation to possible consequences of malfunctioning of kidneys.

For example, 43.3 % of students mention that normally plasma proteins are not filtered into Bowman's capsule, so no protein is expected in the urine. Since, there is protein in the urine of the patient; students claimed that there can be damage in glomerulus structure. These students also realized the plasma proteins and its role in plasma osmotic pressure and indicated that the reason for swollen feet and ankles can be the decrease in the plasma osmotic pressure. 19.9 % of students could further suggest that accumulation of large volume of fluid results in decrease in blood volume and thus blood pressure and these changes trigger the secretion of aldosterone, which stimulates the kidneys to conserve sodium ions and water. They predicted that this action reduces the urine output and increases blood pressure. Nevertheless, most of the students (93.3 %) failed to realize the relationship between protein metabolism and its relation to blood urea nitrogen. They tried to explain the reason for controlling protein intake as the protein loss by the urine. However, in general, students in the experimental group were better in using, integrating and interpreting relevant information while proposing solutions.

Hypothesis 4:

Is there a significant population mean difference between the groups exposed to problem based learning and traditionally designed biology instruction with respect to students' perceived motivation (Intrinsic Goal Orientation, Extrinsic Goal Orientation, Task Value, Control of Learning Beliefs, Self-Efficacy for Learning and Performance, Test Anxiety)?

Hypothesis 5:

Is there a significant population mean difference between boys and girls with respect to students' perceived motivation (Intrinsic Goal Orientation, Extrinsic Goal Orientation, Task Value, Control of Learning Beliefs, Self-Efficacy for Learning and Performance, Test Anxiety)?

Hypothesis 6:

Is there any interaction between treatment and gender with respect to students' perceived motivation (Intrinsic Goal Orientation, Extrinsic Goal Orientation, Task Value, Control of Learning Beliefs, Self-Efficacy for Learning and Performance, Test Anxiety)?

These hypotheses were tested by running two-way MANOVA where the treatment and gender were independent variables and intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performance, and test anxiety were dependent variables. Descriptive statistics for the dependent variables across the experimental (n=30) and control groups (n=31) and gender (boys=39, girls=22) were displayed in Table 5.2.

Table 5.2.5. Descriptive Statistics with respect to IGO, EGO, TV, CLB, SELP, TA

	Mean		Std. Dev		Skewness		Kurtosis	
	CG	EG	CG	EG	CG	EG	CG	EG
IGO	3.94	5.23	1.43	0.90	-0.27	-0.11	-0.73	-1.02
EGO	4.91	5.16	0.85	0.88	-0.57	-0.34	0.06	-0.24
TV	4.52	5.39	1.38	0.90	-0.34	-0.58	-0.61	0.19
CLB	5.25	5.27	1.05	0.76	-0.21	0.28	-0.67	-0.17
SELP	4.99	3.90	0.10	1.08	-0.20	-0.05	-1.04	-0.99
TA	3.44	4.69	1.11	0.86	0.10	-0.35	-1.24	-0.01
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
IGO	4.46	4.80	1.17	1.63	-0.57	-0.94	-0.65	0.46
EGO	5.24	4.66	0.83	0.86	-0.49	-0.42	0.26	-0.49
TV	4.74	5.33	1.23	1.20	-0.57	-1.17	-0.23	1.83
CLB	5.15	5.57	0.89	0.91	0.26	-0.91	-0.25	1.29
SELP	4.93	5.48	0.83	0.92	-0.01	-1.00	-0.80	0.64
TA	3.92	3.21	1.11	0.98	-0.29	-0.13	-0.87	-0.68

Table 5.2.5 showed that experimental group had the highest mean score on each dependent measure. Concerning gender, the table indicated that girls had higher mean scores than boys on each dependent variable except extrinsic goal orientation and test anxiety. Moreover, skewness and kurtosis values displayed in the table indicated univariate normality for the individual dependent variables across independent variables. This finding can be considered as a sign of meeting multivariate normality assumption of MANOVA. Nonsignificant Box's Test result, further suggested that multivariate normality assumption was met as well as homogeneity of variance and covariance matrices assumption $F(63, 4222) = 1.19$, $p = 0.145$. Results of Levene's Test performed to check whether each dependent variable has the same variance across groups were presented in Table 5.2.6

Table 5.2.6. Levene's Test of Equality of Error Variances

	F	df1	df2	*p*
IGO	3.85	3	57	0.01
EGO	1.46	3	57	0.24
TV	2.43	3	57	0.08
CLB	1.12	3	57	0.35
SELP	1.63	3	57	0.19
TV	1.48	3	57	0.23

The results revealed that there was violation of homogeneity of variance assumption for the dependent measures of intrinsic goal orientation. However, it should be notified that Box' Test allowing to test the assumption of homogeneity of variances and covariances among the dependent variables across groups did not yield a significant result indicating homogeneity of variance and covariance matrices. After checking the assumptions, two-way MANOVA was conducted. Results of the analysis were shown in Table 5.2.7.

Table 5.2.7. MANOVA results with respect to collective dependent variables of IGO, EGO, TV, CLB, SELP, TA

Source	Wilks' Lambda	Hypothesis df	Error df	Multivariate *F*	Sig. (*p*)	Eta-Squared	Observed Power
Treatment	0.69	6	52	3.98	0.002	0.32	0.95
Gender	0.73	6	52	3.26	0.009	0.27	0.90
Treatment* Gender	0.86	6	52	1.37	0.246	0.14	0.49

The findings showed that there was a significant mean difference between the experimental and the control groups with respect to collective dependent variables. The multivariate η^2 based on Wilk's Λ was strong, 0.32, implying that the magnitude of the difference between the groups was not small.

In fact, this value indicated 32 % of multivariate variance of the dependent variables was associated with the treatment What is more, power, which is the probability of detecting a significant effect when the effect truly does exist in nature, was found to be very high, 0.95. Moreover, it was found that there was a significant mean difference between boys and girls with respect to collective dependent variables. Parallel to the findings concerning the treatment, η^2 based on Wilk's Λ was strong, 0.27, and power was high, 0.90

In order to determine the effect of the treatment on each dependent variables univariate ANOVA's were run. Table 5.2.8 displays the results of univariate ANOVAs

Table 5.2.8. Follow-Up Pairwise Comparisons

Source	Dependent Variable	df	*F*	Significance (*p*)	Eta-Squared	Observed Power
Treatment	IGO	3	19.35	0.000	0.25	0.99
	EGO	3	1.57	0.215	0.03	0.23
	TV	3	8.91	0.004	0.14	0.84
	CLB	3	0.22	0.638	0.01	0.08
	SELP	3	1.78	0.188	0.03	0.26
	TA	3	0.92	0.342	0.02	0.16
Gender	IGO	3	1.85	0.180	0.03	0.27
	EGO	3	6.50	0.013	0.10	0.71
	TV	3	4.32	0.042	0.07	0.53
	CLB	3	2.98	0.090	0.05	0.40
	SELP	3	6.02	0.017	0.10	0.67
	TA	3	6.48	0.011	0.11	0.73
Treatment * Gender	IGO	3	0.93	0.340	0.02	0.16
	EGO	3	0.92	0.341	0.02	0.16
	TV	3	0.03	0.871	0.00	0.05
	CLB	3	0.05	0.816	0.01	0.06
	SELP	3	0.00	0.968	0.00	0.05
	TA	3	4.36	0.041	0.07	0.54

As it can be inferred from the table, concerning gender there was significant mean difference between boys and girls with respect to perceived extrinsic goal orientation, task value, self-efficacy for learning and performance, and test anxiety. The mean scores given in Table 5.2.5 were examined it was found that girls tend to perceive biology as a more interesting, more important, and more useful course and perceive themselves to be more self-efficacious in their learning. In addition, results revealed that boys' perceived test anxiety was higher than that of girls and boys perceived themselves more extrinsically goal oriented. Concerning treatment, the univariate ANOVAs for the dependent variables of intrinsic goal orientation and task value were significant ($p<0.05$) indicating that there was a statistically significant mean difference between the groups with respect to these two variables. When the mean scores were examined, it was found that perceived intrinsic goal orientation of students in the experimental group was higher than that of the control group students. So, they tend to study biology for reasons such as challenge, curiosity, and mastery. For instance, while 60 % of the students in the experimental rated their agreement with the statement of "when I have opportunity in this class, I choose course assignments that I can learn from even if they don't guarantee a good grade" (item no: 24) as 5, 6, ad 7, the percentage of agreement in the control group was 37.7. Moreover, students in the experimental group appeared to perceive biology as a more interesting, more important, and more useful course which is indicated by a higher mean score on the task value scale of the MSLQ. This finding was, also, reflected in the percentage of the students who agreed with the

statements in this scale. For example, while 86 % of students in the experimental group rated the statement “I think the course material in this class is useful for me to learn” (item no:23) as 5, 6, and 7, this percentage was 61.3 in the control group. Percentages of agreement with the selected items in the intrinsic goal orientation scale and task value scale across groups were presented in Table 5.2.9

Table 5.2.9 Percentages of responses to selected items of the IGO and the TV scale

Scale	Item Number	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 (%)	7 (%)
IGO	1 (C)	25.8	19.4	3.2	29.0	16.1	3.2	3.2
	(E)	0	0	3.3	26.7	26.7	26.7	16.7
	24 (C)	16.1	12.9	19.4	12.9	19.4	16.1	3.2
	(E)	3.3	0	6.7	30	30	23.3	6.7
TV	10 (C)	3.2	3.2	6.5	19.4	25.8	6.5	35.5
	(E)	0	0	3.3	3.3	30	30	33.3
	23(C)	3.2	0	19.4	16.1	19.4	16.1	25.8
	(E)	0	6.7	0	6.7	20	33.3	33.3

On the other hand, results indicated that there was no statistically significant mean difference between the experimental and the control groups with respect to extrinsic goal orientation, control of learning beliefs, self-efficacy for learning and performance, and test anxiety.

Hypothesis 7:

Is there a significant population mean difference between the groups exposed to problem based learning and traditionally designed biology instruction

with respect to students' perceived use of learning strategies (Rehearsal, Elaboration, Organization, Critical Thinking, Metacognitive Self-Regulation, Time and Study Environment, Effort Regulation, Peer Learning, Help Seeking)?

Hypothesis 8:

Is there a significant population mean difference between boys and girls with respect to students' perceived use of learning strategies (Rehearsal, Elaboration, Organization, Critical Thinking, Metacognitive Self-Regulation, Time and Study Environment, Effort Regulation, Peer Learning, Help Seeking)?

Hypothesis 9:

Is there any interaction between treatment and gender with respect to students' perceived use of learning strategies (Rehearsal, Elaboration, Organization, Critical Thinking, Metacognitive Self-Regulation, Time and Study Environment, Effort Regulation, Peer Learning, Help Seeking)?

These hypotheses were tested by running two-way MANOVA where the treatment and gender were independent variables and rehearsal, elaboration, organization, critical thinking, metacognitive self-regulation, time and study environment, effort regulation, peer learning, help seeking were dependent variables. Descriptive statistics for the dependent variables across the experimental (n=30) and control groups (n=31) and gender (boys=39, girls=22) were displayed in Table 5.2.10

Table 5.2.10 Descriptive Statistics with respect to R, E, O, CT, MSR, TSE, ER, PL, HS

	Mean		Std. Dev		Skewness		Kurtosis	
	C	E	C	E	C	E	C	E
R	4.06	4.69	1.54	0.86	0.04	-0.49	-1.14	0.25
E	4.28	5.22	1.36	0.88	-0.44	-0.24	-0.21	-0.34
O	4.40	4.95	1.59	1.08	-0.10	-0.70	-1.11	0.44
CT	3.81	4.87	1.39	0.95	-0.02	0.16	-1.00	-0.42
MSR	4.55	5.24	1.12	0.64	-0.18	-0.42	-0.63	-0.12
TSE	4.60	5.00	1.15	0.76	-0.66	0.11	-0.40	-0.97
ER	4.73	5.38	1.51	0.90	-0.71	-0.20	-0.40	-0.88
PL	3.49	4.51	1.64	0.76	0.05	-0.31	-1.45	1.16
HS	4.02	4.28	1.53	0.94	-0.10	-0.37	-0.64	-0.68
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
R	4.21	4.65	1.54	0.86	-0.36	-0.53	-0.46	-0.44
E	4.28	5.22	1.36	0.88	-0.32	-1.86	-0.22	0.66
O	4.40	4.95	1.59	1.08	-0.21	-1.19	-1.03	1.67
CT	3.81	4.87	1.39	0.95	-0.16	-0.67	-0.51	0.23
MSR	4.55	5.23	1.12	0.64	-0.41	-1.17	-0.60	1.45
TSE	4.61	5.00	1.15	0.76	-0.48	-1.30	-0.19	1.19
ER	4.72	5.38	1.51	0.90	-0.82	-0.77	0.11	1.11
PL	3.50	4.51	1.64	0.76	-0.76	-0.33	-0.11	-1.05
HS	4.01	4.28	1.52	0.94	0.16	-0.43	-0.25	-0.35

Table 5.2.10 showed that girls and experimental group had higher mean scores on each dependent measure. Moreover, skewness and kurtosis values displayed in the table indicated a univariate normality for the individual dependent variables across experimental and control groups which can be considered as a sign of meeting multivariate normality assumption of MANOVA. However, Box's Test result was found to be significant which may be due to violation of the multivariate normality. The significant Box's M statistics mainly indicated that homogeneity of variance covariance matrices assumption was violated, $F(135, 3976) = 1.33$, $p = 0.007$. Results of Levene's Test showing whether each dependent variable has the same variance across groups were presented in Table 5.2.11

Table 5.2.11 Levene's Test of Equality of Error Variances

	F	df1	df2	*p*
R	14.97	3	57	0.002
E	7.23	3	57	0.021
O	7.83	3	57	0.036
CT	4.74	3	57	0.077
MSR	12.89	3	57	0.008
TSE	6.65	3	57	0.179
ER	7.57	3	57	0.102
PL	28.43	3	57	0.000
HS	5.88	3	57	0.201

The results revealed that there was violation of homogeneity of variance assumption for the dependent variables of rehearsal, elaboration, organization, metacognitive self-regulation, and peer learning. While interpreting the MANOVA results, these finding should be kept in mind and related F statistics should be interpreted cautiously.

After checking the assumptions, two-way MANOVA was conducted. Results of the analysis were shown in Table 5.2.12

Table 5.2.12 MANOVA results with respect to collective dependent variables of IGO, EGO, TV, CLB, SELP, TA

Source	Wilks' Lambda	Hypothesis df	Error df	Multivariate *F*	Sig. (*p*)	Eta-Squared	Observed Power
Treatment	0.63	9	49	3.19	0.004	0.37	0.96
Gender	0.66	9	49	2.86	0.009	0.34	0.93
Treatment* Gender	0.52	9	49	4.99	0.000	0.48	0.99

The findings showed that there was a significant mean difference between the experimental and the control groups with respect to collective dependent variables. The multivariate η^2 based on Wilk's Λ showed that the magnitude of the difference between the groups was not small. In fact, eta squared value indicated 37 % of multivariate variance of the dependent variables was associated with the treatment What is more, power, which is the probability of detecting a significant effect when the effect truly does exist in nature, was found to be high, 0.87. Moreover, it was found that there was a significant mean difference between boys and girls with respect to collective dependent variables with multivariate η^2 value of 0.34 and power of 0.93. In addition, a significant interaction was found between treatment and gender.

In order to determine the effect of the treatment on each dependent variables univariate ANOVA's were run. Table 5.2.13 displays the results of univariate ANOVAs

Table 5.2.13. Follow-Up Pairwise Comparisons

Source	Dependent Variable	df	*F*	Significance (*p*)	Eta-Squared	Observed Power
Treatment	R	1	3.86	0.054	0.06	0.49
	E	1	13.27	0.001	0.19	0.95
	O	1	3.26	0.076	0.05	0.43
	CT	1	15.52	0.000	0.21	0.97
	MSR	1	8.25	0.006	0.13	0.81
	TSE	1	2.17	0.146	0.04	0.30
	ER	1	5.02	0.030	0.07	0.59
	PL	1	16.56	0.000	0.23	0.98
	HS	1	2.32	0.134	0.04	0.32
Gender	R	1	2.11	0.152	0.04	0.30
	E	1	7.83	0.007	0.12	0.79

Table 5.2.13 continued

	O	1	7.03	0.010	0.11	0.74
	CT	1	0.99	0.323	0.02	0.17
	MSR	1	1.78	0.188	0.03	0.26
	TSE	1	2.30	0.135	0.04	0.32
	ER	1	2.86	0.096	0.05	0.38
	PL	1	1.27	0.264	0.02	0.20
	HS	1	0.95	0.333	0.02	0.16
Treatment*Gender	R	1	0.00	0.967	0.00	0.05
	E	1	0.90	0.348	0.02	0.15
	O	1	0.12	0.726	0.00	0.06
	CT	1	3.42	0.070	0.06	0.44
	MSR	1	0.00	0.936	0.00	0.05
	TSE	1	0.19	0.661	0.00	0.07
	ER	1	7.94	0.007	0.12	0.79
	PL	1	10.79	0.002	0.16	0.90
	HS	1	7.17	0.010	0.11	0.75

As it can be inferred from the table, concerning gender, the univariate ANOVAs for the dependent variables of elaboration and organization were significant ($p<0.05$) indicating that there was a statistically significant mean difference between boys and girls with respect to these two variables. The mean scores presented in Table 5.2.10 showed that girls appeared to perceive themselves as using the elaboration and organization strategies more than the boys. In addition, concerning the treatment, the univariate ANOVAs for the dependent variables of intrinsic elaboration, critical thinking, metacognitive self-regulation, effort regulation, and peer learning were significant ($p<0.05$) indicating that there was a statistically significant mean difference between the groups with respect to these two variables. When the mean scores given in Table 5.2.10 were examined, it was found that students in the experimental group had higher mean scores on these dependent measures. So, they appeared to use elaboration strategies and metacognitive self-regulatory strategies more than the

students in the control group. For example, while 70 % of students in the experimental group rated their agreement with the statement "I try to apply ideas from course readings in other class activities such as lecture and discussion" (item no: 81) as 5, 6, and 7, the corresponding percentage in the control group was 38.7. Similarly, percentage of rating the statement of "I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying" (item no: 61) as 5, 6, and 7 was 86.7 in the experimental group, while it was 61.3 in the control group. In addition, students in the experimental group tend to apply previous knowledge to new situations to solve problems, reach decisions, or make critical evaluations with respect to standards of excellence more than the students in the control group. For instance, 60 % of the experimental group students rated their agreement with the statement "I treat the course material as a starting point and try to develop my own ideas about it" (item no:51) as 5, 6, 7. In the control group, there were no students who rated his/her agreement as 7. So, no students in the control group were completely agreed with this statement. Percentage of students who rated their agreement as 5 and 6 was 32.2. What is more, students in the experimental group tend to control their effort and attention when there are distractions or difficulties, For example, 83.3 % of students in the experimental group rated their agreement with the statement "Even when course materials are dull and uninteresting, I manage to keep working until I finish" (item no: 74) as 5, 6, 7. There were no students who rated this statement as 1, or 2. So most of the students thought that item 74 was very true of them. On the other hand, 67.8 % students in the control

group rated themselves as 5, 6, and 7 on this item. Moreover, students in the experimental group appeared to collaborate with their peers more than the students in the control group. For instance, 80 % of the students in the experimental group rated themselves on the item (item no: 50) "When studying for this course, I often set aside time to discuss the course material with a group of students from the class" as 4, 5, 6, and 7. Corresponding percentage in the control group was 38.7. Percentages of agreement with the selected items in the elaboration, critical thinking, metacognitive self-regulation, effort regulation, and peer learning scale across groups were displayed in Table 5.2.14

Table 5.2.14. Percentages of responses to selected items of the E, CT, MSR. ER and the PL scale

Scale	Item Number	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	6 (%)	7 (%)
E	62 (C)	9.7	32.3	9.7	9.7	12.9	16.1	9.7
	(E)	0	3.3	6.7	26.7	16.7	26.7	20
	81 (C)	22.6	16.1	19.4	3.2	12.9	16.1	9.7
	(E)	0	6.7	23.3	0	30	26.7	1.3
CT	38 (C)	3.2	25.8	9.7	16.1	22.6	16.1	6.5
	(E)	0	0	13.3	20	33.3	20.3	33.3
	51(C)	9.7	25.8	22.6	9.7	16.1	16.1	0
	(E)	0	0	16.7	23.3	26.7	30	3.3
MSR	61 (C)	3.2	6.5	12.9	16.1	25.8	22.6	12.9
	(E)	0	3.3	3.3	6.7	36.7	33.3	16.7
	78(C)	9.7	3.2	22.6	12.9	16.1	25.8	9.7
	(E)	0	0	3.3	3.3	36.7	36.7	20
ER	60* (C)	29	16.1	19.4	6.5	6.5	19.4	3.2
	(E)	26.7	46.7	6.7	10	6.7	3.3	0
	74 (C)	9.7	6.5	9.7	6.5	25.8	22.6	19.4
	(E)	0	0	6.7	10	30	30	23.3
PL	34 (C)	12.9	29	12.9	12.9	22.6	6.5	3.2
	(E)	3.3	6.7	6.7	33.3	33.3	13.3	3.3
	50 (C)	25.8	22.6	12.9	9.7	12.9	9.7	6.5
	(E)	3.3	0	16.7	40	30	10	0

* Reversed Item

In contrast to these findings, results presented in Table 5.2.13 indicated that there was no statistically significant mean difference between the experimental and the control groups with respect to scores on rehearsal, organization, time and study environment, and help seeking scales. However, when the mean scores were examined, it was found that the students in the experimental group had higher scores than the students in the control group. Therefore, they appeared to use rehearsal and organization strategies and to manage their time and study environments more than the control group students. Also, they were more likely to identify someone (peers, instructors) to provide them with some assistance. But, it must be reemphasized that these differences reflected in the mean scores was not statistically significant.

What is more, univariate ANOVA results revealed that there is a significant interaction between treatment and gender with respect to effort regulation, peer learning, and help seeking. These interactions were presented in Figure 5.2.1, 5.2.2, and 5.2.3, respectively.

According to the Figure 5.2.1, although the perceived effort regulation of girls was higher than that of boys in the control group, perceived effort regulation of boys appeared to be higher in the experimental group. However, the difference between boys and girls was more striking in the experimental group.

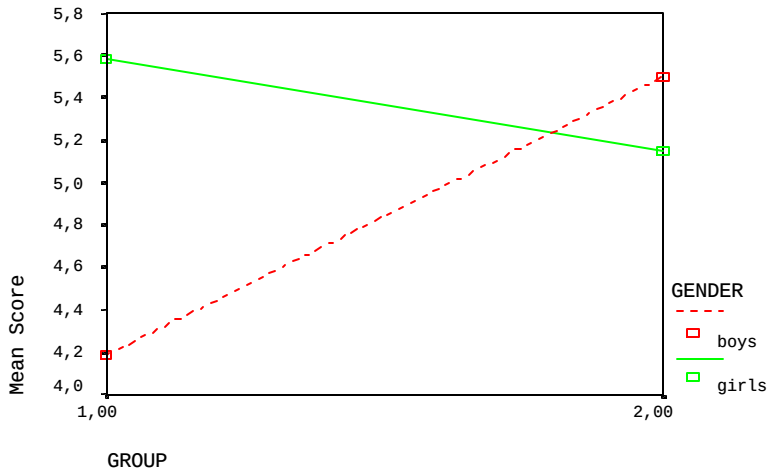

Figure 5.2.1 Interaction Between Treatment and Gender with respect to Effort Regulation

According to the Figure 5.2.2, while boys in the control group appeared to prefer peer learning more than the girls, this situation was reverse in the experimental group.

