THE EFFECT OF MULTIPLE INTELLIGENCES BASED INSTRUCTION ON STUDENTS' ACHIEVEMENT IN BASIC COMPOUNDS OF LIVING ORGANISMS CONCEPTS AND ATTITUDE TOWARD BIOLOGY

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ABSTRACT

THE EFFECT OF MULTIPLE INTELLIGENCES BASED INSTRUCTION ON STUDENTS' ACHIEVEMENT IN BASIC COMPOUNDS OF LIVING ORGANISMS CONCEPTS AND ATTITUDE TOWARD BIOLOGY

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The main purpose of this study was to compare the effectiveness of multiple intelligences based instruction (MIBI) over traditionally designed instruction on ninth grade students' achievement in the unit of basic compounds of living organisms concepts and attitude toward biology as a school subject. In addition, the effect of gender difference on achievement in the unit and attitudes toward biology were investigated. Students' science process skills were also investigated. 59 ninth grade students from two different classes taught by the same teacher at a public Anatolian high school in Kırşehir were enrolled in the study during first semester of 2011-2012 academic years. The classes were randomly assigned as control group and experimental group. While control group students were instructed by traditionally designed biology instruction, the experimental group students were instructed with MIBI over a period of ten weeks. Basic compounds of living organisms achievement test and attitude scale toward biology were given to both groups as a pre-test and post-test. Science Process skills test was given at the beginning of the study to determine students' science process skills. Interviews were hold with some students in the experimental group and the teacher to get their opinions about the implementation of MI based instruction. Multivariate Analysis of Covariance (MANCOVA) was used to analyze the data. The results of the study revealed that MIBI compared to traditional instruction was more effective to improve students' achievement in the unit of basic compounds of living organisms. However there was no significant effect of MIBI on students' attitude toward biology. Moreover there was no significant effect of gender difference on both students' achievement in the unit and attitudes toward biology. The results of interview showed that both students and the teacher had positive opinions toward MIBI.

Keywords: Multiple intelligences based instruction, basic compounds of living organisms, achievement, attitude toward biology, gender.

ÖZ

ÇOKLU ZEKA TEMELLİ ÖĞRETİMİN ÖĞRENCİLERİN CANLILARIN TEMEL BİLEŞENLERİ KAVRAMLARINA İLŞİKİN BAŞARILARINA VE BİYOLOJİYE KARŞI TUTUMLARINA ETKİSİ

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Bu çalışmanın temel amacı çoklu zeka temelli öğretimin geleneksel öğretime göre dokuzuncu sınıf öğrencilerinin canlıların temel bileşenleri ünitesindeki başarısına ve biyoloji dersine yönelik tutumlarına etkisini karşılaştırmaktır. Ayrıca cinsiyet farklılığının ünitedeki başarıya ve biyoloji dersine yönelik tutuma etkisi araştırılmıştır. Öğrencilerin bilimsel işlem becerileri de incelenmiştir. 2011-2012 eğitim öğretim yılı birinci döneminde Kırşehir'deki bir devlet Anadolu lisesinde aynı öğretmenin eğitim verdiği iki farklı sınıfta 59 dokuzuncu sınıf öğrencisi çalışmada yer almıştır. Sınıflar rastgele kontrol grubu ve deney grubu olarak atanmıştır. On hafta boyunca kontrol grubu öğrencileri geleneksel yönteme göre öğretim alırken deney grubu öğrencileri ise çoklu zeka temelli öğretime göre öğretim almışlardır. Her iki gruba da canlıların temel bileşenleri başarı testi ve biyolojieye karşı tutum ölçeği ön-test ve son-test olarak verilmiştir. Öğrencilerin bilimsel işlem becerilerine karar vermek için uygulamanın başında bilimsel işlem becerileri testi verilmiştir. Deney grubundan bazı öğrencilerle ve öğretmenle çoklu zeka temelli öğretimin uygulanması hakkındaki düşüncelerini öğrenmek için görüşmeler yapılmıştır. Verileri analiz etmek için çok değişkenli kovaryans analizi (MANCOVA) kullanılmıştır. Çalışmanın sonuçları çoklu zeka temelli öğretimin geleneksel öğretime göre öğrencilerin canlıların temel bileşenleri ünitesindeki başarılarını geliştirmede daha etkili olduğunu ortaya çıkarmıştır. Bununla birlikte çoklu zeka temelli öğretimin öğrencilerin biyolojiye karşı olan tutumlarına anlamlı bir etkisi yoktur. Ayrıca cinsiyet farklılığının öğrencilerin ünitedeki başarıya ve biyolojiye olan tutumlarına anlamlı bir etkisi yoktur. Görüşme sonuçları öğrencilerin ve öğretmenin çoklu zeka temelli öğretimle ilgili olumlu düşüncelere sahip olduğunu göstermiştir.

