RELATION OF COGNITIVE AND MOTIVATIONAL VARIABLES WITH STUDENTS' HUMAN CIRCULATORY SYSTEM ACHIEVEMET IN TRADITIONAL AND LEARNING CYCLE CLASSROOMS

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

ÖZLEM SADİ

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY
IN
SECONDARY SCIENCE AND MATHEMATICS EDUCATION

MARCH 2010

Approval of the thesis:

RELATION OF COGNITIVE AND MOTIVATIONAL VARIABLES WITH STUDENTS' HUMAN CIRCULATORY SYSTEM ACHIEVEMET IN TRADITIONAL AND LEARNING CYCLE CLASSROOMS

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ABSTRACT

RELATION OF COGNITIVE AND MOTIVATIONAL VARIABLES WITH STUDENTS' HUMAN CIRCULATORY SYSTEM ACHIEVEMENT IN TRADITIONAL AND LEARNING CYCLE CLASSROOMS

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March 2010, 198 pages

This study aimed to investigate the relationships among high school students' relevant prior knowledge, meaningful learning orientation, reasoning ability, self-efficacy, locus of control, attitudes toward biology and achievement in human circulatory system in learning cycle and traditional classrooms.

This study was conducted with 2 teachers and 4 classes and total of 60 11th grade students in the private high schools at Ümitköy district of Ankara in the fall semester of 2008-2009 academic years. One class of each teacher was assigned as experimental group and treated with 5E learning cycle instruction and other class was assigned as control group and treated with traditional instruction. At the beginning of the study, both teachers were trained for how to implement 5E learning cycle instruction in the classrooms. The Human Circulatory System Achievement Test was applied twice as pre-test and after treatment period as a post-test to both experimental and control groups. Learning Approach Questionnaire was used to measure students' approach to learning and Test of Logical Thinking was used to measure reasoning abilitiy of students. Students' levels of self-efficacy, locus of control and their attitudes toward biology also were measured.

The data obtained from the administration of post-test were analyzed by using ANOVA. The statistical result indicates that learning cycle instruction improved students' achievement in human circulatory system compared to traditional instruction. Stepwise multiple regression analysis revealed that in learning cycle classrooms, the main predictors of achievement in human circulatory system were students' reasoning ability (45.8%) and their prior knowledge (15.9%). In traditional classrooms, students' meaningful learning orientation (40%) and locus of control (9.8%) were the main predictors of achievement. This study indicated that different variables may be significant for 11th grade students' human circulatory system achievement in learning cycle and traditional classes.

Keywords: Human Circulatory System, Meaningful learning orientation, reasoning ability, self-efficacy, locus of control, attitude, learning cycle, traditional instruction.

ÖZ

BİLİŞSEL VE GÜDÜSEL DEĞİŞKENLER İLE GELENEKSEL VE ÖĞRENME EVRESİ SINIFLARINDAKİ ÖĞRENCİLERİN İNSANDA DOLAŞIM SİSTEMİ BAŞARILARI ARASINDAKİ İLİŞKİ

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Mart 2010, 198 sayfa

Bu çalışmanın amacı; lise öğrencilerinin ön bilgileri, anlamlı öğrenme yaklaşımları, mantıksal düşünme yetenekleri, güdüsel inançları, denetim odakları ve Biyoloji dersine olan tutumlarının, öğrenme evresi ve geleneksel yaklaşım sınıflarında insanda dolaşım sistemi başarıları ile olan ilişkisini araştırmaktır.

Çalışma, 2008-2009 akademik yılı sonbahar döneminde Ankara'nın Ümitköy ilçesinde bir özel lisede 60 onbirinci sınıf öğrencisiyle, 2 öğretmen ve 4 sınıfta yapılmıştır. Her öğretmenin iki sınıfından bir tanesi 5E öğrenme evresi modelinin uygulandığı deney grubu ve diğer sınıfı da geleneksel öğretim yönteminin uygulandığı kontrol grubu olarak belirlenmiştir. Çalışmanın başında her iki öğretmen 5E öğrenme evresi modelinin nasıl uygulayacağı hakkında bilgilendirilmiştir. İnsanda Dolaşım Sistemi Başarı Testi her iki gruba, iki farklı öğretim yönteminin etkisini karşılaştırmak için ön test ve uygulama sonunda da son test olarak uygulanmıştır. Çalışma öncesinde öğrencilere Öğrenme Yaklaşımı Anketi, Mantıksal Düşünme Testi, ve güdüsel inanç ölçeği uygulanırken, öğrencilerin denetim odakları ve Biyoloji dersine yönelik tutumları da ölçülmüştür.

Son test sonuçları varyans analizi (ANOVA) istatistiksel tekniği kullanılarak analiz edilmiştir. İstatistiksel sonuçlar öğrenme evresinin geleneksel yaklaşıma göre, öğrencilerin insanda dolaşım sistemi başarılarını artırıcı etkisi olduğunu göstermiştir. Çoklu regrasyon analizi sonuçları, öğrenme evresi sınıflarında başarının temel belirleyicileri olarak öğrencilerin mantıksal düşünme yetenekleri (%45.8) ve önbilgileri (%15.9) olduğunu göstermiştir. Öte yandan, geleneksel yaklaşım sınıflarında öğrencilerin anlamlı öğrenme yaklaşımları (%40) ve denetim odakları (%9.8) başarının temel belirleyicileri olarak bulunmuştur. Bu çalışma, öğrenme evresi veya geleneksel yaklaşımın uygulandığı onbirinci sınıf öğrencilerinin insanda dolaşım sistemi konusundaki başarısında bilişsel ve güdüsel değişkenlerin önemli olabileceğini ortaya koymuştur.

Anahtar Kelimeler: İnsanda dolaşım sistemi, anlamlı öğrenme yaklaşımı, mantıksal düşünme yeteneği, güdüsel inanç, denetim odağı, tutum, öğrenme evresi, geleneksel yaklaşım.

Dedicated to my family…

ACKNOWLEDGEMENTS

I would like to express my deep reverence to my supervisor Assoc. Prof. Dr. Jale Çakıroğlu for her encouraging guidance, incredible patience, and supervision throughout this study. I owe her a debt of gratitude for her lovely attitude which is absolutely not restricted with scientific area. I need to acknowledge Assist. Prof. Dr. Ömer Faruk Özdemir for his suggestions and comments.

I am also deeply grateful to Prof. Dr. Ömer Geban and Assist. Prof. Dr. Esen Uzuntiryaki for their invaluable and precise commanding and guidance both in theoretical background and in experimental design of this research thesis by attending my semi yearly PhD fellow ups.

I wish to thank to my close friend, Arzu Tecimer for her sincere friendship, encouragement and supports.

I am very grateful to all members of my family and especially to my mother Elif Türk, to my father Hakverdi Türk, to my brother Şahin Türk and to my sister Mehtap Bübül for their eternal love, help, morale support, encouragement and trust.

I wish to express my deep appreciation to my husband Gökhan Sadi for the extraordinary amount of time and effort he put into to complete this thesis. I want to thank for his support and love. I would like to send my ultimate appreciation to my son Emre Sadi for providing me a good kiss and odor of peace each morning.

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LIST OF SYMBOLS

MRC: Multiple Regression Correlation

PREACH: Students' Human Circulatory System Achievement Pre-Test Scores

PSTACH: Students' Human Circulatory System Achievement Post-Test Scores

HCSACT: Human Circulatory System Achievement Test

MOT: Methods of Teaching

IV: Independent Variable

DV: Dependent Variable

LAQ: Learning Approach Questionnaire

LAQ-M: Learning Approach Questionnaire-Meaningful

LAQ-R: Learning Approach Questionnaire-Rote

TOLT: Test of Logical Thinking

SES: Self-Efficacy Scale

LOC: Locus of Control Scale

ATB: Biology Attitude Scale

df: Degree of Freedom

CHAPTER 1

INTRODUCTION

Science or biology is not just a collection of facts. Facts are just the results of a specific way of knowing which includes observing what's happening, predicting what might happen, testing predictions under controlled conditions, or trying to make sense of our observations. Science also involves tryout and errors. As it known that, scientific process composed of regular steps to reach reasonable conclusion as having a research problem, observation and collection of datum, the formulation and testing of hypotheses, experimentation and evaluation of findings. The students need the process skills when doing scientific investigations and during their learning. Rutherford and Ahlgren (1990) pointed that young people can see, handle, contact, operate and change situations that consent to them to investigate what is happening, which is the very objects of science. Much of the research findings indicate that students are more likely to recognize the natural world if they have experience with natural phenomena, using their sense organs to observe and using instruments to expand the power of their senses (Haury & Rillero, 1994). Shortly, the place of science process skills is prominent and important ways of reaching knowledge. When students use scientific method, they can transfer the theoretical knowledge into the practical applications and make connections between their pre-knowledge and new knowledge (Karslı & Şahin, 2009). Otherwise, several units and concepts can be unfamiliar and difficult to remember for students. Especially in biology, the concepts in each unit are closely related with each other. Thus, students face with difficulties to understand the basic concepts of biology when they could not understand the previously instructed concepts. It is known that prior knowledge of students has an important function in the formation of the new knowledge in science/biology (Hewson & Hewson, 1983). Because, when students come to class, they already have various ideas about biology and natural word. According to Novak (1988), when the students cannot create a useful linkage between their prior knowledge and the new knowledge, they do not develop their biology concepts. To be able to overcome some learning difficulties, each lesson should be planned by considering the students' performance at earlier lessons.

Human circulatory system is one of the most important and difficult topics of the biology curriculum. Major concepts of circulatory system which the students do not fully understand are shown in the research as structure and functions of human cardiovascular system, pumping mechanism of heart, circulatory/respiratory relationships, and systemic/ pulmonary circulation, closed circulation, type of blood vessels, and homeostasis, and the blood flow rate (Arnaudin & Mintzes, 1985; Yip, 1998; Sungur et al., 2001; Windschitl, 2001; Kwen, 2005; Alkhawaldeh, 2007). Abstract natures can one of major reason of students' incomplete understanding of circulatory system concepts. Students' understanding of the human circulatory system concepts related with their understanding of the main concepts of homeostasis, as circulating blood is fundamental for the maintenance of stable internal environment in the body. Thus, students can understand the relation of body systems with each other when they understand how blood circulation mechanism works in human body and realize the central role of the circulatory system in homeostasis (Alkhawaldeh, 2007). Therefore, students should connect each circulatory system concepts with each other in a meaningful way in order to recognize further biological concepts better like; digestive system concepts, immune system concepts and respiratory system concepts. That means that meaningful learning of circulatory system concepts has become an important issue to understand other important biological systems' concepts.

Researchers offer alternative strategies to support meaningful learning in biological concepts such as circulatory system. The conceptual change approach is one of important issues in educational research. Based on Piaget's mental functional model includes design of assimilation, accommodation and disequilibrium, conceptual change theory focuses on conditions for students adjust their existing conceptions with new ones. There are four conditions in order to change students' ideas about understanding and about what they already know. These conditions are: (1) There must be dissatisfaction with existing knowledge (2) The new conception must be intelligible which refers that the students comprehend the meaning of the new concept (3) The new conception must be plausible, which refers that the students discovers the new concept believable (4) The new concept must be fruitful, which refers that the student can explain other problems by the new concept (Posner, Strike, Hewson & Gertzog, 1982). If all four conditions are met, accommodation of the new conception may occur. Additionally, there are several researches that utilize different teaching methods based on inquiry as learning cycle. Karplus and Their (1967) developed the learning cycle model that initially includes three phases as exploration, term introduction and concept application. Even though Karplus is generally viewed as the "father" of this model of instruction, learning cycle model roots go back to the developmental learning theories of Piaget. In exploration phase, the student explores a concept by doing hands-on activities or experiments. When students explore new concepts, the students remember previous experiences or assimilate new concrete experiences helpful for presently discovery. This creates disequilibria in the students and they need to accommodate the concepts to reach equilibrium. In term introduction phase, the teacher collects information from the students, with regard to their exploration experiences. The students explain or define their ideas and the teacher introduces new subjects. As subjects are introduced in this phase, the teacher gives a chance to students who interrelate with the new subject and with their teacher and peers. This interrelation gives rise to help the students assimilate or accommodate specific ideas. In the concept application phase, students try to use these new subjects in different situations. Teacher encourages students for additional physical and social interaction. These experiences may assist students in finding answers to questions that they have generated during the exploration and the concept introduction phases (Karplus, 1977). Basically, the learning cycle is anchored in a thorough understanding of learning theory. Each phase of learning cycle is related with mental functioning model of Piaget as explore scientific ideas, handle materials, and try to solve problems (Exploration), using terminology to the concept (Term Introduction), and application of the concepts into additional conceptual frameworks (Application) (Odom & Kelly, 2000). Moreover, learning cycle includes 5 and 7 phases, namely 5E and 7E learning cycle model. Each 'E' in the *Five Es* model represents a specific phase in the model – namely, Engagement, Exploration, Explanation, Elaboration and Evaluation. Engagement promotes interest and motivation (Boddy, Watson & Aubusson, 2003). Additionally, Each 'E' in the *Seven Es* model represents elicit, engage, explore, explain, elaborate, evaluate and extend.

It is obviously stated that not only instructional strategies but also cognitive and motivational factors have an effect on students' understanding of biology concepts (Araz & Sungur, 2007). Therefore, those cognitive and motivational variables should be taken into consideration while planning, developing and applying instructional strategies. Science education researchers give attention the importance of cognitive variables influencing students' science achievement. When looked at the research evidence cited in the literature, reasoning ability and learning approach are two important cognitive variables (BouJaoude, 1992; Cavallo, 1996; Chandran et al., 1987). Reasoning is a process to reach a conclusion by taking all related factors into account. Individuals who have reasoning ability on a subject are well-informed on the related discipline and can analyze new situation when faced in all aspects, explore, make logical assumptions, explain his thoughts, reach conclusions and defense his conclusions (Umay, 2003). On the other hand, learning approach which measures students' learning orientation is another cognitive variable that affects meaningful understanding. Meaningful learning is having deep understanding of complex ideas or subjects. Because knowledge and understanding exist in the mind of the students, obtaining multiple perspectives can deepen the understanding of meaningful learning and its significance (Wiske, 1998). In the literature, it was pointed out that meaningful learning orientation is significant for meaningful understanding of students in science and stated that meaningful learning orientation together with reasoning abilities gives to students' meaningful understanding of biology (Cavallo, 1996).

Moreover, motivational variables are viewed as a significant predictor of students' classroom learning and science achievement since students who are more highly motivated are likely to give greater effort and persist longer at academic tasks than do students who are less motivated. Motivational variables are potential mediators of students' science achievement (Pintrich & Schunk, 1996). In the general motivation literature, one central dimension is beliefs about one's ability, or self-efficacy (Taboada, Tonks, Wigfield & Guthrie, 2008). Self-efficacy refers to one's beliefs about her/his own capability to perform a task. According to Bandura (1995) "the belief in one's capabilities to organize and execute the course of action required to manage prospective situations" (pp.2). Educational researchers give an importance to self-efficacy studies because of their purported influence on students' academic performance. Another motivational variable is locus of control which is a term in psychology which refers to a person's beliefs about their failure and success in his or her life, either in general or in a specific area. It can either be internal or external. When student attribute that his/her decision is directed by his/her personal decisions and efforts, s/he develops internal locus of control. Students develop their self-management skills develop this type of control. However, when the students attribute that their environment, families or teachers, or other people control their decisions and their life, they develop external locus of control (Rotter, 1975). Finally, one other important variable that effects students' achievement is attitude toward biology. As it known that there are many studies about the effect of attitudes on science/biology achievement. Science/biology attitudes were found to have a positive relationship with science/biology achievement and participation in advanced science/biology courses (Weinburg & Englehar 1994; Lee & Burkam, 1996; Osborne, Simon, & Collins, 2003).

With the consideration of important impressions of using different teaching strategies to prevent students' misunderstanding of the biology concepts and to enhance meaningful learning, the present study aims to investigate 11^{th} grade students' achievement in human circulatory system in relation to several cognitive (prior knowledge, reasoning ability and meaningful learning approach) and motivational variables (self-efficacy, locus of control, and attitudes toward biology) in different types of instructional settings; learning cycle and traditional classrooms in a private school located in Ankara.

1.1 The Purpose of the Study

The purpose of this study was to examine the relationship among 11^{th} grade school students' prior knowledge, learning approach, reasoning ability and self-efficacy, locus of control and attitudes toward biology and students' achievement in human circulatory system in learning cycle and traditional classrooms.

1.2 The Main Problems and Hypothesis

<u>Main Problem 1</u>

What is the relationship among 11^{th} grade students' prior knowledge, meaningful learning approach, reasoning ability, self-efficacy, locus of control, attitudes toward biology and achievement in human circulatory system in learning cycle and traditional classrooms in a private school in Ankara?

H_0 (i): There is no significant relationship among 11^{th} grade students' relevant prior knowledge, learning approach, reasoning ability, self-efficacy, locus of control, attitudes toward biology and achievement in human circulatory system in learning cycle and traditional classrooms.

<u>Sub-problems</u>

1. What is the possible relationship among 11^{th} grade students' relevant prior knowledge, learning approach, reasoning ability, self-efficacy, locus of control and attitudes toward biology and students' achievement in human circulatory system in learning cycle classrooms?

H_0 (i): There is no significant relationship among 11^{th} grade students' relevant prior knowledge, learning approach, reasoning ability, self-efficacy, locus of control, attitudes toward biology and students' achievement in human circulatory system in learning cycle classrooms

2. What is the possible relationship among 11th grade students' relevant prior knowledge, learning approach, reasoning ability, self-efficacy, locus of control and attitudes toward biology and students' achievement in human circulatory system in traditional classrooms?

H_0 (i): There is no significant relationship among 11th grade students' relevant prior knowledge, learning approach, reasoning ability, self-efficacy, locus of control, attitudes toward biology and students' achievement in human circulatory system in traditional classrooms.

Main Problem 2

What are the contributions of 11th grade students' relevant prior knowledge, learning approach, reasoning ability, self-efficacy, locus of control and attitudes toward biology on their achievement in human circulatory system in learning cycle and traditional classrooms?

Sub-problems

1. Whether relevant prior knowledge, learning approach, reasoning ability, self-efficacy, locus of control and attitudes toward biology of 11th grade students contribute to students' achievement in human circulatory system in traditional classrooms?

H_0(i): Relevant prior knowledge, learning approach, reasoning ability, self-efficacy, locus of control, attitudes toward biology of 11th grade students do not contribute to students' achievement in human circulatory system in traditional classrooms.

2. Whether relevant prior knowledge, learning approach, reasoning ability, self-efficacy, locus of control and attitudes toward biology of 11^{th} grade students contribute to students' achievement in human circulatory system in learning cycle classrooms?

H_0 (i):Relevant prior knowledge, learning approach, reasoning ability, self-efficacy, locus of control, attitudes toward biology of 11^{th} grade students do not contribute to students' achievement in human circulatory system in learning cycle classrooms.

Main Problem 3

Which variable best-predicted students' achievement in traditional and learning cycle classrooms?

Main Problem 4

What is the effect of learning cycle instruction on 11^{th} grade students' understanding of human circulatory system?

H_0 (i): There is no significant effect of learning cycle instruction on 11^{th} grade students' understanding of human circulatory system.

1.3 Definition of Important Terms

In order to make the reader familiar with some of the important terms used in this study, following definitions are presented.

Learning Cycle Instruction: The learning cycle is an activity oriented teaching strategies and promote students meaningful understanding of scientific concept, explore and deepen that understanding, and then apply the concept to new situations (Walbert, 1997)

Traditional Instruction: Traditional method is a teacher centered instruction and mainly bases on lectures. In this instructional setting students mainly listen, read, and take notes. Thus, they are passive learners in the class.

Reasoning Ability: Reasoning ability is used to “denote consistent, logical thought patterns which are employed during the process of scientific inquiry that enable individuals to propose relationships between observed phenomena; to design experiments which test hypotheses concerning the proposed relationships; to determine all possible alternatives and outcomes; to consider probabilities of occurrences; to predict logical consequences; to weight evidence, or proof; and to use a number of instances to justify a particular conclusion" (Steussy, 1984, p. 2).

Meaningful Learning: Meaningful learning is having greater understanding of complex ideas. Because new concepts are located in the mind of the students, obtaining complicated and various perspectives can deepen the understanding of meaningful learning and its importance (Wiske, 1998).

Self-Efficacy: Self-efficacy is ″people’s judgments of their capabilities to organize and execute courses of action required to attain designated types of performances ″ (Bandura, 1986, p. 391).

Locus of control: Locus of control can be defined as a person's belief in how they make attributions about their failure of success, either in general or in a specific area such as academics. It can be internal or external.

Attitude towards Biology: Inclination or a tendency to respond positively or negatively towards biology.

Achievement: Something accomplished successfully, especially by means of skill, practice, or perseverance. The act of finishing or the state of being accomplished.

1.4 Significance of the study

The present study examined students' achievement in circulatory system in relation to cognitive and motivational variables in traditional and learning cycle classrooms. While there has been a large amount of research concerning the learning cycle approach since 1960's, much of these researches supporting the learning cycle approach that can result in greater achievement in biology or better retention of concepts. Also, researchers are investigating what predicts the growth of biology ahievement. Researches have examined that both motivational (Chapman & Tunmer, 1995; Guthrie, Wigfield, Metsala, & Cox, 1999; Guthrie et al., 2006) and cognitive variables (e.g., Pressley & Harris, 2006) predict science/ biology achievement outcomes. On the other hand, most studies, to date, have looked either at the relation of motivation variables to science/ biology achievement or the relation of cognitive variables to science/ biology achievement. Few works have examined how both sets of variables predict science/ biology when controlling for the other set of variables (Taboada, Tonks, Wigfield & Guthrie, 2008). The overall purpose of this study was to examine how both motivational and cognitive variables are related to students' achievements in human circulatory system in learning cycle and traditional classrooms.

The results of this study are important since it gives some important clues to biology and science educators in Turkish educational system for several reasons. Firstly, biology is important discipline to follow real life. For that reason, it is not easy to explain the concepts of science with one sentence. Science and biology are not a set of facts and rules to be memorized. As a substitute, memorization is not a good way to learn scientific concepts because life cannot be memorized. Unfortunately, today's biology instruction in the classroom depends on only reading or listening of scientific facts and taking notes and memorizing in Turkey. Therefore, the present study gives information about the human circulatory system instruction which ensures the idea that away from memorization and misconceptions. Secondly, biology teachers and researchers can benefit about how to give biology instructions that students should be aware of categorizing the biological concepts in their mind by correct way. Then, the present study can assist curriculum developers when they evaluate their biology programs to increase students' biology achievement by designing and using different activities, so that they can have an idea about certain teaching methods that incite to place the biological concepts in correct site in the students' and also teachers' minds. Finally, this study will open a new gate for the researchers to conduct further studies about implementing different instructional strategies with different biological concepts, with different group sizes and with different grade levels.

Briefly, there are many researches about cognitive variables, motivational variables and students' biology achievements, separately in literature; however, few works examined the interaction of such variables and types of instructions and discussed how motivational and cognitive processes act together, and how each affects achievement outcomes (Pintrich, 2003; Pintrich, Marx, & Boyle, 1993; Wigfield, Eccles, Schiefele, Roeser, & Davis-Kean, 2006). The purpose of the present study is to extend the finding of preceding research by comparing the relationships in two different instructional modes (traditional vs. learning cycle). Thus, this study is intended to contribute to students' current understanding of human circulatory system by investigating the possible relationships among cognitive and motivational variables in learning cycle and traditional classes.

CHAPTER 2

REWIEV OF RELATED LITERATURE

In this chapter, the previous researches that constitute the theoretical and empirical background for this study are presented.

This chapter consists of five subchapters. In the first one, research on students' understanding of human circulatory system concepts, secondly research on learning cycle, thirdly, research on students' reasoning abilities, fourth one is research on students' learning orientation, and finally, research on students' affective variables are presented.

2.1 Research on Students' Understanding of Human Circulatory System Concepts

There are some sources to arise misconceptions in the human circulatory system. For example, misconceptions may take place due to a lack of knowledge. Secondly, misconceptions may happen since the units are not readily observable or accessible; for instance, not being able to see that vessels be present could children understanding of how blood can flow in only one direction. Finally, misconceptions could occur due to the intricacy of covert process as circulation. This process is complex because it involves relation among several entities such as the heart and the lung (Chi, Chiu & Leeuw, 1991). For that reasons, human circulatory system is one of the most important and difficult topics of the biology/science curriculum. Major concepts of circulatory system which the students do not fully understand are shown in the research as structure and functions of heart and blood, heart, circulatory/respiratory relationships, and closed circulation, pulmonary and systemic pattern of blood flow, blood vessels, and homeostasis, the human cardiovascular system, and the blood flow rate and also human immune system (Arnaudin & Mintzes, 1985; Sungur et al., 2001; Kwen, 2005; Windschitl & Andre, 1998; Yip, 1998; Chi, 2005; Alkhawaldeh, 2007). Concepts related to circulatory system are important for learning of other concepts. For example, students' understanding of the circulatory system influences their understanding of the subjects of homeostasis because blood is vital and essential for constant condition of internal body environment. Therefore, students who understand the mechanism of circulatory system from scientific viewpoint can also understand the main role of the circulatory system and how the system is relate with other important body systems. Students can have some misconceptions about biological concepts because of personal experience, lack of understanding during instruction or unfortunately teachers who are less competent in subject-matter knowledge (Yip, 1998). These teachers may spread incomplete or erroneous views to their students through incorrect teaching or uncritical use of textbooks (Barrass, 1984; Sanders, 1993). For example, the variety of mistaken concepts apprehended by the teachers can be recognized to a reduced understanding of the relationships between blood flow rate, blood pressure and vessel diameter (Yip, 1998). Besides, Arnaudin and Mintzes (1985) carried out a cross-age study in which the human cardiovascular system, structure and functions of blood cells, circulatory and respiratory relationships and closed circulation are found to be common misconceptions among the students. For instance, the results revealed that students in high school or in college mostly recognize the erythrocyte, leucocyte and thrombocyte as blood cells floating in red liquid. And also, most of students at any level failed to imagine of the heart as a double pump.

Another important study was conducted by Sungur, Tekkaya and Geban (2001) about tenth grade students' understanding of circulatory system. In this study, material exchange through capillaries was one of misconceptions since the students did not realize the main role of diffusion of nutrient, gas or metabolic end product. Second misconception was related with heart contraction. The students unfortunately assumed that the brain send stimulus to sinoatrial node to initiate heart contraction. Another common misconception about circulatory system was related with the velocity of blood in capillaries. The students did not realize the main reason of the lowest blood velocity in capillaries. Other example of misconception was connected with homeostasis. Students could not explain why skin takes on a red when the environmental temperature increases.

Actually all of results of researches revealed that students' understanding of human circulatory system is related with their prior knowledge and science process skills. According to Sungur et al. (2001), students understanding of the human circulatory system is associated with students' science process skills.

A well planned instructional strategies support students to alter misconceptions. Teachers should be aware of student' prior knowledge and misconceptions and then they should plan their lesson activities.

2.2 Research on Learning Cycle

The learning cycle originally credited to Karplus and Their and later modified by Roger Bybee for the BCSC project, proposes that learning something new, or understanding something familiar with prior experience and first-hand knowledge gained from new experiences. Also, learning cycle can be defined as an instructional model, based on constructivist epistemology that promotes conceptual change. It is not, however, merely a teaching technique, but a method of curriculum organization derived from Piaget's mental functioning model which includes three different phases: (a) Exploration brings about assimilation among students and teacher presents student with a problem or task, so that students experience the phenomena or concept (b) Term introduction is designed to promote students' accommodation of the concept that teacher introduces the main concept of the lesson and any new vocabulary pertinent to the concept. In that phase the teacher assumes a more traditional role. (c) Concept application promotes students' organization of the concept into their mental structures that provide opportunity to the students to study the additional examples of the concept (Lawson, 1996; Marek & Cavallo, 1997; Odom & Kelly, 2000). The learning cycle was used and also advanced through years and some practitioners have extended from three phases to five phases as 5E learning cycle; Engagement, Exploration, Explanation, Elaboration and Evaluation. In Engagement phase, the teacher accesses the students' prior knowledge and helps them become engaged in a new concept by using short activities and so promote curiosity. In Exploration phase, learners should complete hands-on activities or experiments that help them use pre-existing knowledge to explore new concepts or explore questions and design/conduct a preliminary investigation. In third phase named as Explanation, teachers have opportunities to directly introduce the concepts or process. Students introduce their understanding of the concept or process. Next phase is Elaboration in which teachers challenge and extend student's conceptual understanding and skills. Students try to apply new concepts in their lives. Final phase is Evaluation which teachers have an opportunity to evaluate students' understanding new concepts and also students have a chance to assess own understanding.

During the learning cycle students manage in a variety of physical and logical-mathematical experiences. The learning cycle also addresses students' developmental progression by using developmentally suitable investigations as they employ in the science learning process. Students apply their experiences to make sense of experiences and create logical systems.

There are many studies carried out to assess the effectiveness of learning cycle (Wright, 1995; Lawson, 1996; Colburn & Clough, 1997; Blank, 1999; Lee, 2003; Lauer, 2003; Ates, 2005; Yılmaz & Huyugüzel, 2006; Balcı, Çakıroğlu & Tekkaya, 2006; Atay & Tekkaya, 2008). For instance, the intellectual development of students experiencing with inquiry teaching and those of students experiencing with exposition was compared by Schneider and Renner (1980). A total of 48 students selected from a sample of 150 ninth grade students from a rural junior high school in central Oklahoma involved in the study. While learning cycle teaching method was administered to the inquiry group and expository teaching was assigned to the control group. During the study four physical science units including static electricity, current electricity, light and optics and sound were presented for three months. Results showed that students in learning cycle class had greater gains in intellectual development than students in the exposition group during the instructional period.

Other study was conducted by Yılmaz and Huyugüzel (2006) to show the effectiveness of 4E learning cycle on students' understanding of electricity concept and attitude toward science. In this study, 79 sixth-grade students divided into two groups as experimental and a control group who were tested with the Flowing Electricity Achievement Test and Likert type the Attitudes Scale toward Science.

While the experimental group received 4E learning cycle instruction, control group received the traditional instruction. Analyses of data showed that students in experimental group were more successful in understanding electricity concept than students in control groups. Also, students who were instructed with 4E learning cycle instruction had more positive attitudes towards science than students who were instructed with traditional instruction.

The effects of 5E learning cycle, conceptual change text and traditional instructions on 8th grade students' understanding of photosynthesis and respiration in plants were investigated by Balcı, Çakıroğlu and Tekkaya (2006). A total of 101 8th grade students in three intact classes of the same school were participated and each class was randomly assigned as control which instructed with traditional instruction and experimental groups which instructed with 5E learning cycle instruction (first class) and conceptual change text instruction (second class). Photosynthesis and Respiration in Plants Concept Test and Attitude Scale toward Science as a School Subject test were used to obtain relevant data. According to analyses of data, there were significant differences between the experimental and control groups in which students who instructed by 5E learning cycle and conceptual change text instruction had better score from post-test than students who instructed by traditional instruction. On the other hand, there was no significant difference between 5E learning cycle instruction and conceptual change text instruction.

Yılmaz (2007) conducted a study to examine comparative effects of prediction/discussion based learning cycle instruction, conceptual change text and traditional instruction on 8th grade students' understanding of genetic concepts, on their motivational strategies and perceived learning strategies. A total of 81 students were divided into three groups: first two groups were assigned as experimental groups and instructed by prediction/discussion based learning cycle instruction, conceptual change text separately and third group was assigned as control group and instructed by traditional instruction. In the study, The Genetic Concept Test and The Motivational Strategies for Learning Questionnaire was used to examine the effects of instructional strategies on students' understanding of genetic concepts and on students' motivation and use of learning strategies, respectively. Results indicated that both experimental groups had higher scores in Genetic Concepts test than control group. Also, students who taught by prediction/discussion based learning cycle instruction, used elaboration strategies significantly more than students who received conceptual change text.

Atay and Tekkaya (2008) examined the comparative effect of the learning cycle and expository instruction on 8th grade students' achievement in genetics. A total of 213 students participated in this quasiexperimental design. While the experimental groups (n=104) was instructed with learning cycle, the control group (n=109) was instructed with expository instruction. The Genetics Achievement Test, Learning Approach Questionnaire, Test of Logical Thinking and Self-Efficacy Questionnaire were used to gather relevant data. According to statistical analyses of ANCOVA, there was significant post treatment difference between two groups in the favor of the experimental groups after learning cycle instructions. Moreover, students' logical thinking ability and meaningful learning orientation was reported as a significant section of variation in genetics achievement. On the other hand, authors indicated that there was no significant difference between boys' and girls' performances when considering genetic achievement.

Another study was performed by Mecit (2006) to show the effect of 7E learning cycle on students' critical thinking skills. A total of 46 fifth grade students involved in the study. Moreover, the relationships between 7E learning cycle instruction, gender and family income of students and critical thinking skills were examined. One teacher had two classes which were randomly assigned as experimental and control groups. Experimental group instructed with 7E learning cycle and control group instructed with traditional model. The Cornell Conditional Reasoning Test and the Science Achievement Test were applied. Results showed that students who in experimental group improved their critical thinking skills significantly better than the students who in control group. However, the effects of gender and family income on the improvement of students' critical thinking skills were not significant.

Ören and Tezcan (2009) performed pretest-posttest control group design to investigate the effectiveness of learning cycle approach on students' attitude toward science. In this study 56 seventh grade students were divided into two classes as experimental group and the control group. In experimental class, environmental subject was taught by learning cycle approach and in control group, the same subject was taught by traditional approach. Results indicated that student who was in experimental group had significantly higher positive attitudes towards science than the students who were in control group.

Cavallo (2003) studied on 60 ninth grade physical science students' understanding of chemical reactions with learning cycle instruction. The concept of chemical change and the relationship between atoms and compounds were taught by the learning cycle. To evaluate the student, two forms of open-ended essay questions were used. One question included key terms by which students could write essays and the other did not. The essays were controlled at three points: pre-learning cycle, post concept application, and after additional concept application activities. Results of the study showed that students showed having who were not given key terms prior to learning cycle, appeared to have better understanding than the ones who were given key terms. Students' explanations also pointed out that students' understanding better over the learning cycle.

Comparing the learning cycle teaching approach with a textbook demonstration method of instruction was done by Barman, Barman and Miller (1996). The aim of their study was to investigate whether one method was more effective in facilitating conceptual change concerning sound. An interview protocol to both groups before and after instruction was administered to review the randomly selected 34 students' understanding of specific sound concepts. To comprehend students' levels of understanding, a numerical rating was used. Textbook/ demonstration method was given to one class in which students read information from a textbook, discussion and demonstrations were conducted. Three phases of learning cycle instruction was given to other class, in which students had a chance to decide about how they will learn, questions aroused as a result of classroom interactions. At the end of two weeks instructional period, students who were taught using the learning cycle had a significantly better understanding. The result of this study showed that the learning cycle is an effective teaching model in helping students refines their ideas about science concepts at a variety of grade levels.