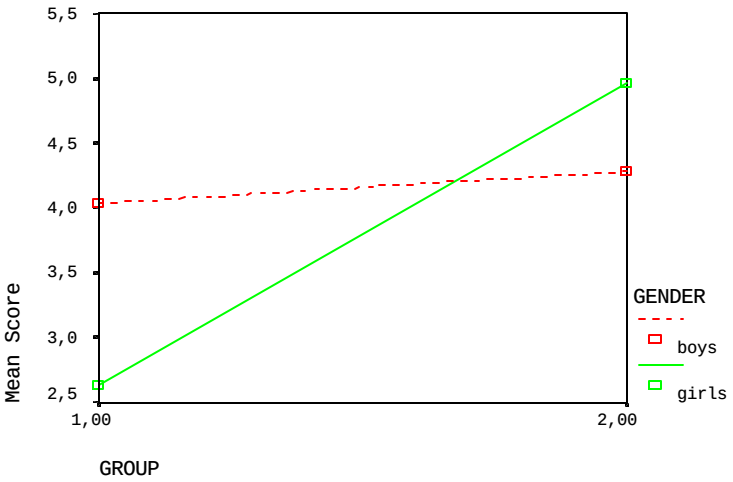

Figure 5.2.2 Interaction Between Treatment and Gender with respect to Peer Learning

According to the Figure 5.2.3, a striking difference existed between boys and girls in the control group with respect to perceived help seeking. Boys appeared to manage support of others more than girls identifying peers and instructors to provide them with assistance. However, in the experimental group, girls appeared to seek help more than boys.

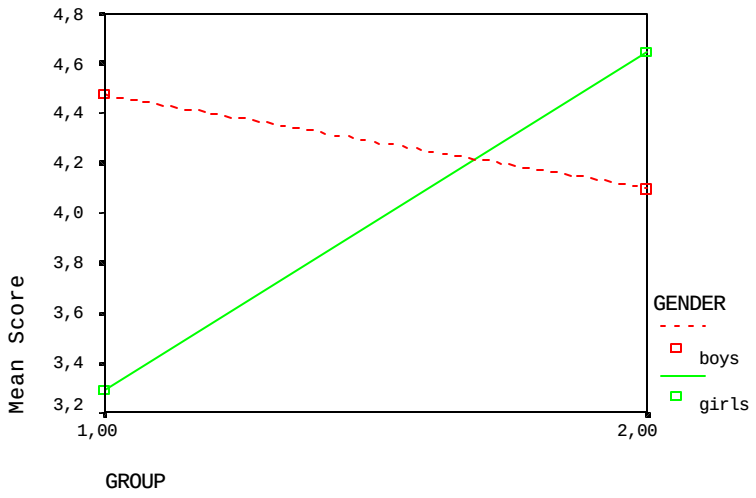

Figure 5.2.3 Interaction between Treatment and Gender with respect to Help Seeking

In summary, findings in this section revealed that there was a statistically significant mean difference between students in the experimental and the control groups with respect to academic achievement, performance skills, intrinsic goal orientation, task value, elaboration, critical thinking, metacognitive self regulation, effort regulation and peer learning. Moreover, it was found that there was a statistically significant mean difference between boys and girls with

respect to extrinsic goal orientation, task value, self-efficacy for learning and performance, test anxiety, elaboration, and organization. In addition, a significant interaction was found between treatment and gender with respect to effort regulation, peer learning, and hep seeking.

5.3 Students' Opinion about the Problem Based Learning

A survey instrument called Problem Based Learning Feedback (see Appendix R) was prepared and administered to students in the experimental group to get their opinions about the PBL after the treatment. The questions in the instrument and selected responses of the students are given below:

Q1. How do you describe PBL? In your opinion, what characteristics best describe PBL?

Student 1: "in this model a group of around 7 students work together. Some roles are assigned to them. Cases are introduced to students to help them learn the related topics.

Student 4: cases related to a topic are discussed by a group of students and they get information about the learning issues they identified. Group, discussion, cases from daily life, increasing amount of information about the case problem provided to students as they discuss are the main characteristics of the PBL, in my opinion.

Student 14: the PBL sessions were based on real life. The "paper patients" in the cases help us better understand biology. Identifying what we know, what we learned, and evidences revealed, interpretations about the patient' problem, learning issues helped us realize the connections among the topics.

Student 19: a case based on real-life problem, inquiry, discussion, interpretation can be the characteristics of the PBL.

The purpose of the first question was to reveal students' perception of the PBL. Answers to this question showed that students identified cases based on real-life problems, small group work, and discussion as key elements of the PBL. According to them, cases were to understand the basic science. Most of the students stated that the PBL helped them learn by identifying what they know, what they need to know, and making interpretations based on evidence.

Q2. Which of these characteristics contributed most to your learning?

Student 2: working in groups, sharing ideas and knowledge, participation, realizing the practical applications of knowledge…especially group discussions, and realizing the practical applications of knowledge contributed to my learning

Student 15: promoting me to make inquiry, accessing different resources

Student 16: active participation of all students, discussion, realizing relevance of what we learn to our lives

Student 18: sharing, inquiry, using outside resources

According to students, cooperation among small group of students, and realization of real life applications of knowledge. development of self-directed learning skills including access to and use of various resources contributed most to their learning.

Q3. What aspects of PBL would you definitely change?

Student 3: nothing

Student 10: I want the teacher to be more active, and respond to our questions.

Student 18: I wish it didn't take so much of my time outside the class and the teacher was more active.

Student 22: nothing, because sessions were very enjoyable.

Students' responses revealed that they were generally pleased with the PBL sessions. However, they stated that they sometimes needed more guidance and the teacher should have been more active.

Q4. What aspects of PBL would you definitely keep?

Student 4: group discussion

Student 7: group discussion, working in groups, respecting others' ideas

Student12: encouraging students to make use of different resources, inquiry

Student 16: active student participation, discussion, emphasis on real life-applications

Student 21: promoting inquiry, use of different out of class resources, group work, making connections between bits of information.

Student 24: everything

According to the students, small group environment in which students are responsible for their own learning was the aspect of the PBL that had to be definitely kept. The analysis of students' answers showed that students were aware of the importance of being in the center of learning process interacting with each other and using different resources

Q5. What problems were faced with during PBL?

Student 3: we were not familiar with some terminology, concepts so making search, accessing resources in order to learn all these took too much of our time.

Student 18: we always faced with uncertainties, unknowns, this led us to carry out continuous search, and interpretations.

Student 19: there was nothing difficult

Students' responses indicated that students had difficulty in adapting to their expected roles. According to them, dealing with uncertainties, a need for continuous inquiry were the difficult aspects of the PBL.

Q6. How would you describe the ideal facilitator? (Science background, knowledge of group process, level of participation/guidance, etc.)

Student 1: he/she should be one who asks questions, encourages participation, group discussion rather than provide answers and give lectures.

Student 10: should know the subject area well, be more active, and respond to students' questions

Student 11: he/she should have significant scientific background, should encourage broad participation from the groups and should distribute case material at appropriate times

Student19: ideal facilitator should keep students on track, provide answer to students' questions, when students complete working on the case, he/she should make a summary of what should be learned. So, he/she should coordinate cases with brief lectures.

Answers of students to above question showed that students were aware of the expected roles of facilitators in the PBL. However, their responses, also, revealed that they wanted facilitators to provide more guidance while deciding on the learning issues, and during group discussions.

Q7. What qualities do you think make for a good PBL student?

Student 14: should be aware of his/her knowledge deficiencies and have desire to learn about them, should be active in the group process, should be ale to think logically, realize the relationships among the concepts.

Student 20: he/she should able to work and think independently, and also be able to interact in a group environment. He/she should be able to accept criticism and make self-evaluation

Student 23: should be a good researcher, and work well in a group.

Purpose of the seventh question was to determine whether students knew what was exactly expected from them as PBL students. Their responses indicated that they were aware of their expected roles in a group process and in the learning process, in general.

Q8. How well written are the cases?

Student 11: they helped us understand related topics better; cases made the course more exciting and enjoyable while learning. Cases were interesting. I think it is a good way to learn.

Student 18: well prepared and reflect real life

Student 19: they were excellent.

According to the students, cases were good and served well for the purpose of the PBL.

Q9. Do you think that any of skills that you acquired in PBL have made a difference in your other academic or social situations? If so, please explain?

Student 10: I became aware of the importance of working in groups, importance of making search, accessing information from different resources, listening to others' opinions and making a synthesis of different opinions with my opinions.

Student 17: I realized that working in a group is very enjoyable. In addition I realized how my ideas changed while discussing and listening

to my friends in the group, I learned how to think systematically and take responsibility.

Student 21: I learned how to work well in a group, my communication skills developed; I feel that my research skills also increased.

Students' answers indicated that they learned how to work in a group and realized the importance of working in a group as a result of the PBL. Moreover, they reported that their research skills were improved and they recognized the importance of making a search, accessing to different resources, and making a synthesis of different opinions, information while forming their own ideas.

To sum up, students' responses to problem based learning feedback form revealed that students were aware of the major characteristics of the PBL and expected roles of students and teachers in this model. Most of the students appreciated the importance of the PBL in their learning and in the development of some social skills such as working in a group effectively, communicating with others in a healthy manner etc. In fact, they reported that realization of real life applications of knowledge, development of skills including access to and use of various resources, and group discussions in which they shared their ideas contributed most to their learning. However, their answers to the fifth question showed that although they are aware of their expected roles and appreciate the importance of them, they had difficulty in adapting to these roles. They found it difficult to deal with uncertainties and unknowns. They wanted more teacher

participation and guidance. They suggested that teacher should provide answers to their questions and brief lectures can be integrated into the PBL sessions.

5.4 Conclusions

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

1. Problem based learning improved students' academic achievement and performance skills, when mean scores of the experimental and control group were compared.
2. Problem based learning had no effect on students' perceived extrinsic goal orientation, control of learning beliefs, self-efficacy for learning and performance, and test anxiety, when mean scores of the experimental and control group were compared.
3. Problem based learning improved students' perceived intrinsic goal orientation and perception of biology in terms of interest, importance, and utility (task value), when mean scores of the experimental and control group were compared.
4. Problem based learning had no effect on students' use of rehearsal, organization strategies, management of their time and study

environment, and help seeking, when mean scores of the experimental and control group were compared.

5. Problem based learning improved students' use of elaboration strategies, metacognitive self-regulation, critical thinking, regulation of their effort, and peer learning, when mean scores of the experimental and control group were compared.
6. Gender had no effect on students' academic achievement and performance skills.
7. Gender had no effect on students' perceived intrinsic goal orientation and control of learning beliefs.
8. Girls' perception of biology in terms of interest, importance, and utility (task value) and perceived self-efficacy for learning and performance was higher than that of boys.
9. Boys' perceived extrinsic goal orientation and test anxiety were higher than that of girls.
10. Gender had no effect on students' perceived use of rehearsal strategy use, critical thinking, metacognitive self-regulation, time and study environment management, effort regulation, peer learning, and help seeking.
11. Girls' perceived use of elaboration and organization strategies was more than that of boys
12. There was a significant interaction between treatment and gender with respect to effort regulation, peer learning, and hep seeking

CHAPTER 6

DISCUSSION, IMPLICATIONS, AND RECOMMENDATIONS

6.1 Discussion

The main purposes of the present study were to investigate the effect of problem based learning and gender on students' academic achievement and performance skills in the unit of human excretory system, and students' perceived motivation (intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performance, test anxiety) and perceived use of learning strategies (rehearsal, elaboration, organization, critical thinking, metacognitive self-regulation, time and study environment, effort regulation, peer learning, help seeking).

In this study, before the treatment, the HESAT and the MSLQ were administered to students both in the experimental and the control groups to determine whether two groups differed with respect to the collective dependent variables of the study. MANOVA results revealed that there was no preexisting differences between two groups with respect to students' academic

achievement and performance skills in the unit of human excretory system; and students' motivation and learning strategies. Determination of the similarity between students in experimental and control groups concerning dependent variables of the study was a good starting point for the treatment. During the treatment, experimental group instructed with problem based learning while students in control group received traditional instruction following traditional textbooks. Results showed that problem based learning improved students' academic achievement (EG_{mean}=21.03; CG_{mean}=17.76) and performance skills (EG_{mean}=2.39; CG_{mean}=1.49). Students' academic achievement was measured by the items requiring students to integrate their knowledge on different topics in biology and on different subject areas such as chemistry as well as the items requiring simple recall of facts and some definitions. For example, item 13 required students to combine their knowledge on excretory system, circulatory system, homeostasis, muscle contraction and nervous system. In this item, the consequences of a decrease in aldosterone secretion on the body were asked. To be able to answer this question, students had to remember that aldosterone is a hormone enhancing sodium reabsorption in kidneys. Then, students had to infer that less aldosterone release results in a decrease in sodium reabsoprtion, ultimately, a decrease in extra-cellular blood volume which contributes to lowering blood pressure. After making this interference, students had to further integrate their knowledge on excretory system and circulatory system to realize the connection between blood pressure and glomerular filtration rate. What is more, they had to see the relation between aldosterone secretion and its

importance in the proper functioning of the nervous system and thus in stimulation of the nerve fibers to a skeletal muscle leading to contraction. When the responses of the students to this item was examined it was realized that majority of the students in the experimental group (93.3 %) selected the correct answer that "when there is a decrease in aldosterone secretion, glomerular filtration rate does not increase" while 79.3 % of the students in the control group the selected the correct response. Similar differences were found between two groups also on such other items revealing that students instructed with the PBL could better integrate the knowledge. Moreover, the responses on the essay type item which aimed at measuring students' performance skills such as articulating uncertainties, use of relevant information in addressing the problem, interpretations of information, use of principles to judge objectively among various options showed that the PBL improved students' performance skills. PBL students appeared to be more proficient in the use and organization of relevant information, in constructing knowledge and moving toward better conclusions. However, when the academic knowledge was considered, no significant difference was found between the PBL students and students in the control group. These findings were in congruence with the findings in the literature. In their meta-analysis, Dochy, Segers, Bossche, and Gijbels (2003) showed that students in the PBL has slightly less knowledge, but remember more of the acquired knowledge and apply it more efficiently. Moreover, they reported that effects of the PBL are moderated by the way the knowledge and skills are assessed, and the more the instrument is capable of evaluating skills to transfer the knowledge, the

larger the ascertained effect of PBL. In addition, Krynock and Robb (1996) stated that PBL does increase higher-level thinking skills by requiring students to think about a problem critically and analyze data to find out solution. Moreover, Nowak (2001) reported that the PBL increases critical thinking skills, problem solving skills, and decision making skills. In fact, what makes the PBL different from other instructional strategies in the development of these skills is that it places students in the center of an authentic, ill-structured problem with no one right answer (Sage, 1996). The problem stimulates students to carry out investigations to satisfy their needs to know, then link the new knowledge into their thinking and decision making processes (Gordon, Rogers, Comfort, Gavula, and McGee, 2001). So, as students struggle with the problem, they become skilled in the critical evaluation and acquisition of new knowledge, with a commitment to life-long learning (Curry, 2002).

What is more, results of the current study revealed that the PBL students tend to participate in a task for reasons such as challenge, curiosity, and mastery. In addition, students instructed by the PBL appeared to perceive biology interesting, important, and useful more than control group students. These findings were revealed by both the statistical analysis and students' opinions. Students indicated that they did out-of-class searches, and tried to learn about the topics because they were curious about the patient's case and wanted to understand it deeply. Moreover, most of the students told that they realized the real life applications of what they learned in the class as a result of the PBL.

Similar results were found in the study performed by Gordon, Rogers, Comfort, Gavula, and McGee (2001). The researchers reported that PBL students values the student centered nature of PBL, the information seeking, the high levels of challenge, the group work, and personal relevance of the material. In fact, Evenson & Hmelo (2000) (as cited in Galand, Bentein, Bourgeois, & Frenay, 2003) stated that PBL is assumed to foster students' motivational beliefs, self-regulation strategies and learning strategies. At this point it should be noted that although the present study showed that the PBL has positive influence on students' intrinsic goal orientation, and task value, it doesn't have effect on control of learning beliefs, self-efficacy for learning and performance, and test anxiety. This can be due to the fact that duration of the PBL implementation was just five weeks. So, this time period may not be enough for realizing the development of expectancy for success or development of beliefs that their efforts to learn will result in positive outcomes. Moreover, since the PBL was a student-centered, novel approach, students might have had concerns about their performance on the exams causing test anxiety. Actually, post-MSLQ results regarding test anxiety revealed that although it was not statistically significant, the scores of the experimental group students were higher than that of the control group students indicating a higher level of test anxiety in the PBL group. Regarding learning strategies, it was found that the PBL enhances students' use of elaboration strategies, critical thinking, metacognitive self-regulation, effort regulation, and peer learning. In their study, Galand, Bentein, Bourgeois, & Frenay (2003) also showed that the PBL students use more deep processing

strategies (especially criticizing) and less surface processing strategies (especially rehearsing). Furthermore, the PBL students reported using more adaptive strategies (especially information search and monitoring) than students from the traditional curriculum. Similarly, the present study revealed that the PBL students use cognitive strategies such as paraphrasing, summarizing, and generative note taking which help them integrate and connect new information more than the students in the control group as indicated by their responses to the MSLQ. Moreover, the extent to which students apply previous knowledge to new situations to solve problems, reach decisions was higher for the PBL students. What is more, the PBL students appeared to use metacognitive self-regulatory activities such as planning, monitoring more than the control group students. Cited by Karabulut (2002), Glaser (1991) claimed that PBL students analyze and discuss problems in a way that they can realize gaps in their own knowledge base and see their own strength and weak points, control their own learning, and develop self-regulatory skills. According to Perry, VandeKamp, Mercer, and Nordby (2002) students can and do engage in self-regulated learning in classrooms where they are provided with opportunities to participate in complex, open-ended activities, make choices that have an influence on their learning, and evaluate themselves and others. Moreover, they reported that instrumental support provided by teachers through questioning, clarifying, correcting, elaborating, modelling and creating an environment in which students can support one another through collaborating, sharing, ideas, and problem solving led students to demonstrate attitudes and actions expected from independent,

academically effective learners: metacognition, intrinsic motivation and strategic action. What is more, according to Karabulut (2002), the PBL creates an environment in which students actively participate in the learning process, take responsibility for their own learning, and become better learners in terms of time management skills, ability to identify learning issues, ability access to resources. As proposed by Perry, VandeKamp, et al., (2002), one of the characteristics of the PBL classes contributing to self-regulated learning is the cooperation among students working in small groups. Results of the current study revealed that the PBL students tend to cooperate with their peers more than the control group students and the PBL students appreciated the importance of cooperation in their learning. Many students indicated, for example, that while discussing and listening to their friends they revised their ideas, and realized the deficiencies in their thoughts. Actually, this was a metacognitive process helping students think about their thinking. In fact, King (2002) claimed that some peer learning tasks such as working together to solve ill-structured problems, problems with several possible solutions, peers analysing and integrating ideas to go beyond presented material to build new knowledge, group decision making, peer assessment of learning product demand a higher, more complex level of cognitive processing. In the current study, it is proposed that presentations made at the beginning of each PBL session, and the final reports written regarding what they learned as a result of the PBL activity in relation to patient's case further helped students continuously monitor their learning, self-evaluate themselves, and set goals for further search, further learning. In these reports, it was revealed that students

critically reviewed the information about the patient, revised their hypotheses/ideas, and presented their opinions of the problem based upon all of the findings and their knowledge acquired from independent study. According to Torp & Sage (1998) the reflective nature of the debriefing is a metacognitive examination of solutions and loose ends, thinking back along the path of the student journey. Finally, Paris and Paris (2001) claimed that problem-based learning which places the responsibility on the students to find information, to coordinate actions and people, to realize goals and to monitor understanding can be utilized by the teachers to support the development of self-regulated learning. Development of self-regulated learning is important because students who can initiate learning tasks, set their own goals, decide on appropriate strategies for the realization of the goals, and then monitor and evaluate their own progress are likely to achieve at higher levels than students who relies on teachers for performing these same functions (Risemberg &Zimmerman, 1992).

Results of the presented study revealed that problem based learning enhances students academic achievement and performance skills, and self-regulatory skills. Therefore, it is suggested that PBL is used in secondary schools to improve students' academic performance by going beyond teaching the content to teaching students how to learn.

6.2 Implications

This study provided the evidence to support the claim that student-centered classrooms in which students work on open-ended tasks cooperatively by identifying knowledge deficiencies, generating appropriate learning issues, accessing different resources, and monitoring understanding lead to development of skills such as planning, monitoring, and evaluating. Therefore, it is suggested that instructional methods promoting high level cognitive processing such as the PBL should be integrated into curriculum. Since the teacher plays a vital role in the implementation of such instructional methods as a coordinator of activities, as a model of an expert learner, as a facilitator, and as an evaluator (Cooper, 2002), they should undergo an extensive training. Moreover, implementation of the PBL or other student-centered methods should start at earlier grade levels so that cognitive and metacognitive learning skills, time and environment management skills, and critical thinking skills begin to develop at early ages. In this way, students become more proficient, for example, in accessing and using different resources when they are a secondary school student. Moreover, classrooms should be designed so that students can work in groups effectively, and they can access to different resources such as books, educational CDs, a computer with internet connection. In this study, during implementation, most of the students indicated that they had difficulty in making use of variety of resources due to the overloaded curriculum. However, if they had used to carry out out-of-class

search, or if there were more resources available for them in the school library, it would be easier for them to access different resources and to make use of them.

Apart from these, since effects of the PBL are moderated by the way the knowledge and skills are assessed, the assessment strategies in appropriate alignment with the PBL should be used.

6.3 Recommendations

1. This study can be replicated in different school types with a larger sample size to increase generalizability.

2. The effect of problem based learning on students' academic achievement and performance skills in biological concepts other than human excretory system can be determined.

3. The effect of based learning on students' academic achievement and performance skills; and students' motivation and learning strategies in other subject areas such as physics, chemistry can be investigated

4. The effect of problem-based learning at different grade levels can be searched for.

5. The effect of problem based learning on retention can be studied.

6. The effect of the nature of concepts under investigation and the duration of the implementation to the success of problem-based learning with respect to the variables of the present study can be investigated

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APPENDIX A

INSTRUCTIONAL OBJECTIVES

Cognitive Domain

Knows characteristics of the excretory system

- to name organs of the excretory system
- to list functions of the organs of the excretory system
- to describe structure of a kidney
- to describe structure of a nephron
- to explain the functions of major parts of a nephron
- to explain how glomerular filtrate is formed
- to define tubular reabsorption
- to define tubular secretion
-

Understands characteristics of the excretory system

- to predict why the osmotic concentration of the glomerular filtrate changes as it passes through a renal tubule
- to describe a counter current mechanism
- to summarize the process of micturition

Applies knowledge on different biological processes to basic renal processes.

- to predict mechanism of transport of the substances in the glomerular filtrate during glomerular reaborption
- to predict forces involved in the glomerular filtration

Analyses the mechanism of renal failure

- to infer why swelling of tissues commonly associated with kidney failure
- to identify mechanism causing increased blood pressure to accompany renal failure

Evaluates the appropriateness of data

- to distinguish fact from assertion
- to select relevant data for the solution of the problem

Integrates knowledge from different subject areas

- to compile findings from different resources for a solution of a problem

- to combine knowledge on circulatory system, osmotic pressure, membrane transport in discussing regulation of water content and mineral composition of body
- to summarize consequences of renal failure on the body

Judges the value of a solution to explain excretory system
- to conclude kidneys as a major organ responsible for homeostasis

Affective Domain

Attention to activities in group
- to listen to other group members
- to ask questions to other group members
- to select a resource to get information

Participates in group activities
- to respond to other group members' questions
- to discuss the problem with other group members
- to report his/her findings to other group members

Demonstrates confidence in scientific problem solving
- to initiate further study
- to base judgments on evidence

APPENDIX B

INSANDA BOSALTIM SISTEMI BASARI TESTI

1. Bölüm: Kisisel Bilgiler

1. *Adiniz, Soyadiniz*: _____

2. *Sinifiniz*: _____

3. *Cinsiyetiniz*:

' Kiz ' Erkek

4. *Yasiniz*: _____

5. *Geçen Döneme Ait Biyoloji Karne Notunuz*: _____

6. *Annenizin Egitim Durumu:*

' Ilkokul ' Ortaokul ' Lise ' Üniversite ' Y. Lisans ' Doktora

7. *Babanizin Egtim Durumu*:

' Ilkokul ' Ortaokul ' Lise ' Üniversite ' Y. Lisans ' Doktora

8. *Anneniz Çalisiyor mu?* :

' Evet ' Hayir

9. *Babaniz Çalisiyor mu?* :

' Evet ' Hayir

10. *Kullandiginiz Okul Kitaplari Hariç Evinizdeki Kitap Sayisi:*

' 0-25 ' 26-60 ' 61-100 ' 101-200 ' 200'den fazla

2. Bölüm: Basari Testi

1. Asagidakilerden hangisi böbregin görevlerinden degildir?

a) kirmizi kan hücrelerinin üretimini kontrol etmek
b) kanin pH'nin sabit kalmasina katkida bulunmak
c) vücut isisinin sabit kalmasini saglamak
d) su ve elektrolit dengesini düzenlemek

2. Böbregin fonksiyonel birimi asagidakilerden hangisidir?

a) medula
b) nefron
c) bowman kapsülü
d) henle kanali

3. Glomerulusu olusturan kilcaldamarlar ile bosaltim kanalcigini saran kilcaldamarlarda gerçeklesen islemler asagidakilerden hangisinde dogru olarak verilmistir?