Anahtar Kelimeler: Çoklu zeka temelli öğretim, canlıların temel bileşenleri, başarı, biyolojiye karşı tutum, cinsiyet.

To my mother

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LIST OF ABBREVIATIONS

MI:	Multiple Intelligences
MIT:	Multiple Intelligences Theory
MIBI:	Multiple Intelligences Based Instruction
TI:	Traditional Instruction
EG:	Experimental Group
CG:	Control group
BCLOAT:	Basic Compounds of Living Organisms Test
ASTB:	Attitude Scale Toward Biology
SPST:	Science Process Skills Test
DV:	Dependent Variable
IV:	Independent Variable
MANCOVA:	Multivariate analysis of Covariance
ANCOVA:	Analysis of Covariance
Df:	Degrees of Freedom
Sig. :	Significance

CHAPTER 1

INTRODUCTION

Education is a hot topic discussed by people continuously both nationally and internationally since it has a dynamic structure not a static one. Results of the international exams for student evaluation forced related authorities to plan reforms to change existing educational systems in most countries resulting in discussion of educational applications. One branch of these discussions is science education (Schroeder, Scott, Tolson, Huang, & Lee, 2007). Although authorities in education agree with the significance of science instruction in formal education, how to perform effective science instruction is open to debate for decades. Understanding scientific concepts instead of memorizing facts is considered as one of the major goals of science education in schools (Dicarlo, 2006). Students get lots of difficulties for learning scientific concepts. Thus educators propose several approaches to make students grasp scientific concepts. In traditional educational settings, students usually memorize information presented in classes. Nevertheless, students should be able to apply, analyze and synthesize information of what they have learned in science classes. Although the difficulties of science education is accepted by educators, teachers, and researchers the way how to overcome these difficulties in practice is not agreed.

Since the beginning of the twentieth century, several theories like behaviorism, constructivism, and multiple Intelligences (MI) theory aroused in order to explain learning process. Educators introduced lots of teaching strategies related with science instruction based on these theories (Akbaş, 2004). There are lots of different approaches to science education. One of them is multiple intelligences based instruction.

According to Gardner (1997) who is the establisher of multiple intelligences theory (MIT), there are eight kinds of intelligences and one possible candidate intelligence. These are logical-mathematical, verbal-linguistic, rhythmic-musical, visual-spatial, bodily-kinesthetic, interpersonal, intrapersonal, naturalistic and existential intelligences as a candidate intelligence. Gardner states that although there is no consensus on explanation of intelligence concept or how to test it, there is indisputable reality that classical approach to intelligence which is thought as single entity is debated (Gardner, Siegel & Shaughnessy, 1994). Gardner (1998) claims two important facts about MI. One of them is every individual has all types of these intelligences and second one is each individual has unique combination of these intelligences. i.e every individual even identical twins have different profiles of intelligences as each individual has different appearance or personality.