Learning cycle instruction was also combined with other teaching tools like concept mapping. Odom and Kelly (2000) conducted an important study about the effect of the learning cycle, concept mapping, expository instruction, and a combination of concept mapping/learning cycle instruction on students' conceptual understanding of diffusion and osmosis in biology. A total of 108 secondary students (grades 10-11) participated in four different biology sections which were randomly assigned to a treatment group named as concept mapping (n=26), learning cycle (n=28), expository (n=27), and concept mapping/learning cycle (n=27). The same teacher teaches all sections. Diffusion and Osmosis Diagnostic Test was used to obtain relevant data. Results showed that the concept mapping/learning cycle and concept mapping treatment groups significantly performed better than the expository treatment in conceptual understanding of diffusion and osmosis.

Colburn and Clough (1997) planned several directions to help teachers while designing the learning cycle approach. The instructions include that doing the laboratory first, before introducing concept discussing the laboratory, requiring students to record and present laboratory findings, providing tests that have need of students to use what they did in the laboratory, providing students' to make clear some aspects of their thinking, helping students to formulate the laboratory procedures, changing teachers' role during laboratory activity, providing students to apply what they learned. The study stated that learning cycle is a successful teaching technique for students to explore new science concepts. Blank (1999) interested in revised learning cycle model named as meta-cognitive learning cycle which is formal opportunities for teachers and students to talk about their science ideas about ecology unit. In the study, two science classrooms were studied with the same ecology content but with different pedagogical orientations. One class of them used meta-cognitive learning cycle (MLC) and the other used Science Curriculum Improvement Study (SCIS) learning cycle. In SCIS learning cycle students completed predictions before exploring concepts and they also had hypotheses to explain new phenomena. In MLC, students were invited to reveal and reflect upon conditions under which a learner constructs knowledge: dissatisfaction, intelligibility, plausibility and fruitfulness of their science ideas through the instruction. Students were asked to reveal their science ideas and to discuss the status of their conceptions throughout the instruction in the meta-cognitive classroom. Findings of the study illustrated that students in the meta-cognitive classroom did not expand a greater content knowledge of ecology, but they did experience more permanent re-structuring of their ecology understandings. Students' generation of causal questions supported them to expand scientific reasoning skills and consciousness of the nature of science.

Another study was conducted by Lawson (2000) to improve students' thinking skills, to incite the generation of causal questions and to assist students construct meaningful concepts developed osmosis by learning cycle. Student material was presented which includes introduction, list of materials, a procedure to guide, students' inquiry, a set of application questions to expand the lesson and the teacher material was also presented that includes tips for teachers. Exploration phase consists of certain observation of what can be happen when red onion, elodea and red blood cells placed in distilled water and salt water. Students made alternative hypothesis that made clear their observations after facts about the molecular structure of the water, chemical bonds and salt solution were discussed. Next, they tested their hypothesis using nonliving model cells made of dialysis tubing. The concept application phase of learning cycle, the process and the meaning of diffusion and osmosis were explained and the students' statements were discussed. As a result, learning cycle had an effect on improving students' thinking skills, provoking the generation of causal questions and assisting students construct meaningful concepts. Other study of Lawson (1996) emphasized that learning cycle is better than traditional instructional approaches since the development of thinking skills is an important goal in the learning cycle. Lawson offered an example of learning cycle that can be used to teach Mendelian genetics. In his learning cycle method, there were two sections. The first section includes an introduction, a materials list, a procedure to guide to student inquiry, and a set of application questions to extend the lesson. The second section includes content related background and teaching tips for each phase of learning cycle. Moreover, literature on the learning cycle describes not only how science should be taught, but why it should be taught in a specific sequence (Lawson, Abraham & Renner, 1989). According to Wright (1995), the use of learning cycle promotes logical reasoning and applications of appropriate psychomotor skills. He also gave three examples of learning cycle instruction about plant growth, freezing point and static electricity.

A study was performed by Atay (2006) to investigate the relationships students' gender, prior knowledge, meaningful learning orientation, reasoning ability, self-efficacy, locus of control, attitudes towards science and achievement in genetics in learning cycle and traditional classrooms. A total of 213 8^{th} grade students participated the study and the experimental groups (n=104) received learning cycle instruction and the control groups (n=109) received traditional instruction. In this study, six instruments were applied and these instruments were Genetics Achievement Test, Learning Approach Questionnaire Test, Test of Logical Thinking, Self-Efficacy Scale, Locus of Control and Attitudes towards Science Scale. Relevant data were analyzed by one-way ANOVA to learn effectiveness of learning cycle on students' genetic achievement, by Stepwise multiple regressions to learn main predictors of achievement in genetics. Results indicated that firstly, learning cycle instruction got better student's genetic achievement. Secondly, the main predictors of achievement were students' meaningful learning orientations and students' attitudes towards science in learning cycle classroom; however, in traditional classroom, students' attitudes towards science and reasoning ability were the main predictor of achievement in genetics.

As summarized in the related literature, learning cycle is a model of instruction based on scientific inquiry and encourages students to develop their own understanding of a scientific concept and so promotes conceptual change while providing better understanding of scientific concepts.

2.3 Research on Students' Learning Orientation

Another important cognitive variable is students' learning orientation which affects students understanding. Williams and Cavallo (1995) described the learning orientation as "the formation of viable relationships among ideas, concepts and information" (p.313). Similarly, for meaningful learning to take place not only students should acquire isolated facts; but also they should construct new knowledge by drawing relationships among several different concepts, both new and old (Entwistle & Ramsden, 1983). According to Ausebel (1968), meaningful learning can occur when new knowledge is associated with pre-existing ideas. Moreover, the learning orientation can be defined as the students' approaches to learning which are consistent with their understandings (Cavallo, 1996). Meaningful learning is a productive process in which the students study to construct an understanding of the information and observations, which create up the body of knowledge of science. Pearsall, Skipper and Mintzes (1997) explained that "For meaningful learning to occur three criteria must be met: the material itself must have potential meaning (i.e., rather than a list of nonsense); the individual must possess a framework of relevant, domain-specific concepts to anchor the new knowledge; and the individual must choose voluntarily to incorporate new concepts in a non-arbitrary, non-verbatim fashion (i.e., a condition referred to as 'meaningful learning set')" (p.195). Dissimilarity to meaningful learning, rote learning can be explained as new knowledge may be attained by verbatim memorization and incorporating into a persons' knowledge construction without connecting it to information or framework previously acquired (Ausubel, 1963; Baird, 1986).

In literature, there have been many studies about the relationships between learning orientation, reasoning ability and students' meaningful understanding since those variables affect students' understanding and achievement in science. For example, Reap and Cavallo (1992) conducted a study with 163 tenth grade students to examine the possible relationships of students' meaningful learning orientations with their achievement of meaningful understanding of meiosis, the Punnett square method, and the procedural and conceptual relations between meiosis and the Punnett square method. Learning approach questionnaire and teacher ratings of their students' learning approach were used to categorize students' meaningful learning orientations. After that, classroom teachers gave instruction on meiosis. Type-written audio tutorial instructional packets that analyzed meiosis, bring in Punnett square method and detailed relation between these subjects, were administered to students. The result of the study indicated that there were no significant differences between males and females in terms of meaningful learning orientation and meaningful understanding of any of the genetic topics.

Araz and Sungur (2007) examined the relationships among reasoning ability, prior knowledge, motivational variables, learning approach and achievement in genetics in problem-based learning (PBL) classes. A total of 126 eighth-grade students were participated in the study. The Test of Logical Thinking (TOLT) was used to measure the formal reasoning ability of the students, The Learning Approach Questionnaire (LAQ) was used to measure student's level of learning orientations ranging from meaningful to rote, The Motivated Strategies for Learning Questionnaire (MSLQ) was used to measure the students' motivational values and The Genetics Achievement Test (GAT) used to measure the students' achievement in the genetics. Results indicated that student' learning approach, formal reasoning ability and task value as motivational variable, and prior knowledge had direct effects on achievement in genetics. Furthermore, reasoning ability and task value were found to have indirect effects which were mediated by learning approach. Similarly, Cavallo and Schafer (1994) focused on the relationship between students' meaningful learning orientation, relevant prior knowledge, instructional treatment and all interactions of these variables on students' meaningful understanding of meiosis, genetics and relationship between these topics. A total of one hundred sixty-three tenth grade students were participated in the study. There are two treatment classes named as reception and generative treatment. In reception treatment, the highlighted questions and problems about the connection between meiosis and the Punnett square method and answers to the questions were obtained. In generative treatment, same highlighted questions and same problems in reception treatment were included but in generative treatment, students generated the answers to questions by themselves. Results showed that meaningful learning orientation contributed to the students' attainment of meaningful understanding of independent of attitude and achievement motivation. They also detected little effect of type of instruction (reception versus generative) on students' meaningful learning.

A study conducted by Cavallo (1996) aimed to investigate relationship between meaningful learning orientation, reasoning ability and 189 tenth grade college students' understanding and problem solving of topics in genetics. Laboratory based learning cycle teaching procedure was employed during instruction. Classroom Test of Scientific Reasoning (CTSR) (Lawson, 1987) and Learning Approach Questionnaire (LAQ) (Cavallo, 1996) were used to measure students' general level of cognitive operation and learning approaches. The test of genetics meaning, test of genetics problems, mental model test, developed by Cavallo and Schafer (1994) were also used to examine the genetics knowledge of students. According to regression analysis, meaningful learning orientation best predicted (13%) students' understanding of genetics interrelationships and reasoning ability best predicted (9%) students' achievement in solving genetics problems.

Moreover, Saunders, Cavallo and Abraham (1999) investigated the relationship between epistemological beliefs, gender, students learning approaches and implementation of instruction in chemistry laboratory. The study was conducted with 232 college students from an introductory chemistry laboratory course at a large Midwestern university. Laboratory experiences were named as ″more inquiry″ or ″less inquiry″. In the study, type of instruction was not connected with learning approach. Meaningful learning approach was not related to students' epistemological beliefs but rote learning approach and epistemological beliefs were connected. On the other hand, they concluded that students' perceptions of classroom tasks pressure their choice of meaningful or rote learning strategies. Furthermore, it was stated that meaningful and rote approaches to learning are not opposite constructs.

The study of BouJaoude and Giuliano (1994) was related with the relationships between students' approaches to studying, prior knowledge, logical thinking ability, and gender and their performance in a nonmajors' 220 college students freshman chemistry course. To measure logical thinking ability and students' approaches to studying TOLT and seven subscales of the Approaches to Studying Inventory were used respectively. The results of the study demonstrated that prior knowledge, TOLT scores and meaningful learning orientation explained for the 32 % of the variance on the final examination scores. Male students' TOLT scores were significantly higher than the scores of female students but female students' meaningful orientation scores were higher than male students.

Furthermore, students' performance on conceptual and algorithmic chemistry problems were compared; the relationship between students' learning orientation, formal reasoning ability, and mental capacity and students' achievement on conceptual and algorithmic problems were examined; and interactions among these three cognitive variables were examined by the study of BouJaoude, Salloum and Abd-El-Khalick (2004). This study was conducted by 68 eleventh grade students from three Lebanese schools. LAQ, TOLT, and the Figural Intersection Test were used to measure students' meaningful learning orientation, formal reasoning abilities and mental capacities, respectively. The result of the study showed that students who have meaningful learning orientations were better than students who have rote learning orientations on a test of conceptual problems while there were no significant differences between both levels in algorithmic problems. According to Multiple regression and stepwise multiple regression analyses, three cognitive variables were found to be the predictors for 26% of the variance in performance on conceptual chemistry problems. Both meaningful learning orientation and formal operational reasoning had significant contributions at 0.05 levels. Moreover, meaningful learners outperformed rote learners on the test of conceptual problems.

In the light of literature, it can be said that to supply better understanding of the scientific conceptions, teachers not only think about the learning strategies but also give attention about students' learning orientation accordingly.

2.4 Research on Students' Reasoning Abilities

Students' levels of conceptual development are important issue to plan teaching methods and materials. As it known that student' cognitive position changes over time and they can't learn if they do not have the required cognitive skills. Piaget (1950) pointed that children in the concrete operational stage (age eleven or twelve) are able to get another's point of view and receive more than one perspective, simultaneously. The students can develop their abilities to think conceptually and to make rational decisions about concrete or observable events. In teaching these students, teachers should give them an opportunity to ask questions and to explain their ideas back to you allows him to mentally manipulate information. However, formal stage brings cognition to its final form. The students do not require concrete objects to make rational decisions. Meanwhile, the student can have hypothetical and deductive reasoning. Teaching for the adult may be extensive because the student will be able to consider many possibilities from several perspectives. Therefore, cognitive development of students is important issue for meaningful understanding of science in which science processes require academic skills used in collecting and analyzing data to solve problems. Scientific processes include observing, gathering data, collecting evidence about scientific problem, writing hypothesis and testing this hypothesis, doing experiment and obtaining conclusions. The main aim of students' formal reasoning ability research has been to identify factors that understand the nature of students' reasoning abilities and its development, so that instruction can be applied to encourage students to become more effective reasoners and achievers. As indicated by Tobin and Capie (1982), the learner characteristics such as formal reasoning ability and locus of control; and types of academic engagement influence those scientific process skills.

Students' reasoning abilities has been established as an important factor in science and achievement (Lawson, 2007; Cavallo 1996; Enveart *et al* 1980). In literature, there are many studies related with investigating students' reasoning abilities and its relationship with students' understanding (Lawson & Renner, 1975;

Ehindero, 1979; Tobin & Capie, 1982; BouJaoude & Giuliano, 1994; Valanides, 1996; Johnson & Lawson, 1998; Musheno & Lawson, 1998; Sungur & Tekkaya, 2003; Oliva, 2003; Yenilmez, Sungur & Tekkaya, 2006). For example, Sungur and Tekkaya (2003) conducted a study to investigate the effect of gender and reasoning ability on the human circulatory system concepts achievement and attitude toward biology. A total of 47 (26 boys and 21 girls) 10th grade students participated in the study. All the students involved in the study were instructed by the same biology teacher and exposed to identical syllabus-prescribed content. Group Assessment of Logical Thinking, Attitude toward Biology Scale, and the Human Circulatory System Concepts Test were administered to determine students' reasoning ability, attitude toward biology, and achievement, respectively. According to the result of Two-way Multivariate Analysis of Variance (MANOVA) there was no statistically significant mean difference between boys and girls with respect to achievement and attitude toward biology. However, they found that there was statistically significant mean difference between concrete and formal students with respect to achievement and attitude toward biology.

Another important study was carried out by Yenilmez, Sungur and Tekkaya (2006) to focus on relation of formal reasoning ability, prior knowledge and gender and students' photosynthesis and respiration achievement. A total of 117 8th grade students participated in the study. All classes were taught by the same science teacher. Test of logical thinking and multiple choice achievement tests were administered to notice students' level of reasoning ability and photosynthesis and respiration achievement, respectively. The results of ANCOVA exposed that there was a significant mean difference between students at high and low formal levels with respect to achievement. Also, stepwise multiple regression analysis showed that prior knowledge, reasoning ability and gender were main predictors of performance on students' photosynthesis and respiration achievement, explaining 42% of the variance.

Another different study was conducted by Lawson and Renner (1975) with 134 students to emphasize the understanding of concrete- and formal operational concepts by concrete and formal operational students in secondary school biology, chemistry and physics classes. In biology class, one subject was categorized as transitional formal, and no subjects were determined to be fully formal operational; in the chemistry class, a majority of subjects were somewhere in the transition between concrete operational and formal operational; in physics class majority of the subjects were between concrete operational and formal operational with higher number of fully formal operational subjects than chemistry sample by four Piagetian-styled tasks. Then, they accomplished that majority of the subjects were below the levels of intellectual development as outlined by Piaget. The major concepts trained during the year in each science class were classified as concrete and formal operational and written tests concerning those concepts were constructed and administered. The result of that study indicated that secondary school science curricula may not be suitable for the intellectual level of students and it should be suitable for students' level of understanding. Consequently, students' intellectual level should be major thought for curriculum developers.

Another study of Johnson and Lawson (1998) performed to show the effects of reasoning ability and prior knowledge on biology achievement in two different teaching classes as expository and inquiry. A total of 366 students were examined in one-semester non-majors' biology course. To assess reasoning ability, written items involving proportional reasoning and controlling variables were used. At the beginning of the semester, students were pretested during laboratory sessions to determine their reasoning abilities and prior knowledge. In inquiry instruction classes, learning cycle model was used. A total semester examinations and quiz percentages, final examination scores were used to compute students' achievement. The study showed that reasoning ability restrictions achievement more than prior knowledge among biology students, whether they were enrolled in inquiry or expository classes. In inquiry classes, significant improvements in reasoning abilities of students were also detected.

Moreover, Musheno and Lawson (1998) performed the study to measure the effects of learning cycle and traditional text on comprehension of science concepts by students at different reasoning levels. A total of 123 high school students participated from two schools in the United States. Lawson's Classroom Test of Scientific Reasoning was used to test the reasoning levels of the students and so, students were classified as empirical-inductive, transitional, or hypothetical-deductive. After classification, the students were randomly assigned to interpret either a learning cycle or traditional text passages. Following reading text, students were given posttest which covering the concepts presented for reading comprehension. One week in a while, students concluded the delayed posttest, which consisted of the same concept comprehension questions and the subjective question. The result of the study indicated that students who read the learning cycle passage got higher scores on concepts comprehension questions than students who read the traditional passages, at all reasoning levels. For that reason, it was also confirmed that learning cycle passages were effective on students' concept comprehension at all reasoning levels.

Oliva (2003) conducted a study to explore the relationship among the degree of structural coherence of students' preconceptions in mechanics and the viability of conceptual change. The study involved 155 tenth grade students who were administered a Spanish version of TOLT to evaluate students' formal reasoning ability and two tests on conceptions of mechanics both before and after instruction. The results of the study showed that students who more developed formal thought change their preconceptions more easily when the latter are well structured, whereas those students who less developed formal thought change their preconceptions with greater ease when the latter are not very organized.

In 1988, Lawson and Thompson conducted a study with 131 seventh grade students to assess whether formal operational students hold significantly fewer misconceptions than concrete operational students. Students' reasoning ability, mental capacity, verbal intelligence and cognitive style were measured at the beginning of the study. During instruction which was about evoluation and genetics, a standard lecture-textbook reading, which includes discussions, textbook readings and study questions was used. An essay test about genetics and natural selection was used as a posttest. The study indicated that, reasoning abilities of the students are one of the factors that can make a payment to students' failure to understand scientific conceptions**.** Moreover, it was confirmed that for the removal of some misconceptions, students' formal reasoning patterns were essential. Concrete operational students held greater number of misconceptions. Mental capacity, verbal intelligence and cognitive style in the amount of misconceptions had no significant role.

In the light of related literature, it can be concluded that in addition to students' meaningful learning orientation, reasoning ability seemed to be important cognitive variable for students' understanding of science/biology.

2.5 Research on Students' Affective Variables

Academic learning outcomes are believed to be influenced by a complex system that involves the interaction of cognitive and affective variables and learning processes. Researchers have examined the interrelationships between these variables and their causal effects on achievement outcomes. Actually, these studies are critical for teacher since they should know students' cognitive and affective characteristics and then they want to plan their lesson by considering students learning strategies to obtain achievement on subject matter. (Drew & Watkins, 1998; Linnenbrink & Pintrich, 2003)

Science educators give an importance of cognitive but also affective variables influencing science achievement (for example; Boujaoude, 1992; Cavallo, 1996). In the light of researches, teachers benefits from how they arouse interest of students to lesson. Therefore, value, affect, interest of students should be taken into consideration. Pintrich and Schunk (1996) expressed that feelings, beliefs, interests and values are essential to have more student's engagement and learning. Self-efficacy, locus of control and attitudes towards biology which are three affective variables play an important role in understanding science subjects.

The concept of self-efficacy lies at the center of Albert Bandura's social cognitive theory which emphasizes the role of observational learning and social experience in the development of personality. According to Bandura (1995) self-efficacy is "the belief in one's capabilities to organize and execute the courses of action required managing prospective situations" (p. 2). Bandura's theory explained that people with high self-efficacy that means, those who believe they can perform well are more likely to view difficult tasks as something to be mastered rather than something to be avoided.

Most of researchers found that an individual's self-efficacy plays a major role in how goals, tasks, and challenges are approached (Schunk, 1995; Bandura, 1997). Schunk (1991, 2003) stressed that when students work on tasks and become more skillful they develop a sense of self-efficacy for performing well.Also, if students aware of their objectives throught studying on a subject, they think that they can improve self efficacy for continued learning. Linnenbrink and Pintrich (2003) stated that "Besides the quantity of effort, the quality of effort in terms of deeper processing strategies and a general cognitive engagement of learning has been strongly linked to self-efficacy perceptions" (p.129). Students who have high self-efficacy are more likely to carry on a subject and to use more complicated learning processes and strategies compared to students with lower self-efficacy (Linnenbrink & Pintrich, 2003). Additionally, success raises students’ self-efficacy but failure decreases it. Pintrich and Schunk (1996) explained a model of self-efficacy as self-efficacy has been connected to the amount of attempt and the willingness to carry on at subjects. Individuals who have strong efficacy beliefs are more likely to apply effort in the face of difficulty and persist at a subject when they have the necessary skills. Individuals who have weaker perceptions efficacy beliefs are likely to be plague by self-doubts and to stop easily when face up difficulties. Likewise, Schunk and Pajares (2001) explained that compared with students who show hesitation their learning capabilities, those who feel efficacious for learning or performing a subject contribute more willingly, work harder, persevere longer when they encounter difficulties, and achieve at a higher level. Similarly, Kang et al. (2005) stated that students who have a higher self-efficacy may be more likely to employ in testing tasks inherent in activities like discrepant events. Strike and Posner (1992) expressed the concept in different aspects that students have a high self-efficacy should demonstrate more conceptual change. Similarly, it can be identified that students’ cognitive and meta-cognitive strategies are connected with self-efficacy judgments and their actual performance (Pintrich & De Groot, 1990; Linnenbrink & Pintrich, 2003). Besides, self-efficacy is related to self-regulate learning variables. Pintrich and De Groot (1990) accounted a relationship between academic self-efficacy and both cognitive strategy use and self-regulation through use of metacognitive strategies. Moreover, researchers used path analysis to display that academic self-efficacy mediated the influence of self-efficacy for self-regulated learning on academic achievement (Zimmerman, 1989; Zimmerman & Martinez-Pons, 1990; Zimmerman & Bandura, 1994).

Lawson, Banks and Logvin (2007) conducted a study to examine the relationships among reasoning ability, self-efficacy and students' biology achievement in introductory college biology. The study implicated pre- and posttesting 459 introductory biology students. Of the sample, 300 were females (65%) and 159 were males (35%). Reasoning ability scale with 22-item group-administered test based on reasoning patterns associated with hypothesis testing was used to measure formal thought as concrete, formal and postformal level. Both self efficacy and reasoning ability scale were accessed during the second week of the semester and again at the end of the semester as part of the course final examination. Student achievement was evaluated by the course final grade.As a result, formal and postformal reasoning ability is a main predictor on self-efficacy; and a significant positive correlation was found between reasoning ability and degree of self-efficacy to complete biological tasks. Additional, reasoning ability was a main predictor on course achievement than self-efficacy. Predicted self-efficacy and reasoning ability were positively correlated. As well, reasoning ability was a strong predictor of self-efficacy; however self-efficacy was not a strong predictor of reasoning ability. Self-efficacy estimates and achievement were higher for the concrete tasks than for the formal tasks and higher for the formal tasks than for the postformal tasks. Likely, Cavallo, Rozman and Potter (2004) described the relationship and influence of self-efficacy, learning approaches, motivational goals, and beliefs about science and reasoning ability on conceptual understanding of physics and course achievement among male and female students. A total of 290 college students (103 male, 187 female) were participated to study. Collaborative group workings were used to provide understanding the subjects of all students. In the group work, discussion/laboratory technique was used. Each lesson was 80-minutes and students connected content with the other parts of the course and with the other courses. Questions/problems and exercises were given to students to be able to offer the development of their specific skills or abilities. And each week students had quizzes but at the end of study they took final exam. In addition, the researchers used the tests and questionnaires to measure students' learning approaches, motivational goals, self-efficacy, epistemological beliefs, scientific reasoning abilities, and understanding of central physics concepts. According to result of the study, self-efficacy was found to be positively correlated with meaningful leaming ($r = .381$) and learning goals ($r = .345$) for both males and females and negatively correlated ($r = -.366$, $p = .01$) with rote learning among females only. Higher self-efficacy and reasoning ability were best predicted for female students' understanding of the subject. On the other hand, for male students, learning goals and rote learning negatively predicted physics concept understanding and self-efficacy positively predicted students' physics understanding. According to the results of the stepwise multiple regression analyses, course achievement was best predicted (35%) by reasoning ability and higher self-efficacy. For males, learning goals and rote learning strategies negatively predicted (45%) course achievement while it was positively predicted by self-efficacy.

Another study was conducted by Shim and Ryan (2005) to show the relationship among achievement goals and changes in students' self-efficacy, challenge avoidance, and intrinsic value in response to grades in a short-term longitudinal study. In the study, 361 college students from eight different classes and different disciplines were joined. The researchers used surveys to measure achievement goals and used three items including students' judgments of their capability to complete their course work productively to measure students' self-efficacy. Data were collected by test-retest technique. The results of the study showed that when students received high grades, there was no relation between a performance-approach goal and changes in self-efficacy; desire to avoid challenge, or intrinsic value. Conversely, when students received low grades, there was a relation between a performance-approach goal and decrease intrinsic value and increased desire to avoid challenge. Researchers confirmed the significance of center on the mastery goals that maintain self-efficacy and intrinsic value and decreasing the performance goals in the classroom.

Finally, Kang, Scharmann, Noh and Koh (2005) studied the relationship between students' cognitive/motivational variables, cognitive conflict and conceptual change. The study was conducted by 159 seventh grade students selected from two city middle schools in Korea. Logical thinking ability, field dependence/independence and learning approach were the cognitive variables and failure tolerance, goal orientation and self-efficacy were the motivational variables. At the beginning of the study, six pretests were applied to students. After that the preconception test which includes a specific question and the Test of Responses to a Discrepant Events (TRDE) which comprise initial explanation, discrepant event and students' rating were administered to look at the degree of students' cognitive conflict induced by a discrepant event. Computer-assisted instruction was used as a conceptual change intervention. A density concept test was used to measure students' understanding of basic concept of the density subject. The result of study indicated that field dependence/ independence was significantly correlated with cognitive conflict ($p<0.01$). Conceptual change was associated with all cognitive variables and failure tolerance and self-efficacy from motivational variables. Stepwise multiple regression analysis illustrated that logical thinking ability (28%), field dependence /independence (4%) and failure tolerance (3%) were statistically significant predictors of conception test scores. As a result the researchers reported that the nonsignificant relationship between meaningful learning approach and conception test scores was linked to the characteristics of the learning topics or context of learning used.

Locus of control which is another affective construct is also considered to be an important aspect of personality. The concept was developed originally Julian Rotter in the 1950S. Rotter (1966) explained the concept of locus of control as the differences between individuals in how they make attributions about their success or failure and how this affects learning. Locus of control tries to link the gap between operant and cognitive psychology. It is stated generally that an individual's perceived control of the environment is measured by psychologists through the personality trait and this was named as locus of control (Praag, Sluis & Wittleloostuijn, 2004; Martinez, 2003).

Locus of control can be considered as internal or external. Firstly, Rotter (1975) defined internal locus of control as the belief that events or outcomes are dependent upon one’s own behavior or on relatively permanent personal characteristics, such as ability. Students who take an internal responsibility for their academic performance have higher levels of overall achievement. However, external locus of control was defined as students do not have any control of what take place to them has been connected with lower academic achievement. That means students take an external responsibility for their academic performance. The studies in literature indicated frequently that generally, locus of control is predictive of academic achievement and related behaviors (Kalechstein & Nowicki, 1997). The studies of Duke and Nowicki (1974) and Finn and Rock (1997) stated that there is a relationship between an internal locus of control and academic success and external locus of control and explanation for academic failure.

The researchers conducted many studies to examine the influence of self-efficacy and locus of control on students understanding and achievement (Duke & Nowicki, 1974; Wishart, 1997; Susskind, 2005; Anderson, Hattie & Hamilton, 2005). For example, Anderson, Hattie and Hamilton (2005) carried out the study to investigate the relationship between locus of control, self efficacy, motivation, and academic achievement in three different types of school. This study used a novel multidimensional locus of control instrument (I-SEE). The strengths of the I-SEE are that it is surrounded in a model of personality and action based on field-theoretical conceptions. At the same time, it takes account of the role of the environment and personality in determining action. It was found significant differences between schools for motivation and achievement and also a mediate effect between locus of control and school type. Furthermore, moderate levels of locus of control and self-efficacy appeared to be more adaptive than either extremely high or low levels. Likewise, Susskind (2005) had a study to explore the effects of computer assisted instruction on students' performance, self-efficacy, motivation, and attitudes. One part of class was taught by traditional lecture and other part was taught by PowerPoint multimedia. 33 students formed the first group and 18 students formed the second group was. Each group received both traditional and PowerPoint lectures by the same instructor to examine whether students favor PowerPoint or traditional lecture formats. Eight questions were asked to students to measure students' self-efficacy and behavior in the course. The results of the study suggested that students had greater self-efficacy with use of PowerPoint. Though, lecture style did not affect academic performance.

Another study was performed by Tobin and Capie (1982). This study was conducted with 12 science classes' students in middle school. Each of them responded nine engagement modes. The results showed that formal reasoning ability and the locus of control were associated with an individual's internal locus of control and each correlated with specific engagement modes. Besides, students' locus of control had a relation with students' total engagement and rates of attendance.

The attitudes of students toward the subject are also related with locus of control. Rowland (1990) had a research to answer following two research questions: 1. is the change in locus of control accompanied by a change in science related attitudes? 2. Do science activities emphasizing cause and effect relationships cause the learners locus of control to become more internal? The study was a quasi-experimental nonequivalant control group design and groups were named as experimental and control groups. Pre-post tests were used to learn effect of the treatment. Seventh and eight grade science students, ninth grade physics students and tenth grade biology students participated in the study. Experimental group took science activities but control group took traditional instruction. As a result, doing science activities increase tendency to internal locus of control and especially, students attitudes towards science. Another study was done by Wishart (1997) to show whether students' internal locus of control were correlated with their attitudes toward using computers and involvement in the use of computers. The study conducted with one hundred fifty-three postgraduate students in teacher training program. To get the information about attitudes towards computers and internal locus of control, a questionnaire and Internal Locus of Control Index (Duttweiler, 1984) were used. The study concluded that the internal dimension of locus of control in females and attitude towards computers are correlated with each other. That means that students who had internal locus of control also held more positive attitudes to using computers. At the same time, there was a significant correlation between being internally controlled and being more prepared to use a computer which means that students with more internal locus of control were more likely to have a positive attitude to using computers and became more involved in the use of computers.

Students' attitude is another affective construct that affect achievement. The relationships among students attidutes toward science and achievement have been extensively researched (Dhindsa & Chung, 2003; Osborne, Simon, & Collins, 2003), but the main purpose of most of these researches was to effect of attitudes on science achievement in general (Dawson, 2000) and it is also known that there are relationships between attitudes and a variety of variables such as, grade levels, socioeconomic status, and gender (Bloom, 1976; Schibeci, 1984; Simpson & Oliver, 1985; Talton and Simpson, 1986; Germann, 1988; Koballa, 1988; Shemesh, 1990; Freedman, 1997; Parker, 2000; Prokop, Tuncer and Chuda, 2007). For example, Prokop, Tuncer and Chuda examined Slovakian students' attitudes toward biology with respect to age and gender. The study was conducted with the 655 (n= 321 girls, n=334 boys) elementary school students attending 5^{th} to 9^{th} grades and the mean age of the students was 12.99 years. The students concentrated on a particular biology concept in different grades. In the study, Biology Attitude Scale with 30-items was used to measure students' attitudes toward biology. Results showed that age and gender had an important impact on student's attitude toward biology. Moreover, in this study, students had a positive attitude toward biology lessons and younger students and girls developed higher attitudes towards biology. In addition, Friedler and Tamir (1990) conducted a study in which 40 studies were analysed to compare achievement in science and the Israeli male and female students’ attitudes towards science and science learning. It was stated that students’ attitudes towards science are very similar in the elementary school. Nevertheless, boys' knowledge and achieveent of physics and chemistry were better than that of girls. Moreover, it was explained that sex differences which is present in all areas are very large at the end of junior high-school.

Another study of Friedler and Tamir (1990) with 13-14 year old students focused on their degree of enjoyment in science classes; their perceptions of the importance of science; students’ attitudes toward practical and non-practical activities in science lessons; views on how difficult science. Likert-type five point scales were performed by 1038 students to get their attitude. Then, structured interviews with a representative sample (N=72) of the students was conducted. As a result of the study, boys and girls had positive attitudes towards science and boys had a greater preference for science. The most of students were aware of the importance of science. Comparatively, a few students saw it as an area of study that they would wish to pursue beyond the age of compulsory schooling.

A series of studies conducted in Israel (Milner, Ben Zvi, & Hofstein, 1986) have shown clearly that enrollment in science courses in secondary schools are highly affected by various affective variables, for example, students' interest in scientific information and activities and their feelings towards school science. It is suggested that future developments in the area of science curricula should aim at meeting the interests, feelings, and needs of a diverse population. This research sample consisted of two categories of junior high school and senior high school students. The junior high school sample (8^{th} grade) consisted of 1,550 students from all over the country who had not enrolled in extracurricular science activities and 100 students who had enrolled voluntarily in extracurricular science activities. The senior high school sample (11^{th} grade) consisted of 1,450 students who had not enrolled in extracurricular activities and 53 students enrolled in such activities.

Many researchers have shown relationship between attitude toward science and achievement in science knowledge. The quasi-experimental study of Bristow (2000) was completed for 57 sixth grade middle school students to examine effects of hands-on teaching methods on students' learning science and attitudes towards science. Control groups received traditional approach or textbook instruction; however, experimental groups received hands-on teaching method. Students' achievement was assessed by multiple-choice test and students' attitude was assessed by Likert type attitude scale. ANOVA results demonstrated that there was no divergence between students' achievement for control and experimental groups; however, students who received hands-on activities had more positive attitude toward science than students who received textbook instruction. On the other hand; Turpin (2000) established diverse results of Bristow's research. Over again, students' achievement and attitudes toward science were assessed for hands-on instruction and traditional instruction. About 531 seventh grade students were in experimental group that was applied activity based curriculum and 398 seventh grade students were in control group that was applied traditional curriculum. Iowa Test of Basic Skills (ITBS) science scores was used to measure students achievement and Science Attitude Survey was used to evaluate students' attitude toward science. According to the analyses of covariance (ANCOVA), it was showed that students in activity based curriculum had significantly higher scores for science achievement than that of students in traditional curriculum. But, there was no difference in students' attitude toward science for two groups. Besides Hardal (2003) examined the effects of hands-on activities on students' achievement and attitudes towards physics. She conducted her study with 130 ninth grade public school students in Turkey. There were two experimental groups which instructed with hands-on activities and there were two control groups which instructed with textbook. Physics Achievement Test and Physics Attitude Scale were used to both groups to assess and compare the effectiveness of hands-on activities and traditional method in physics course. The result of the study indicated that there was significant difference in the achievement of the experimental and control groups in favor of the experimental group. A similar significant difference was not found between two groups in the attitude towards physics.