	Glomerulusu olusturan kilcaldamarlar	Bosaltim kanalcigini saran kilcaldamarlar
a)	süzülme	tübüler salgilama
b)	tübüler salgilama	süzülme, geri emilme
c)	süzülme	geri emilme, tübüler salgilama
d)	geri emilme	tübüler salgilama

4. Glomerulustan Bowman kapsülüne geçen sivi ile kan plazmasi arasindaki fark asagidakilerden hangisine dogru olarak verilmistir?

a) bowman kapsülündeki sivi daha az glikoz içerir
b) bowman kapsülündeki sivi daha çok metabolizma artiklari içerir
c) bowman kapsülündeki sivi da ha az elektrolit içerir
d) bowman kapsülündeki sivi protein içermez

5. Bosaltim kanalinda (üreter) meydana gelen herhangi bir tikanma asagidaki olaylardan hangisine engel olusturur?

a) idrarin vücuttan atilmasi
b) idrarin böbrege girmesi
c) idrarin toplama kanalindan çikmasi
d) idrarin idrar kesesine girmesi

6. Suyun yanisira, idrarin temel bilesenleri asagidakilerden hangisidir?

a) kreatinin ve ürik asit
b) üre ve tuzlar
c) ürik asit ve hidrojen iyonlari
d) bikarbonat iyonlari ve üre

7. Asagidaki olaylardan hangisi glomerüler süzme hizini azaltir?

a) kan sivisinin azalmasi
b) aldosteron saliniminin artmasi
c) efferent arteriollerin büzülmesi
d) kan basincinin artmasi

8. Böbrekte, bosaltim kanalciginda ilerleyen süzüntüdeki bazi maddelerin kilcal damarlara geçmesi asagidaki olaylardan hangisinin tanimidir?

a) geri emilme
b) süzülme
c) idrara çikma
d) tübüler salgilama

9. Tuzun ve suyun geri emilimi büyük ölçüde asagidaki yapilarin hangisinde gerçeklesir?

a) distal tüp
b) toplama kanali
c) henle kanali
d) proksimal tüp

10. Glikoz ve amino asitlerin geri emilimi asagidaki olaylardan hangisi ile gerçeklesir?

a) difüzyon
b) osmoz
c) aktif tasinma
d) pinositoz

11. Asagidaki siklarin hangisinde ürenin bosaltim kanalcigi ile kan arasindaki geçis sekli dogru olarak verilmistir?

a) enerji gerektiren tübüler salgilama
b) enerji gerektiren geri emilim
c) enerji gerektirmeyen geri emilim
d) enerji gerektirmeyen tübüler salgilama

12. Asagidaki siklarin hangisinde kan basincinin normal degerlerin altina düsmesi sonucu meydana gelen ve homeostasiyi saglamaya yönelik olarak gerçeklesen olaylar dogru sirada verilmstir?

1. su geri emiliminin artmasi
2. kan basincinin normal degerlere yükselmesi
3. kan sivisinin artmasi
4. damarlardaki basinca duyarli reseptörlerin hipotalamusa az uyari göndermesi
5. ADH saliniminin artmasi

a) 5-1-4-3-2
b) 4-5-1-3-2
c) 1-5-2-4-3
d) 1-4-5-3-2

13. Aldosteron saliniminin eksikliginde asagidaki durumlardan hangisi ortaya çikmaz?

a) vücut idrarla tuz kaybeder
b) kan basincinda azalma meydana gelir
c) kaslar çabuk yorulur
d) glomeruler süzme hizi artar

14. Asagidaki faktörlerden hangisi glomerüler süzme hizini arttirir?

a) bowman kapsülündeki hidrostatik basinç
b) afferent arterioldaki azalan kan akisi
c) glomerulusu olusturan kilcaldamarlardaki hidrostatik basinç
d) kan sivisindaki azalma

15. Eger çok fazla su içerseniz, vücudunuzda asagidaki olaylardan hangisi gerçeklesir?

a) ADH salinimi artar ve idrarla daha az su vücuttan atilir
b) ADH saliniminda bir degisiklik olmaz. Içtiginiz su miktarinin idrarla atilan su miktarina etkisi yoktur
c) ADH salinimi azalir ve daha çok su vücuttan atilir
d) ADH salinimi azalir ve daha çok tuz geri emilir

16. Asagidaki maddelerden hangisinin miktari proksimal tübün sonunda yer alan birim hacimdeki süzüntüde daha fazla olacaktir?

a) glikoz
b) kreatinin
c) sodyum
d) bikarbonat

17. Böbreklerdeki enerji tüketimi ile ilgili asagidaki ifadelerden hangisi dogrudur?

a) böbreklerdeki enerji tüketimi böbreklere kan akisi arttikça azalir
b) böbreklerdeki enerji tüketimi kirmizi kan hücrelerinin üretimini kontrol eden hormon tarafindan düzenle nir
c) böbreklerdeki enerji tüketimi, böbrekler ve kan arasindaki sodyum tasimasiyla dogru orantilidir
d) böbreklerdeki fazla enerji tüketimi meduladadir

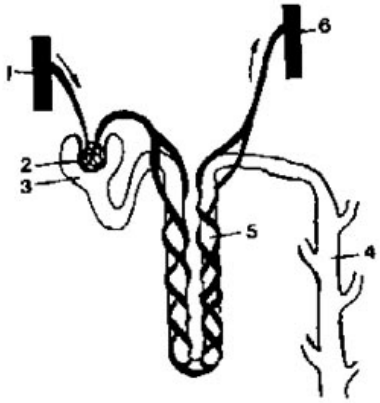
18. Asagidaki olaylardan hangisi, idrar miktarinin artmasina yol açar?

a) ADH salinimindaki artis
b) plazma miktarindaki azalma
c) plazma osmotik basincinin artmasi
d) tübüllerde sodyum geri emiliminin azalmasi

19. Glomerulustan serbestçe süzülen X molekülü gözönüne alindiginda, eger birim zamanda X molekülünden temizlenen kan miktari, birim zamanda kreatininden temizlenen kan miktarindan az ise, asagidaki ifadelerden hangisi dogrudur? (ipucu: glomerular süzülme hizi ve birim zamanda kreatininden temizlenen kan miktari yaklasik olarak aynidir.)

a) X molekülünün net geri emilimi sözkonusudur
b) X molekülünün net tübüler sa lgilanmasi sözkonusudur
c) X maddesi ne geri emilmektedir ne de salgilanmaktadir
d) X maddesi proksimal tüpte distal tüpe nazaran daha çok salgilanmaktadir.

Asagidaki figüre bakarak, 20, 21, 22, 23,ve 24 üncü sorulari cevaplayiniz.



B.1 Nephron Structure

20. Glomerulustan süzülen sivi ilk olarak kaç numarali yapiya girer?

a) 1 b) 2 c) 3 d) 5

21. Hangi yapida idrar toplanir?

a) 2 b) 3 c) 4 d) 5

22. Üç (3) numarali yapiya normalde hangi madde girmez?

a) tuzlar b) kirmizi kan hücreleri c) üre d) glikoz

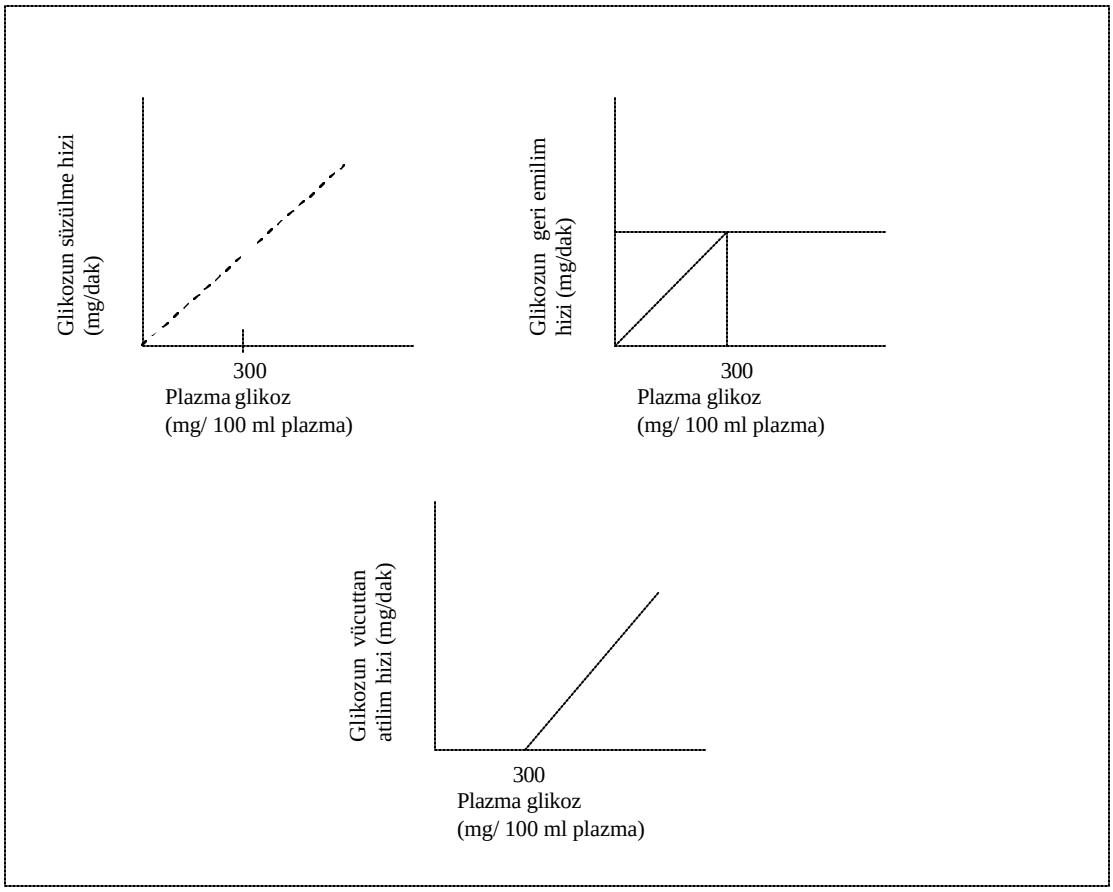
23. Hangi yapi glomerulustur?

a) 1 b) 2 c) 4 d) 6

24. Hangi yapi Henle kanalidir?

a) 1 b) 2 c) 5 d) 6

25. Verilen grafikler gözününe alindiginda, asagidaki ifadelerden hangisi yanlistir?



a) glikozun süzülmesi, glikozun plazma konsantrasyonuyla dogru orantilidir
b) glikozun geri emilimi, glikozun tasinmasindan sorumlu proteinlerin tamami glikozun tasinmasi için kullanilasiya kadar, plazma konsantrasyonu ile dogru orantilidir
c) glikozun idrarla vücuttan atilmasi, glikozun tasinmasindan sorumlu proteinlerin tamami glikozun tasinmasi için kullanilasiya kadar, maksimum düzeydedir
d) glikozun süzülme ve geri emilim hizi glikozun tasinmasindan sorumlu proteinlerin tamami glikozun tasinmasi için kullanildiginda farklilik göstermeye baslar.

26. Asagidaki örnek olayi dikkatlice okuyunuz. Örnek olayla ilgili verilen 4 soru dogrultusunda, örnek olayda yer alan hastaya iliskin belirti ve sikayetleri, biyolojideki (ve gerek duyarsaniz diger fen derslerinizdeki) ilgili konu ve kavramlari kullanarak açiklayiniz. Açiklamalarinizi yazarken, ortaya çikan düsünce ve hipotezlerinizi, bu düsünce ve hipotezlerinizin edindiginiz bilgilerle örtüsen ve örtüsmeyen noktalarini detayli bir sekilde yaziniz.

Mühendis olan 46 yasindaki Mehmet Can, birkaç haftadir kendisini çok yorgun hissetmektedir. Ara sira basi dönmektedir. Son zamanlarda bel kisminda, kaburga kemiginin hemen altina denk gelen bölgede siddetli bir agri hissetmeye baslamistir. Ayrica idrarinin oldukça koyu renk oldugunu farketmistir. Yüzü, ayak ve ayak bilekleri sis gözükmektedir. Esi bu sikayetlerinden dolayi Mehmet Can Bey"in doktora gitmesini istemistir.

Muayene sirasinda, Mehmet Can Bey"in tansiyonunun yüksek oldugu belirlenmis ve idrar tahlili sonucunda idrarinda asiri protein, ve kan bulunmustur. Kan tahlili sonuçlari ise yüksek kan üre azotu (BUN), yüksek kreatin seviyesinin varligini göstermistir. Ayrica serum protein seviyesi düsük bulunmustur.

1. Örnek olayda verilen bilgileri siralayiniz

2. Verilen bilgiler isiginda hangi organ sisteminin çalismasinda bir bozukluk vardir? Cevabinizi detayli olarak açiklayin. Cevabinizi yazarken ilgili organ sisteminin yapi, görevleri ve bu yapi ve görevlerde meydana gelebilecek herhangi bir degisikligin örnek olayda belirtilen belirtilere nasil yol açabilecegini belirtin.

3. Ayak ve ayak bileklerinin sismesine yol açan olaylar zinciri ne olabilir?

4. Hastaya günlük olarak aldigi su, potasyum ve sodyum miktarini kontrol etmesi tavsiye edildigi gibi protein, içeren besinleri de kontrollü olarak almasi söylenmistir. Protein aliniminin dikkatlice kontrol edilmesi niçin istenmis olabilir? Cevabinizi verirken vücuttaki protein metabolizmasini gözönüne alin

APPENDIX C

RUBRIC

Performans Becerileri			
A	B	C	D
*Problemin çözümü için gerekli olan bilginin kullanimi * Belirsizliklerin ifadesi	* Bilginin organize edilmesi * Bilginin yorumlanmasi	* Farkli alternatiflerin objektif olarak degerlendirilmesi için prensiplerin, rehber niteligi tasiyacak bilgilerin kullanimi	*probleme genel yaklasim

1 (A, B, C, D performans becerilerinin hepsi zayif ise)	2 (A performans becerisi yeterli fakat B, C, D performans becerileri zayif ise)	3 (A, B performans becerileri yeterli fakat C, D performans becerileri zayif ise)	4 (A, B, C performans becerileri yeterli fakat D performans becerisi zayif ise)	5 (A, B, C, D performans becerilerinin hepsi yeterli ise)
* Daha çok gerçekler ve tanimlar olmak üzere çok az bilgi kullanilmis * Eger bir takim belirsizilikler ifade edilmis ise, bu daha çok sahip olunan bilginin eksikligine baglanmis ya da konunun uzmanlari tarafindan aydinlatilacak geçici belirsizlikler olarak ortaya atilmistir	*Daha çok genel olarak varilan sonucu destekleyen bilgiler ve edinilen veriler olmak üzere az bilgi kullanilmis * Eger bir takim belirsizilikler ifade edilmis ise, bu belirsizlik için en az bir neden gösterilmis	* Dikkatlice degerlendirilerek gözden geçirilmis, probleme ilgili çesitli bilgiler kullanilmis * Belirsizliklere iliskin nedenler ve bu belirsizliklerden kaynaklanan güçlükler ifade edilmis	* Farkli çözüm yollarinin degerlendirilmesine olanak saglayan kriterleri de içine alan dikkatlice degerlendirilerek gözden geçirilmis, probleme ilgili çesitli bilgiler kullanilmis * Farkli belirsizlikler ve bu belirsizliklerin kaynaklarinin göreceli önemi ortaya konmus	* Farkli çözüm yollarinin degerlendirilmesine olanak saglayan kriterleri de içine alan dikkatlice degerlendirilerek gözden geçirilmis, probleme ilgili çesitli bilgiler kullanilmis ve çözüm yollarinin limitasyonlarini ortaya koyan bilgileri meydana çikaracak uygulanabilir stratejiler gelistirilmis * Devam eden arastirma sirasinda ortaya çikan belirsizlikleri minimum düzeye indirmek için gerekli çaba ortaya konmus

* Bilgi dogru, yanlis, ya da belirsiz olarak kategorilere ayrilmis * bilgi verilmis ama yorumu yapilmamis	* Probleme, problemi parçalara ayirmaksizin yaklasilmis ve daha genis bir kontekste, daha farkli bakis açilari göz önüne alinmamis * Bilgi farkli görüsleri destekiyor ya da desteklemiyor diyerek yorumlanmis	* Bilgi organize edilmis ve kavramlar problemin farkli yönlerini incelemeye olanak saglayacak tarzda bir iskelet olusturmus * Bilgi çesitli bakisli açilarindan nitel olarak degerlendirilmis, birtakim varsayimlar, eldeki verilerin niteligi tartisilmis,	* Bilgi ve kavramlar organize edilmis, farkli bakis açilari için geçerli, ve farkli çözüm yolarinin nitel degerlendirilmesine olanak saglayan genel kriterler kullanilmis * Farkli bakis açilarinin degerlendirilmesine olanak saglayacan genel prensipler kullanilarak bilgi nitel olarak degerelendirilmis	* Bilgi ve kavramlar organize edilmis, farkli bakis açilari için geçerli, ve farkli çözüm yolarinin nitel degerlendirilmesine olanak saglayan genel kriterler kullanilmis ve daha iyi çözüm yollari üretebilmek için kriterler, izlenebilecek yollar nasil gelistirilebilir ifade edilmis * Zaman içersinde yeni bilgiler ortaya çiktikça, eldeki veriler tekrar tekrar yorumlanmis
* Eldeki veri ve bilgilere dayanarak mantikli çikarimlarda bulunulmamis, daha çok test edilmemis, dogrulugu gösterilmemis fikirler üzerinden gerekçeler gösterilmis	* Farkli yaklasimlara çok az yer verilmis, sonuçlara kismen sorgulayarak varilmis, düsünceler, probleme yaklasim yüzeysel olarak anlasilmis bilgi ve verilerle desteklenmis	* Eldeki veriler belli bir perspektif içersinde mantiksal olarak degerlendirilmis (fakat uygulanan kriter farkli çözüm opsiyonlari için daima geçerli olmak zorunda degil)	* Farkli çözüm yollarinin arasindan objektif olarak seçmeye ve objektif olarak karsilastirmaya olanak saglayan saglam temellere dayanan, kapsamli bilgiler, prensipler kullanilmis	* Kendi bakis açisini desteklemek için ikna edici çok yönlü tartisma yapilms. Görüslerinin güçlü ve zayif yönleri belirtilmis. Ortaya atilan çözüme sistematik bir yaklasim, arastirma, düsünme tarziyla nasil ulasildigi ifade edilmis
* Probleme tek bir çözüm yolu ve tek bir dogru cevabi olan kapali uçlu bir problem gibi yaklasilmis	* Varolan birtakim belirsizliklere ragmen amaç varilan sonucu desteklemek için bilgi ve verileri siralamakmis gibi probleme yaklasilmis	* Amaç, farkli bakis açilarinin dengeli ve önyargidan uzak bir tarzda verilmesiymis gibi probleme yaklasilmis	* Amaç, farkli bakis açilarin in objektif olarak degerlendirilmesi sonucu ortaya çikmis saglam temellere dayanan sonuçlar ortaya koymakmis gibi probleme yaklasilmis	* Amaç bilgiyi kendisinin insa etmesi, kendisinden emin olarak saglam temellere dayanan sonuçlar ortaya koymasiymis gibi probleme yaklasilmis

APPENDIX D

MOTIVATED STRATEGIES FOR LEARNING QUESTIONNAIRE

Part A. Motivation

The following questions ask about your motivation for, attitudes about this class. **Remember there are no right or wrong answers, just answer as accurately as possible**. Use the scale below to answer the questions. If you think the statement is very true of you, circle 7; if a statement is not at all true of you, circle 1. If the statement is more or less true of you, find the number between 1 and 7 that best describes you.

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

not at all true of me — very true of me

	not at all true of me						**very true of me**
1. In a class like this, I prefer course material that really challenges me so I can learn new things.	1	2	3	4	5	6	7
2. If I study in appropriate ways, then I will be able to learn the material in this course.	1	2	3	4	5	6	7
3. When I take a test I think about how poorly I am doing compared with other students.	1	2	3	4	5	6	7
4. I think I will be able to use what I learn in this course in other courses.	1	2	3	4	5	6	7

5. I believe I will receive an excellent grade in this class.	1	2	3	4	5	6	7
6. I'm certain I can understand the most difficult material presented in the readings for this course.	1	2	3	4	5	6	7
7. Getting a good grade in this class is the most satisfying thing for me right now.	1	2	3	4	5	6	7
8. When I take a test I think about items on other parts of the test I can't answer.	1	2	3	4	5	6	7
9. It is my own fault if I don't learn the material in this course.	1	2	3	4	5	6	7
10. It is important for me to learn the course material in this class.	1	2	3	4	5	6	7
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.	1	2	3	4	5	6	7
12. I'm confident I can learn the basic concepts taught in this course.	1	2	3	4	5	6	7
13. If I can, I want to get better grades in this class than most of the other students.	1	2	3	4	5	6	7
14. When I take tests I think of the consequences of failing.	1	2	3	4	5	6	7
15. I'm confident I can understand the most complex material presented by the instructor in this course.	1	2	3	4	5	6	7
16. In a class like this, I prefer course material that arouses my curiosity even if it is difficult to learn.	1	2	3	4	5	6	7
17. I am very interested in the content area of this course.	1	2	3	4	5	6	7

18. If I try hard enough, then I will understand the course material.	1	2	3	4	5	6	7
19. I have an uneasy, upset feeling when I take an exam.	1	2	3	4	5	6	7
20. I'm confident I can do an excellent job on the assignments and tests in this course.	1	2	3	4	5	6	7
21. I expect to do well in this class.	1	2	3	4	5	6	7
22. The most satisfying thing for me in this course is trying to understand the content as thoroughly as possible.	1	2	3	4	5	6	7
23. I think the course material in this class is useful for me to learn.	1	2	3	4	5	6	7
24. When I have the opportunity in this class, I choose course assignments that I can learn from even if they don't guarantee a good grade.	1	2	3	4	5	6	7
25. If I don't understand the course material, it is because I didn't try hard enough.	1	2	3	4	5	6	7
26. I like the subject matter of this course.	1	2	3	4	5	6	7
27. Understanding the subject matter of this course is very important to me.	1	2	3	4	5	6	7
28. I feel my heart beating fast when I take an exam.	1	2	3	4	5	6	7
29. I'm certain I can master the skills being taught in this class.	1	2	3	4	5	6	7
30. I want to do well in this class because it is important to show my ability to my family, friends, employer, or others.	1	2	3	4	5	6	7

31. Considering the difficulty of this course, the teacher, and my skills, I think I will do well in this class.	1	2	3	4	5	6	7

Part B. Learning Strategies

The following questions ask about your learning strategies and study skills for this class. Again, there are no right or wrong answers. Answer the questions about how you study in this class as accurately as possible. Use the same scale to answer the remaining questions. If you think the statement is very true of you, circle 7; if a statement is not at all true of you, circle 1. If the statement is more or less true of you, find the number between 1 and 7 that best describes you.