Gardner surprised when his theory of intelligences got attention of educators so much because he didn't intend to propose his theory for educational purposes (Gardner, 1995). Although MI theory is not proposed for educational purposes, it can be said that traditional view of intelligence is not enough to prepare curriculums, make educational policies and creating environments for every student. MI proposes a different view of intelligence that suggests applications suitable for every student which has a unique composition of intelligences (Moran, Kornhaber & Gardner, 2006). MI theory presents a model and vocabulary for the discussion of how main components of education like instruction and curriculum should be constructed to be able to make more students successful (Hoerr, 2003). Gardner thinks that there is no single perfect method based on MI theory which is useful and effective for every educational setting. Actually MI theory doesn't give recipe for educational implementations. Educators are the authorities that decide how to apply theory to educational purposes (Gardner & Moran, 2006). Although MI theory's born is not for

education. MI theory can encourage radical changes about schools and education (Blithe & Gardner, 1990).

Students have different types of learning styles since they have different types of intelligence with varying strength. There is a need to develop different teaching strategies in order to meet different learning styles. Therefore teachers should adjust their instructional strategy in order to meet students' individual needs (Nolen, 2003). Although there are lots of researches about how brain works and how one can construct knowledge for meaningful learning, traditional teaching methods are common in schools (Lawrence, 1998). Teachers find it easy to present the topics directly to students. Teachers expect that all students learn in the same way. Teachers should develop new strategies to diversify the instruction resulting in meeting different needs of students. What type of different strategies and resources should be developed is an issue that must be considered. In this point, MI theory gives guidance to teachers (Mbuva, 2003). Verbal-linguistic and logical-mathematical intelligences based instruction is common in formal school education. Other types of intelligences are neglected in instruction (Hickey, 2004). Teachers should develop lesson plans addressing other types of intelligences in order to reach all of the students in the classroom. By this way the differences between students' level of understanding of the concept can be eliminated.

One of the areas of science is biology. Biology is a life science. It covers every topics related with life. We as human beings are also a part of life. Therefore learning about biology makes excessive contribution to our daily life. Biology education has a central role in science education (Reiss & Tunnicliffe, 2001). Reforms in biology education like changing textbook formats and including more laboratory sessions are not enough to get a complete success in biology education. Mentality of teachers should also be changed, because students don't understand biology by using only traditional methods (Penick, 1995). Biology education like science education must be meaningful in order to apply theoretical knowledge to practice. Most of the time students in biology classes memorize information, enter the exam and some time after the exam they forget what they memorized. Rote learning should be replaced by meaningful learning in order to make students understand biological concepts. Students should understand, apply, analyze and synthesize the concepts besides knowing the concept.

In biology, students have to know some basic knowledge in order to understand further topics better. One of the basic subjects in biology is cell biology. Flores et al. (2003) think that students experience difficulty in understanding cell concept. Some of the topics related with cell biology are cell components, cell physiology, cell metabolism, and cell biochemistry. Students must understand these topics very well in order to learn other biological concepts like respiration, reproduction, nutrition or genetic regulation mechanisms and organelle composition. There have been explosion of new knowledge in molecular and cell biology for last few decades making cell concept more complex (Dicarlo, 2006). Therefore students have to know biochemistry of cell very well in order to understand other subjects of biology. In high school biology curriculum, biochemistry of basic compounds of cell is one of the first subject matters instructed by teachers. Students are exposed some concepts like organic and inorganic first time (Altunoğlu & Atav, 2005). The subject is basically classified as organic compounds and inorganic compounds. Inorganic compounds are water, acids, bases, salts, and minerals. Organic compounds are carbohydrates, proteins, lipids, enzymes, vitamins, and nucleic acids. All of these subjects must be understood well by students to learn further subjects better.

Attitude is one of affective variables in education and discussed by researchers in science education abundantly (Koballa, 1988). There is an interaction between attitude and achievement in science education (Osborne, Simon, and Collins, 2003). Therefore there are lots of research studies investigating students' attitude toward science related courses. There are several factors affecting students' attitude toward course. One of most discussed factors affecting attitude is gender. Although some research results show significant effect of gender on students' attitude toward biology (Pehlivan & Köseoğlu, 2010; Ekici & Hevedanlı, 2010); some indicate no significant effect (Gül & Yeşilyurt, 2010). The effects of instructional methods on attitude in

science education have also been investigated in literature abundantly (Presley, 2005; köksal & yel, 2007; Kurt, 2009).