Furthermore, research indicates that activity-oriented instructions in science can improve students' attitudes toward science (Kyle et al., 1985, 1988; Rowland, 1990). It can be seen that students centered programs that even poorly thought hands-on activities is more interesting to students than the typical textbook oriented program (Penick & Yager, 1993). Elementary school students in science programs using hands-on materials have much more positive attitudes about the nature of science and their ability to learn science than do students in traditional textbook-oriented science programs (Bredderman, 1982; Kyle et al., 1988; Shymansky et al., 1982). However, some studies showed that students attitude toward science are decreasing from elementary to high school (Hofstein et al., 1990; Simpsons & Oliver, 1990; Yager & Yager, 1985). Moreover; Shymansky, Hedges and Woodworth (1990) carried out a meta-analysis of earlier studies and found that children in hands-on programs demonstrated higher achievement, improved skills and a more positive attitude towards science.

Freedman (1997) conducted a study to investigate the relationship among laboratory instruction, attitude toward science, and 9th students' physical science achievement in a large urban high school. In this posttest-only control group design, 20 physical science classes participated and the control and experimental groups were randomly assigned. Score on a midterm examination, score on a final examination, and final report card grade for the course were used to student science achievement and an attitude survey was used to measure student attitude toward science. One-way ANOVA was used to compare students' science achievement and attitudes towards scienece in experimental and contrl groups. Also, ANCOVA was used to examine the effect of the laboratory treatment on student's science achievement when attitude decided as covariate. According to results, students who in experimental groups have higher science achievement score than students who in control groups. Also, students who took laboratory instruction showed higher attitudes towards science compared to students who took traditional instruction. It was summurized that laboratory instruction influenced, in a positive direction, the students' attitude toward science, and influenced their achievement in science knowledge.

Telli, Rakici and Çakıroğlu (2003) carried out a study to investigate 9^{th} and 10^{th} grade high school students' perceptions of learning environment in biology classrooms and to examine relationships among learning environment and students' attitudes toward biology. Also, their purpose was to examine the effect of gender, grade levels and academic achievement on students' perceptions of learning environments in biology classrooms. A total of 1250 high school students participated in the study. Students' perception of their biology-learning environment was measured by What Is Happening in This Class? (WIHIC) questionnaire and students' satisfaction in terms of enjoyment, interest, and how much they anticipated science classes was measured by eight-item scale from the Test of Science Related Attitudes. Results revealed that students had greater student cohesiveness and task orientation and their biology lessons were more cooperative and provided equal opportunity and involvement for all students. Also, high school students had constructive insight of their learning environment in biology classrooms. Finally, girls had more positive perceptions and attitudes towards biology than boys.

Kyle et al. (1988) compared the attitude toward science of students who had completed one year of the Science Curriculum Improvement Study (SCIIS) with students in non-Science Curriculum Improvement Study classes. The students sample was comprised of 228 SCIS students (54% male and 46% female) and 288 non-SCIS students. Students were selected randomly from second through sixth grade classes. Results revealed that attitude of students iwho had experienced one year of an inquiry-oriented process approach curriculum been enhanced greatly when compared to students in textbook-oriented science classes.

The work of Yager and Yager (1985) with sixth through eleventh grade students demonstrated that 60% of sixth grade students who were in science class and had more hands-on activities had more funny time, 40% of seventh grade students who had little hands-on activities and 25% of eleventh grade students who got less hands-on activities had less funny time. For that reason, science was less fun and exciting for the larger students stay in school. Similarly, Simpsons and Oliver (1990) reported that attitude towards science dropped from 6^{th} to 8^{th} grades.

2.6 Summary of Findings of the Reviewed Studies

One can summarize the results of these studies as follows:

1. Students have considerable amount of misconceptions about certain biology concepts. For example, major concepts of circulatory system which the

students do not fully understand are shown in the research as structure and functions of cardiovascular system and types and functions of blood cells, circulatory/respiratory/digestive system relationships, and systemic and pulmonary circulation, blood vessels, and homeostasis, and the blood flow rate and also human immune system (Arnaudin & Mintzes, 1985; Sungur et al., 2001; Kwen, 2005; Windschitl & Andre, 1998; Yip, 1998; Chi, 2005; Alkhawaldeh, 2007).

2. Learning cycle is a specific activity-oriented instructional technique encourages conceptual change and provides better understanding of scientific conceptions among students (Schneider & Renner, 1980; Barman, Barman & Miller, 1996; Odom & Kelly, 2000; Cavallo, 2003; Colburn & Clough, 1997; Wright, 1995; Lawson, 1996; Blank, 1999; Lawson, 2000, Lee, 2003).
3. Reasoning abilities of the students are one of the factors that influence the students' understanding scientific conceptions. Cognitive levels of students should be considered while developing instruction (Tobin & Capie, 1982; Lawson & Thompson, 1988; Lawson & Renner, 1975; Ehindero, 1979; Johnson & Lawson, 1998; Musheno & Lawson, 1998; Valanides, 1996; BouJaoude & Giuliano, 1994; Oliva, 2003).
4. Meaningful learning approach among students is significant for their meaningful understandings of science concepts (Reap & Cavallo, 1992; Cavallo & Schafer, 1994; BouJaoude, 2004).
5. Self-efficacy constructs easy students' engagement and presentation in the classroom and also it can give conceptual change (Bandura, 1986, 1997; Zimmerman, 1989; Zimmerman & Martinez-Pons, 1990; Strike & Posner,

1992; Pintrich & De Groot, 1990; Zimmerman & Bandura, 1994; Schunk, 1990; Pajare, 2002; Cavallo, Rozman & Potter, 2004; Shim & Ryan, 2005; Kong, Scharmann, Noh & Koh, 2005).

6. Locus of control is another motivational variable that refers to a person's attributions about what causes the good or bad results in his or her academic performance. It can either be internal or external (Rotter, 1966; Duke & Nowicki, 1974; Finn & Rock, 1997; Carton, Nowicki & Balser, 1996; Wishart, 1997; Susskind, 2005).

7. Another important factor that affects student's achievement is attitudes towards science/biology and it is related with gender, subjects, grade levels etc. (Kyle et al., 1985, 1988; Rowland, 1990; Yager and Yager ,1985; Bredderman, 1982; Kyle et al., 1988; Shymansky et al., 1982; Hedges and Woodworth ,1990)

These findings proposed that cognitive and motivational constructs of students and also methods of instruction have important impacts on students' achievement. However, there were limited studies about relationships between motivational and cognitive variables and students' biology achievement through different instructional methods. Therefore, the aim of this study is to examine the relationship among 11^{th} grade students' cognitive variables (prior knowledge, learning approaches, and reasoning abilities) and motivational variables (self-efficacy, locus of control and attitudes toward biology) in relation to students' achievement in human circulatory system in different types of classrooms; learning cycle and traditional classrooms.

CHAPTER 3

METHODS

The problem and hypothesis of the study, the related literature and the importance of the study were stated in the previous chapters. In this chapter, population and sampling procedure, description of dependent and independent variables, development of measuring tools, teaching and learning materials, treatment, procedure, analyzing data and assumptions and limitations of the study are presented.

3.1 Population and Sample

The target population of this study is all 11^{th} grade high schools students in Çayyolu, Ankara. According to Ministry of Education (MEB) documents, there are six high schools in this area. The accessible population of the study is selected as all 11^{th} grade high school students in one private high school. In the selected school, there are four 11^{th} grade classes. Due to high number of students in all six high schools, a sample from this population was selected for this study. Also, the major characteristics of target and accessible population are similar with respect to socio-economic status of the students which is obtained by schools document, the proportion of boys and girls in the experimental and control groups, or educational level of students' mother and father. Such characteristics are similar for all students in the study.

Many times it is extremely difficult to select a random sample. Therefore, convenience sampling was used to choose study sample from the target population. A convenience sample is a group of individuals who (conveniently) are available for the study. After selection of school, four classes were included from the selected high school in Çayyolu. Therefore, 60 11^{th} grade students from four classes of two teachers were involved in the study. One of the biology teachers had two classes that one of the classes is experimental group and other is control group. Again, second biology teacher had two classes and one of them is experimental group and another class is control group. Experimental and control groups were assigned randomly. Therefore, each teacher has one experimental group (instructed by the learning cycle) and one control group (instructed by traditional method). Most of the students' ages are 17 in this study. Gender distribution is similar for experimental and control groups (Table 3.1).

Table 3. 1: Characteristics of the Sample

Gender	Experimental Group	Control Group
Female	14	15
Male	17	14
Total	31	29

3.2 Variables

There are eight variables involved in this study. Variables were categorized as dependent variable (DV) and independent variables (IV). There were one dependent variable and seven independent variables. Table 3.2 indicates the characteristics of these variables.

Table 3. 2: Identification of variables

Type of Variable	Name	Type of Value	Type of Scale
DV	PSTACH	Continuous	Interval
IV	PREACH	Continuous	Interval
IV	LAQ	Continuous	Interval
IV	TOLT	Continuous	Interval
IV	LOC	Continuous	Interval
IV	SES	Continuous	Interval
IV	ATB	Continuous	Interval
IV	MOT	Discrete	Nominal

3.2.1 Dependent Variables

The dependent variable (DV) is students' Human Circulatory System posttest scores (PSTACH) that was measured by Human Circulatory System Achievement Test (HCSACT). PSTACH is a continuous variable and measured on interval scales. Minimum and maximum scores of PSTACH are ranged from 0 to 25.

3.2.2 Independent Variables

There are seven independent variables (IVs) that are students' Human Circulatory System pretest scores (PREACH), students' Learning Approach Questionnaire scores (LAQ), students' Test of Logical Thinking scores (TOLT), Self-Efficacy scores (SES), Locus of Control scores (LOC), Attitudes towards Biology scores (ATB), Methods of Teaching (MOT) (learning cycle and traditional method). The students' PREACH, LAQ, TOLT, SES, LOC, ATB are determined as continuous variable and measured on interval scale. MOT is considered to be discrete variables and measured on nominal scale.

3.3 Measuring Tools

Seven measuring tools were used for this study that were Human Circulatory System Achievement test, Learning Approach Questionnaire, Test of Logical Thinking, Locus of Control Scale, Self-Efficacy Scale, Attitude towards Biology Scale and observation checklist.

3.3.1 Human Circulatory System Achievement Test

Human Circulatory System Achievement test (HCSACT) was used in this study in order to examine the students' understanding about human circulatory system (Appendix C). It was developed by the researcher based on the related literature and some textbooks (e.g. ÖSS Question Books). The HCSACT covers the biology content presented in the 11th grade biology curriculum. It consists of 25 multiple choice questions related with all of human circulatory system such as blood, blood vessels, pumping mechanisms and the structures of heart, the systemic circulation and the pulmonary circulation, etc. The content of the items of HCSACT was related to the definitions of important terms in human circulatory system, differences between systemic circulation and the pulmonary circulation, differences between blood vessels, identifications of SA and AV, identifications of blood pressure, hypotension and hypertension. Possible HCSACT scores range from 0 to 25, with higher scores showing greater achievement in human circulatory system topic.

Before developing the test, the objective list of the human circulatory system was arranged. Then, each question was examined in detail and the table of specification was organized (Appendix B) to show content validity. In the table of specification, the objectives and the questions were defined according to cognitive domain of Bloom's Taxonomy. Bloom identified six levels as knowledge, comprehension, application, analysis, synthesis, and evaluation within the cognitive domain, from the simple recall or recognition of facts, as the lowest level, through increasingly more complex and abstract mental levels, to the highest order which is classified as evaluation. Most of items in HCSACT include knowledge, comprehension, and application level of cognitive domain. Moreover, face validity was used to show HCSACT' validity, which is the appropriateness of the interpretations obtained from test results. For this reason one instructor, one research assistant and one biology teacher from both the Department of Secondary School Science and Biology at METU examined in accordance with content and the format of the instrument. At the beginning, all of them knew the main purpose of the HCSACT and then they started to check the measuring tools with respect to given criteria of suitability of items to the grade level, suitability of content by the selected items. There was a direct relationship between the test items and objectives. Level of the questions should be appropriate with the sample of subjects to be measured. Therefore, it was ensured that prepared test items were suitable for content and instructional objectives.

Twenty-five multiple choice questions (HCSACT) were administered as a pretest and posttest to both control and experimental groups to assess students' biology achievement about human circulatory system. The multiple choice questions were preferred as a test questions, because it is easy to apply and scored objectively. HCSACT about human circulatory system was used to learn the effectiveness of the learning cycle instruction method on students' biology achievement in human circulatory system. Reliability was found to be .68.

3.3.2 Learning Approach Questionnaire (LAQ)

The Learning Approach Questionnaire is a four-point Likert-type instrument which is scaled by absolutely disagree, disagree, agree, absolutely agree, considered to measure students' approach to learning ranging from meaningful to rote (Cavallo, 1996). There are 22 items and used a four–point Likert-type scale ranging from "Always True" (4 point) to "Never True"(1 point) or "Strongly Disagree"(1 point) to "Strongly Agree" (4 point) to beat the inclination of respondents to choose the neutral option. The scores obtained therefore range from 88 to 22. Yenilmez (2006) translated and adapted this questionnaire into Turkish (Appendix H). Reliability for the whole scale was found to be .60.

3.3.3 Test of Logical Thinking (TOLT)

Test of Logical Thinking (TOLT), developed by Tobin and Capie (1981), is used to measure five modes of formal reasoning: proportional variables, controlling reasoning, probabilistic reasoning, correlational reasoning, and combinational reasoning of the students. The test composed of 10 items: items 1 and 2 measure proportional variables, items 3 and 4 measure controlling, items 5 and 6 measure probabilistic, items 7 and 8 measure correlational, and items 9 and 10 measure combinational reasoning. Students respond to each item by selecting a response from five possibilities and then they are provided with five justifications among which they choose from. The correct answer calculated by the correct choice plus the correct justification. TOLT scores range from 0 to 10. Test scores from 0-3, 4-7, and 8-10 were used as a basis for categorizing the subjects as low level, medium level and high level of formal thought (Oliva, 2003). Geban, Aşkar, and Özkan (1992) translated and adapted the Test of Logical Thinking into Turkish (Appendix I). For this study, reliability was found to be .65.

3.3.4 Self-Efficacy Scale (SES)

Students' self-efficacy is a self-report questionnaire, which was taken from the Motivational Strategies for Learning Questionnaire (MSLQ). MSLQ, developed by Pintrich and Garcia (1991), have two sections: one on motivations and the other on learning strategies. The motivation section consists of 31 items in three broad areas: Value components, Expectancy components, and Affect component. In this study, only items belonging to self-efficacy were used to measure students' self-efficacy. Nine items regarding perceived competence and confidence in performance of class work are subscale of the self-efficacy. The responses were scored on a 5-point Likert scale, where 1 point was given to "Strongly Disagree" and 5 points were given to "Strongly Agree". SES scores range from 9 to 45. Students scoring high on this subscale were sure they could learn and understand the material being taught in the class and carry out well in the class. Özkan (2003) translated and adapted these items into Turkish (Appendix J). For this study, reliability was found to be .84.

3.3.5 Locus of Control Scale (LOC)

Locus of Control Scale was used to measure students' locus of control. This instrument, developed by Rotter (1966), aspires to offer an idea about students' level of internal control which is defined as the level they believe their actions decide on the events outside them. There are 9 pairs of statements in the LOC scale in the study. Student selected one statement from each pair which best reflected their belief. The original scale consists of 29 forced choice items, which deal with ways in which an individual visions his/her capacity to control his own support. A short version of this scale was adapted and translated into Turkish by Kağıtçıbaşı (1972) (Appendix K). For this study, reliability was found to be .83.

3.3.6 The Attitude towards Biology Scale (ATB)

The instrument ATB scale, developed by Geban, Ertepınar, Yılmaz, Altın and Şahbaz (1994) (Appendix L), used in this study. This scale consists of 15 items and designed to be rated on a 5-point likert type response format (strongly disagree, disagree, neutral, agree, strongly agree). ATB were administered as a pretest to both control and experimental groups to assess students' attitudes towards biology. Possible ATB scores range from 15 to 75, with higher scores demonstrating positive attitude towards biology and lower scores demonstrating negative attitudes towards biology. For present study, reliability was found to be .82.

3.3.7 Observation Checklist

During the treatment both the control and the experimental groups were observed to identify whether the teachers follow the treatment rules (Appendix D). This checklist consists of 12 items, two items (item 5 and item 10) are negative form for the learning cycle activity criteria. First 10 items rated on five-point response format that indicate how frequently some actions were done. Last two items in which one item indicates whether the activities were done alone, in pairs or in groups of three and the other shows how much time the students spend on doing activities, were designed to be rated on four-point response format. Each item concludes with "no activity" option to check whether the control group done any activity or not. The researcher and a research assistant from the Department of Biology at METU observed both experimental and control group classes during the study and filled the observation checklist for both groups.

3.4 Teaching and Learning Materials

Various materials were used in this study; objective list, table of test specification, 5E learning cycle activities (Appendix E), objective-activity table, and handout.

The objective list was used to prepare 5E learning cycle activities (Appendix A). By this way 11 learning cycle activities were prepared to involve with students actively in the human circulatory system by making use of wide range of sources (Bosak, 1991; Lien, 1981; Tolman, 1996; Güngör et al., 2002). As Table 3.3 displays, the titles of the activities are the structure, function and working mechanism of the heart, exploring and structure of blood vessels, understanding of blood circulation, small and big blood circulation (systemic circulation), blood pressure and tension. Every activity consists of purpose, materials and procedure parts. All the activities are designed with simple materials such as plastic water bottle, balloon, different color pencils, papers, scissors, clocks, mammalian heart, gloves, pinafore, study paper, jar, reed, toothpick, ruler, city map, tin box etc. (Bosak, 1991; Lien, 1981; Tolman, 1996; Güngör et al., 2002). Moreover, objective-activity table was constructed to prepare proper and useful learning cycle activities. It indicates which activity matches with which objectives.

Table 3. 3: Learing cycle Activities about human circulatory system

Content	Name of activities
Heart	1. Exploration of heart
	2. Exploration of human heart
	3. Structure of the heart
	4. The mechanisms of heart function
Blood Vessels	1. Exploration of blood vessels
	2. Structure of blood vessels
Blood Circulation	1. Understanding of blood circulation
	2. Big and small blood circulation
Blood Pressure	1. Blood Pressure
	2. Counting of pulse
	3. Measuring tension

Finally, a handout was prepared for both students and teachers (Appendix G). Some of human circulatory system information, pictures and explanations about the subject were given in this handout. This handout was also delivered to control group students.

3.5 Treatment

The students in experimental groups and the control groups treated with different methods of teaching. In the experimental group, 5E learning cycle instruction was used. At the beginning, objective list and objective-activity table were prepared. The objective list was used to prepare learning cycle activities for each phase; secondly, objective-activity table was constructed to prepare proper and useful activities (Appendix F). It indicates which activity matches with which objectives. For each phase of 5E learning cycle, different activities were prepared. The subject of human circulatory system was expressed with four general titles as heart, blood vessels, blood circulation and blood pressure by taken into consideration of 11^{th} grade biology curriculum of Ministry of Education (MEB). Therefore, 5E learning cycle plan was prepared for topics of heart, blood vessel, blood circulation, and blood pressure. Firstly, for the topic of the heart four activities named as exploration of heart, exploration of human heart, structure of the heart and the mechanism of the heart function were prepared. In engagement phase of learning cycle, a story and small activity were used to engage students. However, at the beginning of activities, students filled up first part of KWL chart by answering two questions as "What I Know", "What I Want to Know" about the heart. Then, students read a short story about a man who had health problem at 1535 and answered the questions related with this story, briefly. Also, they performed an activity to notice the subject of the heart and teacher showed some interesting/surprising pictures about the heart to attract student's attention. In exploration phase, students performed two activities to explore the subject. In the first activity, students worked in groups and each group investigated real mammalian heart by cutting and naming each parts of the mammalian heart on the diagram. By this activity, students explored right and left atrium, right and left ventricle and muscle of the heart. Second activity in exploration phase of the learning cycle was done to explore working/function of the heart. Students again, worked in groups and they were used simple materials to investigate contraction and blood pumping mechanism of the heart in this phase. In explanation phase, students answered the questions in the worksheet given by teacher to explain their understanding of concepts and processes. Then, each student watched an animation about structure and mechanism of the human heart from his/her computer. In elobaration phase, activities were done to allow students to apply concepts in different contexts, and extend understanding. Each student was expected to write a paper to describe his/her meals and exercise during one week. By this activity, students used their learnings about heart on their daily lifes. Finally, in evaluation phase, each student formed “Roundhouse Diagram” and completed “KWL chart” about the heart to assess their knowledge. In Roundhouse Diagram, students wrote basic and important concepts about heart on the diagram like SA node, AV node, contraction-loosing mechanisms, heart muscle, right and left atrium, right and left ventricle, places of the heart, blood pumping mechanisms etc. In KWL chart, students answered “What I Know”, “What I Want to Know” at the engagement phase and “What I Learned” at the evaluation phase.

Second 5E learning cycle plan was prepared for blood vessels. In engagement, first of all students answered “What I Know”, “What I Want to Know” about blood vessels in KWL chart and then, teacher started the lesson with an analogy about city map and blood vessels. Students answered the questions by considering analogy and so that they realized differences of arteries, veins and capillaries. Each vessel has specific characteristics as length, wideness and functions. In exploration phase, students worked in groups and each group acted an activity to explore structure and also functions of blood vessels. By this activity, students explored the importance of elastic characteristics of vessels to resist blood pressure. In explanation phase, students answered teacher’s questions and then each student followed pictures, graphs and demonstrations from computer during the teacher’s explanations the subject. In Elaboration phase, students prepared a poster about damages of cigarette and the relationships between heart-blood vessels and health was explored. In Evaluation phase, each student formed “Roundhouse Diagram” and completed “KWL chart” about the blood vessel to assess their knowledge. In

Roundhouse Diagram, students wrote basic and important concepts about blood vessels like arteries, veins and capillaries and the properties of vessels.

Third 5E learning cycle plan was prepared for blood circulation. At the beginning of the engagement phase, again, students answered “What I Know”, “What I Want to Know” about blood circulation. After that, each student completed a human body map by using circulatory system elements as heart with four chambers, blood vessels with veins, capillaries and arteries, blood cells as erythrocytes, leukocytes and thrombosis. Students could make a connection between previous lesson and the new lesson, so that they used previous knowledge to complete human body map. In exploration phase, all class participated “role play” to explore small and big blood circulation. Each student had a name as muscles, right atrium, left atrium, right ventricle, left ventricle, aorta, lung, lung arteries and lung veins and each of them had a function. By this way, students explored big and small blood circulation in human body and then answer the questions about the subject. In Explanation phase, students watched an animation and they tried to explain their understanding about blood circulation by the help of their teacher. In elaboration phase, each student wrote a composition about the factors that affect blood circulation negatively. In final stage of evaluation, each student formed “Roundhouse Diagram” and completed “KWL chart” about the blood circulation to assess their knowledge. In Roundhouse Diagram, students wrote basic and important concepts about blood circulation like systemic circulation and the way of blood through body.

Finally, 5E learning cycle plan was prepared for blood pressure. In engagement phase, first of all students answered “What I Know”, “What I Want to Know” about blood pressure in KWL chart and then, students were shown some graphs and, brochure about hypertension and heart attack from real life to attract the student's attention. Also, students were asked about their experience related with hypertension and heart attack in their families. In exploration phase, there were two activities. The aim of the first activity was to explore the term of pulse and that of the second activity was to explore the term of tension, hypertension and hypotension. In the first activity, the students tried to count pulse of friends during 15 seconds before and after exersize. In the second activity, each group tried to measure blood pressure of their friends and they tried to recognize big or small tension by using tension device. By this way, students realized the differences of those similar terms. In explanation phase, teacher had an oppurtinity to identify the meaning and the importance of pulse, tension, hypertension and hypotension by using different pictures. In elaboration phase, teacher asked for the relations between hormones and blood pressure to extend understanding. Students identified the effects of hormones on blood pressure under certain circumstances. In evaluation phase, each student formed "Roundhouse Diagram" and completed "KWL chart" about the blood pressure to assess their knowledge. In Roundhouse Diagram, students wrote basic and important concepts about blood pressure like tension, pulse, hypertension, and hypotension.

In control group, traditional method was given. Teacher-centered instruction was applied and students were generally taught with note taking strategy. The teacher gave important concepts about human circulatory system. The teacher used some diagrams about the subjects.

3.6 Procedure

At the beginning, the researcher searched a detailed literature. First, the keywords were determined. By the help of these key terms, Educational Resources Information Center (ERIC), Ebscohost, Science Direct and Internet (Goggle) were systematically searched. Previous studies which were done in Turkey were also searched from the Council of Higher Education. These entire tasks took about two months. Also, learning cycle activities were prepared by use of such books as "Science is…A Source of Book Fascinating Facts, Projects and Activities" (Bosak, 1991); "Investigations to Science Inquiry" (Lien, 1981); "Hands-on Science Life Activities for Grades K-8" (Tolman, 1996); "The Best of Wonder Science Elementary Science Activities" (American Chemical Society, 2001);

Next, the researcher prepared the measuring instruments and teaching/ learning materials as detailed in section 3.3 and 3.4. One instructor, one research assistant, and one biology teacher from the Department of Secondary School Science and the Department of Biology at METU checked achievement test and the instrument (objective list, table of test specification, objective-activity table, learning cycle activities, handout and the HCSACT). Before the study, necessary modifications in all teaching/ learning materials were done.

Experimental research as a research methodology was used in this study since it is the best way to establish cause and effect relationships between variables. The effect of learning cycle activities on student's biology achievement was examined in this study. A quasi-experimental study design was preferred as an experimental model since it does not include random assignment. At the beginning of the study, the teachers were trained by the researcher. Each teacher was conscious about how to teach a subject in both experimental and control groups. A teacher handout which explains learning cycle activities step by step for experimental group was prepared and a handout which explains human circulatory system concepts for both experimental and control groups was given to the teachers. By this way, teachers could know how to teach human circulatory system in both experimental group and control group. Moreover, the teachers allowed researcher to observe their classes.

As Table 3.4 displays, six instruments (HCSACT, LAQ, TOLT, SES, LOC scale and ATB) were used in the study. These instruments were administered to both groups. Teachers allowed one class hour to students to complete the TOLT and appropriate time also given to complete LAQ, SES, LOC Scale and ATB Scale. Teachers explained the meaning of the tests and LAQ, TOLT, SES, LOC Scale, ATB Scale was given to each class at the same time and it was given appropriate time interval between the applications of each test. The students were informed that the results of the test would not affect their grades.

Table 3. 4: Research Design of the Study

	Pretest	Treatment	Posttest
Experimental Group	HCSACT, LAQ, TOLT, SES, LOC, ATB	Learning Cycle Instruction	HCSACT
Control Group	HCSACT, LAQ, TOLT, SES, LOC, ATB	Traditional Instruction	HCSACT

Observation checklist was used for both groups during the study to confirm the proper treatment implementation. The checklist showed the degree to which the course was taught with appropriate method.

3.7 Analyses of Data

After obtaining data through pre-test and post-test scores, certain descriptive statistics were performed. The mean, median, mode, standard deviation, skewness, kurtosis and the histograms were presented for both control and experimental groups. For Main problem 1, Pearson correlation analysis was conducted for each group to detect the relationships that might exist among students' prior knowledge, learning approach, formal reasoning ability, self-efficacy, locus of control, attitudes toward biology and human circulatory system achievement in two different types of instruction. Main Problem 2 was answered by Multiple Regression Analysis (MRC) to determine the contributions of these variables on students' understanding for the learning cycle and traditional classrooms. Post-test scores were the dependent variable whiles the pre-test scores, meaningful learning orientation, formal reasoning ability, self-efficacy, locus of control, and attitude toward biology serve as independent variables. For Main Problem 3, Stepwise Multiple Regression Analysis was used to be able to conclude which variable best predicted students' understanding in traditional and learning cycle classrooms. Finally, Main Problem 4 was answered by ANOVA in order to determine the effect of learning cycle instruction on 11^{th} grade students' understanding of human circulatory system.

For inferential statistical analyses, α was set to 0.05 (probability of making Type-1 error) that is mostly used value in educational studies. Effect size was set to small in this study (f^2= 0.3 for mean difference and 0.08 for variance).

3.8 Assumptions and Limitations

1. The application of treatment and the administration of the tests were under standard condition.
2. All subjects of the study responded sincerely to the items on the tests.
3. Students in control and experimental groups did not interact or share the questions of the HCSACT before and during the administration of the tests.

4. The research findings were limited to the concepts in Human Circulatory System.
5. The subjects of this study were limited to sixty eleven grade students.
6. The study was limited to one private school.
7. Student's performance in learning cycle activities assessed with a paper and pencil test in this study. However, it is considered that a paper and pencil test is not appropriate measure of performance for the students occupied in experimental group.
8. Generalizations of the study are limited because the participants of this quasi-experimental study were not selected randomly.

CHAPTER 4

RESULTS

The results are divided into two sections. The first section presents the descriptive statistics associated with the data collected from the administration of the achievement pre-posttest and related scales. The second section of this chapter presents the relationships among variables of the study.

4.1 Descriptive Statistics

Descriptive statistics related to scores which were measured by the students' PREACH and PSTACH, LAQ, TOLT, SES, LOC and ATB scores for both experimental and control groups are presented in Table 4.1.

The mean, median, mode, standard deviation, skewness, kurtosis and the histograms were presented for both control and experimental groups with respect to gender.

Table 4.1: Descriptive Statistics for the Variables of the Study

Instruments	Possible Range	Actual Range	Mean	SD	Skewness	Kurtosis
PREACH						
Girls		2-12	6.83	2.31	0.34	0.24
Boys		3-13	6.71	2.28	0.58	0.71
Total	0-25	2-13	6.77	2.28	0.45	0.32
PSTACH						
Girls		7-20	12.69	4.42	0.36	-1.37
Boys		5-19	12.52	3.79	0.10	-0.86
Total	0-25	5-20	12.60	4.07	0.25	-1.12
LAQ						
Girls		47-74	60	6.39	0.18	0.39
Boys		29-76	57.74	8.89	-0.96	0.82
Total	22-88	29-76	58.83	7.8	-0.79	0.61
LAQ-M						
Girls		22-40	31.1	4.40	-1.36	0.21
Boys		13-42	30.16	0.95	-0.61	1.29
Total	11-44	13-42	30.60	5.23	-0.56	1.25
LAQ-R						
Girls		21-38	28.72	3.42	0.47	1.24
Boys		14-36	28.23	4.48	-0.65	0.84
Total	11-44	14-38	28.47	3.98	-0.37	0.61
TOLT						
Girls		2-9	5.76	1.30	-0.67	0.86
Boys		2-7	5.58	1.17	-1.45	0.82
Total	0-10	2-9	5.67	1.23	-0.96	0.60
SES						
Girls		21-44	36.17	6.31	-0.43	-0.35
Boys		19-44	35.16	7.42	-0.56	-0.65
Total	9-45	19-44	35.65	6.87	-0.53	-0.48
LOC						
Girls		0.11-0.88	0.50	0.23	-0.12	-0.91
Boys		0.22-0.77	0.53	0.14	-0.31	-0.58

Table 4.1 Continued

Total	0-1	0.11-0.88	0.52	0.19	-0.28	-0.38
ATB						
Girls		40-59	50.14	4.83	-0.36	-0.58
Boys		39-59	48.29	4.68	0.16	-0.28
Total	15-75	39-59	49.33	5.16	0.32	0.29

First of all, Human Circulatory System Achievement test (HCSACT) was applied to both control and experimental groups before instruction. It was used as a pretest (PREACH) to measure students' prior knowledge about human circulatory system. Student's achievement scores could range from 0 to 25 in which higher scores mean greater biology achievement. At the beginning of instruction, there was no significant difference between control and experimental groups in students' human circulatory system achievement. As shown Table 4.1 a relatively low mean score of μ=6. 77 indicating low level of relevant prior knowledge are obtained. Figure 4.1 indicates the histogram with normal curves, the right-skewed diagram illustrates that most of the students have low scores on PREACH.

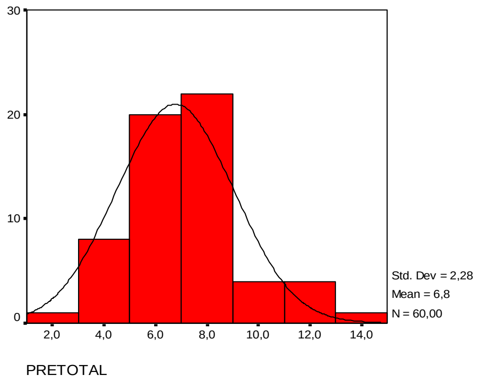


Figure 4. 1: Histograms with normal curves of the Pretest scores

HCSACT was used as a posttest (PSTACH) to decide students' level of understanding about human circulatory system at the end of instruction. The mean increases from 6.77 to 12.60. Figure 4.2 demonstrates that most of students have higher scores on PSTACH.

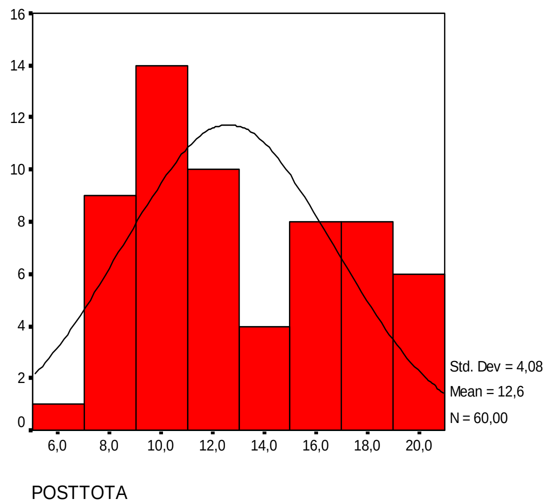


Figure 4. 2: Histograms with normal curves of the Posttest scores

Secondly, the Learning Approach Questionnaire was used to measure students' orientations to learning ranging from meaningful (deep) to rote (surface). Descriptive statistics are summarized in table 4. 1. The possible ranges of both LAQ-M and LAQ-R are 11-44. LAQ-M scores diverge between low to high meaningful approaches to learning, LAQ-R scores differ between low to moderate rote approaches to learning. The mean of meaningful learning scores (μ=30.60) is higher than rote learning (μ =28.47) that means that students may use meaningful learning approaches than rote learning approaches. The mean score of the total learning approaches of students is 58.83. Figure 4.3 indicates that the left-skewed diagram illustrates that most of the students have higher scores on LAQ.