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

not at all true of me — very true of me

	not at all true of me						**very true of me**
32. When I study the readings for this course, I outline the material to help me organize my thoughts.	1	2	3	4	5	6	7
33. During class time I often miss important points because I'm thinking of other things.	1	2	3	4	5	6	7
34. When studying for this course, I often try to explain the material to a classmate or friend.	1	2	3	4	5	6	7
35. I usually study in a place where I can concentrate on my course work.	1	2	3	4	5	6	7
36. When reading for this course, I make up questions to help focus my reading.	1	2	3	4	5	6	7
37. I often feel so lazy or bored when I study for this class that I quit before I finish what I planned to do.	1	2	3	4	5	6	7

38. I often find myself questioning things I hear or read in this course to decide if I find them convincing.	1	2	3	4	5	6	7
39. When I study for this class, I practice saying the material to myself over and over.	1	2	3	4	5	6	7
40. Even if I have trouble learning the material in this class, I try to do the work on my own, without help from anyone.	1	2	3	4	5	6	7
41. When I become confused about something I'm reading for this class, I go back and try to figure it out.	1	2	3	4	5	6	7
42. When I study for this course, I go through the readings and my class notes and try to find the most important ideas.	1	2	3	4	5	6	7
43. I make good use of my study time for this course.	1	2	3	4	5	6	7
44. If course readings are difficult to understand, I change the way I read the material.	1	2	3	4	5	6	7
45. I try to work with other students from this class to complete the course assignments.	1	2	3	4	5	6	7
46. When studying for this course, I read my class notes and the course readings over and over again.	1	2	3	4	5	6	7
47. When a theory, interpretation, or conclusion is presented in class or in the readings, I try to decide if there is good supporting evidence.	1	2	3	4	5	6	7
48. I work hard to do well in this class even if I don't like what we are doing.	1	2	3	4	5	6	7
49. I make simple charts, diagrams, or tables to help me organize course material.	1	2	3	4	5	6	7
50. When studying for this course, I often set aside time to discuss course material with a group of students from the class.	1	2	3	4	5	6	7

51. I treat the course material as a starting point and try to develop my own ideas about it.	1	2	3	4	5	6	7
52. I find it hard to stick to a study schedule.	1	2	3	4	5	6	7
53. When I study for this class, I pull together information from different sources, such as lectures, readings, and discussions.	1	2	3	4	5	6	7
54. Before I study new course material thoroughly, I often skim it to see how it is organized.	1	2	3	4	5	6	7
55. I ask myself questions to make sure I understand the material I have been studying in this class.	1	2	3	4	5	6	7
56. I try to change the way I study in order to fit the course requirements and the instructor's teaching style.	1	2	3	4	5	6	7
57. I often find that I have been reading for this class but don't know what it was all about.	1	2	3	4	5	6	7
58. I ask the instructor to clarify concepts I don't understand well.	1	2	3	4	5	6	7
59. I memorize key words to remind me of important concepts in this class.	1	2	3	4	5	6	7
60. When course work is difficult, I either give up or only study the easy parts.	1	2	3	4	5	6	7
61. I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying for this course.	1	2	3	4	5	6	7
62. I try to relate ideas in this subject to those in other courses whenever possible.	1	2	3	4	5	6	7
63. When I study for this course, I go over my class notes and make an outline of important concepts.	1	2	3	4	5	6	7

64. When reading for this class, I try to relate the material to what I already know.	1	2	3	4	5	6	7
65. I have a regular place set aside for studying.	1	2	3	4	5	6	7
66. I try to play around with ideas of my own related to what I am learning in this course.	1	2	3	4	5	6	7
67. When I study for this course, I write brief summaries of the main ideas from the readings and my class notes.	1	2	3	4	5	6	7
68. When I can't understand the material in this course, I ask another student in this class for help.	1	2	3	4	5	6	7
69. I try to understand the material in this class by making connections between the readings and the concepts from the lectures.	1	2	3	4	5	6	7
70. I make sure that I keep up with the weekly readings and assignments for this course.	1	2	3	4	5	6	7
71. Whenever I read or hear an assertion or conclusion in this class, I think about possible alternatives.	1	2	3	4	5	6	7
72. I make lists of important items for this course and memorize the lists.	1	2	3	4	5	6	7
73. I attend this class regularly.	1	2	3	4	5	6	7
74. Even when course materials are dull and uninteresting, I manage to keep working until I finish.	1	2	3	4	5	6	7
75. I try to identify students in this class whom I can ask for help if necessary.	1	2	3	4	5	6	7
76. When studying for this course I try to determine which concepts I don't understand well.	1	2	3	4	5	6	7

77. I often find that I don't spend very much time on this course because of other activities.	1	2	3	4	5	6	7
78. When I study for this class, I set goals for myself in order to direct my activities in each study period.	1	2	3	4	5	6	7
79. If I get confused taking notes in class, I make sure I sort it out afterwards.	1	2	3	4	5	6	7
80. I rarely find time to review my notes or readings before an exam.	1	2	3	4	5	6	7
81. I try to apply ideas from course readings in other class activities such as lecture and discussion.	1	2	3	4	5	6	7

I would like to thank W.J. McKeachie for permitting me to use the MSLQ.

APPENDIX E

ÖGRENMEDE GÜDÜSEL STRATEJILER ANKETI

Bu anket iki kisimdan olusmaktadir. Ilk kisimda biyoloji dersine karsi tutumunuzu, motivasyonunuzu, ikinci kisimda ise biyoloji dersinde kullandiginiz ögrenme stratejileri ve çalisma becerilerini belirlemeye yönelik ifadeler yer almaktadir. Cevap verirken asagida verilen ölçegi gözönüne aliniz. **Eger ifadenin sizi tam olarak yansittigini düsünüyorsaniz, 7' yi yuvarlak içine aliniz. Eger ifadenin sizi hiç yansitmadigini düsünüyorsaniz, 1' yi yuvarlak içine aliniz. Bu iki durum disinda ise 1 ve 7 arasinda sizi en iyi tanimladigini düsündügünüz numarayi yuvarlak içine aliniz.** Unutmayin Dogru ya da Yanlis cevap yoktur yapmaniz gereken sizi en iyi tanimlayacak numarayi yuvarlak içine almanizdir.

1 --- 2 --- 3 --- 4 --- 5 --- 6 -- 7
beni hiç yansitmiyor — beni tam olarak yansitiyor

A. Motivasyon (Güdülenme)

	beni hiç yansitmiyor						beni tam olarak yansitiyor
1. Biyoloji dersinde yeni bilgiler ögrenebilmek için, büyük bir çaba gerektiren sinif çalismalarini tercih ederim.	1	2	3	4	5	6	7
2. Eger uygun sekilde çalisirsam, biyoloji dersindeki konulari ögrenebilirim.	1	2	3	4	5	6	7
3. Biyoloji sinavlari sirasinda, diger arkadaslarima göre sorulari ne kadar iyi yanitlayip yanitlayamadigimi düsünürüm	1	2	3	4	5	6	7
4. Biyoloji dersinde ögrendiklerimi baska derslerde de kullanabilecegimi düsünüyorum.	1	2	3	4	5	6	7
5. Biyoloji dersinden çok iyi bir not alacagimi düsünüyorum.	1	2	3	4	5	6	7
6. Biyoloji dersi ile ilgili okumalarda yer alan en zor konuyu bile anlayabilecegimden eminim.	1	2	3	4	5	6	7

	beni hiç yansitmiyor						beni tam olarak yansitiyor
7. Benim için su an biyoloji dersi ile ilgili en tatmin edici sey iyi bir not getirmektir	1	2	3	4	5	6	7
8. Biyoloji sinavlari sirasinda bir soru üzerinde ugrasirken, aklim sinavin diger kisimlarinda yer alan cevaplayamadigim sorularda olur	1	2	3	4	5	6	7
9. Biyoloji dersindeki konulari **ögrenemezsem** bu benim hatamdir.	1	2	3	4	5	6	7
10.Biyoloji dersindeki konulari ögrenmek benim için önemlidir	1	2	3	4	5	6	7
11. Genel not ortalamami yükseltmek su an benim için en önemli seydir, bu nedenle biyoloji dersindeki temel amacim iyi bir not getirmektir.	1	2	3	4	5	6	7
12. Biyoloji dersinde ögretilen temel kavramlari ögrenebilecegimden eminim.	1	2	3	4	5	6	7
13. Eger basarabilirsem, biyoloji dersinde siniftaki pek çok ögrenciden daha iyi bir not getirmek isterim	1	2	3	4	5	6	7
14. Biyoloji sinavlari sirasinda bu dersten basarisiz olmanin sonuçlarini aklimdan geçiririm	1	2	3	4	5	6	7
15. Biyoloji dersinde, ögretmenin anlattigi en karmasik konuyu anlayabilecegimden eminim.	1	2	3	4	5	6	7
16. Biyoloji derslerinde ögrenmesi zor olsa bile, bende merak uyandiran sinif çalismalarini tercih ederim.	1	2	3	4	5	6	7
17. Biyoloji dersinin kapsaminda yer alan konular çok ilgimi çekiyor.	1	2	3	4	5	6	7
18. Yeterince siki çalisirsam biyoloji dersinde basarili olurum.	1	2	3	4	5	6	7
19. Biyoloji sinavlarinda kendimi mutsuz ve huzursuz hissederim.	1	2	3	4	5	6	7
20. Biyoloji dersinde verilen sinav ve ödevleri en iyi sekilde yapabilecegimden eminim.	1	2	3	4	5	6	7
21. Biyoloji dersinde çok basarili olacagimi umuyorum	1	2	3	4	5	6	7
22. Biyoloji dersinde beni en çok tatmin eden sey, konulari mümkün oldugunca iyi ögrenmeye çalismaktir.	1	2	3	4	5	6	7

	beni hiç yansitmiyor						beni tam olarak yansitiyor
23. Biyoloji dersinde ögrendiklerimin benim için faydali oldugunu düsünüyorum.	1	2	3	4	5	6	7
24. Biyoloji dersinde, iyi bir not getirecegimden emin **olmasam** bile ögrenmeme olanak saglayacak ödevleri seçerim.	1	2	3	4	5	6	7
25. Biyoloji dersinde bir konuyu **anlayamazsam** bu yeterince siki çalismadigim içindir.	1	2	3	4	5	6	7
26. Biyoloji dersindeki konulardan hoslaniyorum.	1	2	3	4	5	6	7
27. Biyoloji dersindeki konulari anlamak benim için önemlidir.	1	2	3	4	5	6	7
28. Biyoloji sinavlarinda kalbimin hizla attigini hissederim.	1	2	3	4	5	6	7
29. Biyoloji dersinde ögretilen becerileri iyice ögrenebilecegimden eminim.	1	2	3	4	5	6	7
30. Biyoloji dersinde basarili olmak istiyorum çünkü yetenegimi aileme, arkadaslarima göstermek benim için önemlidir.	1	2	3	4	5	6	7
31. Dersin zorlugu, ögretmen ve benim becerilerim gözönüne alindiginda, biyoloji dersinde basarili olacagimi düsünüyorum	1	2	3	4	5	6	7

B. Ögrenme Stratejileri

	beni hiç yansitmiyor						beni tam olarak yansitiyor
32. Biyoloji dersi ile ilgili birseyler okurken, düsüncelerimi organize etmek için konularin ana basliklarini çikaririm.	1	2	3	4	5	6	7
33. Biyoloji dersi sirasinda baska seyler düsündügüm için önemli kisimlari siklikla kaçiririm.	1	2	3	4	5	6	7
34. Biyoloji dersine çalisirken çogu kez arkadaslarima konulari açiklamaya çalisirim	1	2	3	4	5	6	7
35. Genelde, ödevlerime rahat konsantre olabilecegim bir yerde çalisirim.	1	2	3	4	5	6	7
36. Biyoloji dersi ile ilgili birseyler okurken, okuduklarima odaklanabilmek için sorular olustururum.	1	2	3	4	5	6	7
37. Biyoloji dersine çalisirken kendimi çogu zaman o kadar isteksiz ya da o kadar sikilmis hissederim ki, planladiklarimi **tamamlamadan** çalismaktan vazgeçerim.	1	2	3	4	5	6	7

	beni hiç yansitmiyor						beni tam olarak yansitiyor
38. Biyoloji dersiyle ilgili duyduklarimi ya da okuduklarimi ne kadar gerçekçi olduklarina karar vermek için siklikla sorgularim.	1	2	3	4	5	6	7
39. Biyoloji dersine çalisirken, önemli bilgileri içimden defalarca tekrar ederim	1	2	3	4	5	6	7
40. Biyoloji dersinde bir konuyu anlamakta zorluk çeksem bile hiç kimseden yardim almaksizin kendi kendime çalisirim.	1	2	3	4	5	6	7
41. Biyoloji dersi ile ilgili birseyler okurken bir konuda kafam karisirsa, basa döner ve anlamak için çaba gösteririm.	1	2	3	4	5	6	7
42. Biyoloji dersine çalisirken, daha önce okuduklarimi ve aldigim notlari gözden geçirir ve en önemli noktalari belirlemeye çalisirim.	1	2	3	4	5	6	7
43. Biyoloji dersine çalismak için ayirdigim zamani iyi degerlendirebiliyorum.	1	2	3	4	5	6	7
44.Eger biyoloji dersi ile ilgili okumam gereken konulari anlamakta zorlaniyorsam, okuma stratejimi degistiririm.	1	2	3	4	5	6	7
45. Biyoloji dersinde verilen ödevleri tamamlamak için siniftaki diger ögrencilerle çalisirim.	1	2	3	4	5	6	7
46. Biyoloji dersine çalisirken, dersle ilgili okumalari ve ders sirasinda aldigim notlari defalarca okurum	1	2	3	4	5	6	7
47. Ders sirasinda veya ders için okudugum bir kaynakta bir teori, yorum ya da sonuç ifade edilmis ise, bunlari destekleyen bir bulgunun var olup olmadigini sorgulamaya çalisirim.	1	2	3	4	5	6	7
48. Biyoloji dersinde yaptiklarimizdan **hoslanmasam bile** basarili olabilmek için siki çalisirim.	1	2	3	4	5	6	7
49. Dersle ilgili konulari organize etmek için basit grafik, sema ya da tablolar hazirlarim.	1	2	3	4	5	6	7
50. Biyoloji dersine çalisirken konulari siniftaki arkadaslarimla tartismak için siklikla zaman ayiririm	1	2	3	4	5	6	7
51. Biyoloji dersinde islenen konulari bir baslangiç noktasi olarak görür ve ilgili konular üzerinde kendi fikirlerimi olusturmaya çalisirim.	1	2	3	4	5	6	7
52. Çalisma planina bagli kalmak benim için zordur.	1	2	3	4	5	6	7
53. Biyoloji dersine çalisirken, dersten, okuduklarimdan, sinif içi tartismalardan ve diger kaynaklardan edindigim bilgileri biraraya getiririm.	1	2	3	4	5	6	7

	beni hiç yansitmiyor						beni tam olarak yansitiyor
54. Yeni bir konuyu detayli bir sekilde çalismaya baslamadan önce çogu kez konunun nasil organize edildigini anlamak için ilk olarak konuyu hizlica gözden geçiririm.	1	2	3	4	5	6	7
55. Biyoloji dersinde islenen konulari anladigimdan emin olabilmek için kendi kendime sorular sorarim.	1	2	3	4	5	6	7
56. Çalisma tarzimi, dersin gereklilikleri ve ögretmenin ögretme stiline uygun olacak tarzda degistirmeye çalisirim.	1	2	3	4	5	6	7
57. Genelde derse gelmeden önce konuyla ilgili birseyler okurum fakat okuduklarimi çogunlukla **anlamam**	1	2	3	4	5	6	7
58. Iyi anlamadigim bir konuyu ögretmenimden açiklamasini isterim.	1	2	3	4	5	6	7
59. Biyoloji dersindeki önemli kavramlari hatirlamak için anahtar kelimeleri ezberlerim.	1	2	3	4	5	6	7
60. Eger bir konu zorsa ya çalismaktan vazgeçerim ya da yalnizca kolay kisimlarini çalisirim	1	2	3	4	5	6	7
61. Biyoloji dersine çalisirken, konulari sadece okuyup geçmek yerine ne ögrenmem gerektigi konusunda düsünmeye çalisirim.	1	2	3	4	5	6	7
62. Mümkün oldugunca biyoloji dersinde ögrendiklerimle diger derslerde ögrendiklerim arasinda baglanti kurmaya çalisirim.	1	2	3	4	5	6	7
63. Biyoloji dersine çalisirken notlarimi gözden geçirir ve önemli kavramlarin bir listesini çikaririm.	1	2	3	4	5	6	7
64. Biyoloji dersi için birseyler okurken, o anda okuduklarimla daha önceki bilgilerim arasinda baglanti kurmaya çalisirim.	1	2	3	4	5	6	7
65. Ders çalismak için devamli kullandigim bir yer (oda vs.) vardir	1	2	3	4	5	6	7
66. Biyoloji dersinde ögrendiklerimle ilgili ortaya çikan fikirlerimi sürekli olarak gözden geçiremeye çalisirim.	1	2	3	4	5	6	7
67. Biyoloji dersine çalisirken, dersle ilgili okuduklarimi ve derste aldigim notlari inceleyerek önemli noktalarin özetini çikaririm.	1	2	3	4	5	6	7
68. Biyoloji dersinde bir konuyu anlayamazsam siniftaki baska bir ögrenciden yardim isterim.	1	2	3	4	5	6	7
69. Biyoloji dersiyle ilgili konulari, ders sirasinda ögrendiklerim ve okuduklarim arasinda baglantilar kurarak anlamaya çalisirim.	1	2	3	4	5	6	7

	beni hiç yansitmiyor						beni tam olarak yansitiyor
70. Biyoloji derslerinde verilen ödevleri ve derse ilgili okumalari zamaninda yaparim.	1	2	3	4	5	6	7
71. Biyoloji dersindeki konularla ilgili bir iddia ya da varilan bir sonucu her okudugumda veya duydugumda olasi alternatifler üzerinde düsünürüm	1	2	3	4	5	6	7
72. Biyoloji dersinde önemli kavramlarin listesini çikarir ve bu listeyi ezberlerim.	1	2	3	4	5	6	7
73. Biyoloji derslerini düzenli olarak takip ederim	1	2	3	4	5	6	7
74. Konu çok sikici olsa da, ilgimi **çekmese** de konuyu bitirene kadar çalismaya devam ederim.	1	2	3	4	5	6	7
75. Gerektiginde yardim isteyebilecegim arkadaslarimi belirlemeye çalisirim.	1	2	3	4	5	6	7
76. Biyoloji dersine çalisirken iyi anlamadigim kavramlari belirlemeye çalisirim.	1	2	3	4	5	6	7
77. Baska faaliyetlerle ugrastigim için çogu zaman biyoloji dersine yeterince zaman ayiramiyorum	1	2	3	4	5	6	7
78. Biyoloji dersine çalisirken, çalismalarimi yönlendirebilmek için kendime hedefler belirlerim.	1	2	3	4	5	6	7
79. Ders sirasinda not alirken kafam karisirsa, notlarimi dersten sonra düzenlerim.	1	2	3	4	5	6	7
80. Biyoloji sinavindan önce notlarimi ya da okuduklarimi gözden geçirmek için fazla zaman **bulamam**.	1	2	3	4	5	6	7
81. Biyoloji dersinde, okuduklarimdan edindigim fikirleri sinif içi tartisma gibi çesitli faaliyetlerde kullanmaya çalisirim.	1	2	3	4	5	6	7

APPENDIX F

Probleme-Dayali Ögrenme Modeli

ÖGRENCI EL KITAPÇIGI

Hazirlayan: Semra Sungur

Eylül 2003

A. Probleme Dayali Ögrenme Modelinde Ögrencilerin Rolü

Probleme dayali ögrenme modelinin uygulandigi siniflarda her biri yaklasik 7 kisiden olusan gruplar olusturulur. Bu modelde ögrenciler bir takim karmasik roller üstlenirler. Mesela grubun aktif bir üyesi olarak ögrenciden yapici elestiriler yapabilmesi ve kendisi için yapilan elestirileri hosgörüyle karsilayabilmesi, eksikliklerini farkedebilmesi ve bireysel olarak da çalisabilmesi beklenir. Ayni zamanda ögrenciler yaptiklari çalismalari hem bireysel olarak hem de grup düzeyinde dürüstçe degerlendirebilmelidir. Bunlarin yanisira ögrencilerden sinifta oynamalari beklenen bir takim roller vardir. Örnegin, birtakim sikayetlerle acil servise gelen bir hastanin yer aldigi bir örnek olayda ögrencilerden birisi gönüllü olarak hasta digeri doktor rolünü üstlenir. Yine gönüllü olarak gruptaki bir ögrenci ögretmen tarafindan dagitilan ve örnek olayi içeren sayfalari okuma rolünü üstlenir. Baska bir ögrenci örnek olayda verilenleri, örnek olaya iliskin grubun düsüncelerini, örnek olayda verilen problemle basa çikabilmek için cevap verilmesi gereken sorulari ve nelerin ögrenilmesi gerektigini tahtaya not eder. Tahtaya yazilanlar konusunda tüm grup üyelerinin fikirbirligi içersinde olmasi gerekmektedir. Ögrencilerin verilen örnek olaydaki probleme çözüm üretebilmeleri yaklasik 4-6 ders saati almaktadir. Ögrencilerden bir digeri ders basinda bir önceki ders saatinde probleme iliskin yapilanlari özetler. Bu sirada ögrenci örnek olayda verilen bilgilerden, grup harici bireysel çalisma sirasinda bulduklarindan, ve bulduklariyla ilgili yorumlarindan bahseder. Genel olarak etkin bir grup çalismasi için beklenen özellikler su sekilde özetlenebilir:

Risk : Ögrenciler test edildikten sonra yanlis oldugu anlasilabilecek hipotezlerini ifade edebilmeli ve bu riski göze alabilmelidir. Düsüncelerini rahatça dile getirebilmelidirler.

Açiklik: Grup üyeleri birbirlerine karsi açik olmalidir. Birbirleriyle düsüncelerini, bilgilerini, deneyimlerini paylasmali gerektiginde birbirlerini elestirebilmelidir.

Katilim: Iyi bir grup çalismasinin temelini katilim olusturmaktadir. Grubun her bir üyesinin katilimi tesfik edilmelidir.

Deneyim: Herbir ögrenci örnek olayda verilen problemle ugrasmali ve problemi çözebilmek için gerekli olan sorgulama sürecinden geçmelidir. Dolayisiyla burada bahsedilen ögrencilerin önceden sahip olduklari deneyimler degil, grup çalismasi sirasinda probleme çözüm yolu ararken kazanilan deneyimlerdir.

Duyarlik : Grup içersinde herbir ögrenci digerinin farkli ortamlardan farkli deneyimlerle gelmis olabilecegini gözönüne almali ve ögrenciler birbirlerinin ihtiyaçlarina ve duygularina karsi duyarli olmalidir.

B. Probleme Dayali Ögrenme Modelinde Ögretmenin Rolü

Ögrenci merkezli olan ve bilgiyi birbirinden izole gerçekler olarak ögretmekten çok bilgiye ulasmak için gerekli tutum ve yeteneklerin kazanilmasini hedefleyen probleme dayali ögrenme modelinde, ögrencilerden beklenen davranislarin gelistirilebilmesi için ögretmene de büyük görevler düsmektedir. Ögretmen konuyu ögreten degil grup içersinde ögrenciler arasinda tartisma ortami saglayan, tesfik eden ve ögrenciler için gerekli ögrenme ortamini, materyalleri saglayan olmalidir. Probleme dayali ogrenme modelinin uygulandigi siniflarda ögretmenin rolü söyle özetlenebilir:

- Herbir ders saatinde ögrencilerin gönüllü olarak birtakim rolleri üstlenmesinin saglanmasi: her ders saatinde örnek olaya iliskin bilgilerin yer

aldigi sayfalari okuyacak ve bu bilgileri, ortaya çikan fikirleri, vb. tahtaya yazacak, ve örnek olayda geçen rolleri oynayacak gönüllü ögrenciler belirlenir.