Having considered the fact that MI based instruction is an alternative method addressing learning differences of all students, this study aims to examine 9th grade students' achievement in the unit of basic compounds of living organism and attitudes toward biology in two classes instructed by two types of method; MIBI based instruction and traditionally designed instruction in a public Anatolian high school in Kırşehir.

1.1 The purpose of the study

The purpose of this study is to investigate the effectiveness of MI based instruction compared to traditional instruction on students' achievement in the concept of basic compounds of living organisms and students' attitudes toward biology as a school subject in 9th grade biology classes.

1.2 Problems and Hypotheses

In this section, one main problem, seven sub problems and six hypotheses were stated.

1.2.1 The Main Problem and Sub-problems

1.2.1.1 The Main Problem

What is the effect of multiple intelligences based biology instruction as compared to traditional biology instruction and gender on 9th grade students' achievement in basic compounds of living organisms concepts and their attitudes toward biology as a school subject in Kırşehir.

1.2.1.2 The Sub-problems

Sub-Problem 1

Is there a significant mean difference between the effects of multiple intelligences based biology instruction and traditionally designed biology instruction with respect to students' achievement in basic compounds of living organisms concepts when science process skill is controlled as a covariate?

Sub-Problem 2

Is there a significant mean difference between males and females with respect to their achievement in basic compounds of living organisms concepts when science process skill is controlled as a covariate?

Sub-Problem 3

Is there a significant effect of interaction between gender difference and treatment with respect to students' achievement in basic compounds of living organisms concepts when science process skill is controlled as a covariate?

Sub-Problem 4

Is there a significant mean difference between the effects of multiple intelligences based biology instruction and traditionally designed biology instruction with respect to students' attitudes toward biology as a school subject when science process skill is controlled as a covariate?

Sub-Problem 5

Is there a significant mean difference between males and females with respect to students' attitudes toward biology as a school subject when science process skill is controlled as a covariate?

Sub-Problem 6

Is there a significant effect of interaction between gender differences and treatment with respect to students' attitudes towards biology as a school subject when science process skill is controlled as a covariate?

Sub-Problem 7

What are the opinions of the students and the teacher about MI based instruction?

1.2.2 Hypotheses

Null Hypothesis 1

There is no significant mean difference between post-test mean scores of the students taught with multiple intelligences based biology instruction and students taught with traditionally designed biology instruction with respect to students' achievement in basic compounds of living organisms concepts when science process skill is controlled as a covariate.

Null Hypothesis 2

There is no significant mean difference between the post-test mean scores of males and females with respect to their achievement in basic compounds of living organisms concepts when science process skill is controlled as a covariate.

Null Hypothesis 3

There is no significant effect of interaction between gender difference and treatment with respect to students' achievement in basic compounds of living organisms concepts when science process skill is controlled as a covariate.

Null Hypothesis 4

There is no significant mean difference between post-test mean scores of students taught with multiple intelligences based biology instruction and traditionally designed biology instruction with respect to students' attitudes toward biology as a school subject when science process skill is controlled as a covariate?

Null Hypothesis 5

There is no significant mean difference between post-test mean scores of males and females with respect to their attitudes toward biology as a school subject when science process skill is controlled as a covariate?

Null Hypothesis 6

There is no significant effect of interaction between gender difference and treatment with respect to students' attitudes towards biology as a school subject when science process skill is controlled as a covariate?

1.3 Definition of important terms

Definitions of important terms related with the study are given below.