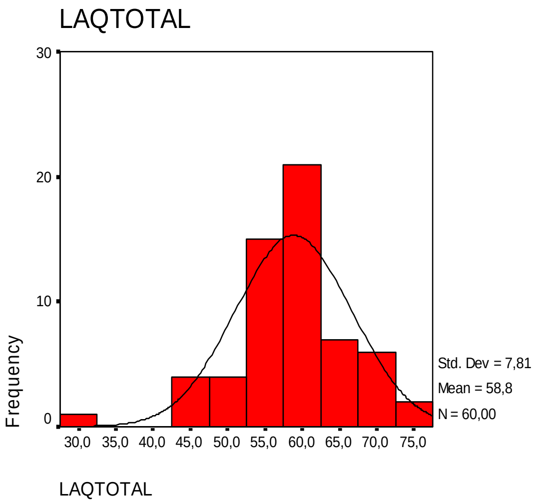


Figure 4. 3: Histograms with normal curves of the LAQ scores

Also, Test of Logical Thinking (TOLT) was used to measure five modes of formal reasoning: controlling variables, proportional reasoning, probabilistic reasoning, correlational reasoning, and combinatorial reasoning of the students. As shown table 4.1, total mean of TOLT is 5. 67. The left-skewed diagram also demonstrates that most of the students have higher scores on TOLT (Figure 4.4). Additionally, the distribution of the students' scores is given in Table 4.2.

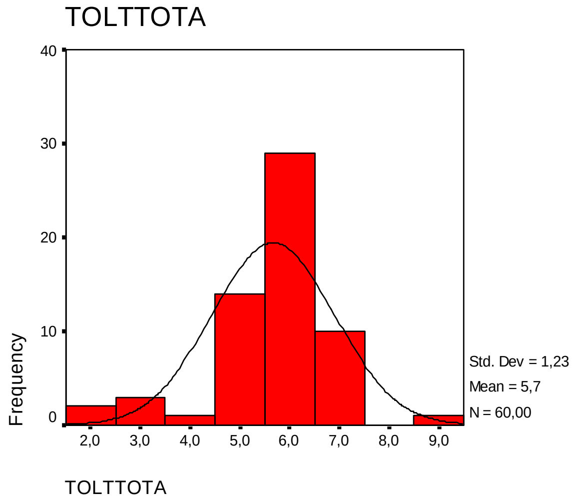


Figure 4. 4: Histograms with normal curves of the TOLT scores

Table 4. 2: Number and frequencies of students according to the scores on TOLT.

TOLT Score	N	Frequency (%)
2	2	3.3
3	3	5
4	1	1.7
5	14	23.3
6	29	48.3
7	10	16.7
9	1	1.7

As mentioned before, five reasoning modes those are controlling variables, proportional, probabilistic, correlational and combinatorial reasoning of the students were measured by TOLT. The frequencies of students who give the correct answers to the items on the test according to the reasoning modes are given in Table 4.3. As shown, students completed best on 1st and 2nd items (84.2%) which measure proportional variables. Students were also good at probabilistic (57.5%), controlling variables (54.2%) and correlational (45.9%) and combinational (40.8 %).

Table 4. 3: Frequencies and percentages of students with respect to five reasoning modes

Item	Responding Mode		N	Frequency (%)
1	Proportional		52	86.7
2	Proportional		49	81.7
		Total	101	84.2
3	Controlling variables		36	60
4	Controlling variables		29	48.3
		Total	65	54.2
5	Probabilistic		37	61.7
6	Probabilistic		32	53.3
		Total	69	57.5
7	Correlational		36	60
8	Correlational		19	31.7
		Total	55	45.9
9	Combinatorial		41	68.3
10	Combinatorial		8	13.3
		Total	49	40.8

In addition, the subjects are classified in relation to formal thought as low level (scores from 0-3), medium level (scores from 4-6), and high level (scores from 7-10) by using TOLT. In this study, 5 (8.3 %) of the students were in low level of formal thought, 44 (73.3%) of the students were in medium level of formal thought, and 11 (9.14 %) of the students were in high level of formal thought (Table 4.4). When the total score is considered, majority of the students are at medium formal thought.

Table 4. 4: Distribution of students with respect to level of formal thought

Formal Reasoning Level (N)

	Low	Medium	High	Total
Girls	2	21	6	29
Boys	3	23	5	31
Total	5	44	11	60

Furthermore, self-efficacy is defined as people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances. In the SES, actual range is 9-45; however, in present study, minimum score was 19 and maximum score was 44. The mean of scores was 35.65. The left-skewed diagram also demonstrates that reasonable number of the students have higher scores on self-efficacy scale (Figure 4.5). This explains that there is moderate number of students with high sense of efficacy to perform given actions.

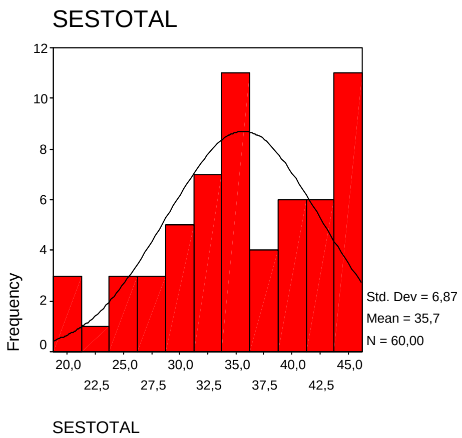


Figure 4. 5: Histograms with normal curves of the SES scores

Moreover, locus of control refers to a person's belief about what causes the good or bad results in his or her life, either in general or in a specific area such as academics. It can either be internal or external. The possible range of LOC scale is 0-

1. In the present study, the mean of score is 0.52. Figure 4.6 shows the histograms with normal curves of the LOC scores and it suggests that half of subjects have internal locus of control.

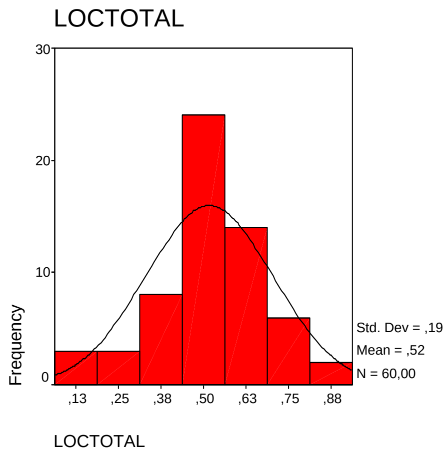


Figure 4. 6: The Histograms with normal curves of the LOC scores

Finally, Attitude Scale (ATB) was used to measure students' feelings, beliefs and values towards subjects. In this scale the possible range is 15-75 and the actual range is 39-59. According to Figure 4.7, the students have both positive and negative attitudes towards biology. That means students have moderate attitudes towards biology.

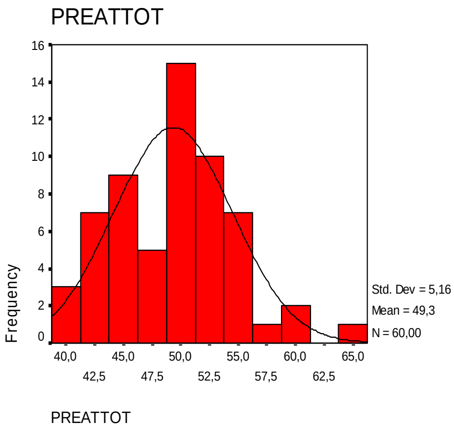


Figure 4. 7: The Histograms with normal curves of the ATB scores

4.2 The Relationships among Variables of the Study

In this section, relationships among variables for experimental and control groups of the study is analyzed.

<u>Main Problem 1</u>

What is the relationship among 11th grade students' prior knowledge, meaningful learning approach, reasoning ability, self-efficacy, locus of control, attitudes toward biology and achievement in human circulatory system in learning cycle and traditional classrooms in a private school in Ankara?

Pearson correlation analysis was carried out for experimental and control group to notice the relationships that might exist among students' prior knowledge, learning approach, formal reasoning ability, self-efficacy, locus of control, attitudes toward biology and human circulatory system achievement in two different types of instruction named as learning cycle instruction and traditional instruction (Table 4.5).

Table 4. 5: Correlation coefficients among variables of the study for each group

Group		PREACH	PSTACH	LAQ	TOLT	SES	LOC	ATB
	PREACH	-	.30**	.070	.390**	.087	.320**	.182*
Experimantal	PSTACH	-	-	0.175	.231*	.010	.098	.077
(Learning cycle classroom)	LAQ	-	-	-	.030	.231*	.152	.101
	TOLT	-	-	-	-	.378**	.318**	.181
	SES	-	-	-	-	-	.231*	.201*
	LOC	-	-	-	-	-	-	.462**
Control	PREACH	-	.128	.082	.290**	.261**	.161	.241
(Traditional classrom)	PSTACH	-	-	.319**	.021	.262*	.235*	.256*
	LAQ	-	-	-	.201*	.216*	.218*	.062
	TOLT	-	-	-	-	.104	.237*	.089
	SES	-	-	-	-	-	.230*	.040
	LOC	-						.201*

*** Correlation is significant at the 0.01 level   *Correlation is significant at the 0.05 level*

When we look at the learning cycle classroom, first of all, students' post-test scores were significantly and positively correlated with their pre-test scores (r=.30, p=.001), formal reasoning ability (r=.231, p=.000). Secondly, students' pre-test scores were also significantly correlated with their formal reasoning ability (r=.39, p=.000) locus of control (r=.320, p=.000), attitudes (r=.182, p=.02). Thirdly, students' meaningful learning orientation was significantly correlated with their self-efficacy (r=.231, p=.000). Furthermore, students' formal reasoning abilities were significantly correlated with their self-efficacy (r=.378, p=.000) and locus of control (r=.318, p=.000). Also, students' attitudes toward biology were significantly correlated with their self-efficacy (r=.201, p=.009) and locus of control scores (r=.462, p=.000). Besides, students' self-efficacy was found to be related with their locus of control scores (r=.231, p=.004). However, there was no statistically significant correlation between post-test scores, meaningful learning orientation, self efficacy, locus of control and attitudes (p>.05).

When we look at the traditional classroom, students' post-test scores were found to be significantly correlated with their meaningful learning orientation (r=.319, p=.000), self- efficacy (r=.262, p=.008), locus of control (r=.235, p=.000) and attitudes toward biology (r=.256, p=.000). Students' meaningful learning orientation was significantly correlated with their formal reasoning ability (r=.20, p=.03), self-efficacy (r=.216, p=000), locus of control (r=.218, p=.010). Also, students' pre-test scores were significantly correlated with their formal reasoning ability (r=.261, p=.02), self-efficacy (r=.290, p=000). Moreover, students' formal reasoning ability was also significantly correlated with their locus of control (r=.237, p=.000). Students' attitudes toward biology also were significantly correlated with their locus of control (r=.201, p=.000). Students' self-efficacy was also found to be related with their locus of control (r=.230, p=.003). However, there was no statistically significant correlation between post-test scores and pre-test scores (p>.05).

According to results of the present study, in learning cycle classrooms, basically, students' understanding of human circulatory system was related with their relevant prior knowledge and formal reasoning ability. It is concluded that students having higher prior knowledge scores and high formal reasoning abilities had better understanding of human circulatory system in learning cycle classrooms. In traditional classrooms, basically students' understanding of human circulatory system was related with their meaningful learning orientation, self-efficacy, locus of control and attitudes toward biology. This means that, students who have higher meaningful learning orientation, self-efficacy beliefs, and locus of control orientations and having more positive attitudes toward biology had better understanding of human circulatory system. Nevertheless, formal reasoning ability and relevant prior knowledge had no significant effect on students' understanding of the human circulatory system in traditional classrooms.

Main Problem 2

What are the contributions of 11^{th} grade students' relevant prior knowledge, learning approach, reasoning ability, self-efficacy, locus of control and attitudes toward biology to their achievement in human circulatory system in learning cycle and traditional classrooms?

Multiple Regression Analysis (MRC) was carried to answer main problem 2. The general purpose of multiple regressions is to learn more about the relationship between several independent or predictor variables and a dependent or criterion variable. Also, MRC is used to predict students' score on one variable on the basis of their scores on several other variables. Therefore, in present study, contributions of variables on students' understanding for the learning cycle and traditional classrooms were determined by using MRC (Table 4.6). In the study, the pre-test scores, meaningful learning orientation, formal reasoning ability, self-efficacy, locus of control, attitude toward biology were the independent variables even as post-test scores were the dependent variable.

On the other hand, to conduct MRC, firstly, assumptions should be checked. Specifically, it is necessary to discuss the assumptions of linearity, homoscedasticity, outlier, and normality. First of all, multicollinearity exists when the independent variables are highly correlated (r=.9 and above) (Stevens, 1996). In this study, the correlations between the independent variables are less than that value as given on Table 4.5. Secondly, homoscedasticity means a situation in which the variance of the dependent variable is the same for all the data. In other words, homoscedasticity explained as the variance of errors is the same across all levels of the IV. When the variance of errors differs at different values of the IV, heteroscedasticity is indicated. In addition to homoscedasticity, outlier and normality assumptions can be checked by visual examination of a plot of the standardized residuals (the errors) by the regression standardized predicted value.

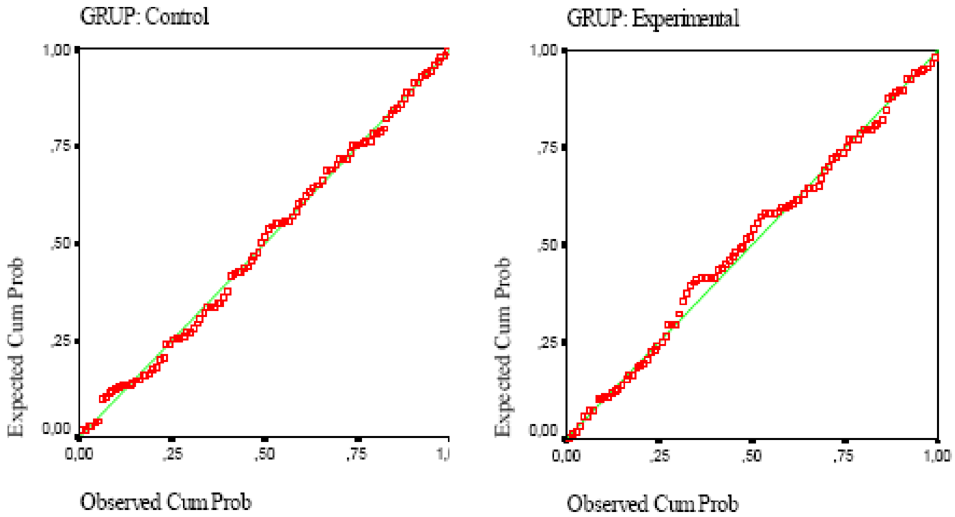


Figure 4. 8: Normal probability plot for control group and experimental group

In the Normal Probability Plot all points lie down a straight diagonal line indicates that there are no major deviations from normality for control group and experimental group. Moreover, there is no systematic pattern to the residuals indicating that there are no outliers violating the assumptions (Figure 4.9 and 4.10).

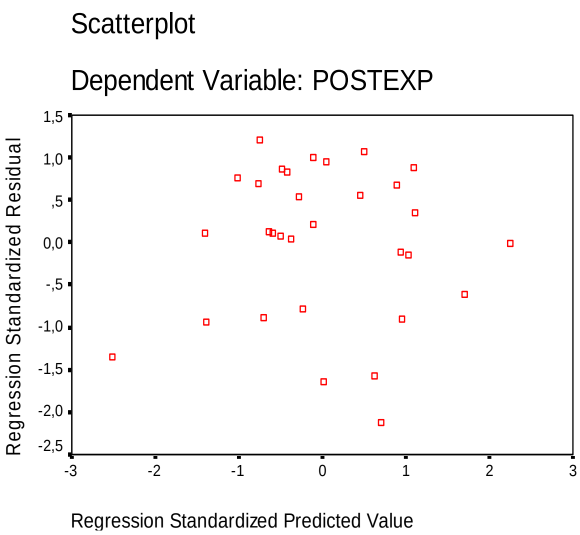


Figure 4. 9: Scatterplot of the standardized residuals for the experimental group

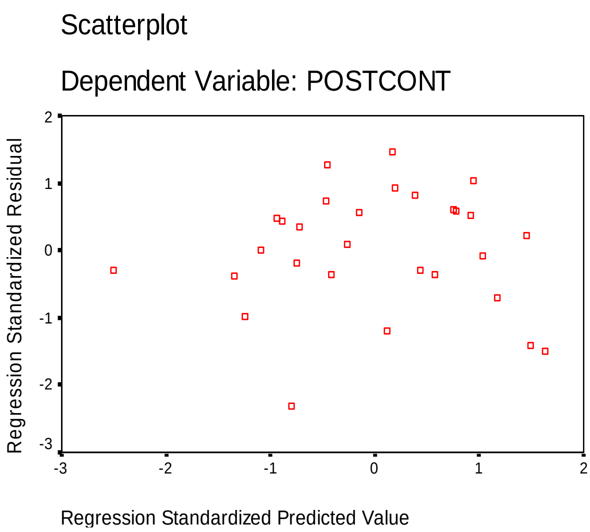


Figure 4. 10: Scatterplot of the standardized residuals for the control group

Table 4. 6: Independent contributions of PREACH, LAQ, TOLT, SES, LOC and ATB to understanding of human circulatory system.

Methods of Teaching								
Variables	Learning Cycle Instruction				Traditional Instruction			
	B	β	t	p	B	β	t	p
PREACH	.104	.055	.241	.000*	- .147	-.189	-.907	.000*
LAQ	-.108	-.211	-1.047	.306	.455	.191	.950	.001*
TOLT	.030	.337	.383	.000*	-.149	- .098	.493	.000*
SES	.78	.111	.529	.602	.742	.278	.299	.208
LOC	.176	.009	.035	.973	2.537	.251	1.25	.000*
ATB	-2.11	-.025	.097	.000*	6.84	.055	.252	.247

**Significant at the 0.05 level*

The multiple correlation *(R)* was .61 with R^2=.37 for the learning cycle classrooms. According to this result, the model significantly explained for the 37% variation in students' understanding in experimental group. Students' prior knowledge and reasoning abilities significantly contributed to their understanding of human circulatory system. On the contrary, students' attitudes towards biology contributed to their understanding of human circulatory system in negative direction.

Moreover, the multiple correlation *(R)* was .55 with R^2=.31 for the traditional classrooms. According to this result, the model significantly accounted for the 31% variation in students' understanding in control group. Students' meaningful learning orientation and locus of control significantly contributed to their understanding of human circulatory system. Conversely, students' reasoning ability and their relevant prior knowledge significantly contributed to their understanding of human circulatory system in a negative direction.

Main Problem 3

Which variable best-predicted students' achievement in traditional and learning cycle classrooms?

Stepwise multiple regression analysis was used to answer the main problem 3 so that it was determined which variable best predicted students' understanding in traditional and learning cycle classrooms.

Table 4. 7: Stepwise multiple regression results for the traditional and learning cycle classrooms

		β	Adjusted R^2	F	p
PSTACH					
Traditional Classrom	LAQ	.319	.28	22.10	.000
(Control Group)	TOLT	.191			
	PREACH	.189			
	LOC	.216			
Learning Cycle Classrom	PREACH	.210	.53	20.35	.000
(Experimental Group)	TOLT	.340			
	ATB	.164			

The results showed that for the learning cycle classrooms students' reasoning ability was the main predictor of performance on post-test scores, explaining 45.8% variance, while students' prior knowledge explaining remaining 15.9% variance on the post-test scores and attitudes towards biology explaining 5.7 % variance on the post-test scores in learning cycle classrooms. Nonetheless, in traditionl classroom, a meaningful learning orientation was the main predictor of performance on the post-test scores, explaining 40% of the variance, even as locus of control accounted for 9.8%. Remaining 5.7% of the variance explained by pre-test scores, locus of control on the post-test scores in traditional classrooms.

According to the results of the stepwise multiple regression analysis, students' reasoning ability was the main predictor of performance on post-test in learning cycle classrooms; however, students' meaningful learning orientation was the main predictor of performance in traditional classrooms.

Main Problem 4

What is the effect of learning cycle instruction on 11th grade students' understanding of human circulatory system?

The null hypothesis was "There is no significant effect of learning cycle instruction on 11th grade students' understanding of human circulatory system". ANOVA was conducted to determine the effect of methods of teaching on the PSTACH. Significant differences were found between learning cycle instruction and traditional method on the dependent variable ($F (1, 28) = 2.136$, $p=.000$).

4.3 Classroom Observation

All through the study, the researcher observed lessons to compare the experimental group with the control group in terms of the treatment implemented.

A total of 12 classroom observations have been done for the purpose of the treatment verification. Eight observations were conducted by the researcher and four observations conducted by the researcher and another observer together.

4.4 Summary of the Results

In the light of the findings obtained by the statistical analysis, the results could be summarized as follows:

1. In learning cycle classrooms, students' post-test scores were significantly and positively correlated with their pre-test scores and formal reasoning ability.
2. In traditional classrooms, students' post-test scores were found to be significantly correlated with their meaningful learning orientation, locus of control and attitudes toward biology.
3. Students' prior knowledge and reasoning abilities significantly contributed to their understanding of human circulatory system in experimental group (37% variation)
4. Students' meaningful learning orientation and locus of control significantly contributed to their understanding of human circulatory system in control group (31% variation).
5. Students' reasoning ability and their relevant prior knowledge significantly contributed to their understanding of human circulatory system in negative direction in control group.
6. Students' reasoning ability was the main predictor of performance on post-test in learning cycle classrooms

7. Students' meaningful learning orientation was the main predictor of performance in traditional classrooms.
8. Statistical results showed that the students instructed by learning cycle instruction gained more biology achievement about human circulatory system than the students instructed by traditional method. Students' active involvement in class discussions and hands-on activities, help them understand important human circulatory system concepts and application of new knowledge to related subjects resulted in higher achievement in learning cycle classrooms.

CHAPTER V

CONCLUSIONS
DISCUSSION AND IMPLICATIONS

The purpose of the study was to investigate the relationship among 11th grade school students' prior knowledge, learning approach, reasoning ability and self-efficacy, locus of control and attitudes toward biology in relation with students' achievement in human circulatory system in learning cycle and traditional classrooms. To finalize this goal, this chapter consists of five sections. First section presents the conclusions and discussions obtained from the results. The second and third sections present internal and external validity of the study, respectively. The fourth one is implication of the study. The final section is recommendations for further studies.

5.1 Conclusions and Discussions of the Results

The accessible population of the study was selected as all 11th grade students in one high school. The sample of the study chosen from this accessible population was a sample of convenience. Therefore, there is a limitation about the generalizability of the study. On the other hand, conclusions of this research can be used to a broader population of similar 11th grade students.

One purpose of the study was to investigate the relationships of some variables as students' prior knowledge, learning approach, reasoning ability and self-efficacy, locus of control and attitudes toward biology in relation with students' achievement in human circulatory system in learning cycle and traditional classrooms. In traditional classrooms, essentially students' understanding of human circulatory system was associated with their meaningful learning orientation, self-efficacy and locus of control and attitudes toward biology. This means that, students who have higher meaningful learning orientation, self-efficacy beliefs, and locus of control orientations and having more positive attitudes toward biology had better understanding of human circulatory system. Alternatively, pretest scores and reasoning ability significantly predicted human circulatory system achievement in negative direction.

When we looked at each variable, in traditional classrooms, the results of the present study revealed that students' meaningful learning orientations was the main predictor of performance on post-test, explaining 40% of the variance. Participants of the study had relatively high meaningful learning orientations (μ=30.60). This means that, when students have high meaningful learning orientations, they also have higher achievement in human circulatory system. This result is not surprising considering the fact that many studies indicated that meaningful learning orientation is important to meaningful understanding of any science subjects (Reap & Cavallo, 1992). Because, meaningful learning is a productive process and the students study to construct an understanding of the information and observations. As indicated before, human circulatory system is connected with other biological systems as human immune system, respiratory system, homeostasis etc. Students should connect the new idea with preexisting knowledge. Therefore, meaningful learning orientation is crucial to understand the new concepts of human circulatory system. The result indicating the predictive influence of meaningful learning orientation is consistent with the study of Cavallo (1996), who revealed that meaningful learning orientation explained more of the variance (13%) in the biology concepts meaning as compared to reasoning ability (3%) in classrooms. Likely, Atay and Tekkaya (2008) stated that meaningful learning approach is important predictor for a significant portion of the eight grade students' performance on genetics. Cavallo and Schafer (1994) investigated that the connection between students' meaningful learning orientation, relevant prior knowledge, instructional treatment and all interactions of these variables on tenth grade students' meaningful understanding of meiosis. Authors found that meaningful learning orientation contributed to students' attainment of meaningful understanding independent of aptitude and achievement motivation. Moreover, Araz and Sungur (2007) examined that the relationships between students' learning approach, reasoning ability, prior knowledge, motivational variables, and achievement in genetics. They indicated that learning approach and prior knowledge had direct effects on achievement in genetics. Similarly, the interactions between students' approaches to studying, prior knowledge, logical thinking ability, gender and their performance was studied by BouJaoude and Giuliano (1994). They found that prior knowledge, TOLT scores, and meaningful orientation accounted for the 32 % of the variance on the final examination scores.

Another predictor of students' achievement in human circulatory system for traditional classrooms was locus of control. As it known that locus of control is the general belief that one's behavior can have an effect on the environment and that one is capable of controlling outcomes through one's own behavior (Martinez, 2003). According to results of study (the mean of LOC score is 0, 52), students had internal control expectancies, and received personal responsibilities for what happens in human circulatory system. The previous studies observed the relation between achievement and locus of control and concluded that there is a positive relationship between an internal locus of control and academic achievement (Bar-Tal & Bar-Zohar, 1977; Findley & Cooper, 1983; Rowland, 1990; Wishart, 1997; Anderson, 2005; Atay, 2006). These researches stated that more internal beliefs are associated with greater academic achievement Except for, positive correlations between locus of control and meaningful learning orientation (r=.22), self-efficacy (r=.23) were found. These results indicated that these variables are related with each other.

Another important variable for students' achievement of human circulatory system in traditional classrooms was self efficacy. A study by Schunk and Pajares (2001) stated that compared with students who indecision their learning capabilities, those who feel efficacious for learning or performing a subject contribute more willingly, work harder, persevere longer when they encounter difficulties, and achieve at a higher level. Other study was performed by Lawson, Banks and Logvin (2007) and they compared the relationships of self-efficacy and reasoning ability to achievement in introductory college biology. Self-efficacy estimates and achievement were higher for the concrete tasks than for the formal tasks and higher for the formal tasks than for the postformal tasks. Moreover, a study by Cavallo, Rozman and Potter (2004) stated that physics achievement scores significantly correlated with girls' and boys' self-efficacy scores, respectively. However, Kang et al. (2005) found no significant relationship between self-efficacy and students conception test scores about density. This study indicated that students' motivational characteristics toward the specific learning material may influence their performance. Also, Pintrich (1999) confirmed that self-efficacy is relatively situation-specific, compared with other motivational variables. Thus, some issues as the type of instruction or subject being taught may influence the relationship between self-efficacy and achievement. In present study, students' self-efficacy was found to be related with their locus of control (r=.230). According to this result students who have internal control expectancies also have high self-efficacy scores. This result is not unexpected, since students' self-efficacy beliefs influence their option of task, effort and achievement (Schunk, 1995; Bandura, 1997). When students have high self efficacy, studies showed that students have more engagement in lessons and they learn more and they perform better (Linnenbrink & Pintrich, 2003).

Finally, the negative predictive influence of pretest score and reasoning ability, on the other hand, demonstrated that students having higher prior knowledge and reasoning ability resulted in low achievement in human circulatory system in traditional classes. In present study, the mean of pretest scores (μ=6, 77) of student showed that students have low level of prior knowledge. This might be due to the nature of traditional instruction as teacher-centered and textbook oriented. This result of the study disagrees with the results of the previous research since literature indicated a significant positive relationship between prior knowledge and achievement (Lawson, 1983; Johnson & Lawson, 1998; BouJaoude, Saouma & Giuliano, 2004). However, in present study, prior knowledge was the main predictor of performance on post-test in learning cycle classrooms. Some previous researches are supported this result. For instance, in their study, Mitchell and Lawson (1988) found that prior genetics knowledge does not account a significant amount of variance on reading comprehension and genetics achievement test. Moreover, Lawson (1983) stated that students' prior knowledge positively correlated with undergraduate students' achievement in evolution and natural selection. Additionally, Johnson (1993) found that there was no correlation between prior biological knowledge and students' course grade. Lastly, Champagne, Klopfer and Anderson (1980) declared that if students' prior beliefs contradict subject matter, then their prior beliefs cause learning to be difficult for the students.

In addition to prior knowledge, reasoning abilities and attitudes were other variables which were predictors for students' human circulatory system achievement in learning cycle classrooms. Firstly, reasoning abilities which explaining 45.8% variance was important to students' understanding of human circulatory system in the present study. As it indicated before students' cognitive status changes over time and they will not learn if they do not have the required cognitive skill. In literature, there are many studies connected with exploring students' reasoning abilities and its relationship with students' understanding (Lawson & Renner, 1975; Ehindero, 1979; Johnson & Lawson, 1998; Musheno & Lawson, 1998; Tobin & Capie, 1982; Valanides, 1996; BouJaoude & Giuliano, 1994; Sungur & Tekkaya, 2003; Yenilmez, Sungur & Tekkaya, 2005). Lawson and Thompson (1988) stated that reasoning abilities of students are one of the factors that can contribute to students' failure to understand scientific conceptions. Additionally, in study of Cavallo (1996), it was reported that reasoning ability (9%) best predicts students' achievement in solving genetics problems in laboratory based learning cycle in biology course. Similarly, Johnson and Lawson (1998) demonstrated that reasoning ability explained more of the variance on student's achievement scores for students in inquiry classes (18.8%) than students in expository classes (7.2%). Additionally, Sungur and Tekkaya (2003) explored the effect of reasoning ability and gender on human circulatory system concepts achievement and attitudes toward biology. They found that there was significant mean difference between concrete and formal students with respect to achievement and attitude toward biology. Furthermore, Atay (2006) reported that reasoning ability was the main predictor of atudents achievement in genetics and it explained 9% of the variance. In present study, Human Circulatory Achievement test was applied as pre-post test for students to have knowledge about abstract concepts in human circulatory system, not to learn facts by rote but transmit and comprehend concepts. For the reason that high formal students have hypothetical and deductive reasoning patterns, they performed better than low formal students' concepts. In the present study, it was indicated that the majority of the students in this study are formal reasoners. The distribution of the students' scores on TOLT for both learning cycle and traditional classrooms revealed that majority of the students (73.3%) was at medium formal level, while 8.3% of the students were at low formal level. The reason for the students' reasoning abilities to be the first predictor of achievement explaining the 45.8% of the variance may be explained by the high number of students having formal reasoning abilities. In learning cycle classrooms, final predictor of students' achievement in human circulatory system was attitudes towards biology which explaining 5.7% of the variance. It can be thought that, when students' attitude toward biology increases, their achievement in human circulatory system also increases. Many researches have shown relationship between attitude toward science and achievement in science knowledge. For example, the study of Freedman (1997) with 270 9th grade students proved that activity based instruction influenced in a positive direction as the students' attitude toward science, and influences their achievement in science knowledge. Similarly, Cannon and Simpson (1985) reported that seventh-grade students' attitudes connected with biology achievement scores. The data from the study revealed a higher correlation between positive attitudes toward science and higher achievement scores for females enrolled in the basic and advanced classes and for males enrolled in general science classes (Cannon & Simpson, 1985). Moreover, Johnson (1993) stated that students' attitudes predict their biology achievement in learning cycle, and expository classes which is consistent with the present study. Other important study was conducted by Kyle et al. (1988). Researchers compared the attitude toward science of students who had completed one year of the Science Curriculum Improvement Study (SCIS) with students in non-SCIS classes. The sample was comprised of 228 SCIS students (54% male and 46% female) and 288 non-SCIS students (%52 male and %48 female). Students were selected randomly from second through sixth grade classes. Result of the study indicated that attitude of students who have experienced one year of an inquiry-oriented process approach curriculum were enhanced greatly when compared to students in textbook-oriented science classes. On the other hand, the results of the some studies contradict with the results of the present study. For instance, Wilson (1983) conducted a meta-analysis about the correlation between science achievement and attitude toward science and found no consistent causal direction between attitude toward science and achievement. Also, Turpin (2000) conducted a study that students' achievement and attitudes toward science were assessed for hands-on instruction and traditional instruction. About 531 seventh grade students were in experimental group that was applied activity based curriculum and 398 seventh grade students were in control group that was applied traditional curriculum. Iowa Test of Basic Skills (ITBS) science scores was used to measure students achievement and Science Attitude Survey was used to evaluate students' attitude toward science. According to the analyses of covariance (ANCOVA), it was showed that student in activity based curriculum had significantly higher scores for science achievement than that students in traditional curriculum. But, there was no difference in students' attitude toward science for two groups. Besides Hardal (2003) examined the effects of hands-on activities on students' achievement and attitudes towards physics. The result of the study indicated that there was significant difference in the achievement of the experimental and control groups in favor of the experimental group. A similar significant difference was not found between two groups in the attitude towards physics. In the present study, students' attitudes toward biology in learning cycle classrooms significantly correlated with their self-efficacy (r=.201) and locus of control (r=.462) means that these variables are related with each other.