- Örnek olaya iliskin materyallerin uygun zamanda dagitilmasi
- Herbir ders saatinin öz degerlendirme ile bitmesinin saglanmasi: ögrencilerin her ders saati sonunda kendilerini, arkadaslarini, ve de ögretmeni degerlendirmesi beklenmektedir. Ayni zamanda ögretmen de kendisini grubun bir parçasi olarak görüp görüslerini dile getirir ve kendisine yapilan elestirileri dinler.
- Grubun belirlenen hedef dogrultusunda hareket etmesinin saglanmasi: probleme dayali ögrenme modelinde ana hedef örnek olayda verilen problemin anlasilmasi, çözüm üretebilmek için gerekli olan konularin belirlenmesi ve ögrenilmesidir. Ögretmen eger ögrencilerin bu hedeften uzaklastigini fazla düsünüp sorgulamaksizin sadece probleme bir çözüm bulma egiliminde oldugunu farkederse, uygulanan bu modelde ana hedefin ne oldugunu ögrencilerin hatirlamasini, gerekirse ellerindeki kitapçiktan okumalarini ister
- Grup çalismasinin gözlemlenmesi ve notlarin alinmasi: ögretmen ögrencilerin karar vermis oldugu ögrenilmesi gereken konular listesini not eder. Eger bu listede ögrenilmesi önemli olan bir konu yer almiyorsa, ögretmen ögrencilerin bunun farkina varabilmesi için yardimci olur. Ancak ögretmen böyle bir durumda mümkün oldugunca ögrencileri yönlendirmekten kaçinmalidir.
- Açik uçlu sorularla grubun uyarilip idare edilmesi: bu ögretmenin en zor görevlerinden birisidir. Cünkü ögretmenin grubu yönlendirmemesi ve grubun kontrolünü almamasi gerekmektedir. Fakat ayni zamanda yeri geldiginde bir takim açik uçlu sorularla grupta tartisma ortami yaratmasi gerekmektedir. Burada dikkat edilmesi gereken nokta ögrencilerin basitçe direk olarak cevap verebilecegi sorularin sorulmamasidir.

- Ögrencilerin degerlendirilmesi: ögrenciler degerlendirilirken uygulanan yazili sinavin sonucunun yanisira ögretmen ve grup üyelerinin doldurdugu degerlendirme formlari da gözönüne alinir. Bu formlarda ögrenciler grup içersindeki katilimlari, katkilari, birbirleriyle olan iliskileri, ne ölçüde hazirlikli geldikleri gibi kriterlere göre degerlendirilirler

C. Probleme Dayali Ögrenme Modelinde Ders Islenisi

Probleme dayali ögrenme modelinin temelini grup halinde çalisan ögrenciler ve ögretmen olusturmaktadir. Grubun herbir üyesi grubun diger üyelerini yapici olarak elestirebilmeli, sorgulayabilmeli ve elestirilmekten, sorgulanmaktan çekinmemelidir. Bu tür davranislar grup üyelerinde rahatsizlik olusturabileceginden, ilk baslarda bunu gerçeklestirmek zor olabilir. Fakat zaman geçtikçe, ögrenciler modele alistikça bu, ögrencilerin bilgilerini arttirmalari gerektigi konulara yogunlasmasini saglayan eglenceli bir egzersiz haline gelecektir.

Biyoloji derslerinde kullanailabilecek bir örnek olayin probleme dayali ögrenme modeli ile islenisi asagida belirtildigi gibi olmaktadir:

Ders baslamadan önce örnek olaya iliskin bilgileri kimin okuyacagi, kimin tahtaya yazacagi belirlenir. Ayrica kimin hasta, kimin doktor rolünü oynaycagi da belirlenir. Bu rol dagilimi gönüllü ögrenciler arasinda yapilir. Eger örnek olay daha önceki ders saatlerinde basladiysa kura ile beirlenen bir ögrenci daha önceki ders saatlerinde örnek olaya iliskin yapilanlari özetler bu arada grup harici bireysel çalisma sirasinda bulduklarindan ve kendi düsüncelerinden kisaca bahseder.

Roller belirlendikten sonra örnek olayin ilk sayfasi ögrencilere dagitilir. Örnek olay bir hastayi anlatir. Hastaya iliskin bilgiler 5 ya da daha fazla sayfada verilir. Genel

olarak birinci sayfada hastanin adi, cinsiyeti, yasi ve sikayeti belirtilir. Ikinci sayfada hastanin sikayetleri, geçmisteki rahatsizliklari, kullandigi ilaçlar, ailesinde görülen rahatsizliklar ve yasam tarzi ile ilgili daha detayli bilgiler verilir. Ikinci sayfa hasta rolünü üstlenecek ögrenciye birinci sayfayla birlikte verilir. Ögrenciler birinci sayfa üzerine tartisirken hasta rolünü oynayan ögrenci bir taraftan da ikinci sayfayi içinden okur. Üçüncü sayfada muayene sonucu elde edien veriler yer alir. Dördüncü ve onu takip eden sayfalarda yapilan test, çekilen röntgen, EKG sonuçlari ve diger ilgili sonuçlar bulunur. Son sayfada ise teshis yer alir.

Ilk sayfa dagitildiktan sonra örnek olayda verilenleri okumaktan sorumlu olan ögrenci ilk sayfada verilen bilgileri yüksek sesle okur diger ögrenci tahtaya bilgileri not eder. Bu arada ögrenciler verilen bilgiler hakkinda tartismaya baslarlar. Hastanin sikayetleri hangi organ sistemiyle ilgili olabilir, daha çok bilgi edinebilmek için hastaya ne tür sorular sorulmalidir gibi konular üzerine odaklasirlar. Ögrenciler düsüncelerini belirtirken niçin öyle düsündüklerini de açiklarlar ve ortaya atilan düsünceleri, söylenen bilgileri dogruluklari konusunda sorgularar. Tartisma sirasinda probleme çözüm üretebilmek için hangi konularda bilgi edinmeleri gerekiyor buna karar verirler. Tüm bu tartismalar yapilirken tahtaya yazmaktan sorumlu olan kisi hastanin probleminin hangi sistemle ilgili oldugu, ne gibi sorulara cevap bulunmasi ve hangi konularin ögrenilmesi gerektigine dair grubun vermis oldugu kararlari tahtaya yazar. Daha sonra doktor rolünü oynayacak olan ögrenci belirlenen sorulari hasta rolünü oynayan ögrenciye sorar. Bu arada diger ögrenciler akillarina baska sorular gelirse hastaya sorabilirler. Hastanin verdigi cevaplar tahtaya not edilir ve bu yeni bilgiler dogrultusunda daha önceki düsüncelerini gözden geçirirler. Bu arada ögrenilmesi gereken konular üzerinde tartisirlar. Gerekli bilgileri sorduklari sorularla edindiklerini düsündüklerinde örnek olaya iliskin ikinci sayfayi ögretmenden isterler ve ögretmen ikinci sayfayi dagitir. Örnek olayi okumaktan sorumlu olan ögrenci yüksek sesle ikinci sayfayi okur. Daha sonra ögrenciler spesifik olarak hangi fiziksel

muayene sonucuna ihtiyaç duyulduguna karar verir ve ögretmenden fiziksel muayene sonuçlarini içeren üçüncü sayfayi ister. Ögrenciler ilk üç sayfada verilen bilgileri kullanarak hastadan ne tür tetkiklerin istenmesi gerektigine karar verirler. Mesela, hastanin kan degerlerine, akciger röntgenin sonucuna ihtiyaç duyabilirler. Ögrenciler hangi testlerin sonucuna ihtiyaç duyulduguna karar verince ögretmen dördüncü sayfayi dagitir. Ögrenciler örnek olaya iliskin bilgilerin yer aldigi sayfalari edindikçe daha önce ortaya atmis olduklari düsünceleri, hipotezleri gözden geçirirler ve teshis koymaya çalisirlar ve aralarinda tartistiktan sonra ögretmen teshisi içeren besinci sayfayi dagitir. Bu arada ögrenciler esas amacin bu örnek olay sayesinde bir takim biyolojik kavramlarin konularin ögrenilmesi oldugu, teshis koymak olmadiginin bilincinde olmalidir.

Probleme dayali ögrenme modelinin uygulanisina iliskin olarak vurgulanmasi gereken önemli noktalardan birisi sudur: Bir örnek olay yaklasik 4-6 saatte tamamlanir. Bu da ögrencilerin 2 ya da 3 kere grup çalismasi yapmasina denk gelmektedir. Ögrenciler herbir grup çalismasinin sonunda ögrenilmesi gereken konular ve bu konular hakkinda nerelerden bilgi edinebileceklerine dair karar verirler ve bir sonraki grup çalismasina kadar bu konular üzerinde bireysel çalisma yaparlar. Bireysel çalisma sirasinda ögrenciler kitaplardan, internetten faydalanabilir ya da konusunda uzman bir kisiye danisabilirler. Ögrenciler isterlerse grup halinde de çalisabilirler. Herbir ögrenci konu hakkinda bilgi edindikten sonra, bu bilgiler dogrultusunda görüslerini belirtecek tarzda hazirlanarak bir sonraki ders saatine katilir. Her ögrencinin ders saatlerine hazirlikli gelmesi gerekmektedir. Çünkü bir sonraki dersin basinda kurayla bir ögrenci belirlenir ve bu ögrenci örnek olayda hastaya iliskin verien bilgileri ve bireysel çalisma sonucu elde ettigi bilgiler dogrultusunda probleme iliskin görüslerini anlatir. Daha sonra diger ögrenciler görüslerini belirtir ve bir önceki ders saatinde kalindigi yerden örnek olay üzerinde tartisilmaya devam edilir, yeri geldikçe ilgili sayfalar istenir.

Ögrenciler kendi aralarinda tartisirken ögretmen onlari gözlemler. Herhangi bir sekilde ögrencileri yönlendirmez. Fakat raporun ‘probleme dayali ögrenme modelinde ögretmenin rolü’ kisminda belirtildigi gibi gerektiginde birtakim stratejiler izleyerek dersin model dogrultusunda ögrenci merkezli olarak islenmesini saglar.

Genel olarak özetlemek gerekirse probleme dayali ögrenme modelinin uygulandigi siniflarda:

- ögrenciler ögrenme sürecinde aktif olarak yer alir
- ögrencilerde bilgiye ulasabilmek için gerekli olan tutum ve davranislar gelistirilir.
- ögrenciler ortak bir problemi analitik olarak grup içersinde çözebilme ortami bulur.

APPENDIX G

Probleme-Dayali Ögrenme Modeli

ÖGRETMEN EL KITAPÇIGI

Hazirlayan: Semra Sungur

Eylül 2003

A. Probleme Dayali Ögrenme Modelinde Ögrencilerin Rolü

Probleme dayali ögrenme modelinin uygulandigi siniflarda her biri yaklasik 7 kisiden olusan gruplar olusturulur. Bu modelde ögrenciler bir takim karmasik roller üstlenirler. Mesela grubun aktif bir üyesi olarak ögrenciden yapici elestiriler yapabilmesi ve kendisi için yapilan elestirileri hosgörüyle karsilayabilmesi, eksikliklerini farkedebilmesi ve bireysel olarak da çalisabilmesi beklenir. Ayni zamanda ögrenciler yaptiklari çalismalari hem bireysel olarak hem de grup düzeyinde dürüstçe degerlendirebilmelidir. Bunlarin yanisira ögrencilerden sinifta oynamalari beklenen bir takim roller vardir. Örnegin, birtakim sikayetlerle acil servise gelen bir hastanin yer aldigi bir örnek olayda ögrencilerden birisi gönüllü olarak hasta digeri doktor rolünü üstlenir. Yine gönüllü olarak gruptaki bir ögrenci ögretmen tarafindan dagitilan ve örnek olayi içeren sayfalari okuma rolünü üstlenir. Baska bir ögrenci örnek olayda verilenleri, örnek olaya iliskin grubun düsüncelerini, örnek olayda verilen problemle basa çikabilmek için cevap verilmesi gereken sorulari ve nelerin ögrenilmesi gerektigini tahtaya not eder. Tahtaya yazilanlar konusunda tüm grup üyelerinin fikirbirligi içersinde olmasi gerekmektedir. Ögrencilerin verilen örnek olaydaki probleme çözüm üretebilmeleri yaklasik 46 ders saati almaktadir. Ögrencilerden bir digeri ders basinda bir önceki ders saatinde probleme iliskin yapilanlari özetler. Bu sirada ögrenci örnek olayda verilen bilgilerden, grup harici bireysel çalisma sirasinda bulduklarindan, ve bulduklariyla ilgili yorumlarindan bahseder. Genel olarak etkin bir grup çalismasi için beklenen özellikler su sekilde özetlenebilir:

Risk : Ögrenciler test edildikten sonra yanlis oldugu anlasilabilecek hipotezlerini ifade edebilmeli ve bu riski göze alabilmelidir. Düsüncelerini rahatça dile getirebilmelidirler.

Açiklik: Grup üyeleri birbirlerine karsi açik olmalidir. Birbirleriyle düsüncelerini, bilgilerini, deneyimlerini paylasmali gerektiginde birbirlerini elestirebilmelidir.

Katilim: Iyi bir grup çalismasinin temelini katilim olusturmaktadir. Grubun her bir üyesinin katilimi tesfik edilmelidir.

Deneyim: Herbir ögrenci örnek olayda verilen problemle ugrasmali ve problemi çözebilmek için gerekli olan sorgulama sürecinden geçmelidir. Dolayisiyla burada bahsedilen ögrencilerin önceden sahip olduklari deneyimler degil, grup çalismasi sirasinda probleme çözüm yolu ararken kazanilan deneyimlerdir.

Duyarlik : Grup içersinde herbir ögrenci digerinin farkli ortamlardan farkli deneyimlerle gelmis olabilecegini gözönüne almali ve ögrenciler birbirlerinin ihtiyaçlarina ve duygularina karsi duyarli olmalidir.

B. Probleme Dayali Ögrenme Modelinde Ögretmenin Rolü

Ögrenci merkezli olan ve bilgiyi birbirinden izole gerçekler olarak ögretmekten çok bilgiye ulasmak için gerekli tutum ve yeteneklerin kazanilmasini hedefleyen probleme dayali ögrenme modelinde, ögrencilerden beklenen davranislarin gelistirilebilmesi için ögretmene de büyük görevler düsmektedir. Ögretmen konuyu ögreten degil grup içersinde ögrenciler arasinda tartisma ortami saglayan, tesfik eden ve ögrenciler için gerekli ögrenme ortamini, materyalleri saglayan olmalidir. Probleme dayali ogrenme modelinin uygulandigi siniflarda ögretmenin rolü söyle özetlenebilir:

- Herbir ders saatinde ögrencilerin gönüllü olarak birtakim rolleri üstlenmesinin saglanmasi: her ders saatinde örnek olaya iliskin bilgilerin yer aldigi sayfalari okuyacak ve bu bilgileri, ortaya çikan fikirleri, vb. tahtaya yazacak, ve örnek olayda geçen rolleri oynayacak gönüllü ögrenciler belirlenir.
- Örnek olaya iliskin materyallerin uygun zamanda dagitilmasi

- Herbir ders saatinin öz degerlendirme ile bitmesinin saglanmasi: ögrencilerin her ders saati sonunda kendilerini, arkadaslarini, ve de ögretmeni degerlendirmesi beklenmektedir. Ayni zamanda ögretmen de kendisini grubun bir parçasi olarak görüp görüslerini dile getirir ve kendisine yapilan elestirileri dinler.
- Grubun belirlenen hedef dogrultusunda hareket etmesinin saglanmasi: probleme dayali ögrenme modelinde ana hedef örnek olayda verilen problemin anla silmasi, çözüm üretebilmek için gerekli olan konularin belirlenmesi ve ögrenilmesidir. Ögretmen eger ögrencilerin bu hedeften uzaklastigini fazla düsünüp sorgulamaksizin sadece probleme bir çözüm bulma egiliminde oldugunu farkederse, uygulanan bu modelde ana hedefin ne oldugunu ögrencilerin hatirlamasini, gerekirse ellerindeki kitapçiktan okumalarini ister
- Grup çalismasinin gözlemlenmesi ve notlarin alinmasi: ögretmen ögrencilerin karar vermis oldugu ögrenilmesi gereken konular listesini not eder. Eger bu listede ögrenilmesi önemli olan bir konu yer almiyorsa, ögretmen ögrencilerin bunun farkina varabilmesi için yardimci olur. Ancak ögretmen böyle bir durumda mümkün oldugunca ögrencileri yönlendirmekten kaçinmalidir.
- Açik uçlu sorularla grubun uyarilip idare edilmesi: bu ögretmenin en zor görevlerinden birisidir. Cünkü ögretmenin grubu yönlendirmemesi ve grubun kontrolünü almamasi gerekmektedir. Fakat ayni zamanda yeri geldiginde bir takim açik uçlu sorularla grupta tartisma ortami yaratmasi gerekmektedir. Burada dikkat edilmesi gereken nokta ögrencilerin basitçe direk olarak cevap verebilecegi sorularin sorulmamasidir.
- Ögrencilerin degerlendirilmesi: ögrenciler degerlendirilirken uygulanan yazili sinavin sonucunun yanisira ögretmen ve grup üyelerinin doldurdugu degerlendirme formlari da gözönüne alinir. Bu formlarda ögrenciler grup içersindeki katilimlari, katkilari, birbirleriyle olan iliskileri, ne ölçüde hazirlikli geldikleri gibi kriterlere göre degerlendirilirler

Probleme dayali ögrenme modeli uygulanirken çok farkli gruplarla, ögrencilerle karsilasilabilir. Kimi gruplarda ögrenciler birbirlerine karsi olumsuz, saldirgan davranislar sergilerken, kimi gruplarda ögrenciler ortaya atilan fikirleri hiç sorgulamadan kabul etme egiliminde olabilirler. Ögretmenin bunun farkinda olup her kosulda ögrencilerin merkezde oldugu ve modelin gerektirdigi tarzda davrandigi bir ortam olusturmasi gerekmektedir. Mesela, ögrenciler ne yapmalari, nasil davranmalari gerektigi konusunda belirsizlige düserse ögretmen hemen müdehale etmemeli, beklemelidir. Eger ögrenciler tamamen bir belirsizlik içersinde ise ögretmen 'problemi anlayabilmek için ne tür ek bilgilere ihtiyaciniz var?', 'tüm bunlardan ne çikarabilirsiniz' gibi genel, direkt cevabi olmayan sorular sorabilir. Benzer bir sekilde, eger ögrenciler birtakim bilgieri, fikirleri sorgulamadan kabul ediyorsa 'bunu nerden ögrendin?', 'bu söylemis oldugun bir gerçek mi yoksa senin düsüncen mi?', 'bu konuda emin misin?', 'herkes bu konuda hemfikir mi?' gibi sorular yöneletebilir. Dolayisiyla karsilastigi grubun özellikleri ne olursa olsun ögretmenin sinifin kontrolünü almadan rolünü yerine getirebilmesi için:

- tartisma ortaminin kontrolünün ve devamliliginin ögrencilerde olmasini saglamalidir. Eger ögrenciler soru sorarsa kontrolün tekar onlara geçmesini saglayacak tarzda davranmalidir. Grup çalismasi ögretmen ve herbir ögrenci arasindaki soru cevap oturumlarina dönüsmemelidir.
- ögrencilerin konuya yönlenmelerini, konu üzerine daha derinlemesine düsünmesini saglamalidir. Bunu yapabilmek için ise açik uçlu, çok genel sorular sormalidir
- sabirli olmalidir. Özellikle probleme dayali ögrenme modelinin ilk uygulanmaya basladigi siralarda ögrenciler beklendigi gibi davranamayabilir. Ögretmen ögrencilerine zaman tanimalidir
- ögrencilerin sorgulama yeteneklerini gelistirmelidir. Ögrenciler bulduklari bilgileri hemen kabul etmeyip üzerinde düsünmelidirler.

Ögretmenin sinifta yapmamasi gerekenler söyle siralanabilir:

- sessizlik oldugunda hemen kontrolü almamalidir
- sorulan sorulara direkt olarak cevap vermemelidir
- ögrencilere dogru ya da yanlis yolda olduklarini söylememelidir
- direkt olarak ögrencileri ögrenmeleri gereken konular konusunda yönlendirmemelidir

C. Probleme Dayali Ögrenme Modelinde Ders Islenisi

Probleme dayali ögrenme modelinin temelini grup halinde çalisan ögrenciler ve ögretmen olusturmaktadir. Grubun herbir üyesi grubun diger üyelerini yapici olarak elestirebilmeli, sorgulayabilmeli ve elestirilmekten, sorgulanmaktan çekinmemelidir. Bu tür davranislar grup üyelerinde rahatsizlik olusturabileceginden, ilk baslarda bunu gerçeklestirmek zor olabilir. Fakat zaman geçtikçe, ögrenciler modele alistikça bu, ögrencilerin bilgilerini arttirmalari gerektigi konulara yogunlasmasini saglayan eglenceli bir egzersiz haline gelecektir.

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Roller belirlendikten sonra örnek olayin ilk sayfasi ögrencilere dagitilir. Örnek olay bir hastayi anlatir. Hastaya iliskin bilgiler 5 ya da daha fazla sayfada verilir.

Genel olarak birinci sayfada hastanin adi, cinsiyeti, yasi ve sikayeti belirtilir. Ikinci sayfada hastanin sikayetleri, geçmisteki rahatsizliklari, kullandigi ilaçlar, ailesinde görülen rahatsizliklar ve yasam tarzi ile ilgili daha detayli bilgiler verilir. Ikinci sayfa hasta rolünü üstlenecek ögrenciye birinci sayfayla birlikte verilir. Ögrenciler birinci sayfa üzerine tartisirken hasta rolünü oynayan ögrenci bir taraftan da ikinci sayfayi içinden okur. Üçüncü sayfada muayene sonucu elde edien veriler yer alir. Dördüncü ve onu takip eden sayfalarda yapilan test, çekilen röntgen, EKG sonuçlari ve diger ilgili sonuçlar bulunur. Son sayfada ise teshis yer alir.

Ilk sayfa dagitildiktan sonra örnek olayda verilenleri okumaktan sorumlu olan ögrenci ilk sayfada verilen bilgileri yüksek sesle okur diger ögrenci tahtaya bilgileri not eder. Bu arada ögrenciler verilen bilgiler hakkinda tartismaya baslarlar. Hastanin sikayetleri hangi organ sistemiyle ilgili olabilir, daha çok bilgi edinebilmek için hastaya ne tür sorular sorulmalidir gibi konular üzerine odaklasirlar. Ögrenciler düsüncelerini belirtirken niçin öyle düsündüklerini de açiklarlar ve ortaya atilan düsünceleri, söylenen bilgileri dogruluklari konusunda sorgularar. Tartisma sirasinda probleme çözüm üretebilmek için hangi konularda bilgi edinmeleri gerekiyor buna karar verirler. Tüm bu tartismalar yapilirken tahtaya yazmaktan sorumlu olan kisi, hastanin probleminin hangi sistemle ilgili oldugu, ne gibi sorulara cevap bulunmasi ve hangi konularin ögrenilmesi gerektigine dair grubun vermis oldugu kararlari tahtaya yazar. Daha sonra doktor rolünü oynayacak olan ögrenci belirlenen sorulari hasta rolünü oynayan ögrenciye sorar. Bu arada diger ögrenciler akillarina baska sorular gelirse hastaya sorabilirler. Hastanin verdigi cevaplar tahtaya not edilir ve bu yeni bilgiler dogrultusunda daha önceki düsüncelerini gözden geçirirler. Bu arada ögrenilmesi gereken konular üzerinde tartisirlar. Gerekli bilgileri sorduklari sorularla edindiklerini düsündüklerinde örnek olaya iliskin ikinci sayfayi ögretmenden isterler ve ögretmen ikinci sayfayi dagitir. Örnek olayi okumaktan sorumlu olan ögrenci yüksek sesle ikinci sayfayi okur. Daha sonra ögrenciler spesifik olarak hangi fiziksel muayene sonucuna ihtiyaç duyulduguna karar verir ve ögretmenden

fiziksel muayene sonuçlarini içeren üçüncü sayfayi ister. Ögrenciler ilk üç sayfada verilen bilgileri kullanarak hastadan ne tür tetkiklerin istenmesi gerektigine karar verirler. Mesela, hastanin kan degerlerine, akciger röntgenin sonucuna ihtiyaç duyabilirler. Ögrenciler hangi testlerin sonucuna ihtiyaç duyulduguna karar verince ögretmen dördüncü sayfayi dagitir. Ögrenciler örnek olaya iliskin bilgilerin yer aldigi sayfalari edindikçe daha önce ortaya atmis olduklari düsünceleri, hipotezleri gözden geçirirler ve teshis koymaya çalisirlar ve aralarinda tartistiktan sonra ögretmen teshisi içeren besinci sayfayi dagitir. Bu arada ögrenciler esas amacin bu örnek olay sayesinde bir takim biyolojik kavramlarin konularin ögrenilmesi oldugu, teshis koymak olmadiginin bilincinde olmalidir.