MI theory: A theory developed by Howard Gardner (1983). Gardner proposed multiple intelligences concept instead of single intelligence. Gardner (1997) defined eight types of intelligences as follows:

Linguistic intelligence is related with the capacity to use words effectively whether orally or in writing.
Logical-mathematical intelligence is the capacity to use numbers effectively and to reason well.
Spatial intelligence is the ability to perceive the visual-spatial world accurately.
Bodily-kinesthetic intelligence is the capacity to use body to express ideas and feelings.
Musical intelligence is the capacity to perceive, discriminate, transform and express musical forms.
Interpersonal intelligence is the ability to perceive and make distinctions in the moods, intentions and feelings of other people.
Intrapersonal intelligence is self knowledge and the ability to act adaptively on the basis of that knowledge.
Naturalistic intelligence is the expertise in the recognition and understanding of nature.

MI based instruction. The type of instruction based on MI theory. The instruction is student centered. The teacher use different activities, methods, materials and techniques addressing different intelligences or combination of different intelligence (Stanford, 2003).

Traditional instruction: Students are instructed by lecturing. The instruction is teacher centered. Students mostly listen to teacher and take notes.

Achievement: Something which someone has succeeded in doing, especially after a lot of effort.

Attitude: The way that someone thinks and feel about something, especially when this shows in the way someone behave.

Science Process Skill: Ability which someone shows in solving complex science problems.

Basic compounds of living organisms: Inorganic and organic compounds that constitute living beings.

1.4 Significance of the study

As it is known new curriculum introduced for primary education in academic year of 2004-2005 as a pilot study in some schools in Turkey. Curriculum change attempts continued for the other levels of education in the following years (Kırıkkaya, 2009). Main philosophy of new curriculum is to change teacher centered instruction to student centered instruction. However it is not easy for teachers to adapt these new changes. Therefore teachers need concrete application examples to understand the philosophy of new curriculum and to apply new methods. MI based instruction gives good examples for student centered instruction and this study presents one of them.

This study is a long lasting study having ten weeks application period. This is very important to show the effectiveness of MI based instructions and to show that teachers can apply MI based instructions not only for short terms but also long terms. Students start to attend biology course in 9^{th} grade in Turkey. The topic selected for this study is the first unit of 9^{th} grade biology lesson. Therefore first impression about biology lesson is very important for further attitudes towards biology.

Gardner (2003) stresses that MI theory shouldn't be supposed that instructions based on the theory are suitable and effective for all levels and all settings of education. He for example thinks that MI based instructions can be particularly beneficial for learning new challenging subject

matter. On the other hand it may not show same effect for learning new foreign languages. Therefore he believes in the importance of conducting randomized control group experimental designs to make evaluations for the appropriateness of MI theory for different educational applications. Although there are lots of studies, research articles and thesis related with the effectiveness of MI based instruction, most of them don't give specific examples that can be applied in practice. Not many of them give teachers lesson plan examples that can be applied in daily school environments (Silver, Strong, & Perini, 2000). We need many more specific examples related with the application of MI based instruction in the schools (Hickey, 2004). The number of examples of individual application of MI instruction by teachers is not many. Even, examples related with high schools are not abundant compared to primary and elementary education. Saban (2009) analyzed the research studies related with MI theory conducted in Turkey between the years of 1999 and 2007. Most of studies were master theses (73.2 %), with the sample of elementary students (56.7 %). Only 17.5 % of studies used high school students as sample. Moreover only 3.2 % of studies were related with biology. Therefore this study make important contributions to the literature concerning the effect of MI based instruction on high school biology course. It is important to put new examples into literacy related with MI based instruction in order to demonstrate the effectiveness of the theory for different educational settings. If the number of specific examples related with MI based instruction increases, the effectiveness of theory can be discussed in more perceptible base. This study investigates the effectiveness of MI based instruction in a typical biology lesson with concrete lesson plans prepared according to MI theory. Teachers are advised to use activities addressing several types of intelligences yet they are not given lesson plans for specific biological topics. This study shows a clear example how teachers can prepare and apply activities prepared according to MI theory. This study can give insights to researchers interested in the application of MI theory in biology lessons.