Another purpose of this study was that measuring the effects of different teaching strategies (learning cycle versus traditional instruction) on students' human circulatory system achievement. According to results, learning cycle instruction formed better attainment of human circulatory system concepts compare to traditional instruction. This result illustrates consistency with the role of learning cycle which is a model of instruction based on scientific inquiry. This model encourages students to develop their own understanding of a scientific concept, explore and deepen that understanding, and then apply the concept to new situations. Moreover, the model is a successful teaching approach based on Piaget's model of intellectual development and constructivism which composed of four components: quality of thought (the four stages of development), mental content, mental structure, and mental function. Mental functioning is described as the learning process. The learning cycle was derived from mental functioning. It is composed of four parts which include: assimilation (exploration phase of the learning cycle), disequilibrium (exploration phase of the learning cycle), accommodation (explanation phase of the learning cycle), and organization (expansion phase of the learning cycle). There are different type of learning cycle, i.e., three phases learning cycle, 4 E and 5 E. In this study, 5E learning cycle was used. 5E learning cycle instruction exposed students to problem situations (i.e., engage their thinking) and then provided opportunities to explore, explain, extend, and evaluate their learning (Bybee et al., 2006). That model consists of the following phases: engagement, exploration, explanation, elaboration, and evaluation. In engagement phase, teacher tried to capture students' attention and accessed prior knowledge about structure and function of the heart and the blood vessels, the mechanisms of blood circulation and the importance and the meaning of blood pressure and tension in the subject of human circulatory system. The activity in this phase built a connection between past and present learning experiences, representation prior conceptions, and organized students' thinking toward the learning outcomes of current activities. In exploration phase, students completed various activities that help them use prior knowledge to generate new ideas, explore four chambers of the heart, the role of arteries, veins and capillaries and also, structural differences between blood vessels, the pathway of blood circulations and finally meanings of hypertension and hypotension. In explanation phase, students were provided some opportunities to demonstrate their conceptual understanding. In this phase students explained their understanding of the human circulatory system concepts. In elaboration phase, the students developed deeper and broader understanding and they applied their understanding of the human circulatory system concepts by giving real examples from their life. Finally, evaluation phase encouraged students to assess their understanding about the main idea of human circulatory system. To conclude that the results of the study offered the use of learning cycle as an alternative teaching strategy for providing students' better understanding of human circulatory system concepts. Since, teachers should ensure their students become active and so biology lesson should be student-centered but not to be teacher-centered. In all phase of learning cycle, students performed activities by group work which fosters a deeper and more active learning process. In addition to exposing students to different approaches and ways of thinking, working with other students in groups, also gives students the opportunity to learn from and teach each other. And so group work provides an opportunity to obtain conceptual understanding. Thus, findings indicated that the learning cycle is more effective teaching model that help students refine their ideas about science concepts compare to traditional instruction (Barman, Barman & Miller, 1996; Cavallo, 2003; Balcı, Çakıroğlu & Tekkaya, 2006; Atay & Tekkaya, 2008).

As a summary, the present study exposes that different variables may be important for 11th grade students' human circulatory achievement in learning cycle and traditional classes. To conclude, it can be said that ability of variables to determine human circulatory system achievement depends on the methods of instruction.

5.2 Internal Validity

Internal validity of the study is the degree to appropriateness of the interpretations obtained from test results. There are possible threats, which may influence the results of research, to internal validity and the methods used to cope with them are presented in this section.

The design of the study provides some control for the internal validity threats of subject characteristics, data collector characteristics, data collector bias, history, location and mortality. On the other hand, the effects of implementation must be considered in the study.

In this study the groups were randomly assigned to the treatment conditions. Since many subject characteristics (students' previous biology knowledge, previous grade point average and attitude) might affect students' human circulatory system achievement posttest scores (PSTACH). To be able to overcome with this threat, students' attitudes were integrated in the study. Consequently, an attitude scale was given to students in both control and experimental group earlier to the study.

Data collector characteristics and data collector bias should not be threat for the study hence the data collector (teachers) was trained to obtain standard procedures under which the data were collected. Besides, location and history threats were controlled by administering the tests to all students at the same time.

Another threat is mortality which is the one of the most important threats to internal validity to control. However, there was any missing value and mortality was not a problem for this study.

The other possible threat to internal validity might be implementation. Each teacher had one experimental and one control group, that means there was one implementer for both experimental and control groups. Also, the implementer was trained by the researcher to standardize the conditions and also all groups were observed in an attempt to see that the treatments were implemented as intended.

Moreover, subject attitudes can be possible threat to internal validity. To be capable of eliminate that threat, subjects in both experimental and control groups had handout about human circulatory system and the activities that were used during learning cycle also were done with control groups just after the completion of the traditional instruction. Furthermore, testing threat can be other threat to internal validity. To be able to eliminate testing threat the necessary time interval was given between pre and posttest.

Final internal threat was confidentiality which was not a problem for this study since names of the students and the teachers were not used anywhere. Their names were just taken for the sake of statistical analyses and only the researcher had a contact on them.

5.3 External Validity

Population Generalizability: The population generalizibality refers to the degree to which a sample of a study represents the population of interest (Fraenkel & Wallen, 1996). In this study the accessible population was selected as all 11^{th} grade high school students in one high school. The subjects of the study were 60 11^{th} grade students of two teachers from one private high school. Subjects of the study were not randomly selected from accessible population. Generalization according to the results of the study is limited because of nonrandom sampling. But generalizations to similar populations' private high school students might be possible.

Ecological Generalizability: The degree to which the results of a study can be extended to other settings or conditions is called ecological generalizability (Fraenkel & Wallen, 1996). All treatments and testing procedure took place in ordinary classrooms during regular class time in this study. There were no notable differences among the environmental conditions. So that it was thought that other private high schools have similar settings and conditions. Thus, the results can be generalized to private high schools that have similar settings and conditions with this study.

5.4 Implications

According to the findings of this study and previous studies, following suggestions are offered:

1. Biology teachers should use different teaching strategies rather than traditional instruction.

2. Biology teachers should be informed about the applications of the learning cycle.
3. Biology teachers should develop new learning cycle lesson plans for increasing achievement not only about human circulatory system but also other subjects of biology. They should ensure their students become active and so biology/science lesson should be student-centered but not to be teacher-centered.
4. Activity books about biology subjects should be written for biology teachers and so they can use those activites when preparing learning cycle lesson plans.
5. Curriculum developers should plan some activities in biology curricula. Therefore, teachers use learning cycle activites when applying such biology curricula.
6. The study presents the possible predictors of biology achievement. Thus, increase in the level of these variables results in increase in the level of achievement. Curriculum developers, teachers and school psychologists should consider these variables to be able to increase achievement.
7. Teachers should concentrate on cognitive variables which are learning approach, prior knowledge, reasoning ability of students and also on motivational variables that are locus of control, self-efficacy and the attitudes toward biology because these variables can promote academic success. Also, teachers should take into account these variables to be able to increase achievement.

8. Universities should educate preservice biology/science teachers about teaching strategies, cognitive and motivational variables which effects students' achievement.
9. School administrators should inform teachers about teaching strategies and encourage teachers to integrate teaching strategies into instruction by in-service training. They should also inform the counselors and teachers about the effects of these cognitive and motivational variables on students' achievement.
10. Biology teachers and students should realize the significance of cognitive and motivational variables.

5.5 Recommendations for Further Research

This study has suggested variety of useful topics for further researches. These are briefly as follows:

1. Future study could examine the relationship among students' prior knowledge, learning approach, reasoning ability and self-efficacy, locus of control and attitudes toward biology in relation with students' achievement in different biology topics, and different grade levels.
2. This study was conducted with private high school students in Ankara. Future study could investigate the relationship among students' prior knowledge, learning approach, reasoning ability and self-efficacy, locus of control and attitudes toward biology in relation with students' achievement in public high schools.
3. Sample size could be larger for obtain more accurate results.

4. Further research could examine the relationship among 11th grade school students' prior knowledge, learning approach, reasoning ability and self-efficacy, locus of control and attitudes toward biology in relation with students' achievement in human circulatory system in learning cycle and traditional classrooms for a longer time which is integrated in the flow of normal biology course.
5. The contribution of additional cognitive and motivational variables such as achievement motivation, goal orientation, beliefs or attitudes toward school on the understanding of human circulatory system or other topics can be investigated.
6. In addition to learning cycle model including 5 phases that was used in the present study, other learning cycle models, including 7 phases can be used.

REFERENCES

Alkhawaldeh, S. (2007). Facilitating conceptual change in ninth grade students' understanding of human circulatory system concepts. *Research in Science & Technological Education, 25*(3), 371-385.

Anderson, A., Hattie, J., & Hamilton, R. J. (2005). Locus of control, self-efficacy, and motivation in different schools: Is moderation the key to success? *Educational Psychology, 25*(5), 517–535.

Araz, G., & Sungur, S. (2007). The interplay between cognitive and motivational variables in a problem-based learning environment. *Learning and Individual Differences, 17*, 291-297.

Arnaudin, Mary W., Mintzes, Joel J. (1985). Students' alternative conceptions of the human circulatory system; a cross-age study. *Science Education, 69*(5), 721-733.

Atay, D.P. (2006). Relative Influence of cognitive and motivational variables on genetic concepts in traditional and learning cycle classroom. (Doctoral Dissertation, METU, 2006).

Atay, D.P., & Tekkaya, C. (2008). Promoting students' learning in genetics with the learning cycle. *The Journal of Experimental Education, 76* (3), 259-280.

Ates, S. (2005). The effectiveness of the learning-cycle method on teaching DC circuits to prospective female and male science teachers. *Research in Science and Technological Education, 23,* 213-227.

Ausubel, D. P. (1963). *The psychology of meaningful verbal learning*. New York: Grune & Stratton.

Ausubel, D. P. (1968). *The psychology of meaningful learning*. New York: Grune & Stratton.

Baird, J. R. (1986). Improving learning through enhanced metacognition: A classroom study. *European Journal of Science Education, 8*(3), 262-282.

Balcı, S., Çakıroğlu, J. & Tekkaya C. (2006). Engagement, exploration, explanation, extension, and evaluation (5E) learning cycle and conceptual change text as learning tools. *Biochemistry and Molecular Biology Education, 34*(3), 199-203.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ. Prentice-Hall.

Bandura, A. (1995). *Self-efficacy in changing societies*. New York: Cambridge University Press.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.

Barman, C. R., Barman, N. S., & Miller, J. A. (1996). Two teaching methods and students' understanding of sound. *School Science and Mathematics, 96*(2), 63-67.

Barrass, R. (1984). Some Misconceptions and misunderstandings perpetuated by teachers and textbooks of Biology. *Journal of Biology Education, 18*, 201-205.

Bar-Tal,D., & Bar-Zohar, Y. (1977). The relation between perception of locus of control and academic achievement. *Contemporary Educational Psychology, 2*(2), 181-199.

Blank, L. M. (1999). A metacognitive learning cycle: A better warranty for student understanding? *Science Education, 2*, 486-506.

Bloom, B. S. (1976). *Human characteristic and school learning*. New York: McGraw-Hill.

Boddy, N., Watson, K., Aubusson, P. (2003). A Trial of the Five Es: A referent model for constructivist teaching and learning. *Research in Science Education, 33*, 27–42.

BouJaoude, S. B. (1992). The relationship between students' learning strategies and the change in their misunderstandings during a high school chemistry course. *Journal of Research in Science Teaching, 29*, 687-699.

BouJaoude, S. B., & Giuliano, F. (1994). Relationships between achievement and selective variables in a chemistry course for nonmajors. *School Science and Mathematics, 94*(6), 296-302.

BouJaoude, S., Salloum, S., & Khalick, F. A. (2004). Relationships between selective cognitive variables and students' ability to solve chemistry problems. *International Journal of ScienceEducation 26*, 63-84.

BouJaoude, S.B. (1992). The relationship between high school students' learning strategies and the change in their understandings during a high school chemistry course. *Journal of Research in Science Teaching, 29*(7), 687-699.

Bredderman, T. (1982). What research says: Activity science the evidence shows it matters. *Science and Children, 20*(1), 39-41.

Bristow, B.R. (2000). The effects of hands-on instruction on sixth grade students' understanding of electricity and magnetizm. *Dissertation Abstracts International* (UMI No. AAT1400301).

Bybee, R.W., Taylor, J.A., Gardner, A., Scotter, P.V., Powell, J.C., Westbrook, A., & L, A. (2006). The BSCS 5E instructional model: Origins and effectiveness. Retrieved from http:// science.education.nih.gov. 10/07/2009

Cavallo, A. M. L. (1996). Meaningful learning, reasoning ability and students' understanding and problem solving of topics in genetics. *Journal of Research in Science Teaching, 33*(6), 625-656.

Cavallo, A. M. L. (2003). Eliciting students' understandings of chemical reactions using two forms of essay questions during a learning cycle. *International Journal of Science Education, 25*(5), 583-603.

Cavallo, A. M. L., & Schafer, L. E. (1994). Relationships between students' meaningful learning orientation and their understanding of genetics topics. *Journal of Research in Science Teaching, 31*(4), 393-418.

Cavallo, A. M. L., Rozman, M., & Potter, W. H. (2004). Gender differences in learning constructs, shifts in learning constructs, and their relationship to course achievement in a structured inquiry, yearlong college physics course for life science majors. *School Science and Mathematics, 104*(6), 288-300.

Champagne, A. B., Klopfer, L. E., & Anderson, J. H. (1980). Factors influencing learning of classical mechanics. *American Journal of Physics, 48*(12), 1074-1079.

Chapman, J. W., & Tunmer, W. E. (1995). Development of young children's reading self-concepts: An examination of emerging subcomponents and their relationship with reading achievement. *Journal of Educational Psychology, 87*, 154–167.

Chi, M.T.H., Chiu, M.H., & Leeuw, N. (1991). Learning in a non-physical science domain: The human circulatory system. Retrieved from http://eric.ed.gov. 15/07/2009

Chi, Michelene T.H. (2005). Common sense conceptions of emergent processes: Why some misconceptions are robust. *Journal of the Learning Sciences, 14*, 161-199.

Colburn, A., & Clough, M. (1997). Implementing the learning cycle. *The Science Teacher, 64*(5), 30-33.

Dawson, C. (2000). Upper primary boys' and girls' interests in science: have they changed since 1990? *International Journal of Science Education, 22*(6), 557-570.

Dhindsa, H. S., & Chung, G. (2003). Attitudes and achievement of Bruneian science students. *International Journal of Science Education, 25*(8), 907-922.

Drew, P., & Watkins, D. (1998). Affective variables, learning approaches and academic achievement: a casual modeling investigation with HonKong tertiary students. *British Journal of Educational Psychology, 68* (2), 173-188.

Duke, M., & Nowicki, S. Jr. (1974). Locus of control and achievement-the confirmation of a theoretical expectation. *Journal of Psychology, 87*, 263-267.

Duttweiler, P. C. (1984). The internal control index: A newly developed measure of locus of control. *Educational and Psychological Measurement, 44*, 209-21.

Ehinndero, O. J. (1979). Formal operational and achievement in biology among some Nigerian high school students. *Science Education, 63*(2), 231-236.

Entwistle, N. J., & Ramsden, P. (1983). *Understanding student learning*. London: Croom Helm.

Enveart, M. A., Baker, D ., & Vanharlingen, D. (1980). Correlation of inductive and deductive logical reasoning to college physics achievement. *Journal of Research and Science Teaching, 17* 263–76.

Findley, M.J., & Cooper, H.M. (1983). Locus of control and academic achievement. *Journal of Personality and Social Psychology, 44*(2), 419-427.

Finn, J. D., & Rock, D. A. (1997). Academic success among students at risk for school failure. *Journal of Applied Psychology, 82*, 221–234.

Fraenkel, J. R. & Wallen, N. E. (1996). *How to design Research in Education 3rd edition.* New York : McGraw-Hill, Inc.

Freedman, M. P. (1997). Relationship among laboratory instruction, attitude toward science and achievement in science knowledge. *Journal of Research in Science Teaching, 34*, 343-357.

Friedler, Y., & Tamir, P. (1990). Sex differences in science education in Israel: An analysis of 15 years of research. *Research in Science & Technological Education, 8*(1), 21-35.

Geban, Ö., Aşkar P., & Özkan, İ. (1992). Effects of computer simulations and problem solving approaches on high school students. *Journal of Educational Research, 86*(1), 5-10.

Geban, Ö., Ertepınar, H., Yılmaz, G., Altın, A. & Şahbaz, F. (1994). Bilgisayar destekli eğitimin öğrencilerin fen bilgisi başarılarına ve fen bilgisi ilgilerine etkisi. I. Ulusal Fen Bilimleri Eğitimi Sempozyumu: Bildiri Özetleri Kitabı, İzmir.

Germann, P. J. (1988). Development of the attitudes toward science in school assessment and its use to investigate the relationship between science achievement and attitudes toward science in school. *Journal of Research in Science Teaching, 25*, 689-703.

Guthrie, J. T., Wigfield, A., Humenick, N. M., Perencevich, K. C., Taboada, A., & Barbosa, P. (2006). Influences of stimulating tasks on reading motivation and comprehension. *Journal of Educational Research, 99*, 232–245.

Hardal, Ö. (2003). The effects of hands-on activiites on 9th grade student's achievement and attitudes towards physics. (Doctoral Dissertation, METU, 2006).

Haury, D.L., & Rillero, P. (1994). Perspectives of hands-on science teaching. Retrieved from http://eric.ed.gov. Last visited 15/07/2009.

Hewson, M. G., & Hewson, P. W. (1983). Effect of instruction using students' prior knowledge and conceptual change strategies on science learning. *Journal of Research in Science Teaching, 20*(8), 731-743.

Hofstein, A., Mooz, N., & Rishpon, M. (1990). Attitudes toward school science: A comparison of participants and non-participants in extracurricular science activities. *School Science and Mathematics, 90*(1), 13-22.

Johnson, M. A., & Lawson A. E. (1998). What are the relative effects of reasoning ability and prior knowledge on biology achievement in expository and inquiry classes? *Journal of Research in Science Teaching, 35*(1), 89-103.

Johnson, M. A., (1993). Evaluating educational outcomes with alternative methods of instruction in a non-majors college biology course. (Doctoral Dissertation, The Arizona State University, 1993). *Dissertation Abstracts International*. (UMI No. 9410981).

Kağıtçıbaşı, Ç. (1972). *Sosyal değişmenin psikolojik boyutları. Sosyal Bilimler Derneği yayınları.* Ankara: Ayyıldız Matbaası.

Kalechstein, A. D., & Nowicki, S. Jr. (1997). A meta-analytic examination of the relationship between control expectancies and academic achievement: An 11-year follow-up to Findley and Cooper. *Genetic Social and General Psychology Monographs, 123*, 27–56.

Kang, S., Scharmann, L. C., Noh, T., & Koh, H. (2005). The influence of students' cognitive and motivational variables in respect of cognitive conflict and conceptual change. *International Journal of Science Education, 27*(9), 1037-1058.

Karplus, R. (1977). Science teaching and development of reasoning. *Journal of Research in Science Teaching, 14*(2), 169-175.

Karplus, R., & Their, H. (1967). *A new look at elementary school science.* Chicago: Rand McNally.

Karslı, F., & Şahin, Ç. (2009). Developing worksheet based on science process skills: Factors affecting solubility. *Asia-Pacific Forum on Science Learning and Teaching, 10 (1).*

Koballa, T. R. (1988). Attitudes and related concepts in science education. *Science Education, 72*, 115-126.

Kwen, B.H. (2005). Teachers' misconceptions of biological science concepts as revealed in science examination papers. Annual Conference of the Educational Research Association, Singapore.

Kyle, W.C., & Bonnstetter, R.J., McCloskey, J. & Frults, B.A.(1985). What research says: Science through discovery: Students love it. *Science and Children, 23*(2), 39-41.

Lauer, T. E. (2003). Conceptualizing ecology: A learning cycle approach. *The American Biology Teacher, 65*(7), 518-522.

Lawson, A. E. (1983). Predicting science achievement: The role of developmental level, disembedding ability, mental capacity, prior knowledge, and beliefs. *Journal of Research in Science Teaching, 20*(2), 117-129.

Lawson, A. E. (1996). A learning cycle approach to introducing osmosis. *The American Biology Teacher, 62*(3), 189-196.

Lawson, A. E. (2000). Introducing mendelian genetics through a learning cycle. *The American Biology Teacher, 58*(1): 38-45

Lawson, A. E., Banks, L.D., & Logvin, M. (2007). Self-efficacy, reasoning ability and achievement in college biology. *Journal of Reseach in Science Teaching, 44* (5), 706-724.

Lawson, A. E., & Thompson, L. D. (1988). Formal reasoning ability and biological misconceptions concerning genetics and natural selection. *Journal of Reseach in Science Teaching, 25*, 733-746.

Lee, C. A. (2003). A learning cycle inquiry into plant nutrition. *The American Biology Teacher, 65*(2), 136-141.

Lee, V. E., & Burkam, D. T. (1996). Gender differences in middle grade science achievement: subject domain, ability level, and course emphasis. *Science Education, 80*(6), 613-650.

Linnenbrink, E. A., & Pintrich, P. R. (2003). The role of self-efficacy beliefs in students engagement and learning in the classroom. *Reading & Writing Quarterly, 19*, 119-137.

Marek, E. A., & Cavallo, A. M. L. (1997). *The learning cycle: Elementary school science and beyond.* Portsmouth, NH: Heinemann.

Martinez, J. R. (2003). *Academic locus of control, achievement motivation, and academic self-efficacy: Predicting academic achievement in Hispanic and Non-Hispanic middle school children.* A Master Thesis. California State University, Fresno.

Mecit, Ö. (2006). The effect of 7E learning cycle model on the improvement of fifth grade Students' critical thinking skills. (Doctoral Dissertation, METU, 2006).

Milner, N., Ben-Zvi, R., & Hofstein. A. (1987). Variables that affect students' enrollment in science courses. *Research in Science and Technological Education, 5*(2), 201-208.

Mitchell, A., & Lawson, A. E. (1988). Predicting genetics achievement in nonmajors college biology. *Journal of Research in Science Teaching, 25*(1), 23-37.

Musheno, B. V., & Lawson A. E. (1998). Effects of learning cycle and traditional text on comprehension of science concepts by students at differing reasoning levels. *Journal of Research in Science Teaching, 36*(1), 23-37.

Novak, J. D. (1970). *The improvement of biology teaching.* New York: Cornell University Press.

Odom, A. L., & Kelly, P. V. (2000). Integrating concept mapping and the learning cycle to teach diffusion and osmosis concepts to high school biology students. *Science Education, 85*(6), 615-635.

Oliva, J. M. (2003). The structural coherence of students' conceptions in mechanism and conceptual change. *International Journal of Science Education, 25*(5), 539-561.

Ören, F.Ş., & Tezcan, R. (2009). The Effectivness of the learning cycle approach on learners' attitude toward science in seventh grade sience classes of elementary school. *Elementary Education Online, 8* (1), 103-118.

Osborne, J., Simon S., & Collins, S. (2003). Attitudes towards science: a review of the literature and its implications. *International Journal of Science Education, 25*(9), 1049-1079.

Özkan, Ş. (2003). *The roles of motivational beliefs and learning styles on tenth grade students' biology achievement.* A Master Thesis, METU, Ankara.

Parker, V. (2000). Effects of a science intervention program on middle-grade student achievement and attitudes. *School Science and Mathematics, 100*(5), 236-242.

Pearsall, N.R., Skipper, Jo El J., Mintzes Joel J. (1997). Knowledge restructuring in the life sciences: A longitudinal study of conceptual change in biology. *Science Education, Volume 81* (2), 193-215.

Penick, J.E., & Yager, R.E. (1993). Learning from excellence. Some elementary exemplars. *Journal of Elementary Science Education, 51*(1), 1-19.

Piaget, J. (1950). *The psychology of intelligence*. New York: Harcourt and Brace.

Pintrich, P. R. (1999). The role of motivation in promoting and sustaining self-regulated learning. *International Journal of Educational Research 31*, 459-470.

Pintrich, P. R. (2003). A motivational science perspective on the role of student motivation in learning and teaching contexts. *Journal of Educational Psychology, 95,* 667–686.

Pintrich, P. R., & De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology 82*, 33-40.

Pintrich, P. R., & Garcia, T. (1991). Student goal orientation and self-regulation in the college classroom. In M. L. Maehr & P. R. Pintrich (Eds.), *Advances in motivation and achievement: Goals and self-regulatory processes*. Greenwich, CT: JAI Press.

Pintrich, P. R., & Schunk, D. H. (1996*). Motivation in education: Theory, research and applications.* Englewood Cliffs, NJ: Prentice Hall Merrill.

Pintrich, P. R., Marx, R. W., & Boyle, R. A. (1993). Beyond cold conceptual knowledge: The role of motivational beliefs and classroom contextual factors in the process of conceptual change. *Review of Educational Research 63*, 167-200.

Posner, G. J., Strike, K. A., Hewson, P. W., & Gertzog, W. A. (1982). Accommodation of a scientific conception: toward a theory of conceptual change. *Science Education 66*(2), 211-227.

Praag, M., Sluis, J., & Wittleloostuijin, A. (2004). The impact of the locus of control personality trait on the earnings of employees. Retrieved from http://www.tinbergen.nl/discussionpapers. Last visited 25/07/2009.

Pressley, G. M., & Harris, K. H. (2006). Cognitive strategies instruction: From basic research to classroom instruction. Handbook of educational psychology. Mahwah, NJ: Erlbaum.

Prokop, P., Tuncer, G., Chuda, J. (2007). Slovakian students' attitudes toward biology. *Eurasia Journal of Mathematics, Science and Technology Education, 3*(4), 287-295.

Reap, M. A., & Cavallo, A. L. (1992). Students' meaningful understanding of science concepts: Gender differences. Paper presented at the annual meeting of the National Association for Research in Science Teaching, Boston.

Rotter, J. B. (1966). Generalized expectancies for internal versus external control of reinforcement. American Psychological Association, Washington.

Rotter, J. B. (1975). Some problems and misconceptions related to the construct of internal versus external control of reinforcement. *Journal of Consulting and Clinical Psychology, 43*, 56-67.

Rowland, P.M. (1990). Using science activities to internalize locus of control and influence attitudes towards science. Paper Presented at the Annual Meeting of the National Association for Research in Science Teaching, Atlanta.

Rutherford, F.J., & Ahlgren, A. (1990). Science for all Americans, NY: Oxford University Press.

Sanders, M. (1993). Erroneous ideas about respiration: the teacher factor. *Journal of Research in Science Teaching, 30*, 919-934.

Saunders, G.L, Cavallo, A. L., & Abraham, M. (1999). Relationships among epistemological beliefs, gender, approaches to learning, and implementation of instruction in chemistry laboratory. Paper presented at annual meeting of the National association for research in science teaching, Boston.

Schibeci, R. A. (1984). Attitudes to science: An update. *Studies in Science Education, 11*, 26-59.

Schneider, L. S., & Renner, J. W. (1980). Concrete and formal teaching. *Journal of Research in Science Teaching*, 17(6), 503-517.

Schunk, D. H. (1991). Self-efficacy and academic motivation. *Educational Psychologist, 26*, 207-232.

Schunk, D. H. (1995). *Self-efficacy and education and instruction. In J. E. Maddux (Ed.), Self-efficacy, adaptation, and adjustment: Theory, research, and application.* New York: Plenum Press.

Schunk, D. H. (2003). Self-efficacy for reading and writing: Influence of modeling, goal setting and self-evaluation. *Reading & Writing Quaterly: Overcoming Learning Difficulties, 19*, 159-172.

Schunk, D. H., & Pajares, F. (2001). *The development of academic self-efficacy.* SanDiego: SanDiego Academic Press.

Shavelson, R. J., & Bolus, R. (1982) Self-methods. Psychology, 74: 3-17

Shemesh, M. (1990). Gender-related differences in reasoning skills and learning interests of junior high school students. *Journal of Research in Science Teaching, 27*, 27-34.

Shim, S., & Ryan, A. (2005). Changes in self-efficacy, challenge avoidance, and intrinsic value in response to grades: The role of achievement goals. *The Journal of Experimental Education, 73*(4), 333–349.

Shymansky, J. A., Hedges, L. V., & Woodworth, G. (1990). A reassessment of the effects of inquiry-based science curricula of the 60's on student performance. *Journal of Research in Science Teaching, 27*, 127-144.

Shymansky, J.A., Kyle, W.C., & Albort, J.M. (1982). How effective were the hands-on science programs of yesterday. *Science and Children, 20*(3), 14-15.

Simpson, R. D., & Oliver, J. S. (1985). Attitude toward a science and achievement motivation profiles of male and female science students in grades six through ten. *Science Education, 69*, 511-526.

Simpson, R.D., & Oliver, J.S. (1990). A summary of major influences on attitude toward and achievement in science among adolescent students. *Science Education, 74*(1), 1-18.

Strike, K. A. & Posner, G. J. (1992). A revisionist theory of conceptual change. In R. A. Duschl & R. J. Hamilton (Eds.), Philosophy of Science, Cognitive Psychology and Educational Theory and Practice (pp. 147-176). Albany, N. Y.: State University of New York Press.

Stuessy, C. (1984). Path Analysis: A model for the development of scientific reasoning abilities in adolescents. *Journal of Research in Science Teaching, 26*(1), 41-53.

Sungur, S. & Tekkaya, C. (2003). Students' achievement in human circulatory system unit: the effect of reasoning ability and gender. *Journal of Science Education and Technology, 12*, 59-64.

Sungur, S., Tekkaya, C. and Geban, O. (2001). The contribution of conceptual change texts accompanied by concept mapping to students' understanding of the human circulatory system. *School Science and Mathematics, 101*, 91-101.

Susskind, J. E. (2005). PowerPoints power in the classroom: enhancing students' self-efficacy and attitudes. *Computers and Education, 45*, 200-215.

Talton, E. L., & Simpson, R. D. (1986). Relationship of attitudes toward self, family, and school with attitude toward science among adolescents. *Science Education, 70*, 365-374.

Telli S., Rakıcı N., & _Cakiroglu, J_. (2003). Learning environment and student's attitudes towards biology. ESERA Conference: Research and the Quality of Science Conference Noordwijkerhout, The Netherlands.

Tobin, K. G., & Capie, W. (1981). The development and validation of a group test of logical thinking. *Educational and Psychological Measurement,* 41, 413-423.

Tobin, K. G., & Capie, W. (1982). Relationship between formal reasoning ability, locus of control, academic engagement and integrated process skill achievement. *Journal of Research in Science Teaching, 19*(2), 113-121.

Umay, A. (2003). Mathematical reasoning ability. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 24*, 234-243.

Valanides, N. (1996). Formal reasoning and science teaching. *School Science and Mathematics, 96*(2), 99-112.

Weinburg, M. H., & Englehar, Jr. G. (1994). Gender, prior academic performance and beliefs as predictors of attitudes toward biology laboratory experinces. *School Science and Mathematics, 94*(3), 118-123.

Wigfield, A., Eccles, J. S., Schiefele, U., Roeser, R., & Davis-Kean, P. (2006). *Development of achievement motivation. Handbook of child psychology*. New York: Wiley.

Williams, K., & Cavallo,A.M.L. (1995). Relationships between reasoning ability, meaningful learning and students' understanding of physics concepts. *Journal of College Science Teaching, 24*, 311-314.

Windschit, M. (2001). Using simulations in the middle school: Does assertiveness of dyad partners influence conceptual change? *Science Education, 23*(1), 17-32.

Wishart, J. M. (1997). Initial teacher training students'attitudes to use of information technology and individual locus of control. *Journal of Information Technology for Teacher Education, 6*(3), 271-286.

Wiske, M.S. (1998). *What is teaching for understanding? In Wiske, M.S. (Ed.) Teaching for understanding: Linking research with practice.* San Francisco: Jossey-Bass Publishing.

Wright, E. I. (1995). Discrepant event demonstrations: Motivating students to learn science concepts. *The Science Teacher, 15*, 25-28.

Yager, R.E., & Yager, S.O. (1985). Changes in perceptions of science for third, seventh, and eleventh grade students. *Journal of Research in Science Teaching, 20*(4), 347-358.

Yenilmez, A. (2006). *Exploring relationships among students' prior knowledge, meaningful learning orientation, reasoning ability, mode of instruction and understanding of photosynthesis and respiration in plants.* A Master Thesis. METU, Ankara.

Yenilmez, A., Sungur, S. And Tekkaya, C. (2005). Investigating students' logical thinking abilities: The effects of gender and grade level. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 28*, 219-225.

Yılmaz, D. (2007). *The comparative effects of prediction/discussion-based learning cycle, conceptual change text and traditional instructions on students' genetics understanding and self-regulated learning.* A Master Thesis. METU, Ankara.

Yılmaz, H., & Huyugüzel, Ç. P. (2006). 4-E öğrenme döngüsü yönteminin öğrencilerin elektrik konusunu anlamalarına olan etkisi. *Türk Fen Eğitimi Dergisi, 3*, 1-18.

Yip, D. Y. (1998). Teachers' misconceptions of the circulatory system. *Journal of Biological Education, 32*(3), 207-216.

Zimmerman, B. J., & Martinez-Pons, M. (1990). Student differences in self-regulated learning: Relating grade, sex, and giftedness to self-efficacy and strategy use. *Journal of Educational Psychology, 82*, 51-59.

Zimmerman, B.J. (1989). A social cognitive view of self-regulated academic learning. *Journal of Educational Psychology, 81*, 329-339.

Zimmerman, B.J., & Bandura, A. (1994). Impact of self-regulatory influences on writing course attainment. *American Educational Research Journal, 31*, 845-862.

APPENDIX A

OBJECTIVE LIST

Students will be able to;

1. list the structures of a human heart. (Knowledge (K))
2. identify a heart model with given materials. (Analyze (A))
3. define the functions of the structures in a human heart. (K)
4. explain the importance of blood circulation through the heart. (Comprehension (C))
5. discriminate the vessels that going in and getting out the heart. (A)
6. describe how to contract the heart. (K)
7. explain how people have heart attack. (C)
8. predict the relationships between blood cells and blood vessels. (Applying (Ap))
9. design a blood vessels by given an analogy. (Synthesizing (S))
10. list the structures of an arteries. (K)
11. list the structures of a veins. (K)
12. list the structures of a capillaries. (K)
13. define the functions of the blood vessels. (K)
14. state that the procedures of how blood vessels carry nutrients and waste materials. (K)
15. list the function of blood. (K)
16. predict the importance of blood pressure on blood vessels.(Ap)
17. explain the main task of blood circulation. (C)

18. explain how blood circulates through the body. (C)
19. discriminate large and small blood circulation. (A)
20. state that how to material exchange takes place through blood vessels. (K)
21. define the term blood pressure. (K)
22. define the term pulse. (K)
23. state that how to originate tension. (K)
24. discriminate big and small tension. (A)
25. explain the importance of hypotension and hypertension. (C)

APPENDIX B

TABLE OF TEST SPECIFICATION

Table B1: Table of Test Specification

Content \ Obj.level	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation
İnsan Kalbinin yapısı	**1,2**	**21**				
Kalbin çalışma mekanizması		**16**				
Kalpte kan dolaşımı		**9**				
Kan damarları çeşitleri	**18**	**3,20,22**	**25**			
Kan damarlarının yapısı	**14,24**		**5**			
Kan damarlarının görevi			**4**			
Kanın görevleri	**6**					
Kan basıncı Nedir?	**15**	**3,19**	**8,**			
Nabız, Tansiyon Nedir?	**17**					
İnsanda kan dolaşımı		**12**	**10, 11**	**23**		
Küçük kan dolaşımı		**7**				
Büyük kan dolaşımı		**13**				

APPENDIX C

HUMAN CIRCULATORY SYSTEM ACHIEVEMENT TEST

1.İsim:__________

2. Cinsiyet: ❑ Kız ❑ Erkek

3. Annenizin mesleği _________________ 4. Babanızın mesleği__________________

5. Annenizin Eğitim Durumu

❑ Hiç okula gitmemiş ❑ İlkokul

❑ Ortaokul

❑ Lise ❑Üniversite

❑ Yüksek lisans (Mastır/Doktora)

6. Babanızın Eğitim Durumu:

❑ Hiç okula gitmemiş ❑ İlkokul

❑ Ortaokul

❑ Lise ❑Üniversite

❑ Yüksek lisans (Mastır/Doktora)

1. Kalbin yapısında bulunan miyokard tabakası ile ilgili olarak aşağıdakilerden hagisi <u>söylenemez.?</u>
   A) Çalişmasi otonom sinir sistemi kontrolündedir.
   B) Hücrelerinde laktik asit birikimi gerçekleşmez.
   C) Hücreleri tek, lifleri çok çekirdekli olup çizgili kas görünümündedir.
   D) Hücreleri besin ve oksijeni kroner damarlardan karşılar.
   E) Sağ karıncıkta kalınlığı en fazladır.