Probleme dayali ögrenme modelinin uygulanisina iliskin olarak vurgulanmasi gereken önemli noktalardan birisi sudur: Bir örnek olay yaklasik 4-6 saatte tamamlanir. Bu da ögrencilerin 2 ya da 3 kere grup çalismasi yapmasina denk gelmektedir. Ögrenciler herbir grup çalismasinin sonunda ögrenilmesi gereken konular ve bu konular hakkinda nerelerden bilgi edinebileceklerine dair karar verirler ve bir sonraki grup çalismasina kadar bu konular üzerinde bireysel çalisma yaparlar. Bireysel çalisma sirasinda ögrenciler kitaplardan, internetten faydalanabilir ya da konusunda uzman bir kisiye danisabilirler. Ögrenciler isterlerse grup halinde de çalisabilirler. Herbir ögrenci konu hakkinda bilgi edindikten sonra, bu bilgiler dogrultusunda görüslerini belirtecek tarzda hazirlanarak bir sonraki ders saatine katilir. Her ögrencinin ders saatlerine hazirlikli gelmesi gerekmektedir. Çünkü bir sonraki dersin basinda kurayla bir ögrenci belirlenir ve bu ögrenci örnek olayda hastaya iliskin verien bilgileri ve bireysel çalisma sonucu elde ettigi bilgiler dogrultusunda probleme iliskin görüslerini anlatir. Daha sonra diger ögrenciler görüslerini belirtir ve bir önceki ders saatinde kalindigi yerden örnek olay üzerinde tartisilmaya devam edilir, yeri geldikçe ilgili sayfalar istenir.

Ögrenciler kendi aralarinda tartisirken ögretmen onlari gözlemler. Herhangi bir sekilde ögrencileri yönlendirmez. Fakat raporun ‘probleme dayali ögrenme modelinde ögretmenin rolü’ kisminda belirtildigi gibi gerektiginde birtakim stratejiler izleyerek dersin model dogrultusunda ögrenci merkezli olarak islenmesini saglar.

Genel olarak özetlemek gerekirse probleme dayali ögrenme modelinin uygulandigi siniflarda:

- ögrenciler ögrenme sürecinde aktif olarak yer alir
- ögrencilerde bilgiye ulasabilmek için gerekli olan tutum ve davranislar gelistirilir.
- ögrenciler ortak bir problemi analitik olarak grup içersinde çözebilme ortami bulur.

APPENDIX H

CASE ABOUT RESPIRATORY SYSTEM

Örnek Olay: 1
Osman Mutlu

1. 64 yasindaki Osman Mutlu, Ankara'daki bir hastanenin acil servisine yüksek ates, siklikla devam eden öksürme ve yorgunluk sikayetleriyle getirilmistir.

Örnek Olay: 1
Osman Mutlu

2. Osman Bey'in bilinci yerinde fakat hasta görünüslüdür. Son on güne kadar kendisini iyi hissettigini fakat son on gündür ates, üsüme, yorgunluk, ve kuru öksürük sikayetlerinin basladigini belirtmistir. Osman Bey, hastaneye kabulünden 48 saat önce, nefes darligi sikayetinin arttigini, yüksek ates ve titremenin basladigini söylemistir. Ayrica baslangiçta pas renginde olan balgamin artan öksürügü takiben iltihapli bir hal aldigini ifade etmistir. Herhangi bir gögüs agrisinin olmadigini ve agzindan kan gelmedigini belirtmstir.

   Osman Bey asbestos içeren çati malzemelerinin üretildigi bir fabrikada isçi olarak çalismaktadir. Günde 2 paket olmak üzere 40 yildir sigara içmektedir. Ara sira alkol almaktadir. Kullanmakta oldugu herhangi bir ilaç yoktur. Herhangi bir alerjisi yoktur. Ayrica ailesinde yüksek tansiyon, seker, ya da kanser olan kimse yoktur.

Örnek Olay: 1
Osman Mutlu

3. **Fiziksel Muayene**

Osman bey uzun boylu ince yapili birisidir. Cildi kirmizi, sicak ve kurudur. Akcigerler dinlendiginde hiriltili, islik tarzinda solunum sesi belirlenmistir. Kalp atislari normaldir. Kalp sesleri herhangi bir yapisal ya da fonksiyonel bozuklugu göstermemektedir. Kol ve bacaklarda sislik, morluk ya da ödem yoktur.

Ates	=	39.7 ^{0}C
Tansiyon	=	130 / 82
Nabiz	=	128/dak
Solunum Hizi	=	28/dak
Boy	=	1.92 m
Kilo	=	70 kg

Örnek Olay: 1
Osman Mutlu

4. **Laboratuvar Test Sonuçlari**

Atardamar Gazlari:

		Bulunan Deger	Normal Deger
pH	=	7.47	(7.36 - 7.44)
pCO_2	=	28	(31 - 42)
pO_2	=	74	(80 - 95)
HCO_3	=	21	(22 - 26)
O_2 saturation	=	40 %	(90 - 98)

Tam Kan Sayimi:

		Bulunan Deger	Normal Deger
Alyuvarlar	=	4.88 milyon/mm^3	(4.22 – 5.4)
Akyuvarlar	=	14300/ mm^3	(5000 – 10000)
Trombositler	=	320000/ mm^3	(150000-400000)

Örnek Olay: 1
Osman Mutlu

5. Akciger röntgeni çekilmistir. Röntgenin yorumlanmasi sirasinda sag akcigerin alt kisminda bozuk para büyüklügünde lekelerin varligi tespit edilmistir.

Örnek Olay: 1
Osman Mutlu

6. Balgam analizi istenmistir. Analiz sonucu zatüreye yolaçan ikili ya da kisa zincir halinde gözüken küre seklindeki Gram (+) bakterilere (*Streptococcus pneumoniae)* rastlanmistir

Örnek Olay: 1
Osman Mutlu

7. Osman Bey'e Penisilin tedavisi baslatilmistir. Hasta herhangi bir komplikasyonla karsilasmaksizin zamanla iyilesmistir.

APPENDIX I

INTEGRATION OF SYSTEMS

Ad Soyad
Sinif:

Yönerge: Asagida verilen figürü gözönüne alarak sindirim sistemi, solunum sistemi, dolasim sistemi, ve bosaltim sistemi arasindaki iliskiyi açiklayan detayli bir yazi yaziniz. Adi geçen sistemlerin yapi ve görevlerinden bahsetmeyi unutmayiniz.

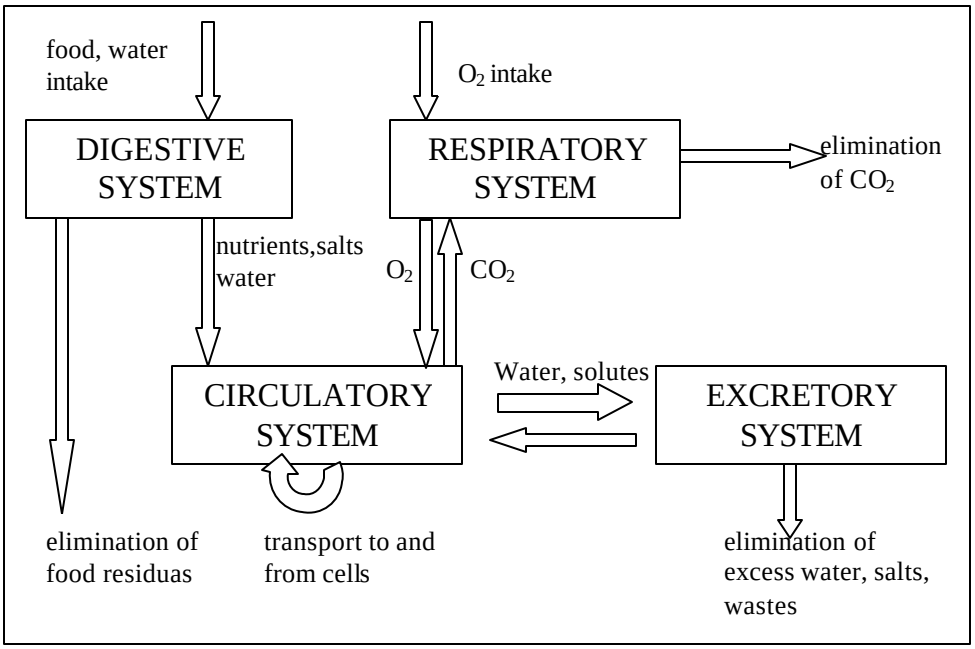
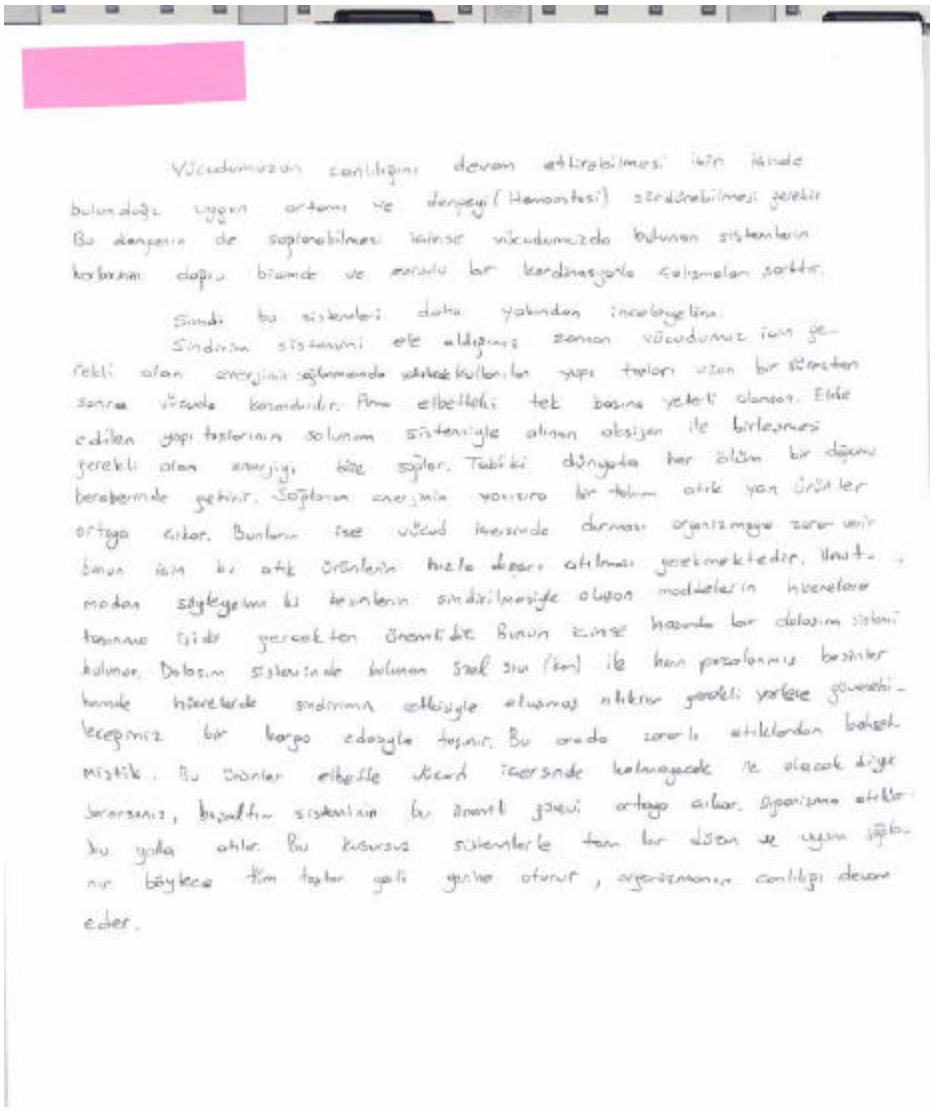


Figure I.1 Integration of Systems

APPENDIX J

STUDENTS' ESSAYS ON INTEGRATION OF SYSTEMS

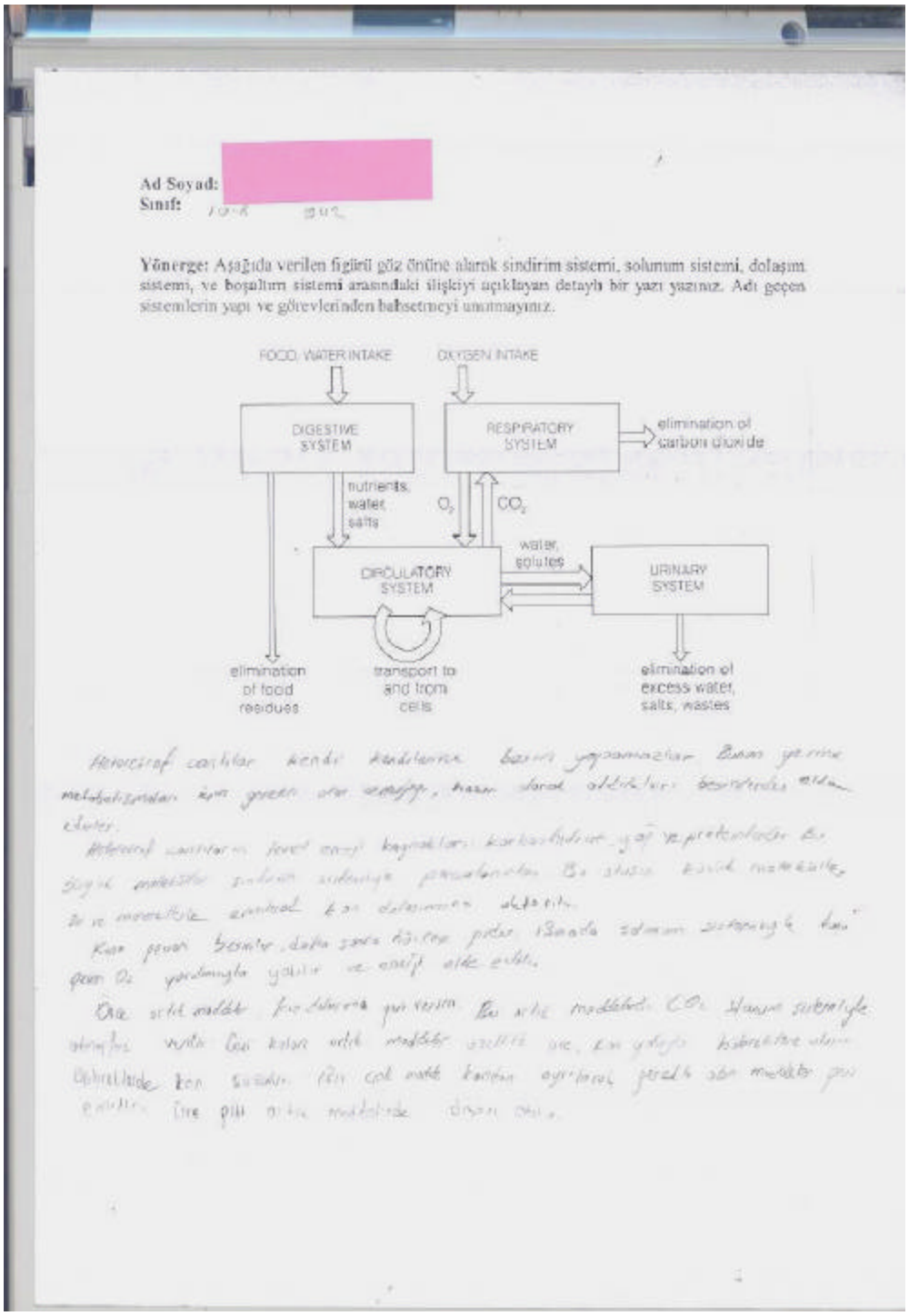


Vücudumuzun canlılığını devam ettirebilmesi için içinde bulunduğu uygun ortamı ve dengeyi (Homeostasi) sürdürebilmesi gerekir. Bu dengenin de sağlanabilmesi ancak vücudumuzda bulunan sistemlerin karşılıklı düzgün biçimde ve sorunlu bir kardeşçesine çalışmaları sayesinde.

Şimdi bu sistemleri daha yakından inceleyelim.

Sindirim sistemini ele aldığımız zaman vücudumuz için gerekli olan enerjinin sağlanmasında yardımcı kullanılan yapı taşları uzun bir süreçten sonra vücuda kazandırılır. Fakat elbetteki tek başına yeterli olamaz. Elde edilen yapı taşlarının solunum sisteriyle alınan oksijen ile birleşmesi gerekli olan enerjiyi bize sağlar. Tabiki dünyada her ölüm bir doğumu beraberinde getirir. Sağlanan enerjinin yanısıra bir takım atık yan ürünler ortaya çıkar. Bunların ise vücud içerisinde durması organizmaya zarar verir. Bunun için bu atık ürünlerin hızla dışarı atılması gerekmektedir. Unutmadan söylegeyim ki besinlerin sindirilmesiyle oluşan maddelerin hücrelere taşınma işi de gerçekten önemlidir. Bunun için hazırda bir dolaşım sistemi bulunur. Dolaşım sisteminde bulunan sıvı kan ile hem parçalanmış besinler hemde hücrelerde sindirimin etkisiyle oluşmuş atıkların gerekli yerlere güvenebileceğimiz bir kargo edasıyla taşınır. Bu arada zararlı etkilerden bahetmiştik. Bu zararlı etkiler elbette vücut içersinde kalmayacak ne olacak diye sorarsanız, boşaltım sistemlerin bu önemli görevi ortaya çıkar. Organizma atıkları bu yolla atılır. Bu kusursuz sistemlerle tam bir düzen ve uyum sağlanır böylece tüm taşlar yerli yerine oturur, organizmanın canlılığı devam eder.

Figure J .1 A Sample of Students' Essays



Ad-Soyad: [redacted]
Sınıf:

Yönerge: Aşağıda verilen figürü göz önüne alarak sindirim sistemi, solunum sistemi, dolaşım sistemi, ve boşaltım sistemi arasındaki ilişkiyi açıklayan detaylı bir yazı yazınız. Adı geçen sistemlerin yapı ve görevlerinden bahsetmeyi unutmayınız.

Figure J .1 A Sample of Students' Essays

APPENDIX K

TREATMENT VERIFICATION CHECKLIST

1. An ill-structured problem is posed to students O Yes O No

	Rarely/ Never	Frequently	Usually/ Always
2. Students generate ideas, hypotheses related to the problem	O	O	O
3. Students work in small groups	O	O	O
4. Students identify learning issues	O	O	O
5. Students share relevant information they obtained though individual study with each other	O	O	O
6. Students help each other	O	O	O
7. Students show respect for opinions of each other	O	O	O
8. When a student is expressing his/her opinions, other group members listen to him/her	O	O	O
9. Students evaluate group performance, their own individual performance after each session	O	O	O
10. Teacher hands out the case information at the appropriate times	O	O	O
11. Teacher encourages student to student interaction	O	O	O
12. Teacher ensures equal participation	O	O	O
13. When providing guidance, teacher asks open-ended, non-directive questions	O	O	O
14. Teacher establishes a relaxing, comfortable environment	O	O	O
15. Teacher keeps group focus on the goal	O	O	O
16. Teacher encourages critical thinking	O	O	O

APPENDIX L

CASE ABOUT EXCRETORY SYSTEM

Örnek Olay: 2
Mert Özkan

1. Agri'da bir köyde yasamakta olan anne ve babasini ziyaret etmek için esi ve 2 çocuguyla yola çikan 37 yasindaki Mert Özkan trafik kazasi geçirmis ve trafik kazasini takip eden 9 saat içerisinde acil servise getirilmistir. Kazada yalnizca Mert Bey yaralanmistir. Kaza aninda yogun kar yagisi ve yollarda buzlanma vardi. Olay aninin taniklari, Mert Bey'i göründügünden daha ciddi bir sekilde yaralanmis olabilecegini düsünerek hastaneye getirmislerdir. Mert Bey, karin bölgesindeki siddetli bir agridan sikayet etmektedir.

Örnek Olay: 2
Mert Özkan

2. Mert Bey'in yaninda esi, çocuklari, ve onlari hastaneye getiren kaza aninin taniklari bulunmaktadir. Esi, Mert Bey'in buzlu yolda direksiyon hakimiyetini yitirdigini, arabada hava yastiginin bulunmadigini ve Mert bey'in emniyet kemerini takmadigini belirtmistir. Ayrica, Mert Bey'in arabanin yoldan çikip, elektrik diregine vurdugu sirada, siddetli bir sekilde direksiyona çarptigini söylemistir. Mert Bey'in disardan gözüken herhangi bir yarasi bulunmamaktadir. Uyanik olmasina ragmen, zihin bulaniklgi vardir. Güçsüz, ve soluk görünmektedir. Hizli, kesik kesik, derin olmayan soluk alip vermektedir.

   Mert Bey 10 yildir bir bankada çalismaktadir. Sigara içmemekle beraber ara sira alkol almaktadir. Kullanmakta oldugu herhangi bir ilaç yoktur. Su ana kadar herhangi bir ameliyat geçirmemistir. Herhangi bir alerjisi yoktur. Ayrica ailesinde yüksek tansiyon, seker, ya da kanser olan kimse de yoktur.

Örnek Olay: 2
Mert Özkan

3. **Fiziksel Muayene**

Sirtüstü olarak sedyede yatmakta olan Mert Bey'in fiziksel muayene sonuçlari asagidaki gibidir:

Ates	=	36.7 ^{0}C
Tansiyon	=	Büyük Tansiyon: 50
		Küçük Tansiyon: Belirlenemiyor
Nabiz	=	130/dak
Solunum Hizi	=	24/dak

Akcigerler: Hizli ve derin olmayan soluk alip verme. Her iki akcigerde de normal solunum sesleri.

Kalp-Damar Sistemi: Düzenli fakat hizli kalp atisi. Kalp sesleri herhangi bir yapisal ya da fonksiyonel bozuklugu göstermemektedir. Nabiz hizli ve zayif

Karin: Hastanin elle yapilan muayenesinde, karnin sol üst bölgesinde dokunmaya bagli aci hali, hassasiyet, ve istek disi ani, siddetli kas kasilmasi gözlenmistir. Karnin bu bölgesi elle yavasça bastirilip hizlica birakilinca hasta agridan çiglik atmistir, göbek deliginin çevresinde kirmizi benekler vardir.

Kol-Bacaklar: Renksiz, soluk görünüslü. Ayaklarin alt kismi ve ayak parmaklarinda mor lekeler var. El ve ayaklar soguk. Ödem ya da sislik yok.

Sinir Sistemi: Uyusuk, hareketsiz, fakat kendinde. uyanik

Burada belirtilmeyen diger tüm fiziksel muayene sonuçlari normal.