One of the important issues in science education is attitudes of students towards science. Attitude in science education is one of the most popular research topics discussed and investigated by authorities in science education (Lee, Wu, & Tsai, 2009; Osborne, Simon, & Tytler, 2009). Students' attitude toward course could be a significant predictor for students' achievement in biology and chemistry (Çakıcı, Arıcak, & Ilgaz, 2011; Kan & Akbaş, 2006). Therefore investigating affective variables like attitude is important as investigating cognitive variables. This study also investigates how treatment affects students' attitude toward course. The average implementation periods of studies related with MI conducted in Turkey is six weeks (Saban, 2009). On the other hand the current study lasted ten weeks. Ten weeks are well enough periods to observe the change in attitude.

The issue of gender difference in science education has also been discussed from several perspectives (Jones, Howe, & Rua, 2000). Two of them are whether there are differences between boys and girls with respect to science achievement and attitudes toward science. Concerning both variables some research results indicate gender difference while some others do not. Putting new findings to literature makes educators to discuss gender difference more concretely. Therefore the results of this study can give ideas for people who interested in gender difference in science education.

CHAPTER 2

REVIEW OF LITERATURE

This review will cover some relevant literature on the concept of intelligence, multiple intelligences theory (MIT), MI theory and instruction, MI theory and assessment, Science education, Biology education and MI theory, Basic Compounds of Living Organisms and Biology and attitude. This chapter will also provide a theoretical and practical background for the current study.

2.1 The concept of intelligence

Intelligence is an attractive and controversial concept that has been discussed for centuries. Different cultures give different meanings to intelligence term. The term "intelligence" is understood differently from one culture to another. In west cultures, intelligent people are considered as logical, determine quickly and wise. On the other hand, in east cultures, intelligent person is the one who are well-behaved, obedient or having magical powers (Gardner, 1991). In history, philosophers like Plato who is an ancient Greek philosopher and Immanuel Kant who is an eighteenth century philosopher are the first people who think about intelligence and make comments about the intelligence concept. They explained the intelligence from philosophical point of view. Until twentieth century these discussion was not concrete or scientific. At the beginning of twentieth century, the intelligence concept was started to be discussed more scientifically (Cianciolo & Sternberg, 2004).

British psychologist Charles Spearman developed a concept of general intelligence called "g factor" in 1904 by using correlation between discrimination test results and school examination results (Deary, Strand, Smith, & Fernandes, 2007). Later, Spearman extended his theory and proposed two kinds of factor explaining intelligence. One of them is "g" general ability and the other one is "s" specific ability which has narrower aspects than g since it is measured by specific tests like mathematical computational tests. Although Spearman was not the first person explaining intelligence as a single ability he was the first one that used experimental and statistical methods (Cianciolo & Sternberg, 2004).

It was thought that one's intelligence can be measured by applying tests having set of items ranging from sensory discrimination to vocabulary knowledge. Intelligence tests become popular in 1920s and 1930s. These tests were started to use widely both in US and in other parts of the world (Gardner, 1991). The father of first intelligence test is thought to be British biologist Francis Galton. Galton believed that biological capacities like better hearing, seeing, touching is very important to be successful in life. However, practical and diagnostic use of Galton's test was not good (Cianciolo & Sternberg, 2004). On the other hand, the first professional intelligence test developed by Binet and Simon called Binet-Simon scale in 1905. This test revised in 1908 and 1911 leading to getting attention of western world (Siegler, 1992). The idea of "intelligence quotient" which is the ratio of a person's mental age to his or her chronological age, multiplied by 100 had been suggested by German psychologist William Stern in 1912. However it was the American psychologist Lewis M. Terman who put forward the term "Intelligence quotient" (Montagu, 1999). Terman (1916) revised and extended Binet's test and adapted by adding new items to the test to form a new test called Stanford-Binet test in 1916. Final version of the test was published in 2003 after 98 years later from the original Binet's test indicating its power for IQ test uses. Developing intelligences test after First World War run up and several intelligence scales appeared like Wechsler' intelligence scale which current version of the test is still used today (Cianciolo & Sternberg, 2004). Single intelligence concept was argued by scientists. Thurnstone is the first person claiming that human intellectual capacity is too complex that one single entity

can not explain (Morgan, 1996). Thurstone (1938) proposed 7 "primary mental abilities: Verbal comprehension, reasoning, perceptual speed, numerical ability, word fluency, associative memory, spatial visualization. After Thurstone some other scientist likes Godfrey Thomson and Joy Paul Guilford proposed multiple abilities concept instead of single intelligence concept (Cianciolo & Sternberg, 2004).