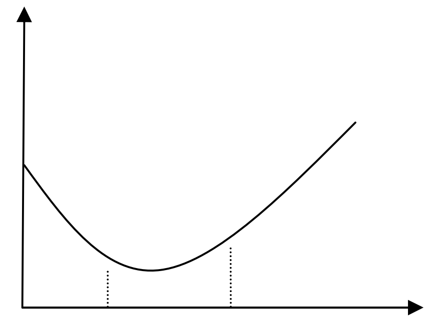
2. I.Endokard
   II.Miyokard
   III.Perikard
   Kalbi besleyen kroner damarlar yukarıda verilen tabakaların hangilerinde bulunur?
   A) Yalniz I B) Yalnız II C) Yalnız III D) I,III E) II,III

3. İnsan vücudunda aşağıda verilen damarların hangisinde kan basıncı minimum değerdedir?
   A) Alt ana toplardamar
   B) Aort atardamarı
   C) Akciğer kılcalları
   D) Karaciğer atardamarı
   E) Akciğer atardamarı

4. Sağlıklı bir insanın birbirinden farklı üç damarında kan akış hızı I > II > III ise, bu damarlarla ilgili olarak, aşağıdakilerden hangisi söylenemez?

   A) I nolu damarın duvar kalınlığı diğerlerinden daha fazladır.
   B) II nolu damarın yapısında tek yönlü açılan kapakçıklar bulunur.
   C) Kan basıncına gore sıralanışları I > III > II şeklindedir.
   D) III nolu dammar ile kan ve doku hücreleri arası madde alış-verişi sağlanır.
   E) II nolu dammar yapısındaki elastic liflerin miktarı I nolu dammar yapısındaki elastic liflerin miktarından daha fazladır.

5. Damar çapı



I II III Damarlar

Yukarıdaki grafikte insane kan dolaşım sisteminin farklı damarlarının çapı verilmiştir. Buna gore I, II, III ile gösterilen damarlar aşağıdakilern hangisidir?

	I	II	III
A)	Atardamar	Kılcaldamar	Toplardamar
B)	Kılcaldamar	Toplardamar	Atardamar
C)	Toplardamar	Atardamar	Kılcaldamar
D)	Atardamar	Toplardamar	Kılcaldamar
E)	Kılcaldamar	Atardamar	Toplardamar

6. Sağlıklı bir insanda aşağıdakilerden hangisi kanın görev ve özelliklerinden biri <u>değildir?</u>

A) Kan plazması doku sıvısına gore daha az protein bulundurur.
B) Sindirilmiş besin maddelerini ince bağırsaklardan dokulara taşır.
C) Dokuların su dengesini ve organların gerginliğini korur.
D) Alyuvar antijenleri ile kan grupları belirlenir.
E) Solunum enzimlerini bulundurarak karbondioksitin dokulardan akciğerlere kadar taşınmasını sağlar.

7. Küçük dolaşımda kan;
I.Alveol kılcalları
II.Akciğer atardamarı
III.Sol kulakçık
IV.Akciğer toplardamarı
gibi yapılardan hangi sırada geçer?

A) II-I-IV-III   B) I-II-III-IV   C) II-III-IV-I

D) IV-I-II-III   E) II-I-III-IV

8. Bir insanda kan basıncının azalması durumunda;
I.Doku sıvısının kana geçmeye başlaması
II.Doku hücrelerinin yeterince oksijen alamaması
III.Doku hücrelerine geçen besin miktarının azalması
olaylarından hangilerinin gerçekleşmesi beklenir?

A) Yalnız I   B) Yalniz II   C) Yalniz III
D) IV-I-II-III   E) II-I-III

9. Sağlıklı bir insan kalbinde ikili ve üçlü kapakçıkların açıldığı sırada;
I. Kulakçıkların kasılması,
II. Karıncıkların gevşemesi,
III. Yarım ay kapakcıkların kapanması
olaylarından hangileri meydana gelir?
A) Yalniz I   B) Yalnız II   C) Yalnız III   D) I ve II   E) I, II ve III

10. Sağlıklı bir insanda kanın vücuttan kalbe geri dönüşünde;
I. İskelet kaslarının kasılıp-gevşemesi
II. Soluk alma sırasında göğüs bölgesindeki basıncın azalması
III. Kulakcıkların gevşemesi ile emme kuvvetinin artması.
olaylarından hangileri etkilidir?
A) Yalniz I B) Yalnız II C) Yalnız III D) I ve II E) I, II ve III

11. Sağlıklı bir insan vücudunda kan;
I. Akciğer alveolleri,
II. Doku kılcalları,
III.Akciğer toplardamarı
gibi yapıların hangilerinden geçerken oksijenini hızla kaybeder?
A) Yalniz I B) Yalnız II C) Yalnız III D) I ve II E) II ve III

12. İnsan vücudunda aşağıda verilen yapıların hangisindeki oksijen ve karbondioksit derişimleri farklılık göterir?
A) Aort atardamarı-Akciğer toplardamarı
B) Sol kulakçık-Sol karıncık
C) Akciğer atardamarı-Sağ karıncık
D) Akciğer atardamarı-Aort atardamarı
E) Sağ kulakçık-Sağ karıncık

13. Sağlıklı bir insanda büyük kan dolaşım aşağıdakilerden hangisini <u>gerçekleştirmez?</u>
A) Küçük dolaşım ile sağlanan oksijenin dokulara dağıtılmasını sağlar.
B) İnce bağırsaktan emilen besin maddelerinin dağılımını gerçekleştirir.
C) Metabolik faaliyetler sonucu dokularda oluşan azotlu bileşiklerin uzaklaştırılmasını sağlar.
D) Hücreler ile kan arasında madde ve gaz alış-verişinin yapılmasını sağlar.
E) Kanın oksijen derişiminin artmasını sağlar.

14. Sağlıklı bir insanda aşağıdaki damarların hangisinde hem kan basıncı, hem de karbondioksit derişimi en fazladır?
A) Akciğer atardamarı
B) Kapı toplardamarı
C) Akciğer toplardamarı
D) Aort atardamarı
E) Karaciğer atardamarı

15. Aşağıda verilenlerin hangisinin ikisi birden kalp atışını hızlandırıcı etki yapar?
    A) Asetil kolin-Adrenalin
    B) Tiroksin- Adrenalin
    C) Vagus siniri-Adrenalin
    D) Sempatik sinirler-Asetil kolin
    E) Adrenalin-Parasempatik sinirler

16. Sağlıklı bir insan kalbinin çalışması sırasında gerçekleşen olaylar aşağıda karışık olarak verilmiştir. Bunlardan hangisi 3. Sırada gerçekleşir?
    A) İmpulsları AV düğümüne aktarılması
    B) Kulakçıkların kasılması
    C) SA düğümün uyartıyı alması
    D) Karıncıkların kasılması
    E) Uyartıların his demetlerine yayılması

17. Kalbin dakikada atış sayısına "nabız" denir. Kalp atış hızını ve nabız sayısını çeşitli faktörler etkileyebilir.
    I. Kan pH'sının azalması
    II.Parasempatik sinirlerin uyarılması
    III.Kandaki karbondioksit yoğunluğunun artması
    faktörlerinden hangileri kalp atış hızını arttırıcı özelliktedir?
    A) Yalniz I B) Yalnız II C) Yalnız III D) I ve III E) II ve III

18. Aşağıdaki özelliklerden hangisi damar çeşitinin toplardamar olduğunu kanıtlar?
    A) Kirli kan taşıma
    B) Vücuttan kalbe doğru kan taşıma
    C) Kalpten vücuda doğru kan taşıma
    D) Temiz kan taşıma
    E) Çeperinde bağ doku ve düz kas bulundurma

19. İnsanlarda aşağıdakilerden hangisi kan basıncının yükselmesine neden <u>olmaz?</u>
    A) Atardamar çeper esnekliğinin azalması
    B) Kalbin diastole durumuna geçmesi
    C) Kandaki lipit ve proteinin artması
    D) Kandaki tuz konsantrasyonunun artması
    E) Kandaki adrenalin miktarının artması

20. Atardamarların çeperleri oransal olarak toplardamarlardan kalındır ve esnek liflerden meydana gelmiştir.
Eğer kan yüksek basınç ile esnek olmayan bir dammar sistemine pompalanmış olsaydı;
I. Atardamar içindeki basıncın artması,
II.Kalbe düşün yükün artması,
III.Kalbin büyümesi
olaylarından hangilerinin gerçekleşmesi beklenirdi?
A) Yalniz I B) Yalnız II C) Yalnız III D) I ve II E) I, II ve III

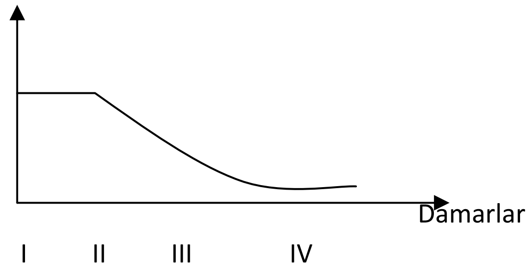
21. Sağlıklı bir insanda yarım ay kapakçıkları açıldığında aşağıdaki olaylardan hangisinin meydana gelmesi beklenmez?
A) İkili ve üçlü kapakçıkların kapanması
B) Akciğer toplardamarından gelen temiz kanın kalbin sol kulakçığına dolması
C) Akciğer atardamarındaki kirli kanın aort atardamarına dolması
D) Sol karıncıktaki temiz kanın aort atardamarına pompalanması
E) Alt ve üst ana toplardamardan gelen kanın kalbin sağ kulakçığına dolması

22. 1. Akciğer atardamarı
2. Alveol kılcalları
3. Akciğer toplardamarı
Sağlıklı bir insanda küçük dolaşımda görev yapan yukarıdaki damarlar ile ilgili olarak;
I. Kan basıncı en az 3. damardadır.
II. Oksijen derişimi en fazla 1. damardadır.
III. Kan akış hızı en fazla 1. damardadır.
açıklamalarından hangileri yanlış olur?
A) Yalniz I B) Yalnız II C) Yalnız III D) I ve II E) II ve III

23. Bir insanın ince bağırsağına verilen işaretli bir glikoz molekülü sol eline gidinceye kadar aşağıdaki yapıların hangisinden geçmez?
A) Karaciğer üstü toplardamarı
B) Kapı toplardamarı
C) Akciğer atardamarı
D) Karaciğer atardamarı
E) Akciğer toplardamarı

24. I.Dış tabaka: Bağ doku
II. Orta tabaka: Düz kaslar ve elastiki lifler
III. İç tabaka: Endotelyum
Yukarıda atardamar ve toplardamarların tabakaları ve yapıları verilmiştir. Bu tabakaların hangileri çıkarılırsa geriye kılcaldamarların yapısı kalır?
A) Yalniz I B) Yalnız II C) Yalnız III D) I ve II E) II ve III

25. Kan basıncı



İnsan dolaşım sisteminde yer alan yukarıdaki damarlarla ilgili;
I. I nolu damarda kan akış hızı en fazladır.
II. IV nolu dammar alt ana toplardamardır
III. II nolu damardaki kan akışı hızı, IV nolu damardan daha fazladır.
Açıklamalarından hangileri <u>yapılamaz?</u>

A) Yalniz I B) Yalnız II C) Yalnız III D) I ve II E) II ve III

APPENDIX D

OBSERVATION CHECKLIST

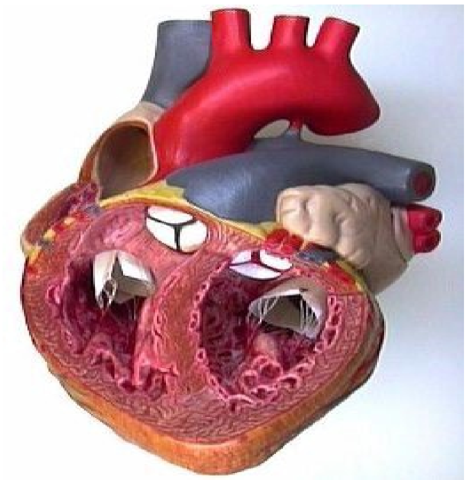
Table D1: Observation Checklist

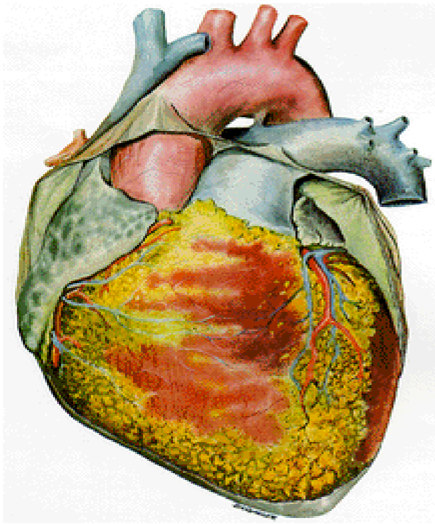
		always	frequently	sometimes	never	no activity
1.	Students obey the procedures					
2.	Students can follow the activities easily					
3.	Students seem to enjoy the lesson					
4.	Students get the information by doing the activities					
5.	Information is given based on textbook					
6.	There is a student- student interaction during the lesson					
7.	Teacher acts as a quide					
8.	Teacher answer questions with short explanations					
9.	Activity consist easy to obtain, inexpensive materials					
10.	Teacher has the primary role in delivering the content					
		Indivitually	In Pairs	In Groups	No activity	
11.	Students do activity					
		0-15 min	15-30 min	30-40 min	No activity	
12.	Students are actively engaged in activity within the class hour					

APPENDIX E

İNSANDA DOLAŞIM SİSTEMİ 5E ÖĞRENME EVRESİ AKTİVİTELERİ

1. KALP





<u>Aktivite 1</u>: Kalbimizi Keşfetmek

Amaç: Kalbimizin dolaşım sisteminin bir parçası olduğunu hatırlamak.

Araç ve Gereçler:

- Kalp ile ilgili küçük bir hikaye ve şaşırtıcı gerçekler içeren örnekler,

Yöntem:

1) Bu aktiviteyi tek başınıza yapınız. Öğretmeninizin sizlere dağıttığı küçük hikayeyi öncelikli olarak okuyunuz.
2) Hikayede anlatılan problemin dolaşım sistemimiz ile olan ilişkisi neler olabilir? Açıklayınız.

....

....

....

3) Hikayeden çıkarabildiğiniz kadarı ile problemin kaynağında hangi organ/ organlarımız olabilir? Yazınız.

....

....

....

<u>Aktivite 2</u>: Kalbimizi Keşfetmek

Amaç: Kalbimizin çalışma mekanizması hakkında basit olarak çıkarımlar yapabilmek.

Araç ve Gereçler: Saat

Yöntem:

1) Bu aktiviteyi tek başınıza yapınız.
2) Avuç içlerinizi yukarı gelecek şekilde ellerinizi sıranın üzerine koyup, bir dakika boyunca ellerinizi açıp-kapatınız.

3) Ellerini açıp-kapama hareketi vücutlarında hangi organın çalışma prensibini çağrışım yaptırmıştır? Açıklayınız.

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4) Bu organ hangi sistemimize ait bir organ olabilir? Yazınız.

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Aktivite 3: Kalbin Yapısı

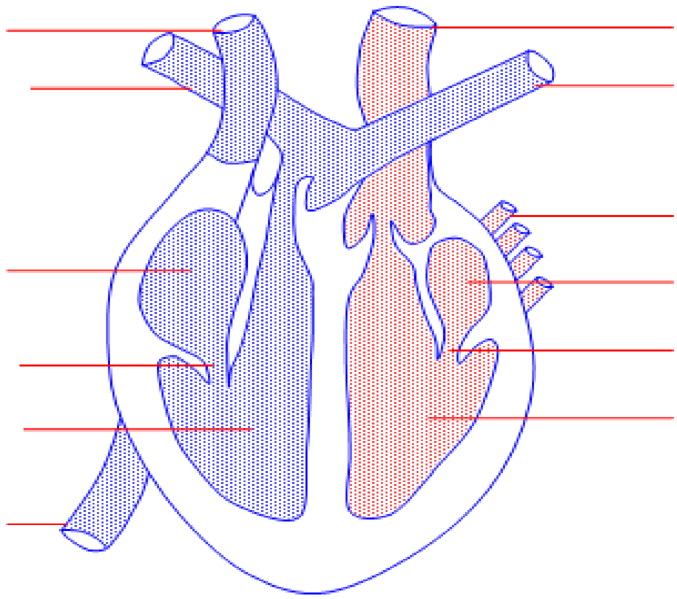
Amaç: Kalbimizin yapısı hakkında bilgi edinmek

Araç ve Gereçler: Memeli kalbi, bistüri, diseksiyon küveti, deney eldiveni, önlük, çalışma kağıdı

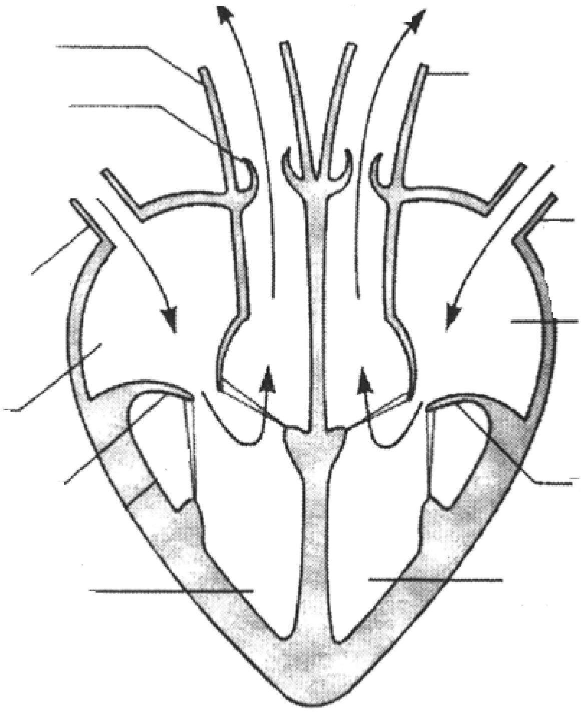
Yöntem:

1) Üçer kişilik gruplar oluşturunuz. Her grup bir memeli kalbi ile deneyini yapacaktır.
2) Önce kalbi yıkayınız. Sonra kalbi uzunlamasına ikiye bölünüz.
3) Kalbin odacıklarını gözlemlemeye çalışınız. Üstte ve altta yer alan odacıkları fark edip, kanın akışı ile ilgili çıkarımlar yapmaya çalışınız.
4) Kalbin kas yapısını ve kan damarlarını gözlemlemeye çaılşınız.

5) Deneyinizi yaparken kalbin şeklini gösteren şemayı tamamlamaya çalışınız.



Kalbin Yapısı



6) Kalbin içerisinde neler gördünüz? Yazınız.

....

....

....

7) Kalbe dokunduğunuzda neler hissettiniz? Yazınız.

....

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8) Kalbin farklı kısımlarını yapısal olarak nasıl karşılaştırırsınız?
   Açıklayınız.

   ....
   ....
   ....

<u>**Aktivite 4**</u>**:** Kalbin Çalışma Mekanizması

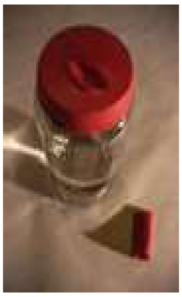
Amaç: Kalbimizin çalışma mekanizmasını anlamak

Araç ve Gereçler: Orta boy cam kavanoz, balon, 2 tane pipet, uzun tahta ince kürdan

Yöntem:

1) Üçer kişilik gruplar oluşturunuz.
2) Balonlarınızın ağız kısmını keserek resimdeki gibi dörtte biri su dolu olan kavanozunuza sıkı bir şekilde yerleştiriniz.

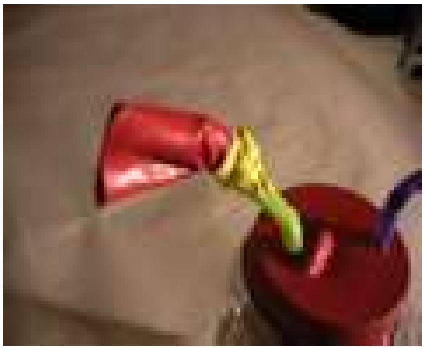




3) Daha sonra 2 cm aralık bırakacak şekilde balondan kürdan yardımı ile 2 tane küçük delik açınız.

4) 2 tane pipeti yavaşça bu açılan deliklere yerleştiriniz. Pipet ile balondaki delikler arasında boşluk kalmamasına dikkat ediniz. Eğer boşluk olursa yeni bir balonla yukarıdaki işlemleri tekrarlayınız.

5) Pipetlerden birine daha önce kesilen balonun boğaz kısmını yerleştiriniz.



6) Balonu bastırıp tekrar bıraktığımızda suyun pipet içerisinde nasıl hareket ettiğini gözlemleyiniz

7) Deney sırasında neler buldunuz? Açıklayınız.

....

....

....

8) Kalpte bulunan temel yapılar nelerdir? Yazınız.

....

....

....

9) Bir kalbin şeklini çizmeye çalışınız. Şekil üzerinde kısımlarını gösteriniz.

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10) Kalp içerisinde kanın akış şeması nasıldır? Yazınız.

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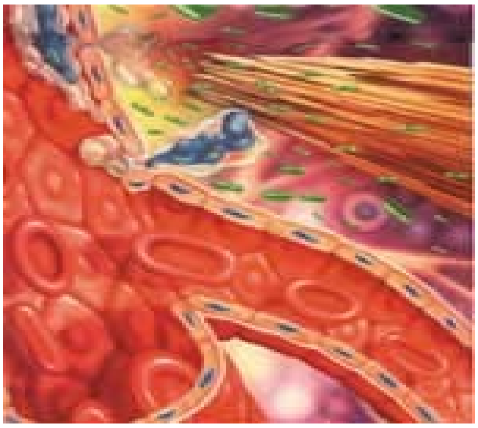
2. KAN DAMARLARI



Aktivite 1: Kan damarlarımızı Keşfetmek

Amaç: Kan damarlarımızın dolaşım sisteminin bir parçası olduğunu anlamak, kan damarları ile ilgili analogy kurabilmek

Araç ve Gereçler:

- Şehir haritası,

Yöntem:

1. Üçer kişilik gruplar oluşturunuz. Her grup bir şehir haritasına sahip olacaktır.
2. Ailenize yada arkadaslarınıza şehir içi yada şehirler arası yolculuklarda hiç harita kullanarak yardım ettiniz mi? Açıklayınız.

....

....

....

3. Bu harita örneğini kullanarak bir sehre giriş ve cıkısların otoyallar ile gerçekleştiğini ve bu yollardan cogunun tek yonlu yol oldugunu fark ediniz.
4. Araçların yakıt ve besin almak için hangi yönleri tercih ettiğini, özellikle nasıl merkezlerde durduklarını açıklayınız.

....

....

....

5. Verilen haritadan da yararlanarak özellikle 4. Soruda yazdıklarınızı dikkate alarak aşağıdaki soruları cevaplamaya çalışınız.
   a. Insanlar nasıl seyahat ederler?

   ....

   ....

   ....

   b. Her otoyol aynı boy ve uzunlukta mıdır?

   ....

   ....

   ....

c. İnsanlar neden şehirlere/ şehir merkezlerine doğru yolculuk ederler?

....

....

....

d. İnsanlar neden yakıt ve besinleri alma gereksinimi duyarlar?

....

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6. Size gore aşağıdaki kan damarları- şehir haritasında eşleştirmeler nasıl olmalıdır? Yazınız.
   a. Kan hücreleri: __________________?
   b. Toplardamarlar: __________________?
   c. Temiz oksijen ve besin: __________________?
   d. Atardamarlar: __________________?

Aktivite 2: Kan damarlarımızın yapısı

Amaç: Kan damarlarımızın elastiki yapısının kan basıncına karşı önemli bir rol oynadığını anlamak

Araç ve Gereçler:

- pipet,
- bir miktar su,
- cetvel yada mezro,
- üzerinde boyuna delikler açılan teneke kutu,

Yöntem:

1. 3’er kişilik gruplar oluşturunuz. Kan damarlarımızla ilgili aklınıza gelen her cümle ya da terimi yazınız.

   ....

   ....

   ....

2. Teneke kutunuza bir miktar su doldurunuz.

   

3. Kutunuzda bulunan deliklerden pipetlerinizi geçiriniz.

4. Pipetlerinizi değişik şiddetlerde üfleyiniz. (çok yavaş, yavaş, orta hızdsa, ve çok hızlı)

5. Pipetininzi üflediğiniz zaman basıncın pipet içinden gecen su akısını nasıl etkilediğini yazınız.

   ....

   ....

   ....

6. Elde ettiğiniz verilere gore bir grafik çizmeye çalışınız.

   ....

   ....

   ....

7. “Pipet içindeki yüksek basınç, suyun daha ileriye gitmesine neden olmaktadır.” Bu cümle doğrumudur yoksa yanlışmıdır? Açıklayınız.

....

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....

8. Bu aktivitedeki buluşlarınızı atar ve toplar damarlardaki kan basıncı ile ilişkilendirebilirmisiniz? Açıklayınız.

....

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9. Sigara içmenin kan damarlarını nasıl etkilediği kısaca belirtiniz. Bu konu ile ilgili grup olarak bir poster hazırlayınız. Ve bu posterinizi sınıf arkadaşlarınıza sununuz.

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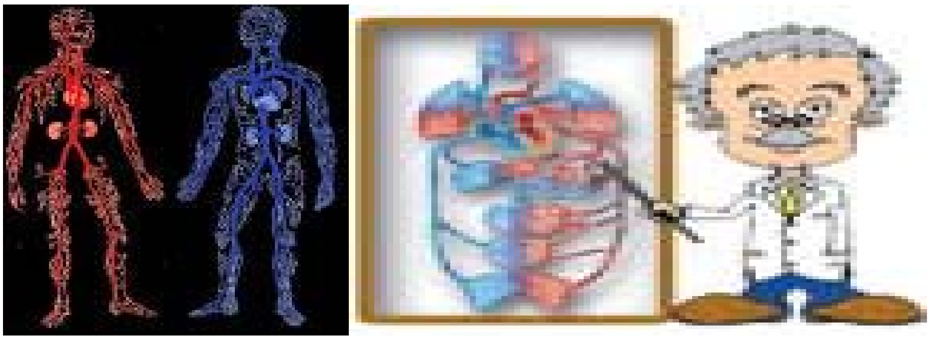
3. KAN DOLAŞIMI



Aktivite 1: Kan Dolaşımını anlamak

Amaç: İnsanda dolaşım sistemi elemenlarını hatırlamak.

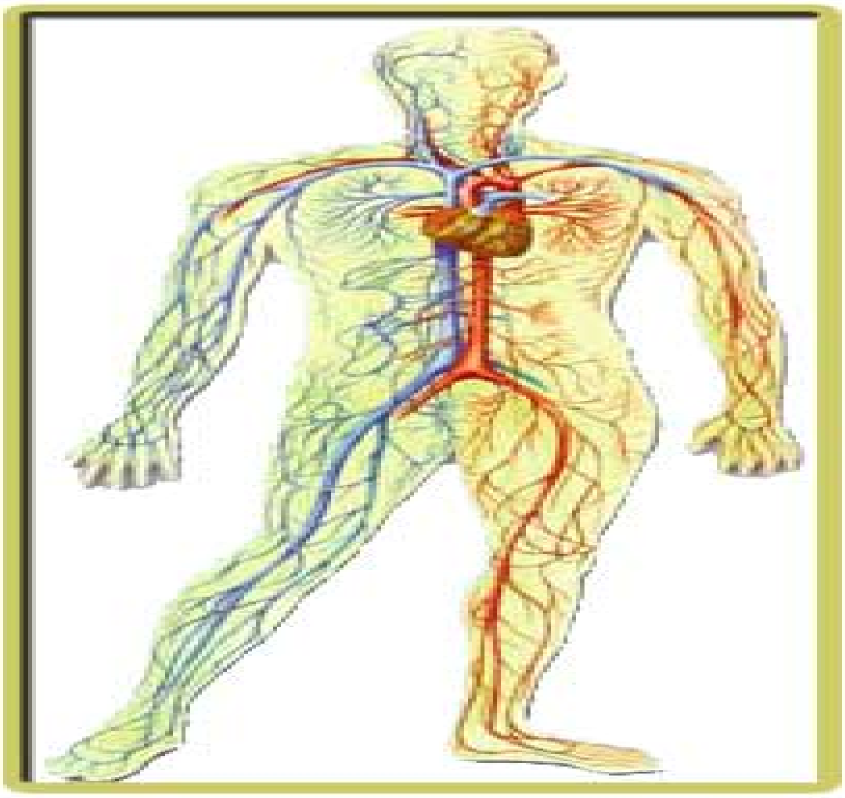
Araç ve Gereçler:

- Dolaşım sistemi haritası, renkli kalemler

Yöntem:

1. Üçer kişilik gruplar oluşturunuz. Size verilen harita üzerinde dolaşım sistemine ait olduğunu düşündüğünüz organları renkli kalemlerle gösteriniz/ çiziniz.

İnsanda dolaşım sistemi elemenları



2. Tamamladığınız haritanızı sınıftaki diğer arkadaşlarınızla paylaşınız.
3. Kendi vücudunuzda ne kadar kan olduğunu düşünüyorsunuz? Yazınız.

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4. Size gore kanımızın vücudumuzu dolaşırken izlediği yol ne olabilir? Yazınız.

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Aktivite 2: Büyük ve Küçük Kan Dolaşımı

Amaç: Büyük ve küçük kan dolaşımını anlamak

Araç ve Gereçler:

- Renkli kartonlar,
- Mavi ve kırmızı balonlar,
- Renkli kalemler

Yöntem:

1. Sınıf olarak büyük bir grup şeklinde aktivite yapılacaktır.
2. Renkli kartonlarınıza kaslar, kalbin sağ kulakçık ve karıncığı, kalbin sol kulakçık ve karıncığı, aort, akciğer, akciğer atardamarı ve akciğer toplardamarı yazınız.
3. İçinizden dokuz kişi bu renkli kartonlardan bir tanesini alarak sınıfta projeksiyon ile yansıtılan insanda dolaşım sistemi haritasına bakarak uygun yerlerde durunuz.
4. Geri kalan öğrencilerden üç öğrenci şişirilmiş mavi balonları ve diğre üç kişi ise şişirilmiş kırmızı balonları alarak öğretmeninizin rehberliğinde uygun yerlerde durunuz.

5. Kırmızı balon taşıyacak olan öğrenciler önce kalbin sol karıncığı yazan kartonun bulunduğu yere gidiniz.

6. Buradan kırmızı balonları alarak aort yazan kartonun bulunduğu yere gidiniz.

7. Daha sonra kırmızı balonları taşıyan öğrenciler, bu balonları kaslara iletiniz. Ve balonlarınızı bırakınız.

8. Bu sırada mavi balonları taşıyacak olan üç öğrenci kaslardaki mavi balkonları alınız ve kalbin sağ kulakçığı yazan kartonun bulunduğu yere gidiniz.

9. Mavi balon taşıyan öğrenciler kalbin sağ kulakçığından ayrılarak kalbin sağ karıncığına mavi balonlar taşıyınız.

10. Mavi balonlarla birlikte akciğer atardamarı yazan kartonun bulunduğu yere gidiniz.

11. Buradan ayrılarak balonlarla birlikte akciğerler yazan kartonun bulunduğu yere gidiniz.

12. Burada mavi balonları bırakınız.

13. Kırmızı balonları taşıyan öğrenciler balonlarını alarak dolaşım sistemini yeniden başlatınız. Bu şekilde kan dolaşımını tamamlamış bulunmaktasınız.

14. Hangi grup (kırmızı balon taşıyan ya da mavi balon taşıyan) yolculuklarını daha kısa sürede tamamlamıştır? Yazınız.

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15. Her grup sadece tek bir yönde hareket ederek dolaşımı tamamlamıştır. Eğer böyle bir durum olmasaydı ne gibi problemler olabilirdi? Dolaşımın tek yönlü olmasının önemi sizce ne olabilir? Açıklayınız.

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16. Sizce hangi faktörler vücudumuzdaki kan dolaşımını olumsuz yönde etkiler? Açıklayınız.

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17. Yukarıda yaptığınız etkinliğide düşünerek Kan dolaşımı ile ilgili kısa bir hikaye yazınız.

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4. KAN BASINCI

Aktivite 1: Kan basıncı

Amaç: Kalp krizi, yüksek tansiyon ya da düşük tansiyon hakkında hatırlatmalarda bulunmak

Araç ve Gereçler:

- Gazete haberleri,
- Bazı broşürler,
- Posterler

Yöntem:

1. Bu aktiviteyi tek başınıza yapınız.
2. Öğretmeninizin size gösterdiği haber başlıklarına bakarak, poster ya da broşürlerden yararlanarak kalp krizi, yüksek ya da düşük tansiyon hastalıkları ile ilgili gözlemlerinizi/bildiklerinizi kısaca yazınız.

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3. Bu gözlemlerinizi / bilgilerinizi sınıf arkadaşlarınız ile paylaşınız.

Aktivite 2: Nabız Sayımı

Amaç: Nabız terimini kavramak

Araç ve Gereçler:

- Saat,
- Renkli kalemler,

Yöntem:

1. Bu aktiviteyi tek başınıza yapınız.
2. Sağ elinizin işaret ve orta parmağını ile bileğin iç kısmına koyarak hafifçe bastırınız.
3. Nabzınızı 15 saniye boyunca sayınız.
4. Bulduğunuz nabız sayısını dört ile çarparak bir dakika için ortalama nabız sayınızı bulunuz. Ve bu bulduğunuz sayıyı not tutunuz.
5. İçinizden iki arkadaşınızı seçiniz. Bu iki arkadaşınızın, belirli bir süre egzersiz yaptıktan sonra nabızlarını aynı şekilde sayınız.
6. Bu farklı değerleri aşağıdaki tabloya yazınız.

Dinleme Anında	Zaman aralığı 15 saniye	Nabız hızı (nabız sayısı) / dk
1.deneme		
2.deneme		
3.deneme		
4.deneme		
Ortalama nabız hızı		

Egzersizden Sonra	Zaman aralığı 15 saniye	Nabız hızı (nabız sayısı) / dk
1.deneme		
2.deneme		
3.deneme		
4.deneme		
Ortalama nabız hızı		

7. Bulduğunuz değerleri dikkate alarak dinlenme anında ve egzersizden sonra nabız sayıları ile ilgili bir grafik çiziniz.