Örnek Olay: 2
Mert Özkan

4. **Hastaneye Kabulü Sirasindaki Tahlil Sonuçlari**

Tam Kan Sayimi :

		Bulunan Deger	Normal Deger
Hemoglobin	=	12.7 gm/dl	(12 – 15)
Akyuvarlar	=	20700/ mm^3	(4800 – 10800)
Trombositler	=	55000/ mm^3	(150000-400000)

Rutin Biyokimya Testleri

		Bulunan Deger	Normal Deger
BUN (Kan Üre Azotu)	=	26 mg/dl	(5-24)
Kreatinin	=	1.4 mg/dl	(0.7-1.3)
Glikoz	=	115 mg/dl	(65-115)
Na^+	=	138 mmol/l	(136-146)
K^+	=	4.0 mmol/l	(3.7-5.3)
Cl^-	=	107 mmol/l	(101-111)
CO_2	=	20 mmol/l	(21-31)

Atardamar Gazlari:

		Bulunan Deger	Normal Deger
pH	=	7.40	(7.38 - 7.44)
pCO_2	=	32 mmHg	(35 - 45)
pO_2	=	72 mmHg	(80 - 95)
HCO_3^-	=	20 mEq/l	(23 - 28)

Idrar Tahlili:

		Bulunan Deger	Normal Deger
pH	=	6	(4.6-8)
Idrar dansitesi	=	1.09	(1.003-1.030)
Protein	=	negatif	(negatif)
Akyuvarlar	=	3	(negatif)
Alyuvarlar	=	nadir	(negatif)
Glikoz	=	negatif	(negatif)
Aseton	=	negatif	(negatif)

Örnek Olay: 2
Mert Özkan

5. **Hastaligin Seyri**

Ultrason sonucu karin boslugunda kan biriktigini göstermistir.

Örnek Olay: 2
Mert Özkan

6. **Hastaligin Seyri**

Mert Bey'e iç kanama teshisi konmustur. Damardan (intravenous fluid) serum ve dopamin verilmistir. Karin bölgesinde meydana gelen hasari ve boyutunu kesfe yönelik yapilan müdahale dalakta yirtilma oldugunu ve bunun sonucunda karin boslugunda önemli ölçüde kan biriktigini göstermistir. Dalak ve karin boslugunda birikmis olan kan alinmistir. Fakat serum takviyesine ragmen Mert Bey idrara çok az çikmaktadir. Mert Bey'in hastaneye kabulünden 24 ve 48 saat sonraki test sonuçlari asagidaki gibidir:

		24 saat	48 saat	Normal Deger
Kan Tahlili Sonuçlari				
BUN (Kan Üre Azotu)	=	32 mg/dl	54 mg/dl	(5-24)
Kreatinin	=	2.2 mg/dl	4.3 mg/dl	(0.7-1.3)
Idrar Tahlili Sonuçlari				
Protein		1+	2+	(negatif)
Akyuvarlar		2	6	(negatif)
Alyuvarlar		nadir	4	(negatif)
Glikoz		negatif	1+	(negatif)

48 saat sonra yapilan mikroskopik inceleme, idrarda nefronlari olusturan tübüler epitelyal hücrelerinin varligini göstermistir.

Örnek Olay: 2
Mert Özkan

7. **Hastaligin Seyri**

Hastanedeki dördüncü gününde, Mert Bey hala idrara az çikmaktaydi. Test sonuçlari kandaki üre azotu (BUN) seviyesinin 76 mg/dl, Kreatinin seviyesinin 7.2 mg/dl oldugunu göstermistir.,

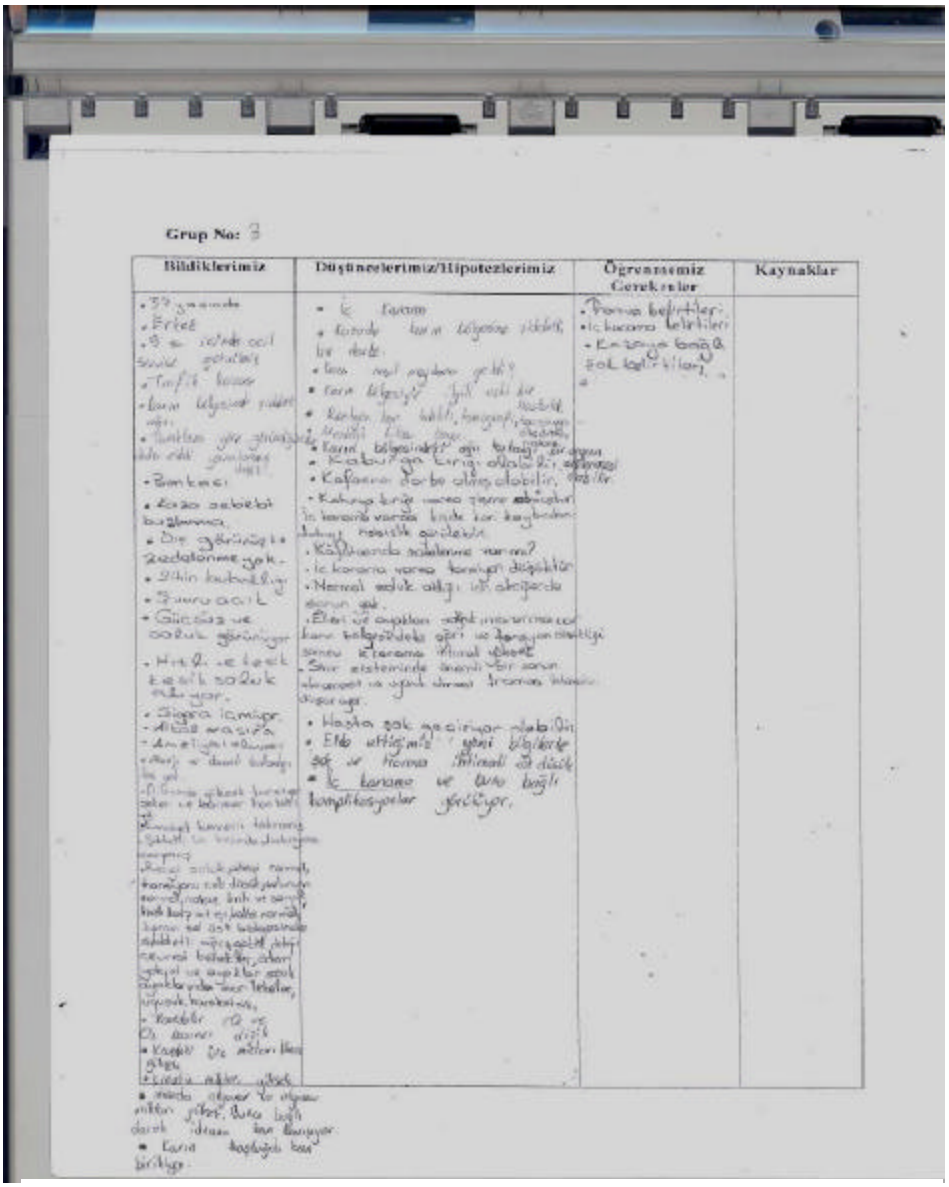
Sergiledigi klinik tabloya bakilarak doktorlar, hastanin böbreklerin kan kaybindan dolayi geçici olarak kansiz kaldigini ve bu nedenle de dokularin bozularak normal fizyolojik fonksiyonlarini yapamayacak duruma geldigini belirtmisler ve hastaya "akut tübüler nekroz" (ATN) teshisi koymuslardir.

Hemodiyalize baslanmistir. Mert Bey'in böbrek yetmezligi, idrarinin 500-1000 ml/gün' e çiktigi hastanedeki 22inci gününe kadar devam etmstir. BUN ve Kreatinin seviyesi normale dönmüstür.

.

APPENDIX M

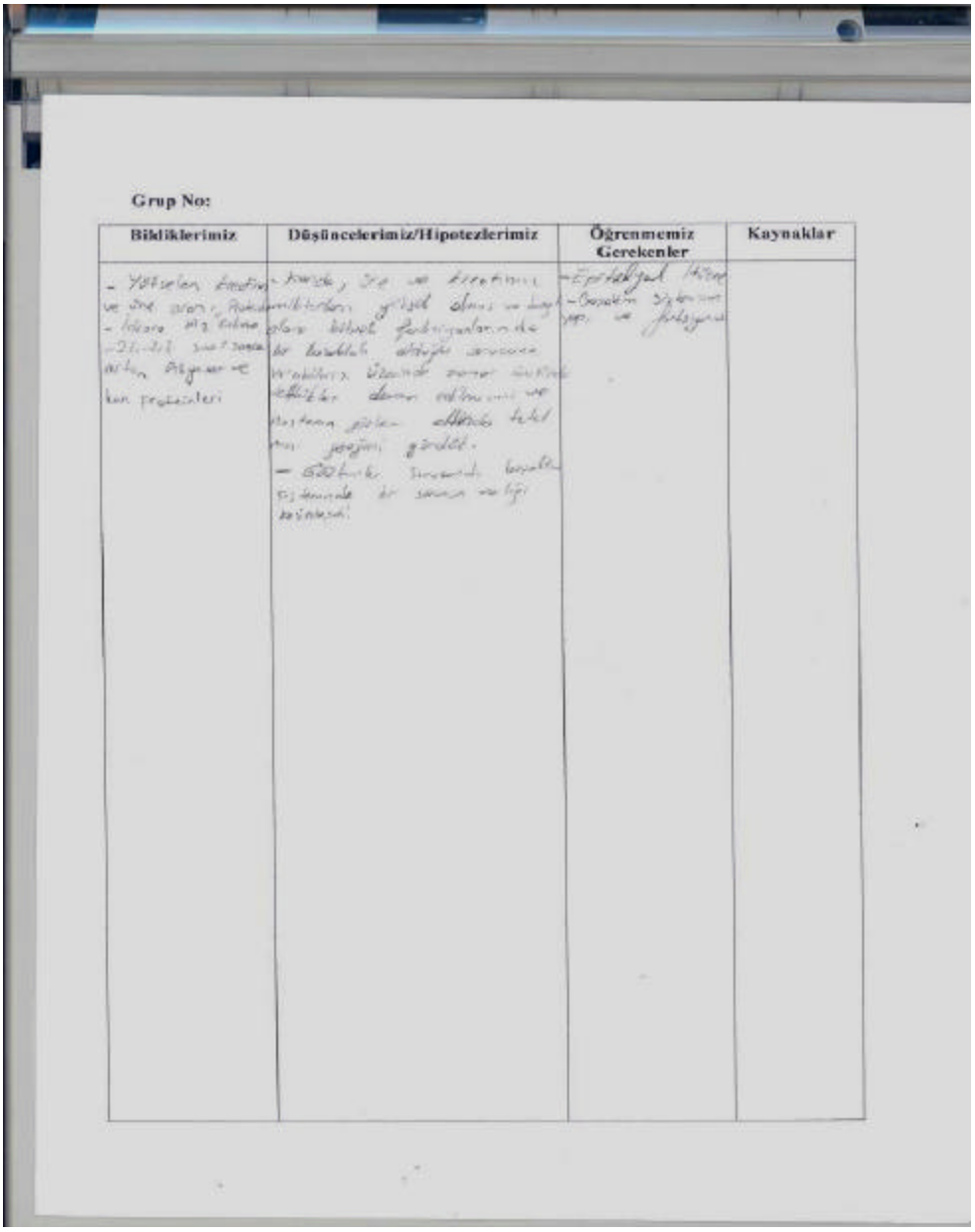
A SAMPLE GROUP SHEET



Grup No: 3

Bildiklerimiz	Düşüncelerimiz/Hipotezlerimiz	Öğrenmemiz Gerekenler	Kaynaklar
[illegible]	[illegible]	[illegible]	

Figure M.1 A Sample of Group Sheet Page 1



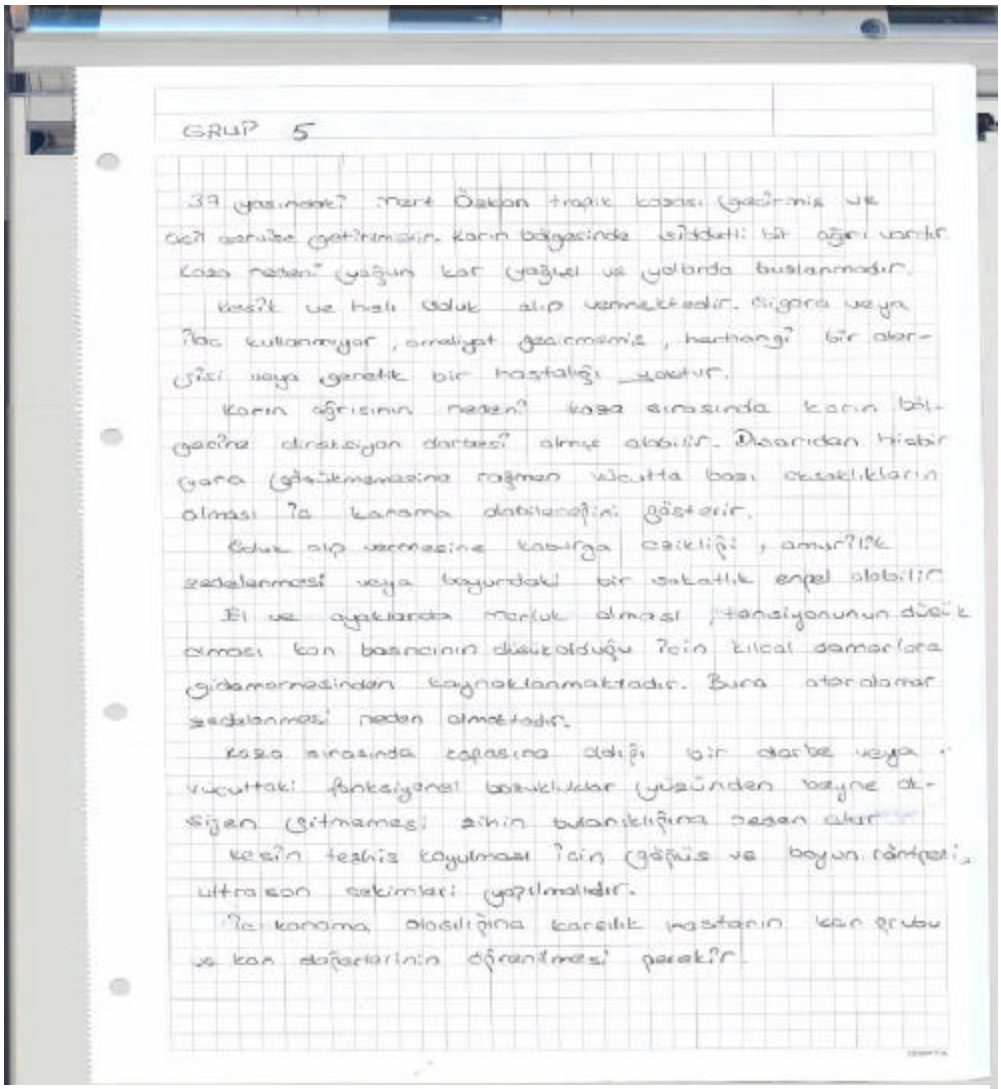
Grup No:

Bildiklerimiz	Düşüncelerimiz/Hipotezlerimiz	Öğrenmemiz Gerekenler	Kaynaklar

Figure M.2 A Sample of Group Sheet Page 2

APPENDIX N

SAMPLE PRESENTATION REPORTS



GRUP 5

39 yaşında Mert Özkan trafik kazası geçirmiş ve ölü olarak getirilmiştir. Karın bölgesinde şiddetli bir ağrı vardır. Kaza neden yağışın kar yağışı ve yolda buzlanmadır.

Kesik ve hali çoluk alıp vermektedir. Sigara veya ?ay kullanmıyor, ameliyat geçirmemiş, herhangi bir alerjisi veya genetik bir hastalığı yoktur.

Karın ağrısının neden? kaza sırasında karın bölgesine direksiyon darbesi almış olabilir. Dışarıdan hiçbir şey görünmemesine rağmen vücutta bazı ezikliklerin olması ?a kanama olabileceğini gösterir.

Çoluk alıp vermesine kaburga ezikliği, omurilik zedelenmesi veya boyundaki bir sakatlık engel olabilir.

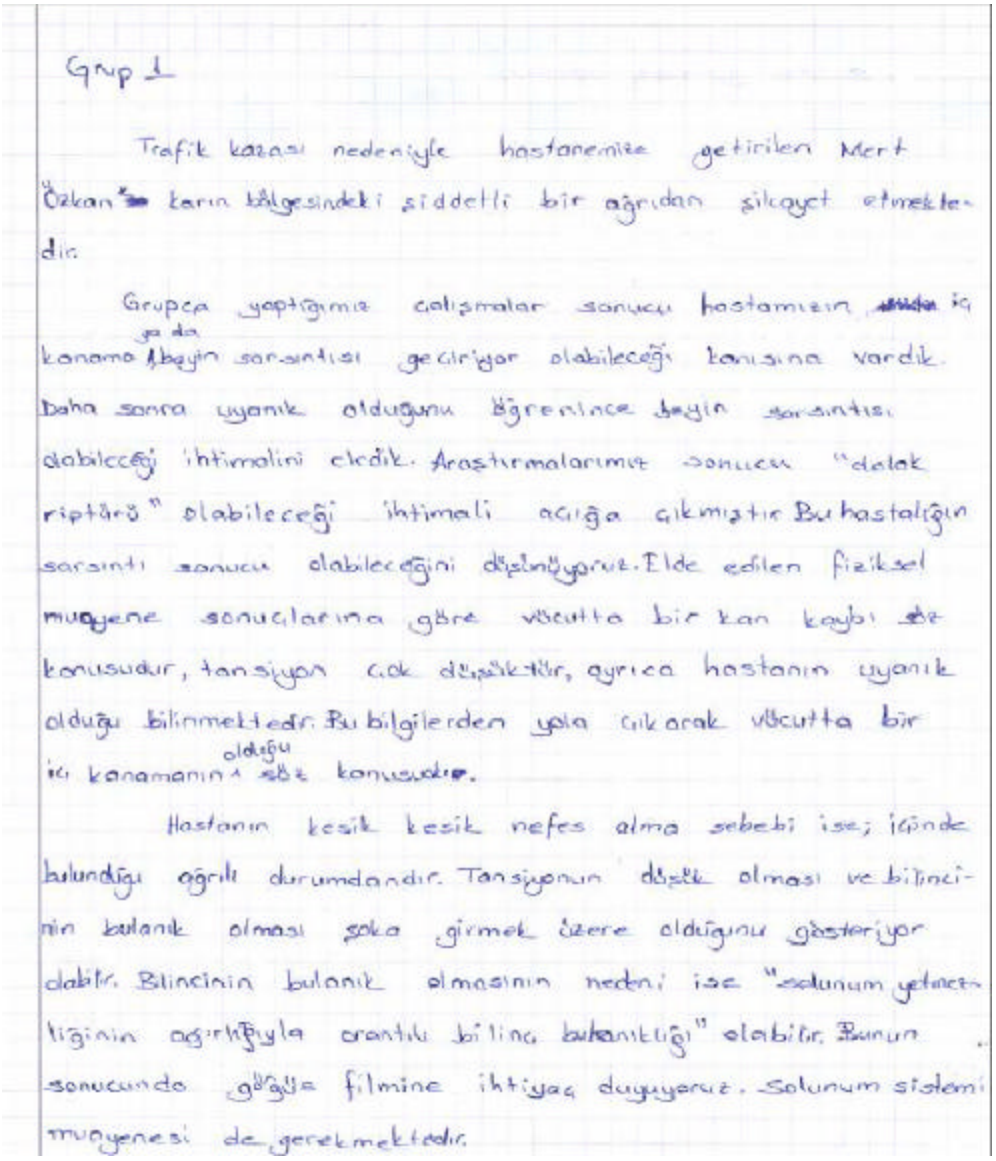
El ve ayaklarda morluk olması trombosyonunun düşük olması kan basıncının düşük olduğu ?ein kılcal damarlara gidememesinden kaynaklanmaktadır. Bura atardamar zedelenmesi neden olmaktadır.

Kaza sırasında kafasına aldığı bir darbe veya vücuttaki fonksiyonel bozukluklar yüzünden boyne düşen çıtırtıması zihin bulanıklığına neden olur.

Kesin teşhis koyulması ?ein çağrış ve boyun röntgeni, ultrason çekimleri yapılmalıdır.

?a kanama olasılığına karşılık hastanın kan grubu ve kan değerlerinin öğrenilmesi gerekir.

Figure N.1 A Sample of Students' Report



Grup 1

Trafik kazası nedeniyle hastanemize getirilen Mert Özkan karın bölgesindeki şiddetli bir ağrıdan şikayet etmektedir.

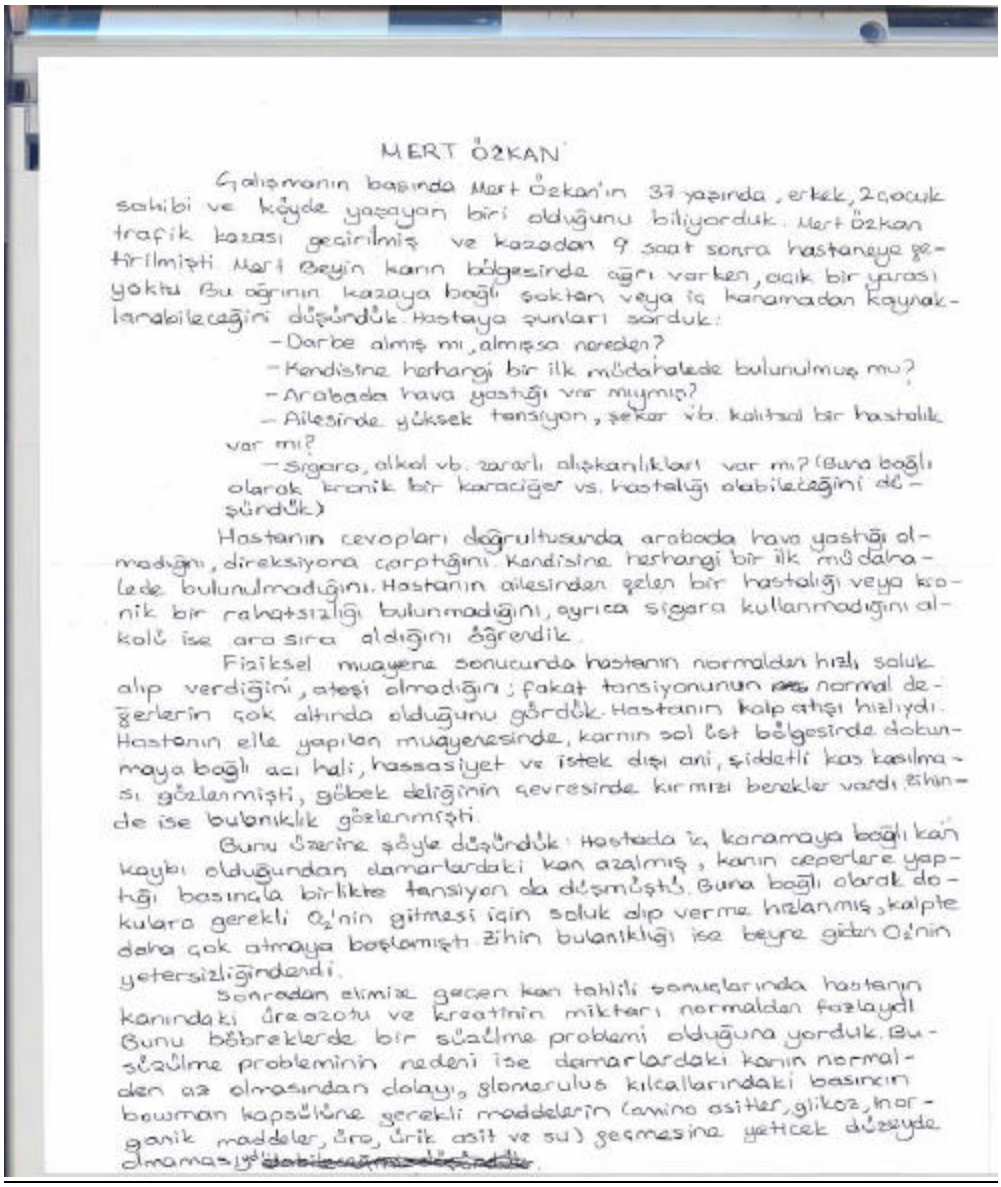
Grupça yaptığımız çalışmalar sonucu hastamızın iç kanama ya da beyin sarsıntısı geçiriyor olabileceği kanısına vardık. Daha sonra uyanık olduğunu öğrenince beyin sarsıntısı olabileceği ihtimalini elediik. Araştırmalarımız sonucu "dalak rupturü" olabileceği ihtimali açığa çıkmıştır. Bu hastalığın sarsıntı sonucu olabileceğini düşünüyoruz. Elde edilen fiziksel muayene sonuçlarına göre vücutta bir kan kaybı söz konusudur, tansiyon çok düşüktür, ayrıca hastanın uyanık olduğu bilinmektedir. Bu bilgilerden yola çıkarak vücutta bir iç kanamanın olduğu söz konusudur.

Hastanın kesik kesik nefes alma sebebi ise; içinde bulunduğu ağrılı durumdandır. Tansiyonun düşük olması ve bilincinin bulanık olması şoka girmek üzere olduğunu gösteriyor olabilir. Bilincinin bulanık olmasının nedeni ise "solunum yetersizliğinin ağırlığıyla orantılı bilinç bulanıklığı" olabilir. Bunun sonucunda göğüs filmine ihtiyaç duyuyoruz. Solunum sistemi muayenesi de gerekmektedir.

Figure N.2 A Sample of Students' Report

APPENDIX O

SAMPLE FINAL REPORTS



MERT ÖZKAN

Çalışmanın başında Mert Özkan'ın 37 yaşında, erkek, 2 çocuk sahibi ve köyde yaşayan biri olduğunu biliyorduk. Mert Özkan trafik kazası geçirilmiş ve kazadan 9 saat sonra hastaneye getirilmişti. Mert Beyin karın bölgesinde ağrı verken, açık bir yarası yoktu. Bu ağrının kazaya bağlı şoktan veya iç kanamadan kaynaklanabileceğini düşündük. Hastaya şunları sorduk:

- Darbe almış mı, almışsa nereden?
- Kendisine herhangi bir ilk müdahalede bulunulmuş mu?
- Arabada hava yastığı var mıymış?
- Ailesinde yüksek tansiyon, şeker vb. kalıtsal bir hastalık var mı?
- Sigara, alkol vb. zararlı alışkanlıkları var mı? (Buna bağlı olarak kronik bir karaciğer vs. hastalığı olabileceğini düşündük.)

Hastanın cevapları doğrultusunda arabada hava yastığı olmadığını, direksiyona çarptığını. Kendisine herhangi bir ilk müdahalede bulunulmadığını. Hastanın ailesinden gelen bir hastalığı veya kronik bir rahatsızlığı bulunmadığını, ayrıca sigara kullanmadığını alkolü ise ara sıra aldığını öğrendik.

Fiziksel muayene sonucunda hastanın normalden hızlı soluk alıp verdiğini, ateşi olmadığını; fakat tansiyonunun normal değerlerin çok altında olduğunu gördük. Hastanın kalp atışı hızlıydı. Hastanın elle yapılan muayenesinde, karın sol üst bölgesinde dokunmaya bağlı acı hali, hassasiyet ve istek dışı ani, şiddetli kas kasılması gözlenmişti, göbek deliğinin çevresinde kırmızı benekler vardı. Zihinde ise bulanıklık gözlenmişti.

Bunu üzerine şöyle düşündük: Hastada iç kanamaya bağlı kan kaybı olduğundan damarlardaki kan azalmış, karın çeperlere yaptığı basınçla birlikte tansiyon da düşmüştü. Buna bağlı olarak dokulara gerekli O_2'nin gitmesi için soluk alıp verme hızlanmış, kalpte daha çok atmaya başlamıştı. Zihin bulanıklığı ise beyne giden O_2'nin yetersizliğindendi.

Sonradan elimize gecen kan tahlili sonuçlarında hastanın kanındaki üreazotu ve kreatinin miktarı normalden fazlaydı. Bunu böbreklerde bir süzülme problemi olduğuna yorduk. Bu süzülme probleminin nedeni ise damarlardaki kanın normalden az olmasından dolayı, glomerulus kılcallarındaki basıncın bowman kapsülüne gerekli maddelerin (amino asitler, glikoz, inorganik maddeler, üre, ürik asit ve su) geçmesine yetecek düzeyde olmaması yüzünden

Figure O.1 A Sample of Students' Report Page 1

Atardamar gazlarda normal değerlerinden düşüktü bunun nedeni ise muhtemelen damarlarda yeterli kan taşınamamasıydı.

Ultrason sonucundan hastanın karın boşluğunda kan birikti-ğini öğrendiğimizde ise iç kanama şüphemizin doğru olduğunu anladık.

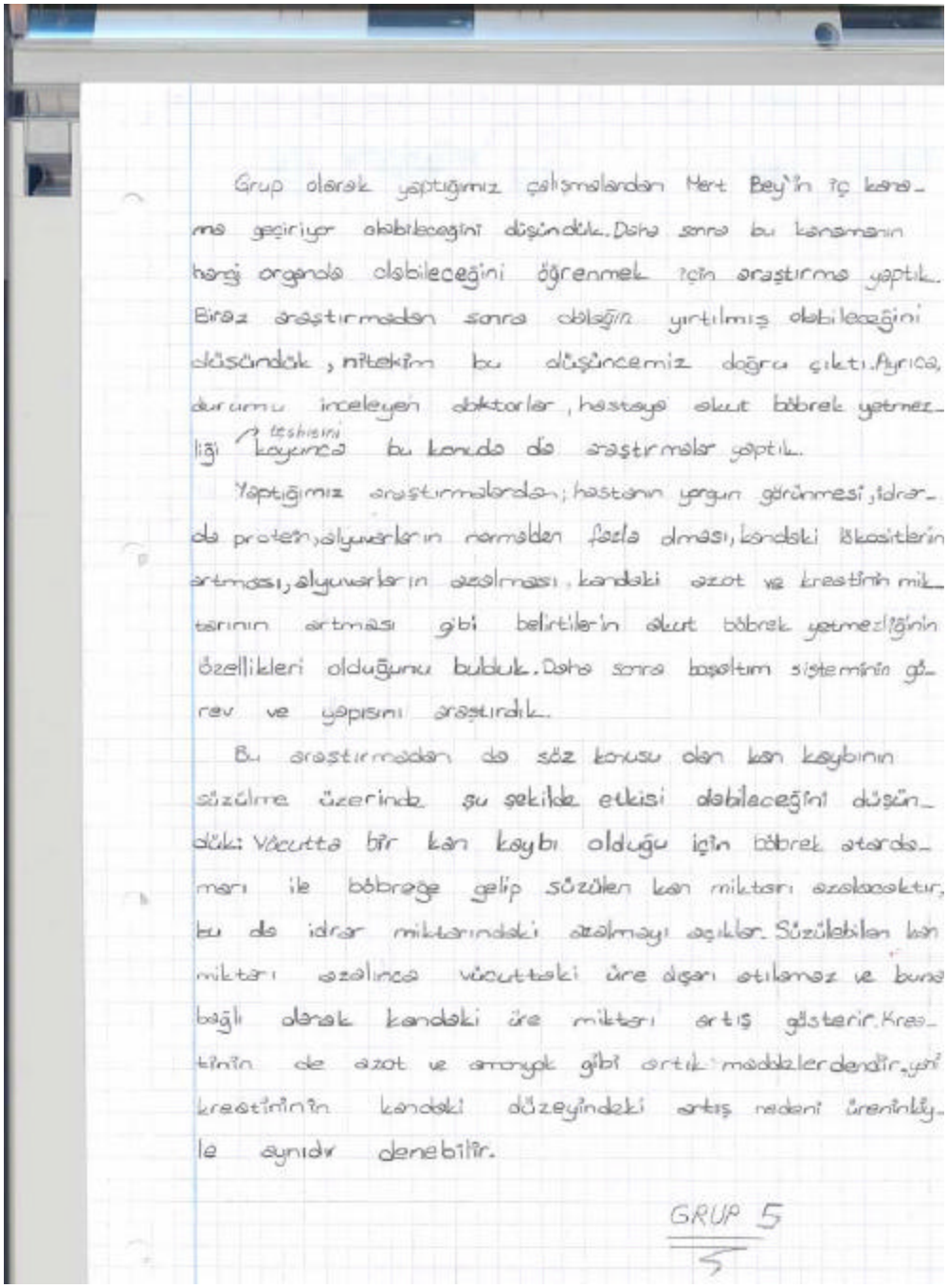
Verilen son kağıtlardan öğrendiğimize göre hasteya iç kanama teşhisi konmasına ve gereken müdahaleler yapılmasına rağmen, hasta idrara çok az çıkmaktaydı, kanındaki üre azotu ve kreatinin sürekli arterken, idrarındaki protein, alyuvar ve akyuvar oranıda artıyordu. 48 saat sonra yapılan mikroskopik incelemede Mert Beyin idrarında nefronları oluşturan tübüler epitelyal hücrelerin varlığı gözlenmişti.

Bu taklitlere bakılırsa hastanın kanındaki üre azotu ve kreatinin miktarı giderek artıyordu, bu da bize böbreklerde bir süzülme problemi olduğunu gösteriyordu. İdrarda normal şartlar altında bulunmaması gereken protein, alyuvar, akyuvarın bulunmasıyla ilgilide şöyle bir açıklama yapabiliriz: getirici ve götürücü damarlar arasında bulunan glomerulus kılcal damarları iki katlı epitel doku ile örtülü olduğundan içine alyuvar, akyuvar, trombosit ve proteinler geçemez. Bundan yola çıkarak hastamızın glomerulus kılcallarında iç kanamadaki basınç değişimine bağlı bir zedelenme olabileceğini düşünüyoruz, hastanın idrarındaki epitelyal hücrelerin varlığıda bu kanımızı kuvvetlendirmekte.

Böbreklerde glomerulustan gelen süzüntünün tamamı dışarı atılmaz eğer atılsaydı kanın kimyasal bileşimi bozulurdu. Süzüntü içinde bulunan su, glikoz, amino asitler ve inorganik tuzların nefron kanallarındaki hücrelere alınmasına geri emilim denir. Hastanın idrarında hiç olmaması gereken glikozun (hastada ailede kalıtım şeker hastalığı yok) idrarda olması böbreklerdeki geri emilimde bir sorun olduğunu gösteriyor.

Sonuç olarak biz Mert Beyde glomerulus kılcal damarlarında zedelenme ve kısa süreli O_2 eksikliğine bağlı olarak süzülme ve geri emilimde boşaltık olduğunu düşünüyoruz.

Figure O.2 A Sample of Students' Report Page 2



Grup olarak yaptığımız çalışmalardan Mert Bey'in iç kana-
ma geçiriyor olabileceğini düşündük. Daha sonra bu kanamanın
hangi organda olabileceğini öğrenmek için araştırma yaptık.
Biraz araştırmadan sonra dalağın yırtılmış olabileceğini
düşündük, nitekim bu düşüncemiz doğru çıktı. Ayrıca,
durumu inceleyen doktorlar, hastaya akut böbrek yetmez-
liği teşhisini koyunca bu konuda da araştırmalar yaptık.

Yaptığımız araştırmalardan; hastanın yorgun görünmesi, idrar-
da protein, alyuvarların normalden fazla olması, kandaki lökositlerin
artması, alyuvarların azalması, kandaki azot ve kreatinin mik-
tarının artması gibi belirtilerin akut böbrek yetmezliğinin
özellikleri olduğunu bulduk. Daha sonra boşaltım sisteminin gö-
rev ve yapısını araştırdık.

Bu araştırmadan da söz konusu olan kan kaybının
süzülme üzerinde şu şekilde etkisi olabileceğini düşün-
dük: Vücutta bir kan kaybı olduğu için böbrek atarda-
ları ile böbreğe gelip süzülen kan miktarı azalacaktır,
bu da idrar miktarındaki azalmayı açıklar. Süzülebilen kan
miktarı azalınca vücuttaki üre dışarı atılamaz ve buna
bağlı olarak kandaki üre miktarı artış gösterir. Kreatinin de azot ve amonyak gibi artık maddelerdendir, yani kreatininin kandaki düzeyindeki artış nedeni ürenin kiy-
le aynıdır denebilir.

GRUP 5

5

Figure O 3 A Sample of Students' Report

APPENDIX P

DEGERLENDIRME FORMU

Ögrencinin Adi: _____

Grup No:_____

Yönerge: Asagida ögrencilerin grup çalismasina olan katilim, hazirlik, katki ve de kisilerarasi becerilerini belirlemeye yönelik birtakim ifadeler yer almaktadir. Grubunuzdaki herbir ögrenci için bu formu ayri ayri doldurunuz ve her bir ögrenciyi en iyi tasvir ettigini düsündügünüz ifadenin yanina isaret koyunuz

A. Katilim			
1) ' tüm grup çalismalarina katildi	' bazi grup çalismalarina gubun onayini alarak gelmedi	' bazi grup çalismalarina grubun onayi olmaksizin gelmedi	' grup çalismalarinin tümüne gruba onayi olmaksizin gelmedi
2) ' her zaman grup çalismasina zamaninda geldi	' genelde grup çalismasina zamaninda geldi	' sik sik grup çalismasina 5 dakikanin üstünde geç geldi	' her zaman grup çalismasina 5 dakikanin üstünde geç geldi
3) ' her zaman grubun aktif bir üyesi oldu	' gemelde grubun aktif bir üyesi oldu	' grubun çok aktif ya da çok pasif bir üyesi olma egilimindeydi	' sik sik grubun çok aktif ya da çok pasif bir üyesi oldu
4) ' her zaman grup çalismasina konunun derinlemesine anlasilmasini saglayacak tarzda katililimda bulundu	' grup çalismasina katilmaya istekliydi	' bazen grup çalismasina katilmayi istemedi ve grup içi etkilesim hakkindaki duygularini açiklamakta isteksizdi	' grup çalismasina katilmayi istemedi ve grup içi etkilesim hakkindaki duygularini açiklamadi

5) ' ögrenilmesi gereken konular belirlenirken her zaman önerilerini belirtti ve aktif olarak rol aldi	' ögrenilmesi gereken konular belirlenirken genelde önerilerini belirtti ve/ya da aktif olarak rol aldi	' ögrenilmesi gereken konular belirlenirken nadiren önerilerini belirtti ya da aktif olarak rol aldi	' ögrenilmesi gereken konular belirlenirken önerilerini belirtmedi ve aktif olarak rol almadi
B. Hazirlik			
6) ' grup çalismasina belirlenen konu/örnek olaya uygun olarak her zaman hazirlikli geldi	' grup çalismasina genelde hazirlikli geldi	' grup çalismasina daha iyi hazirlanmis olarak gelebilirdi	' grup çalismasina sürekli olarak hazirliksiz geldi
7) ' yeni ögrendiklerini ve düsüncelerini organize, sistematik bir tarzda sundu	' genede yeni ögrendiklerini ve düsüncelerini organize ya da sistematik bir tarzda sundu	' yeni ögrendiklerini ve düsüncelerini daha organize ve sistematik bir tarzda sunabilirdi	' yeni ögrendiklerini ve düsüncelerini düzensiz ya da rastgele bir tarzda sundu
8) ' bir fikri savunurken ya da bir konuyu açiklarken sürekli olarak kaynak gösterdi	' bir fikri savunurken ya da bir konuyu açiklarken genelde kaynak gösterdi	' bir fikri savunurken ya da bir konuyu açiklarken sik sik kaynak göstemedi	' bir fikri savunurken ya da bir konuyu açiklarken sürekli olarak kaynak göstermedi
9) ' sik sik örnek olayla ilgili fikir alisverisi, tartisma ortami yaratacak sorular hazirladi	' bazen örnek olayla ilgili fikir alisverisi, tartisma ortami yaratacak sorular hazirladi	' nadiren örnek olayla ilgili sorular hazirladi ya da hazirladigi sorular tartisma ortami yaratabilecek düzeyde degildi	' hiçbir zaman tartisma ortami yaratacak soru hazirlamadi
C. Kisilerarasi Beceriler			
10) ' her zaman diger grup üyelerinin katilimina olanak verdi	' genelde diger grup üyelerinin katilimina olanak verdi	' bazen diger grup üyelerinin konusmasina firsat vermedi grup içi etkilesimi kisitladi	' sik sik diger grup üyelerinin konusmasina firsat vermedi grup içi etkilesimi engelledi
11) ' diger grup üyelerinin düsüncelerine her zaman saygi gösterdi	' diger grup üyelerinin düsüncelerine genelde saygi gösterdi	' diger grup üyelerinin düsüncelerine bazen saygi göstermedi	' diger grup üyelernin katkisini gözardi etti ve kendisinden farkli düsüncelere karsi çok az tolerans gösterdi
12) ' diger grup üyelerine her zaman yardim etti	' diger grup üyelerine genelde yardim etti	' diger grup üyelerine karsi daha yardimci olabilirdi	' diger grup üyelerinin basarilarina, gelisimlerine engel oldu

13) ' kendisi hakkindaki yapici elestirileri her zaman saygiyla karsiladi	' kendisi hakkindaki yapici elestirileri genelde saygiyla karsiladi	' yapici elestirileri kabul etmede zorlandi	' yapici elestirileri kabul etmedi ya da yapici elestirilerden faydalanamadi.
14) ' diger grup üyelerinin davranislarinin kendisini nasil etkiledigini her zaman için "ben" diliyle ifade etti	' diger grup üyelerinin davranislarinin kendisini nasil etkiledigini genelde "ben" diliyle ifade etti	' diger grup üyelerinin davranislarinin kendisini nasil etkiledigini nadiren "ben" diliyle ifade etti	' diger grup üyelerinin davranislarindan çok kisiliklerini elestirdi ve yapici elestirilerde bulunamadi
15) ' her zaman grup çalismasi için yaptigi hazirlik ve katilima iliskin gerçekçi bir özdegerlendirme yapti	' genelde gerçekçi bir özdegerlendirme yapti	' genelde gerçekçi bir özdegerlendirme yapmadi	' grup çalismasi için yaptigi hazirlik ve katilima iliskin gerçekçi bir özdegerlendirme yapmadi
16) ' grup performansini gelistirmek için büyük çaba gösterdi	' grup performansini gelistirmek için çaba gösterdi	' grup performansini gelistirmek için çok az çaba gösterdi ya da çabalari yetersiz kaldi	' performansi arttirmak için yapilan önerileri gerçeklestirmek için çaba göstermedi
D. Grup Çalismasina Katki			
17) ' ortaya atilan düsünceleri açiklik getirerek, özetleyerek, ya da düsünceler arasinda bag kurarak grup üyeleri arasindaki iletisime sik sik yardimci oldu	' ortaya atilan düsünceleri açiklik getirerek, özetleyerek, ya da düsünceler arasinda bag kurarak grup üyeleri arasindaki iletisime sik sik bazen yardimci oldu	' genelde ortaya atilan düsünceleri açiklik getirmedi, özetlemedi, ya da düsünceler arasinda bag kurmadi	' grup üyeleri arasindaki iletisimi engelledi
18) ' zararli grup prensiplerini engellemek ya da ortadan kaldirmak için sik sik ugras verdi	' zararli grup prensiplerini engellemek ya da ortadan kaldirmak için bazen ugras verdi	' zararli grup prensiplerine yol açmadi	' zararli grup prensiplerini destekledi
19) ' konu disina çikildiginda grubu tekrar konuya yönlendirmek için her zaman çaba gösterdi	' konu disina çikildiginda grubu tekrar konuya yönlendirmek için çaba gösterdi	' bazen grubu konudan uzaklastirdi	' her zaman grubu konudan uzaklastirdi

APPENDIX R

PROBLEME DAYALI ÖGRENME MODELI'NE ILISKIN

GERIBILDIRIM FORMU

Ad Soyad:

Asagida verilen sorular Probleme Dayali Ögrenme Modeline iliskin görüslerinizi belirlemek için hazirlanmistir. Görüsleriniz, bu model dogrultusunda yeni ders planlari hazirlanirken gözününe alinacaktir. Bu nedenle verdiginiz cevaplar probleme dayali ögrenme modelinin ileride etkili bir sekilde uygulanabilmesi için büyük önem tasimaktadir. Lütfen her soruyu dikkatlice okuyarak, görüslerinizi içtenlikle belirtiniz. Tesekkürler.

1. Probleme Dayali Ögrenme Modelini nasil tanimlarsiniz? Sizce Probleme Dayali Ögrenme Modelinin karakteristik özellikleri nelerdir?

2. Yukarida belirttigini karakteristik özelliklerden hangisinin ögrenmenize en çok katkisi oldu?

3. Probleme Dayali Ögrenme Modelindeki hangi özellikleri kesinlikle degistirmek isterdiniz?

4. Probleme Dayali Ögrenme Modelindeki hangi özellikler kesinlikle uygulanmaya devam edilmelidir?

5. Probleme Dayali Ögrenme Modelinin uygulanmasi sirasinda ne tür zorluklarla karsilastiniz?

6. Sizce Probleme Dayali Ögrenme Modelinde ideal bir ögretmen ne tür özellikler tasimalidir? (Alan bilgisi, grup çalismasina katki vb. açilardan)

7. Probleme Dayali Ögrenme Modelinin uygulandigi siniflarda iyi bir ögrencinin özellikleri ne olmalidir?

8. Ders sirasinda islenen örnek olaylar hakkindaki görüsleriniz nelerdir?

9. Probleme Dayali Ögrenme Modelinin size akademik ve sosyal açidan neler kazandirdigini düsünüyorsunuz ?

VITA

Semra Sungur was born in Ankara on January 8, 1976. She received her B.S. degree in Science Education from the Middle East Technical University in June 1998. Since then, she has been a research assistant at the Department of Elementary Education, at the Middle East Technical University. She prepared a Master thesis about "Contribution of Conceptual Change Texts Accompanied with Concept Mapping to Students' Understanding of Human Circulatory System" and received her M.Sc degree in Secondary Science And Mathematics Education from Middle East Technical University in June 2000. Then, she studied on problem based learning as a visiting scholar in the Problem-Based Learning Pathway, at College of Medicine and Public Health, at the Ohio State University between August, 2002 and May, 2003. Her main area of interest is problem based learning, self-regulation, and conceptual understanding. She has experience in Laboratory Applications in Science, Probability and Statistics, Computer Applications in Education, Instructional Planning and Evaluation, School Experience, Maternal and Child Nutrition, and Instructional Technology and Material Development course.

She has articles on "Students' Achievement in Human Circulatory System Unit: The Effect of Reasoning Ability and Gender", "The Contribution of Conceptual

Change Texts accompanied by Concept Mapping to Students' Understanding of the Human Circulatory" published in international journals and one article under review to be considered for publication in an international journal "Environmental Attitude of Young People in Turkey: Effect of School Type and Gender". She has two articles on "Effect of Gender Difference and Reasoning Ability on Human Circulatory System Concepts Achievement" and "Biology Concepts Perceived as Difficult by Turkish High School Students" published in national journals and two articles under review to be considered for publication in an national journal "Environmental Attitudes of the 6th Grade Students From Rural and Urban Areas: A Case Study for Ankara" and "Ninth Grade Students' Understanding of the Nature of Scientific Knowledge". She participated in three international conferences with presentations on "An Analysis of Students' Understanding of the Human Circulatory System", "A Cross Age Study of Turkish Students' Attitude toward Environment: A Multivariate Analysis (accepted)", "Motivational Beliefs As Predictor of Biology Achievement of Turkish High School Students (accepted)", and two national conferences with presentations on "The Views about Teachers' Role in Multiple Intelligence Theory", "Teachers' Attitude Toward Laboratory Courses", "Identification of Students' Misconceptions Concerning Human Circulatory System", and "Student's Difficulties in Understanding Biology Topics".