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8. Bulduğunuz değerleri sınıf arkadaşlarınızla paylaşınız.

Aktivite 3: Tansiyon Ölçümü

Amaç: Tansiyon (büyük tansiyon, küçük tansiyon), hipertansiyon ve hipotansiyon terimlerini kavramalark

Araç ve Gereçler:

- Saat,
- Tansiyon aleti,
- Renkli kalemler,
- Karikatürler

Yöntem:

1. Sınıfta üç büyük grup oluşturarak bu aktiviteyi yapınız.
2. Her grupta mutlaka tansiyon aletinin olmasına dikkat ediniz.
3. Grup içerisinde öğretmeninizin rehberliğinde arkadaşlarınızın kan basınçlarını dinleyiniz.

4. Atardamarlarınızdaki kanın yaptığı ve öğrencilerin dinlediği bu basıncın tansiyon olduğunu fark ediniz.

5. Büyük tansiyon ve küçük tansiyon değerlerinizi ölçmeye çalışınız.

6. Daha önce öğrendiğiniz endokrin sistem ile kan basıncı arasında ilişki kurmaya çalışınız.. Hormonların kan basıncını nasıl etkileyebileceklerini yazınız.

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7. Öğretmeninizin size verdiği karikatürleri de inceleyerek fazla tuzlu ve yağlı besinlerin tüketilmesinin etkilerini açıklayınız.

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5-E LEARNING CYCLE ACTIVITIES ABOUT THE HEART

ENGAGEMENT:

A) Öğrencilere ders başlamadan önce konu ile ilgili bir hikaye dağıtılır ve bu hikayeyi okumaları istenir.

B) Hikaye ile ilgili konunun bağlantısını kurabilmek amacıyla sorular sorulur.

  a. Hikayede anlatılan problemin dolaşım sistemimiz ile olan ilişkisi neler olabilir?

  b. Hikayeden çıkarabildiğiniz kadarı ile problemin kaynağında hangi organ/ organlarımız olabilir?

C) Bu aşamada öğrencilere küçük bir aktivite yaptırarak konuya dikkatlerini çekmek isteniyor. Öğrenciler avuç içleri yukarı gelecek şekilde ellerini sıralarının üzerine koyup, bir dakika boyunca ellerini açıp-kapatacaklar. Yaklaşık 45 saniye sonra yorulma belirtileri ortaya çıkacaktır. Bu küçük aktivite ile aşağıdaki soruları düşüneceklerdir.

  a. Ellerini açıp-kapama hareketi vücutlarında hangi organın çalışma prensibini çağrışım yaptırmıştır?

  b. Bu organ hangi sistemimize ait bir organ olabilir?

D) Öğrencilerin derse katılımlarını sağlamak ve konuya ilgilerini çekebilmek için kalple ilgili ilginç ve şaşırtıcı bilgiler öğrencilere sunulur.

EXPLORATION:

Aktivite 1: Öğrencilerin kalbin yapısını ve çalışma mekanizmasını keşfedebilmeleri için bazı aktiviteler yapacaklardır.

A) 3'er kişilik gruplar oluşturularak aktivite yapılır. Deneye başlamadan önce öğrencilere üzerinde herhangi bir açıklama ya da bilgi bulunmayan kalbin şeklini gösteren çalışma kağıtları dağıtılır. Aynı çalışma kağıdı projeksiyon ile de sınıfta da yansıtılır.(Ek 1)

B) Her grup bir memeli kalbi ile deneyini yapacaktır. Önce kalbi yıkayacaklardır. Sonra her grup kalbi uzunlamasına ikiye bölecektir.Böylece kalbin odacıklarını gözlemleyeceklerdir. Üstte ve altta yer alan odacıkları fark edip, kanın akışı ile ilgili çıkarımlar yapmaya çalışacaklardır. Ayrıca, kalbin kas yapısını ve kan damarlarını gözlemleyeceklerdir.

C) Her grup deneyini yaparken ve kalbi incelerken daha önce onlara verilen çalışma kağıdı üzerinde kalbin yapısını oluşturmaya çalışacaklardır.

D) Her grup deneyini yaptıktan sonra, deney sırasındaki gözlemlerini öğretmenin tahtaya yazacağı soruları dikkate alarak not tutacaklardır.
   a. Klabin içerisinde neler gördünüz?
   b. Kalbe dokunduğunuzda neler hissettiniz?
   c. Kalbin farklı kısımlarını yapısal olarak nasıl karşılaştırırsınız?

E) Her grup çalışma kağıtlarını ve gözlemlerini birbirleriyle paylaşacaktır.

<u>Aktivite 2:</u> Öğrencilerin kalbin çalışma mekanizmasını keşfedebilmeleri için bazı aktiviteler yapacaklardır.

A) Öğrenciler ikişer kişilik gruplar halinde çalışacaklardır.

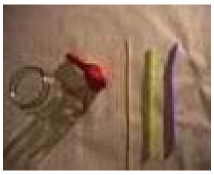
B) Her grup balonların boğaz kısmını keserek su dolu bir kavanozun ağzına sıkı bir şekilde geçireceklerdir.

C) Daha sonra 2 cm aralık bırakarak balondan kürdan yardımı ile 2 tane küçük delik açacaklardır.

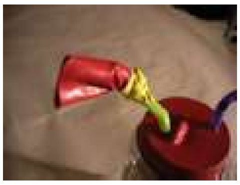
D) 2 tane pipeti yavaşça bu açılan deliklere yarleştireceklerdir. Pipet ile balondaki delikler arasında boşluk kalmamasına dikkat edilmelidir. Eğer boşluk olursa yeni bir balonla yeniden aktiviteye başlanır.

E) Pipetlerden birine daha önce kesilen balonun boğaz kısmı yerleştirilir.

F) Balonu bastırıp tekrar bıraktığımızda suyun pipet içerisinde nasıl hareket ettiğini gözlemleyiniz.





<u>EXPLANATION:</u>

<u>Aktivite 1:</u>

A) Öğrenciler deneylerini tamamladıktan sonra , kalbin yapısı hakkında grup olarak öğretmenin soracağı bazı sorulara cevap vereceklerdir.

a. Deney sırasında neler buldunuz?

b. Kalpte bulunan temel yapılar nelerdir?

c. Bir kalbin şeklini ve yapısını resmedebilirmisiniz.

d. Kalp içerisinde kanın akış şeması nasıldır?

B) Öğrenciler kendi bilgisayarlarında yüklü bulunan kalbin yapısını gösteren grafik, resim ve videolardan yararlanarak öğretmenin konu ile ilgili açıklamalarını takip edeceklerdir.(Ek2)

Aktivite 2:

A) Öğrenciler bilgisayar üzerinden harketli olarak kalbin çalışma mekanizmasını ve kalpeki kanın akış şemasını gözlemleyeceklerdir. Bu şekilde kendilerinin yaptığı deneyle analogy kurabileceklerdir.(Ek 3)

B) Öğrenciler kalbin yapısı ve çalışması ile ilgili bilgisayar üzerinden küçük bir aktivite daha yaparak konuya hakim olup olmadıklarını gözlemleyeceklerdir.(Ek 4)

ELABORATION:

A) Her öğrenci bir hafta boyunca yediklerini ve yaptıkları ekzersizleri not tutacaktır. Okula geldiklerinde kalp sağlığı için derste öğrendiklerini göz önünde tutarak neler yaptıklarını yada yapmadılarsa neler yapmaları gerektiğini , nasıl değişikliklere ihtiyaçları olduklarını birbirleriyle paylaşacaklardır.

EVALUATION:

A) Her öğrenci kalbin çalışma mekanizması ve yapısı ile ilgili "Roundhouse Diagram" oluşturacaklardır.

B) Kalp ile ilgili bulmaca çözerek portfolio dosyalarına koyacaklardır.

C) Ders sonunda "KWL chart" doldurulacaktır. (Ek 4)

5-E LEARNING CYCLE ACTIVITIES ABOUT BLOOD VESSELS

ENGAGEMENT:

Öğrencilere bir önceki derste öğrenme döngüsü yaklaşımı kullanılarak kalbin yapısı ve çalışma mekanizması anlatılmıştı. Bu konuyla bağlantılı olarak atardamar, toplardamar ve kılcaldamarların yapısı yine öğrenme döngüsü ile anlatılacaktır.

A) Öğrencilerin kan damarlarımız konusunda daha verimli olabilmeleri için dersin başında bir analogy ile dikkatleri konuya çekilmeye çalışılacaktır. Her öğrenciye bir şehir haritası verilerek bu haritada yer alan, çok geniş olan ana caddeleri, daha küçük olan ara caddeleri ve sokakları renkli kalemlerle işaretlemeleri istenecektir. Bu sırada projektör ile insanda dolaşım sisteminin haritası sınıfta yansıtılacaktır.

B) Bu sırada öğrencilere bir soru sorularak sınıf içinde küçük bir tartışma konusu ortaya çıkarılacaktır**.**

   a. Ailenize yada arkadaslarınıza şehir içi yada şehirler arası yolculuklarda hiç harita kullanarak yardım ettiniz mi?

C) Bir harita örneğini kullanarak bir sehre giriş ve cıkısların otoyallar ile gerçekleştiğini ve bu yollardan cogunun tek yonlu yol oldugunu belirtin. Araçların yakıt ve besin almak için şehre girdiklerini ve bu şekilde evlerine gittiklerini söyleyin. Yine öğrencilere şehir merkezinin "şehrin kalbi" olduğunu, çünkü bütün şehir aktivitelerinin gerçekleştirildiği ve bir çok ihityacın karşılandığı merkez olduğunu belirtin.

D) Yukarıda verilen duruma göre öğrenciler bazı sorulara cevap vereceklerdir.

   a. Insanlar nasıl seyahat ederler?
   b. Her otoyol aynı boy ve uzunlukta mıdır?
   c. İnsanlar neden şehirlere/ şehir merkezlerine doğru yolculuk ederler?

d. İnsanlar hangi yakıt ve besinleri alma gereksinimi duyarlar?

E) Yukarıda verilen cevapların ardından öğrenciler şehir haritası ile dolaşım sistemimizin parçası olan kan damarlarımız arasında ilişki kurmaya çalışacaklardır.

“Kan hücreleri (arabalar) tek yönlü olarak toplardamarlardan (otoyollardan) kalp ve akciğerlere doğru yolculuk yapar ve atık malzemelerini (çöplerini) bırakıp temiz oksijen ve besin (yakıt ve yemek) alırlar. Daha sonra besin ve oksijence zengin kan hücrelere (evlerine) farklı bir yoldan yani atardamarlardan (otoyol) geri dönerler.

Öğrencilere bu konuyu ilişkilendirmek için şehir taşımacılığı sistemi damar sitemi ile ilişkilendirilmelidir.”

<u>EXPLORATION:</u>

Öğrencilerin kan damarlarının yapısını keşfedebilmeleri için aktivite yapılacaktır.

<u>Aktivite</u> :Kan damarlarının elastiki yapısının kan basıncına karşı önemli bir rol oynadığını keşfedebilmeleri için aktivite yapılacaktır.

A) Bu aktivite 3’er kişilik gruplar halinde yapılacaktır. Her grupta mutlaka pipet, bir miktar su, cetvel yada mezro, üzerinde boyuna delikler açılan teneke kutu, grafik kağıdı bulunacaktır

B) Derse basınçla ilgili beyin fırtınası ile başlayın. Bu aktivitede ortaya çıkacak terimler düz ve basit bir şekilde tahtaya da yazılabiir yada bir diyagram şeklinde de tahtaya çizilebilir. Aktivitenin sonuna kadar bu bilgilerin referans olarak tahtada kalmasını sağlayın.

C) Daha sonra öğrencilere kamışa bakmaları ve üflediklerinde basıncın kamış içinden gecen su akısını nasıl etkilediğini anlattırmaya calısın.

D) Tahtaya değişik fikirleri yazın ve gönüllü bir öğrenciyi tahtaya kaldırarak konuyu modellemesini isteyin ve alakalı bilgileri kayıt ederek öğrencilerin uygulanan gücün kaynagının basınc oldugunu anlatmaya calısın.

E) Öğrencilerin tahta üzerinde elde ettiği dataları en iyi anlayabilecekleri şekilde grafik halinde gostermelerini isteyin. Datalar aynı olmasına rağmen öğrencilerin her birinin bağımsız olarak grafikleri çizmelerini isteyin.

F) Öğrenciler grafik aktivitesini bitirdiklerinde kullandıkları metodları tartışın. Bağımlı ve bağımlı olmayan değişkenleri, grafikteki ölçü birimlerini ve grafik sitilini tanımlamalarını isteyin.

EXPLANATION:

A) Öğrenciler yaptıkları aktivitelerle ilgili olarak öğretmenin tahtaya yazacağı bazı sorulara grup olarak cevap vermeye çalışacaklardır.

a. “Tüp içindeki yüksek basınç, suyun daha ileriye gitmesine neden olmaktadır.” Bu cümle doğrumudur yoksa yanlışmıdır?

b. Bu aktivitedeki buluşlarınızı atar ve toplar damarlardaki kan basıncı ile ilişkilendirebilirmisiniz?

B) Öğrenciler kendi bilgisayarlarında yüklü bulunan kan damnarları ile ilgili resim, grafik ve videolardan yararlanarak öğretmenin konu ile ilgili açıklamalarını takip edeceklerdir.

ELABORATION:

Öğrencilere bu bölümde sigara içmenin kan damarlarını nasıl etkilediği sorulur. Her öğrenciye bir çalışma kağıdı verilerek sigaranın ortaya çıkardığı riskleri poster şeklinde ifade etmeleri istenecektir. Daha sonra bu posterler hem sınıf içinde hem de okulda diğer öğrenciler ile paylaşılacaktır. Bu şekilde kalp-damar sağlığı arasındaki ilişkiyi ortaya çıkarmak için iyi bir fırsat yaratılacaktır.

EVALUATION:

D) Her öğrenci atardamar, toplardamar ve kılcal damarların yapısı ve görevleri ile ilgili "Roundhouse Diagram" oluşturacaklardır.

E) Ders sonunda "KWL chart" doldurulacaktır.

5-E LEARNING CYCLE ACTIVITIES ABOUT THE BLOOD CIRCULATION

ENGAGEMENT:

A) Büyük ve küçük kan dolaşımı konusuna geçmeden önce, öğrencilere insanda dolaşım sistemini içeren bir harita dağıtılır ve her öğrencinin bu harita üzerinde dolaşım sistemi elemanları olan organları; kalbi, atardamar, toplardamar, kılcal damar ve kan hücrelerini göstermeleri istenir.

B) Öğrencilerden kendi haritalarını sınıfta birbirleriyle paylaşmaları istenir.

C) Daha sonra öğrencilere bazı sorular sorularak bu soruları düşünmeleri istenir.

   a. Kendi vücudunuzda ne kadar kan olduğunu düşünüyorsunuz?
   b. Kanımızın vücudumuzu dolaşırken izlediği yol ne olabilir?

D) Öğrencilerin kendi cevaplarını sınıfa açıklamaları istenir.

EXPLORATION:

Aktivite : Öğrencilerin büyük ve küçük kan dolaşımını öğrenebilmeleri için "role play" kullanılarak aşağıdaki aktivite yapılacaktır.

A) Öğrencilere dolaşım sistemimizin elemanları olan kaslar, kalbin sağ kulakçık ve karıncığı, kalbin sol kulakçık ve karıncığı, aort, akciğer, akciğer atardamarı ve akciğer toplardamarı yazan kartonlar dokuz öğrenciye verilerek öğretmen rehberliğinde sınıfta uygun yerlerde durmaları istenir.

B) Bu sırada projeksiyon ile insanda dolaşım sistemi haritası yansıtılır.

C) Altı öğrenciden üç tanesi şişirilmiş kırmızı balon, diğer üç öğrenci ise şişirilmiş mavi balon taşırlar.(Kırmızı balon temiz kanı, mavi balon kirli kanı temsil edecektir.)

D) Öğrenciler öğretmenlerinin rehberliğinde kırmızı ve mavi balonları uygun olduğu takdirde diğer dokuz arkadaşlarının bulundukları yerlere taşırlar.

  a. Kırmızı balon taşıyan öğrenciler önce kalbin sol karıncığına ulaşırlar.
  b. Daha sonra bu kırmızı balonlarla aorta giderler.
  c. Aorttan sonra temiz kanı (kırmızı balonlar) kaslara iletirler.
  d. Bu sırada mavi balonları taşıyacak olan üç öğrenci kaslardaki mavi balkonları alır ve kalbin sağ kulakçığına getirir.
  e. Kalbin sağ karıncığına kirli kan (mavi balonlar) taşınır.
  f. Buradan ayrılan akciğer atardamarı kirli kanı akciğerlere getirir.
  g. Burada temizlenen kanı kırmızı balon taşıyan öğrenciler alır ve tekrar kalbin sol kulakçığına getirir. Bu şekilde dolaşımı yapmış olurlar.

E) Öğrenciler bu hareketli aktiviteyi tamamladıktan sonra öğretmenin sorularına cevap vermeleri istenir.

  a. Hangi grup (kırmızı balon taşıyan ya da mavi balon taşıyan) yolculuklarını daha kısa sürede tamamlamıştır?

b. Her grup sadece tek bir yönde hareket ederek dolaşımı tamamlamıştır. Eğer böyle bir durum olmasaydı ne gibi problemler olabilirdi? Dolaşımın tek yönlü olmasının önemi sizce ne olabilir?

F) Öğrenciler aktivite sonrasında neler öğrendiklerini ve sorulara verdikleri cevapları birbirleriyle paylaşmaları istenir.

EXPLANATION:

A) Öğrenciler bilgisayar üzerinden harketli olarak büyük ve küçük kan dolaşımını takip edeceklerdir.

ELABORATION:

A) Her öğrenciden bir kompozisyon yazması istenir. Bu kompozisyonun konusu ise öğretmenin öğrencilere yönelttiği soruda verilmiştir.

a. Sizce hangi faktörler vücudumuzdaki kan dolaşımını olumsuz yönde etkiler? Açıklayınız.

EVALUATION:

F) Her öğrenci kan dolaşımı ile ilgili "Roundhouse Diagram" oluşturacaklardır.

G) Ders sonunda "KWL chart" doldurulacaktır.

5-E LEARNING CYCLE ACTIVITIES ABOUT THE BLOOD PRESSURE

ENGAGEMENT:

A) Öğrencilere daha önceden öğrendikleri konularla da bağlantılı olarak günlük hayattan kalp krizi, yüksek tansiyon gibi hastalıklara ait bazı haberler ve broşürler gösterilir.

B) Öğrencilere yüksek tansiyonu ya da düşük tansiyonu olan hasta yakınları olup olmadığı sorulur. Ve bu konuda bildiklerini, gözlemlerini anlatmaları istenir.

EXPLORATION:

Aktivite 1: Öğrencilerin nabız terimini kavramaları amacıyla aşağıdaki aktivite yapılacaktır.

A) Her öğrencinin sağ elin işaret ve orta parmağı ile bileğin iç kısmına koyarak hafifçe bastırması istenir.

B) Nabızlarını 15 saniye boyunca saymaları beklenir.

C) Bulunan nabız sayısını dört ile çarparak bir dakika için ortalama nabız sayılarını bulmaları istenir.

D) Aynı işlemi belirli bir süre egzersiz yaptıktan sonra tekrarlamaları beklenir.

E) Her iki uygulama için bir tablo yapmaları istenir.

F) Beş öğrenci için nabız hızı eğrisini çizmeleri istenir.

G) Bu aktivite sonunda öğretmenin sorduğu soruları düşünmeleri beklenir.

   a. Dinlenirken bulunan değerlerin birbirinden farklı olmasının nedeni nedir?

   b. Dinlenme anında ve egzersiden sonra bulunan ortalama nabız hızının farklı olmasının nedeni nedir?

H) Öğrenciler soruların cevaplarını birbirleriyle tartışacaklardır.

Aktivite 2: Öğrencilerin tansiyon (büyük tyansiyon, küçük tansiyon), hipertansiyon ve hipotansiyon terimlerini kavramaları amacıyla aşağıdaki aktivite yapılacaktır.

A) Sınıf iki büyük gruba ayrılarak bu aktivite yapılacaktır.

B) Her grupta mutlaka birer tane tansiyon aleti bulunacaktır.

C) Öğretmenin rehberliğinde öğrenciler tansiyon aletini kullanarak birbirlerinin kan basınçlarını dinleyeceklerdir.

D) Atardamarlarda kanın yaptığı ve öğrencilerin dinlediği bu basıncın tansiyon olduğunu fark edeceklerdir.

E) Büyük tansiyon ve küçük tansiyon değerlerini ölçmeye çalışacaklardır.

F) Her iki grup bulduğu değerleri birbirleriyle paylaşacaklardır.

EXPLANATION:

Öğretmen çeşitli poster ve resimleri kullanarak nabız, tansiyon hiper-hipotansiyon terimlerini öğrencilere açıklayacaktır.

ELABORATION:

A) Öğrenciler daha önce öğrendikleri endokrin sistem ile kan basıncı arasında ilişki kurmaya çalışacaklardır. Hormonların kan basıncını nasıl etkileyebileceklerini düşünecekler ve sınıf içinde tartışacaklardır.

B) Öğrenciler öğretmenin rehberliğinde fazla tuzlu ve yağlı besinlerin tüketilmesinin etkilerini tartışacaklardır.

EVALUATION:

A) Ders sonunda “KWL chart” doldurulacaktır.

APPENDIX F

OBJECTIVE ACTIVITY TABLE

Table F1: Objective Activity Table

Activity / Objective	Activities about Heart	Activities about Blood vessels	Activities about Blood Circulation	Activities about Blood Pressure
1	*			
2	*			
3	*			
4	*			
5	*			
6	*			
7	*			
8		*		
9		*		
10		*		
11		*		
12		*		
13		*		
14		*		
15		*		
16		*		
17			*	
18			*	
19			*	
20			*	
21				*
22				*
23				*
24				*
25				*

APPENDIX G

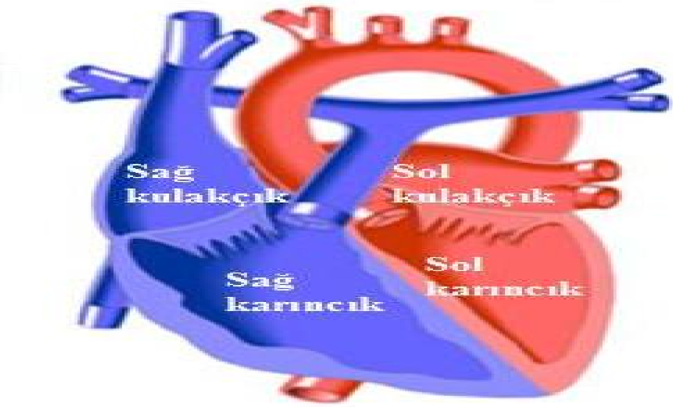
HANDOUT

İNSANDA DOLAŞIM SİSTEMİ

1. KALP

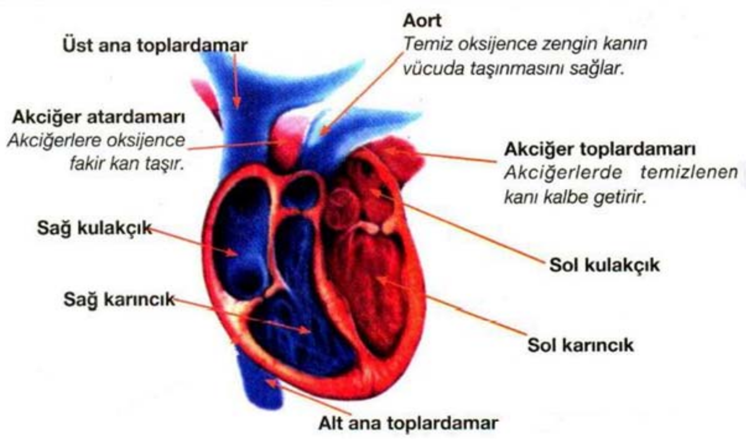
A) Kalbin Yapısı

- Kalp,insanın gögüs boşluğunda iki akciğerin arasında ve gögüs kemiğinin hemen arkasında yer alır,
- Aşağıdaki şekilde görüldüğü gibi dört odacıklı olan kalpte üstteki iki odacığa kulakçık,alttaki iki odacığa karıncık adı verilir.



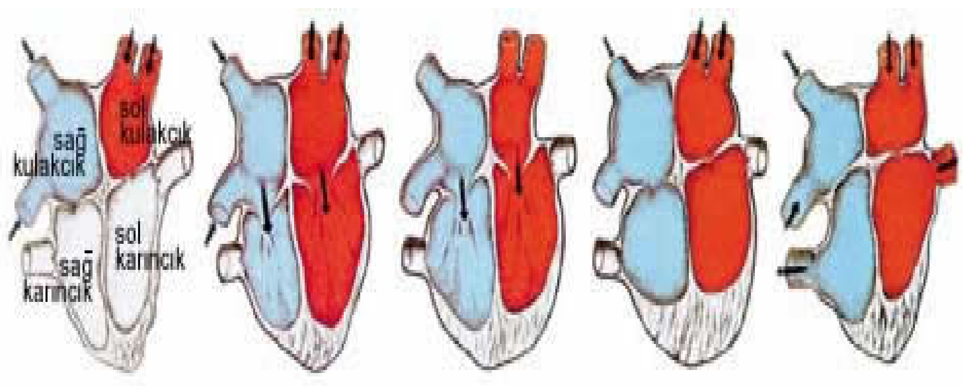
- Sağ kulakçık ile sağ karıncık arasında üçlü,sol kulakçık ike sol karıncık arasında ikili kapakçık bulunur.
- Sağ kulakçığa üst ana toplar damar ile alt ana toplar damar bağlanır.Sağ karıncıktan ise akciğer atardamarı çıkar.
- Sol kulakçığa kalbin en büyük damarlarından biri olan aort atardamarı çıkar.
- Kulakçıklar ile karıncıkar arasındaki kapakçıklar karıncıklara doğru tek yönde açılır.Karıncıkları atardamarlara bağlıyan açıklıklarda da yarım ay şeklinde üçlü kapakçıklar bulunur.

- Kalbin yapısında içten dışa doğru endokard,miyokard ve perikard olmak üzere üç farklı yapı görülür.



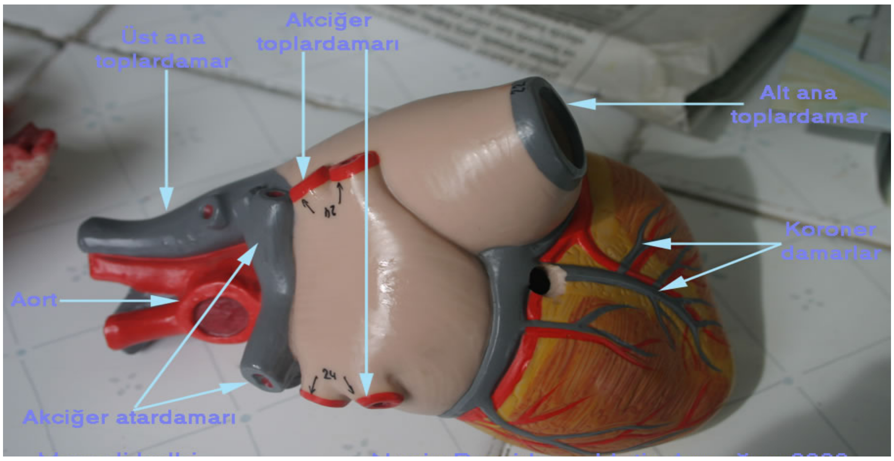
B) Kalbin Çalışma Mekanizması

- Kalbin çalışması,Kalp kasının kasılıp gevşemesi ile olur.Kalbin her odacığı kasılma sırasında içindaki kanı pompalar,gevşeme sırasında ise kanla dolar.
- Kalbin çalışması, kalp kasının kasılıp (=sistol) ve gevşemesi (=diastol) ile olur. Kalp atışı 0,15 sn. de kulakçıklar 0,30 sn. de karıncık kasılır, 0,40 sn. lik sürede kalp dinlenir.



- Organlardan gelen ve oksijeni az olan kirli kan toplardamarlar ile sağ kulakcığa dökülür, buradan triküspid kapak aracılığı ile sağ karıncığa geçer.

- Sağ karıncık kirli kanı pulmoner kapaktan pulmoner arter aracılığı ile akciğerlere pompalar.
- Akciğerlere gelen kan oksijenden zenginleşir. Oksijenden zenginleşen temiz kan, akciğer toplardamarları ile sol kulakcığa, buradan da mitral kapak aracılığı ile sol karıncığa geçer.
- Sol karıncığa gelen temiz kan aort kapağından geçerek aort aracılığı ile tüm organlara pompalanır.
- Sol karıncıkdaki kanın basıncı kolda ölçülen kan basıncına eşittir.



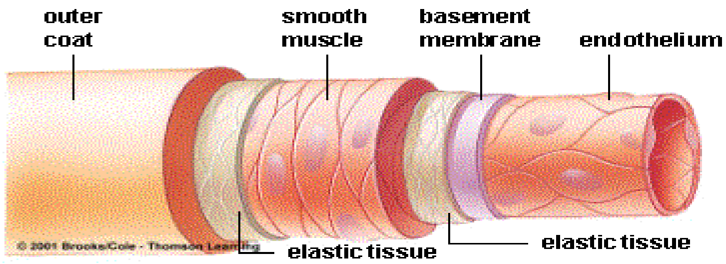
2. KAN DAMARLARI

- İnsan dolaşım sisteminde; atardamar, toplardamar ve kılcal damarlar olmak üzere üç çeşit kan damarı vardır.

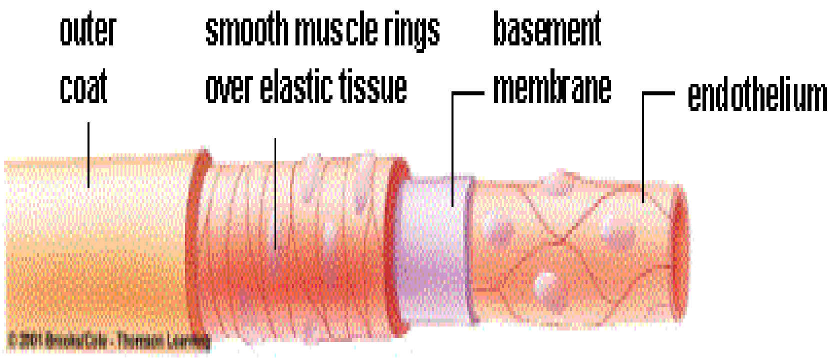
<u>A) Atardamarlar (Arterler)</u>

- Kalpten çıkan kanı organ ve dokulara taşıyan damarlardır.
- Kanı kalbin sağ karıncığından akciğere, sol karıncığından da bütün vücuda götüren ve yayan damardır
- Atardamarlar geniş, esnek ve sağlam bir yapıdadır.
- Atardamarlar, silindirik borulardır. Duvarlarında üç kılıf vardır. İç kılıf, endotel hücrelerinden, orta kılıf çizgisiz kaslardan ve esnek liflerden, dış kılıf ise gevşek bir baş dokusundan yapılmıştır. İç tabaka kanın

pıhtılaşmasına engel olur, orta tabaka damarların büzülmesini ve gevşemesini sağlar, dış tabaka orta tabakanın işini düzenler.



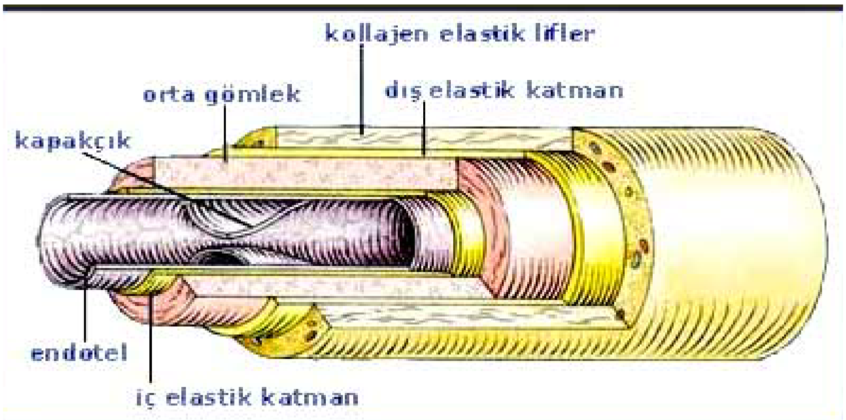
- Atardamarlar, dokuları oluşturan hücrelere besin ve oksijen taşırlar. Kalpten akciğer atardamarı ve aort damarları çıkar. Akciğer atardamarı hariç bütün atardamarlar temiz kan taşır. Akciğer atardamarı kirli kan taşır. Atardamarlar karıncıklardan çıkarlar.



B) Toplardamarlar (Venler)

- Toplardamarlar kanı kalbe taşıyan kan damarlarıdır.
- Kanı kalpten vücudun diğer bölgelerine taşıyan kısacası venlerin tam zıddı görevi yapan kan damarlarına ise arter yani atardamar denir.

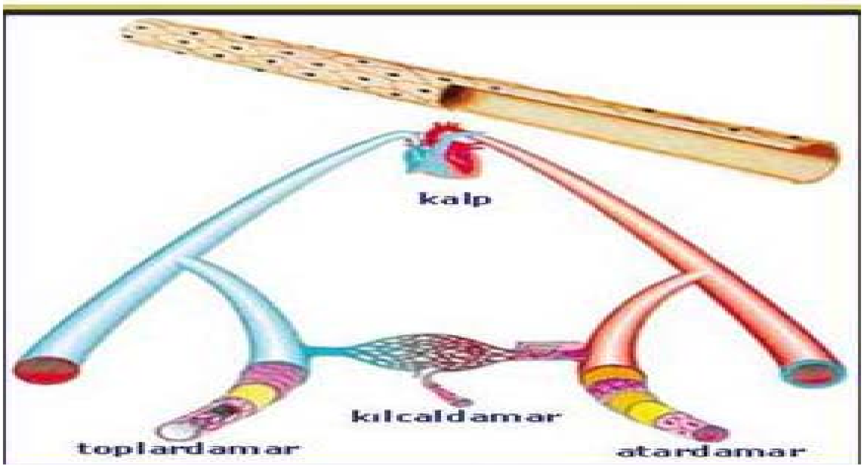
- Oksijenden fakir, metabolizma artıklarını taşıyan, kanın kalbe dönüşünü sağlayan sistem. Toplardamarlar vücutta umûmiyetle aynı organa veya dokuya giden atardamarlara eşlik eder. Derinde seyreden toplardamarlar, kasların arasından geçer.
- Toplardamarların duvarı da atardamarlarda olduğu gibi üç tabakadan oluşur. Yalnız atardamarlardan farklı olarak dış tabakadaki bağ dokusu kollegen lifler bakımından zengin, orta tabakada ise elastiki lifler daha azdır.
- Çapları atardamarlarınkinden daha büyük olduğundan daha fazla kan taşırlar.

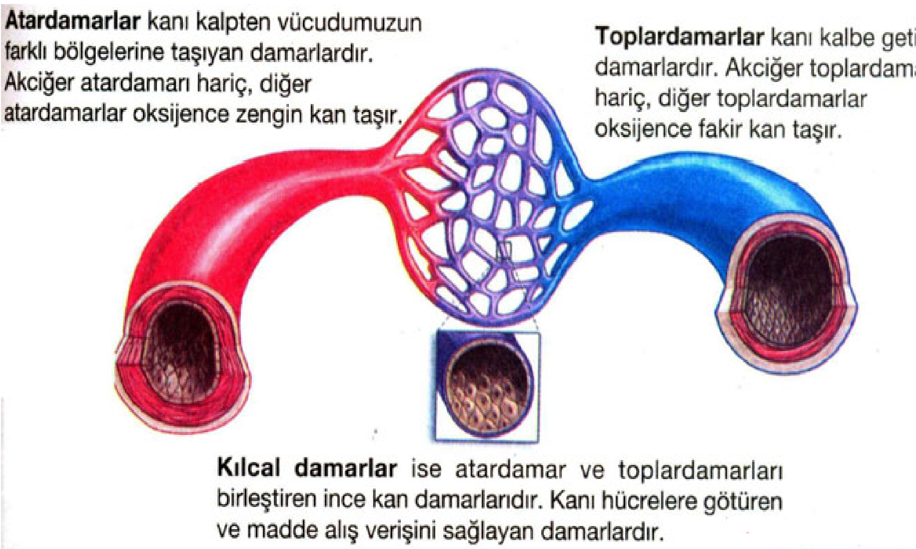


C) Kılcal Damarlar (Kapiller)

- Atardamarların son dallarını, toplardamarların ilk dallarına birleştiren ince damarlar.
- Bir kıldan elli defâ daha incedir. Çapları 0,007 mm ile 0,150 mm arasında değişir. Duvarlarında düz kas telleri bulunmayan damarlardır.
- Kılcal damarların içinde dolaşım hızı ve basıncı azdır. Doku hücreleri ile doğrudan doğruya temas hâlinde olan kılcal damarlar, dokular arası beslenmede başlıca yer teşkil eder.
- Kılcal damarlar, bütün vücut hücrelerinin aralarını ağ gibi kapsar. Hücrelerle kan arasındaki alış veriş kılcal damarlarda gerçekleşir.

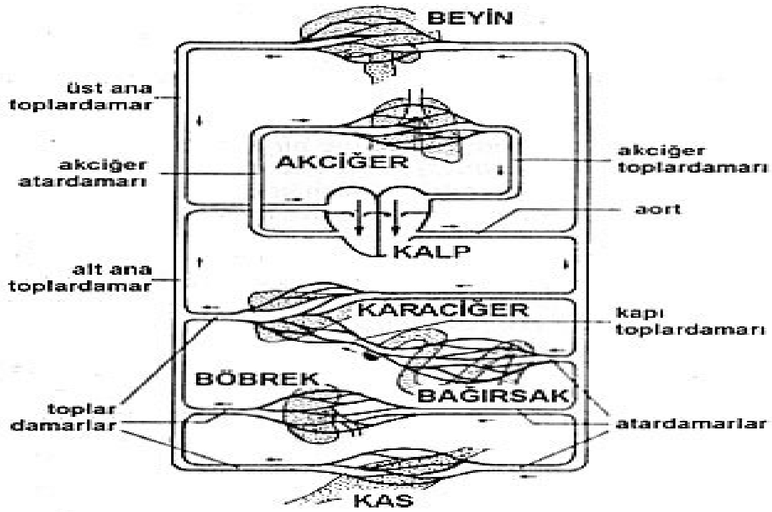
Kandaki oksijen ve besin, hücrelere geçerken hücrelerdeki karbon dioksit ve diğer atık maddeler kana geçer.





3. KAN DOLAŞIMI

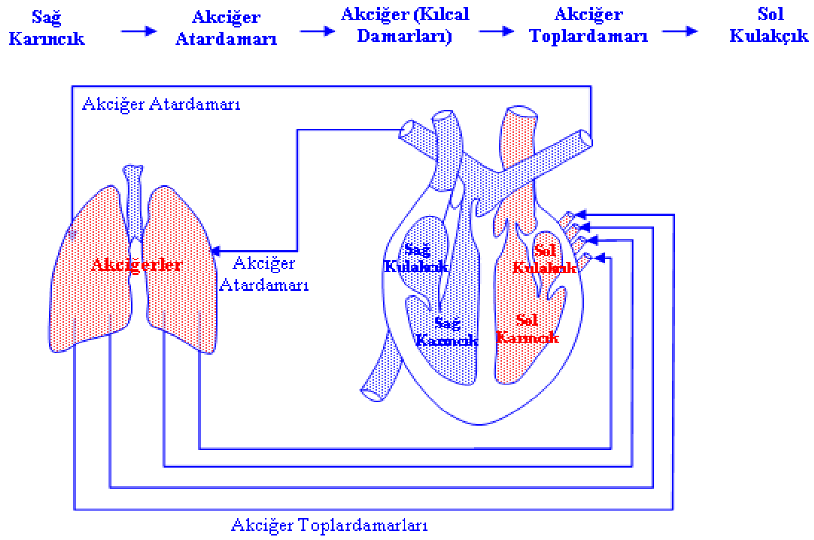
- Dolaşım sistemi, amino asitleri, yağ asitlerini ve glikoz gibi besin maddelerini, hormonları ve oksijeni dokulara götürür. Dokularda oluşan metabolizma atıklarını ise boşaltım organlarına taşır.
- İnsanda kan dolaşımı küçük ve büyük dolaşım sistemi olarak ikiye ayrılır.



<u>A) Küçük Dolaşım</u>

- Sağ karıncıktan akciğer atardamarı ile çıkan kirli kanın akciğerlere gidip temizlendikten sonra, akciğer toplardamarı ile kalbin sol kulakçığına gelmesine küçük dolaşım denir.

  Sağ karıncık -->Akciğer atar damarı -->Akciğer kılcalları -->Akciğer toplar damarları -->Sol kulakçık

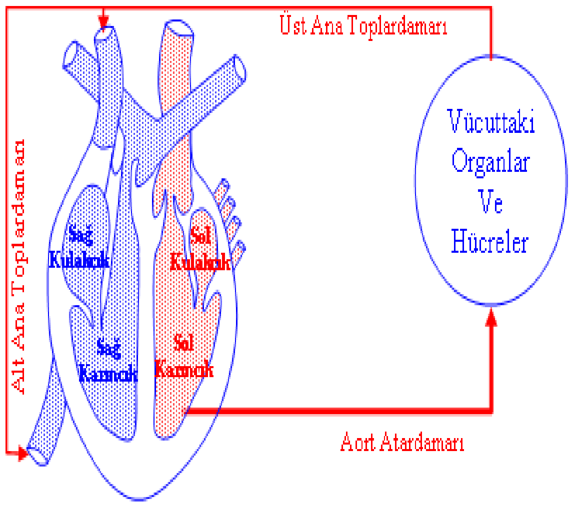


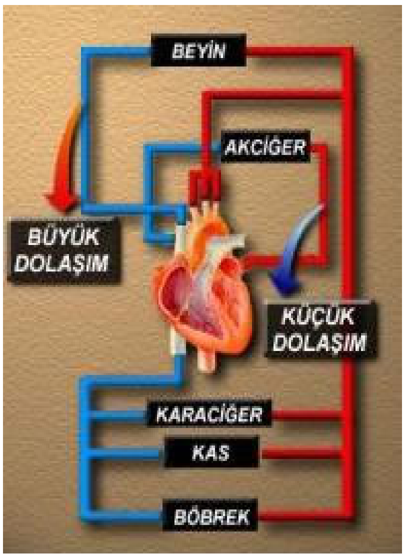
B) Büyük Dolaşım

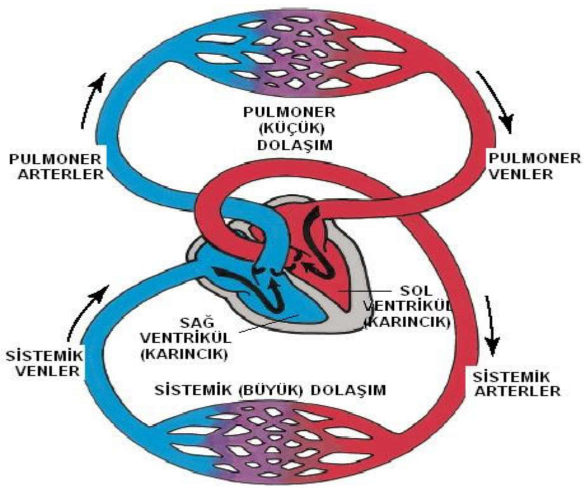
- Sol karıncıktan aort ile çıkan temiz kanın tüm vücudu dolaşarak oksijeni azalıp karbondioksiti çoğaldıktan sonra, alt ve üst ana toplardamarlarla kalbin sağ kulakçığına gelmesine büyük dolaşım denir.

  Sol karıncık -->AORT Organ atar damarları -->Kılcallar -->Organ toplar damarları -->Üst ve alt ana toplar damarı -->Sağ kulakçık

Sol Karıncık → Aort Atardamarı → Vücut (Atardamarları) → Vücut (Kılcal Damarları) → Vücut (Toplardamarları) → Alt ve Üst Ana Toplardamarları → Sağ Kulakçık







4. KAN BASINCI

- Nabız, kalbin 1 dakika içinde kaç kere kasıldığını yani kalbin hızını yansıtır. Kalp her kasılmasıyla bir miktar kanı atardamarlar içine fırlatır ve damarların esneyebilme özelliğinden dolayı atardamarlarda buna bağlı bir genişleme olur ve ardından eski durumuna dönmek ister. İşte bu genişleme, damarların yüzeyel seyrettiği yerlerde (el bileği, dirsek içi, kasık, şakak, ayak bileği gibi) nabız dalgası olarak hissedilir.
- Kanın sol karıncıktan büyük atardamarlara pompalanması sırasında, uç noktalardaki atardamarlarda oluşturduğu dalgalanmadır. Kalp atışının uçtaki atardamarlardan (periferik arterlerden) hissedilmesine **Nabız** denir.
- Normalde nabız (kalp atım hızı/sayısı) **erişkinde** 60-90 kez/dk, **çocukta** 80-100 kez/dk, **bebekte** 100-120 kez/dakika civarındadır
- Kan basıncı, kanın arterlerden geçerken arter duvarına yaptığı basınçtır. Sol karıncık kasılarak kanı aortaya pompalamasına sistol (büyük tansiyon), gevşeyerek kanla dolmasına ise diastol (küçük tansiyon) denilmektedir.
- Kan basıncının ortalama değerleri **erişkinde** 110-120 / 70-80 mmHg, **çocukta** 90 / 60 mmHg, **bebekte** 70 / 50 mmHg'dır.
- Atardamarlardaki basıncın sürekli yüksek olması **hipertansiyona** neden olur.
- Atardamar çeperinin esneklik özelliğini kaybedip iyice genişlemesi sonucunda kan basıncı düşer, **hipotansiyon** meydana gelir.
- Kan basıncı, kolda dirseğin 3 cm üstünden, bacakta ise diz üstünden ölçülür.

A) Kanın Görevleri

1. Taşıma görevi,
2. Düzenleme görevi,
3. Savunma görevi,
4. Koruma görevi.

APPENDIX H

LEARNING APPROACH QUESTIONNAIRE

Table H1: Learning Approach Questionare

	Kesinlikle Katılmıyorum	Katılmıyorum	Katılıyorum	Kesinlikle Katılıyorum
1.Genellikle ilk bakışta zor gibi konuları anlamak için çok çaba sarfederim.				
2.Bir konuya çalışırken öğrendiğim yeni bilgileri eskisi ile ilişkilendirmeye çalışırım.				
3. Ders çalışırken öğrendiğim bilgileri günlük hayatta nasıl kullanabileceğimi düşünürüm.				
4. Konuları en iyi öğretmenin anlattığı sırayı düşündüğümde hatırlarım.				
5. Öğrenmek zorunda olduğum konuları ezberlerim.				
6. Önemli konuları tam olarak anlayana kadar tekrar ederim.				
7. Öğretmenler, öğrencilerinden, sınavda sorulmayacak konular üzerinde çok fazla zaman harcamalarını beklememelidirler.				
8. Bir kez çalışmaya başladığımda her konunun ilgi çekici olduğuna inanırım.				
9. Derslerde duyduğum ya da kitaplarda okuduğum bazı bilgiler hakkında sık sık düşünürüm.				
10. Konuların birbirleriyle ile nasıl ilşkilendiğini anlayarak, yeni bir konu hakkında genel bir bakış açısı edinmenin benim için faydalı olduğunu düşünürüm.				
11. Anladığımdan iyice emin olana kadar dersten yada laboratuvardan sonra notlarımı tekrar tekrar okurum.				
12. Bir konu hakkında çok fazla araştırma yapmanın zaman kaybı olduğunu düşündüğümden, sadece sınıfta yada ders notlarında anlatılanları ciddi bir şekilde çalışırım.				
13. Okumam için verilen materyalleri, anlamıno tam olarak anlayıncaya kadar okurum.				
14. Gerçek olaylara dayanan konuları, varsayılara dayanan konulardan daha çok severim.				
15. Bir konuda öğrendiğim bilgiyi, başka bir konuda öğrendiğimle ilişkilendirmeye çalışırım.				
16. Benim için teknik terimlerin ne anlama geldiğini anlamanın en iyi yolu ders kitabındaki tanımı hatırlamaktır.				
17. Bulmaca ve problemler çözerek mantıksal sonuçlara ulaşmak beni heyecanlandırır.				
19. Konuları ezberleyerek öğrenirim, yani öğrendiğime inanana kadar ezberlerim.				
20. Çoğunlukla konuları gerçekten anlamadan okurum.				
21. Bir konuyla ilgili verilen fazladan okumalar kafa karıştırıcı olabileceğinden sadece derste öğrendiklerimize paralel olarak tavsiye edilen birkaç kitaba bakarım.				
22. Ekstra birşeyler yapmanın gereksiz olduğunu düşündüğüm için, çalışmamı genellikle derste verilen bilgiyle sınırlarım.				

APPENDIX I

TEST OF LOGICAL THINKING

AÇIKLAMA: Bu test, çeşitli alanlarda, özellikle Fen ve Matematik dallarında karşılaşabileceğiniz problemlerde neden-sonuç ilişkisini görüp, problem çözme stratejilerini ne derece kullanabileceğinizi göstermesi açısından çok faydalıdır. Bu test içindeki sorular mantıksal ve bilimsel olarak düşünmeyi gösterecek cevapları içermektedir.

NOT: Soru Kitapçığı üzerinde herhangi bir işlem yapmayınız ve cevaplarınızı yalnızca cevap kağıdına yazınız. CEVAP KAĞIDINI doldururken dikkat edilecek hususlardan birisi, 1 den 8 e kadar olan sorularda her soru için cevap kağıdında iki kutu bulunmaktadır. Soldaki ilk kutuya sizce sorunun uygun cevap şıkkını yazınız, ikinci kutucuğa yani AÇIKLAMASI yazılı kutucuğa ise o soruyla ilgili soru kitapçığındaki Açıklaması kısmındaki şıkları okuyarak sizce en uygun olanını seçiniz. Örneğin 12'nci sorunun cevabı sizce b ise ve Açıklaması kısmındaki en uygun açıklama ikinci şık ise cevap kağıdını aşağıdaki gibi doldurun:

12. [b] AÇIKLAMASI [2]

9. ve 10. soruları ise soru kitapçığında bu sorularla ilgili kısımları okurken nasıl cevaplayacağınızı daha iyi anlayacaksınız.

SORU 1: Bir boyacı, aynı büyüklükteki altı odayı boyamak için dört kutu boya kullandığına göre sekiz kutu boya ile yine aynı büyüklükte kaç oda boyayabilir?

a. 7 oda

b. 8 oda

c. 9 oda

d. 10 oda

e. Hiçbiri

Açıklaması:

1. Oda sayısının boya kutusuna oranı daima 23 olacaktır.
2. Daha fazla boya kutusu ile fark azalabilir.
3. Oda sayısı ile boya kutusu arasındaki fark her zaman iki olacaktır.
4. Dört kutu boya ile fark iki olduğuna göre, altı kutu boya ile fark yine iki olacaktır.
5. Ne kadar çok boyaya ihtiyaç olduğunu tahmin etmek mümkün değildir.

SORU 2: On bir odayı boyamak için kaç kutu boya gerekir? (Birinci soruya bakınız)

a. 5 kutu

b. 7 kutu

c. 8 kutu

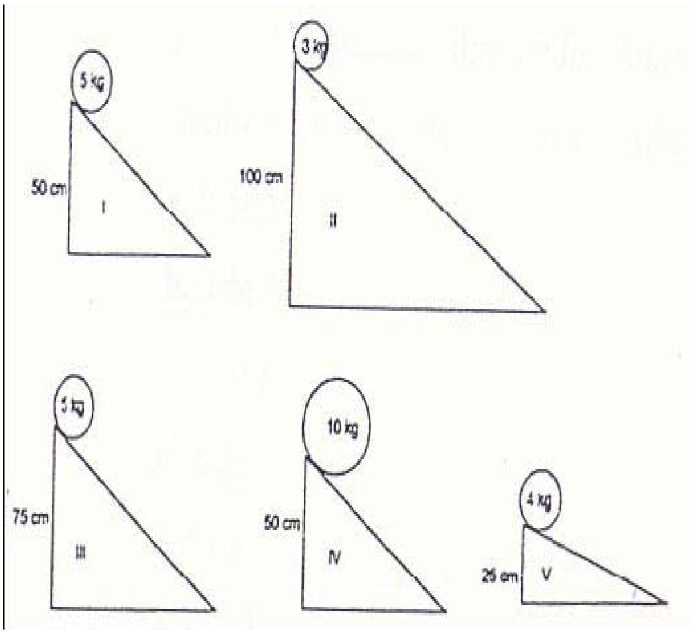
d. 9 kutu

e. Hiçbiri

Açıklaması:

1. Boya kutusu sayısının oda sayısına oranı daima32dür.
2. Eğer beş oda daha olsaydı, üç kutu boya daha gerekecekti.
3. Oda sayısı ile boya kutusu arasındaki fark her zaman ikidir.

SORU 3: Topun eğik bir düzlemden (rampa) aşağı yuvarlandıktan sonra kat ettiği mesafe ile eğik düzlemin yüksekliği arasındaki ilişkiyi bulmak için deney yapmak isterseniz, aşağıda gösterilen hangi eğik düzlem setlerini kullanırdınız?



a. I ve IV

b. II ve IV

c. I ve III

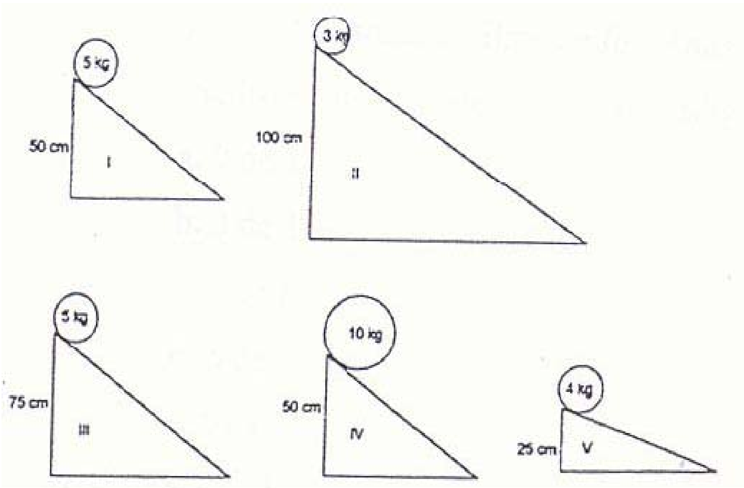
d. II ve V

e. Hepsi

Açıklaması:

1. En yüksek eğik düzlemle (rampa) karşı en alçak olan karşılaştırılmalıdır.
2. Tüm eğik düzlem setleri birbiriyle karşılaştırılmalıdır.
3. Yükseklik arttıkça topun ağırlığı azalmalıdır.
4. Yükseklikler aynı fakat top ağırlıkları farklı olmalıdır.
5. Yükseklikler farklı fakat top ağırlıkları aynı olmalıdır.

SORU 4: Tepeden yuvarlanan bir topun eğik düzlemden (rampa) aşağı yuvarlandıktan sonra kat ettiği mesafenin topun ağırlığıyla olan ilişkisini bulmak için bir deney yapmak isterseniz, aşağıda verilen hangi eğik düzlem setlerini kullanırdınız?



a. I ve IV

b. II ve IV

c. I ve III

d. II ve V

e. Hepsi

Açıklaması:

a. En ağır olan top en hafif olanla kıyaslanmalıdır.

b. Tüm eğik düzlem setleri birbiriyle karşılaştırılmalıdır.

c. Topun ağırlığı arttıkça, yükseklik azaltılmalıdır.

d. Ağırlıklar farklı fakat yükseklikler aynı olmalıdır.

e. Ağırlıklar aynı fakat yükseklikler farklı olmalıdır.

SORU 5: Bir Amerikalı turist Şark Expresi'nde altı kişinin bulunduğu bir kompartımana girer. Bu kişilerden üçü yalnızca İngilizce ve diğer üçü ise yalnızca Fransızca bilmektedir. Amerikalının kompartımana ilk girdiğinde İngilizce bilen biriyle konuşma olasılığı nedir?

a. 2 de 1
b. 3 de 1
c. 4 de 1
d. 6 da 1
e. 6 da 4

Açıklaması:

1. Ardarda üç Fransızca bilen kişi çıkabildiği için dört seçim yapmak gerekir.
2. Mevcut altı kişi arasından İngilizce bilen bir kişi seçilmelidir.
3. Toplam üç İngilizce bilen kişiden sadece birinin seçilmesi yeterlidir.
4. Kompartımandakilerin yarısı İngilizce konuşur.
5. Altı kişi arasından, bir İngilizce bilen kişinin yanısıra, üç tanede Fransızca bilen kişi seçilebilir.

SORU 6: Üç altın, dört gümüş ve beş bakır para bir torbaya konulduktan sonra, dört altın, iki gümüş ve üç bakır yüzük de aynı torbaya konur. İlk denemede torbadan altın bir nesne çekme olasılığı nedir?

a. 2 de 1
b. 3 de 1
c. 7 de 1
d. 21 de 1
e. Yukarıdakilerden hiçbiri

Açıklaması:

1. Altın, gümüş ve bakırdan yapılan nesneler arasından bir altın nesne seçilmelidir.
2. Paraların 41ü ve yüzüklerin 94u altından yapılmıştır.
3. Torbadan çekilen nesnenin para ve yüzük olması önemli olmadığı için toplam 7 altın nesneden bir tanesinin seçilmesi yeterlidir.
4. Toplam yirmi bir nesneden bir altın nesne seçilmelidir.
5. Torbadaki 21 nesnenin 7 si altından yapılmıştır.

SORU 7: Altı yaşındaki Ahmet'in şeker almak için 50 lirası vardır. Bakkaldaki kapalı iki şeker kutusundan birinde 30 adet kırmızı ve 50 adet sarı renkte şeker bulunmaktadır. İkinci bir kutuda ise 20 adet kırmızı ve 30 adet sarı şeker vardır. Ahmet kırmızı şekerleri sevmektedir. Ahmet'in ikinci kutudan kırmızı şeker çekme olasılığı birinci kutuya göre daha fazla mıdır?

a. Evet
b. Hayır

Açıklaması:

1. Birinci kutuda 30, ikincisinde ise yalnızca 20 kırmızı şeker vardır.
2. Birinci kutuda 20 tane daha fazla sarı şeker, ikincisinde ise yalnızca 10 tane daha fazla sarı şeker vardır.
3. Birinci kutuda 50, ikincisinde ise yalnızca 30 sarı şeker vardır.
4. İkinci kutudaki kırmızı şekerlerin oranı daha fazladır.
5. Birinci kutuda daha fazla sayıda şeker vardır.

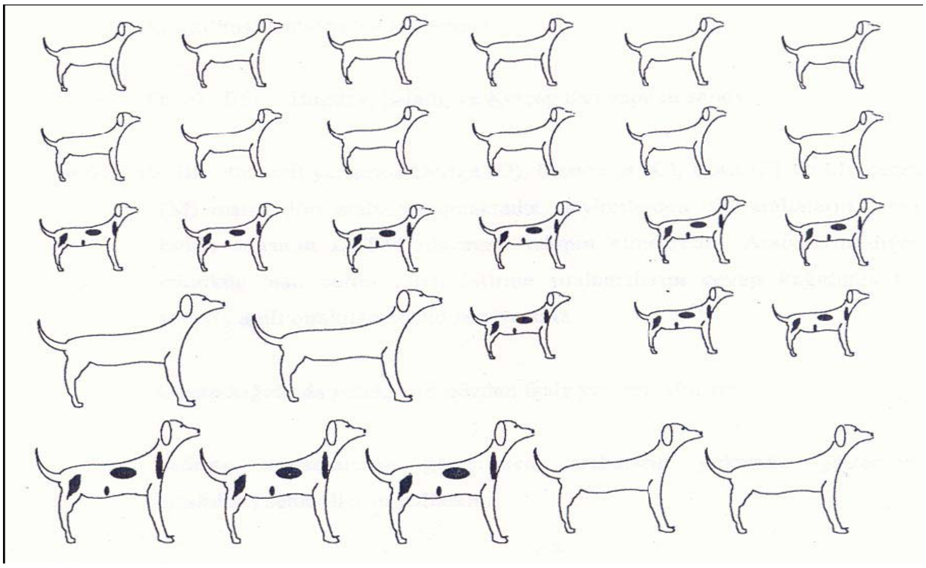
SORU 8: 7 büyük ve 21 tane küçük köpek şekli aşağıda verilmiştir. Bazı köpekler benekli bazıları ise beneksizdir. Büyük köpeklerin benekli olma olasılıkları küçük köpeklerden daha fazla mıdır?

a. Evet

b. Hayır

Açıklaması:

1. Bazı küçük köpeklerin ve bazı büyük köpeklerin benekleri vardır.
2. Dokuz tane küçük köpeğin ve yalnızca üç tane büyük köpeğin benekleri vardır.
3. 28 köpekten 12 tanesi benekli ve geriye kalan 16 tanesi beneksizdir.
4. Büyük köpeklerin 73si ve küçük köpeklerin 219i beneklidir.
5. Küçük köpeklerden 12 sinin, fakat büyük köpeklerden ise sadece 4ünün beneği yoktur.



SORU 9: Bir pastanede üç çeşit ekmek, üç çeşit et ve üç çeşit sos kullanılarak sandviçler yapılmaktadır.

Ekmek Çeşitleri	Et Çeşitleri	Sos Çeşitleri
Buğday (B)	Salam (S)	Ketçap (K)
Çavdar (Ç)	Piliç (P)	Mayonez (M)
Yulaf (Y)	Hindi (H)	Tereyağı (T)

Her bir sandviç ekmek, et ve sos içermektedir. Yalnızca bir ekmek çeşidi, bir et çeşidi kullanılarak kaç çeşit sandviç hazırlanabilir?

Cevap kağıdı üzerinde bu soruyla ilgili bırakılan boşluklara bütün olası sandviç çeşitlerinin listesini çıkarın.

Cevap kağıdında gereksiniminizden fazla yer bırakılmıştır.

Listeyi hazırlarken ekmek, et ve sos çeşitlerinin yukarıda gösterilen kısaltılmış sembollerini kullanınız.

Örnek: BSK= Buğday, Salam ve Ketçap dan yapılan sandviç

SORU 10: Bir otomobil yarışında Dodge (D), Chevrolet (C), Ford (F) ve Mercedes (M) marka dört araba yarışmaktadır. Seyircilerden biri arabaların yarışı bitiriş sırasının DCFM olacağını tahmin etmektedir. Arabaların diğer mümkün olan bütün yarışı bitirme sıralamalarını cevap kağıdında bu soruyla ilgili bırakılan boşlukalara yazınız.

Cevap kağıdında gereksiniminizden fazla yer bırakılmıştır.

Bitirme sıralamalarını gösterirken, arabaların yukarıda gösterilen kısaltılmış sembollerini kulanınız.

Örnek: DCFM yarışı sırasıyla önce Dodge'nin, sonra Chevrolet'in, sonra Ford'un ve en sonra Mercedes'in bitirdiğini gösterir.

APPENDIX J

SELF EFFICACY SCALE

Açıklama: Bu ölçekte, Biyoloji dersine ait güdüsel inancınızı ilişkin 9 cümle ile her cümlenin karşısında KESİNLİKLE KATILMIYORUM, KATILMIYORUM, KARARSIZIM, KATILIYORUM, KESİNLİKLE KATILIYORUM olmak üzere beş seçenek verilmiştir. Her cümleyi dikkatlice okuduktan sonra kendinize uygun seçeneği **√** işareti ile belirleyiniz.

Table J1: Self Efficacy Scale

	Tamamnen Katılıyorum	**Katılıyorum**	**Kararsızım**	**Katılmıyorum**	**Kesinlikle Katılmıyorum**
1) Sınıftaki diğer öğrenciler ile karşılaştırıldığında Biyoloji dersinde başarılı olmayı beklerim.					
2) Biyoloji dersinde öğretilen konuları anlayabildiğime eminim.					
3) Biyoloji dersinde başarılı olacağımı düşünüyorum.					
4) Sınıftaki diğer öğrenciler ile karşılaştırıldığında, iyi bir öğrenci olduğumu düşünüyorum.					
5) Biyoloji dersi için belirlenen görevleri ve problemleri en iyi şekilde yapabileceğime eminim.					
6) Biyoloji dersinden iyi bir not alacağımı düşünüyorum.					
7) Sınıftaki diğer öğrenciler ile karşılaştırıldığında, çalışma becerilerim mükemmeldir.					
8) Sınıftaki diğer öğrenciler ile karşılaştırıldığında, Biyoloji konuları hakkında daha fazla bilgiye sahip olduğumu düşünüyorum.					
9) Biyoloji dersinde verilen bilgileri öğrenebileceğime inanıyorum.					

APPENDIX K

LOCUS OF CONTROL SCALE

Aşağıda a ve b olarak verilen çift cümlelerin hangisinin daha doğru olduğunu düşünüyorsanız onun önüne bir çarpı (X) işareti koyunuz. Bazı çift cümlelerin her ikisi de fikrinize uygun olmayabilir. Böyle bir durumda bu iki cümleden düşüncenize biraz daha uygun olanı seçiniz. Her çift cümleyi kendi başına ele alınız; ona cevap verirken diğer çift cümlelerin etkisi altında kalmayınız.

( )	a	İnsanların yaşamındaki üzüntülü olayların çoğuna kısmen kötü talih sebep olur.
( )	b	İnsanların talihsizlikleri tamamen kendi yaptıkları hataların sonucudur
( )	a	Bu dünyada insanlar eninde sonunda hakettikleri saygıyı görürler
( )	b	Bir insan ne kadar uğraşırsa uğraşsın onun değeri maalesef genellikle farkedilmez
( )	a	Başarı sağlamak çok çalışmaya bağlıdır, şansla hemen hemen hiç ilgisi yoktur
( )	b	İyi bir işi elde etmek esas olarak doğru zamanda doğru yerde olmaya bağlıdır
( )	a	Herhangi bir vatandaşın devlet kararlarına etkisi olabilir
( )	b	Bu dünyayı başta bulunan az sayıda insan idare eder ve herhangi bir kimsenin bu konuda yapabileceği pek bir şey yoktur
( )	a	Planlar yaptığım zaman o planları uygulayabileceğimden hemen hemen eminimdir
( )	b	Çok önceden plan yapmak her zaman akıllıca bir iş değildir, çünkü birçok şey zaten iyi veya kötü şans işi oluyor

( )	a	Dünya meselelerinde çoğumuz anlayamadığımız ve kontrol edemediğimiz kuvvetlerin kurbanı oluyoruz
( )	b	İnsanlar siyasi ve sosyal olaylara aktif olarak katılarak dünya olaylarını kontrol edebilirler
( )	a	İnsanların çoğu hayatlarının ne dereceye kadar tesadüfi olaylarla kontrol edildiğinin farkında değiller
( )	b	Gerçekte şans diye birşey yoktur
( )	a	Birisinin bizi gerçekten sevip sevmediğini bilmek zordur
( )	b	Kaç tane arkadaşımız olduğu bizim ne kadar iyi bir insan olduğumuza bağlıdır
( )	a	Çok zaman başıma gelen iyi ve kötü olaylarda rolümün çok az olduğunu hissederim
( )	b	Şans veya talihin hayatımda önemli bir rol oynadığına inanmak benim için imkansızdır

APPENDIX L

BIOLOGY ATTITUDE SCALE

Bu ölçek, Biyoloji dersine ilişkin tutum cümleleri ve her cümlenin karşısında sizin düşüncenizi ölçen beş seçenek içermektedir. Lütfen her cümleyi dikkatle okuduktan sonra kendinize uygun seçeneği işaretleyiniz.

Table L1: Biology Attitude Scale

		Tamamen katılıyorum	Katılıyorum	Kararsızım	Katılmıyorum	Hiç katılmıyorum
1)	Biyoloji çok sevdiğim bir alandır.					
2)	Biyoloji ile ilgili kitapları okumaktan hoşlanırım.					
3)	Biyolojinin günlük yaşantıda çok önemli yeri yoktur.					
4)	Biyoloji ile ilgili ders problemlerini çözmekten hoşlanırım.					
5)	Biyoloji konuları ile ilgili daha çok şey öğrenmek isterim.					
6)	Biyoloji dersine girerken sıkıntı duyarım.					
7)	Biyoloji derslerine zevkle girerim.					
8)	Biyoloji dersine ayrılan ders saatinin daha fazla olmasını isterim.					
9)	Biyoloji dersine çalışırken canım sıkılır.					
10)	Biyoloji konularını ilgilendiren günlük olaylar hakkında daha fazla bilgi edinmek isterim.					
11)	Düşünce sistemimizi geliştirmede Biyoloji öğrenimi önemlidir.					
12)	Biyoloji çevremizdeki doğal olayların daha iyi anlaşılmasında önemlidir.					
13)	Dersler içinde Biyoloji dersi sevimsiz gelir.					
14)	Biyoloji konuları ile ilgili tartışmalara katılmak bana cazip gelmez.					
15)	Çalışma zamanımın önemli bir kısmını Biyoloji dersine ayırmak isterim.					

CURRICULUM VITAE

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