After second half of the 20th century there has been lots of findings related with biology. One of the popular topics was mind and brain which changed the course of approaches to intelligence (Blake & Gardner, 2007). By 1980 as in education and biology new findings changed the way of arguments about intelligence radically (Gardner, Siegel & Shaughnessy, 1994). After 1980s single intelligence concept was debated among scientist and psychologists and new approaches introduced. New information obtained from related sciences challenged the concept of general intelligence and questioned instruments measuring intelligence (Gardner, 2000). At the end of the 80s artificial intelligence concept emerged parallel with improvements in computer and neurosciences. Questions about mind illuminated better compared to old explanations (Gardner, 1991b).

For decades intelligence considered as a single concept which can be demonstrated in numbers. Nevertheless in recent years the concept of "everyone has an IQ score and this shows his intelligence level" becomes open to debate. Particularly, developments in the area of psychology, neurosciences and artificial intelligence research, have made scientist consider intelligences from different perspectives (Gardner, 1991). Without doubt one of the leading and radical alternative approach was Gardner's multiple intelligences theory. Gardner defined intelligence as "the capacity to solve problems or fashion products which are valued in one or more cultural settings" (Gardner, 2007). He also thinks that "an intelligence is a biological and psychological potential; that potential is capable of being realized to a greater or lesser extent as a consequence of the experiential, cultural, and motivational factors that affect a person" (Gardner, 1995). Gardner questioned the concept of general intelligence. Instead, he proposed that mind has different types of capabilities that a single intelligence cannot explain (Blythe & Gardner, 1990).

There are several perspectives explaining intelligence concepts from different points of view. Piaget evaluated from cognitive perspective. He explained cognitive development of children as different stages: sensory motor 0-2, preoperational 2-7, concrete operational 7-11, and formal operational 11-16 and forward. On the other hand, Vygotsky dominated importance of social effect to intelligence (Cianciolo & Sternberg, 2004). Sternberg (1999) defined a triarchic theory of intelligence called "successful intelligence" which are analytical, creative and practical. It is inevitable to look at intelligence from the view of biology since it is related with brain. Scientists asked two questions why do people have different intelligence capacity and what are the common points or processes of intelligence true for all human being. Research related with brain size and volume, neurological differences e.t.c. and new technological developments like EEG, PET, fMRI beginning from the ends of 1800 opened new windows for biological research of intelligence (Cianciolo & Sternberg, 2004).

Although the definition or explanation of intelligence concept differ from society to society it is always affected from some main factors like time, place and culture. It can be mentioned 3 common dynamics affecting intelligence concept: 1- the content of knowledge essential to live in a given time, culture and place. Today is for example technology but in past maybe farming. 2- Values important for society or culture. 3- Educational system (Kornhaber, Krechevsky & Gardner, 1990). For example a person knowing lots of memorized information may be smart if educational system favors memorizing information but in an other setting a person having a high problem solving capacity may be thought as smart if the system encourage problem solving abilities. Several perspectives exists explaining intelligence concept showing that there is no standard definition of intelligence. Moreover there are several approaches that combines intelligence concept with education. Multiple intelligence theory is one of the theories bringing a different approach to concept of intelligence.

2.2 Multiple Intelligences Theory

Single intelligence concept limits one's capabilities. Rather it would be better if someone thinks that one can potentially has more than one relatively independent cognitive competence and these competences interact with each other and constitutes one's general ability. This type of thinking provides us wider and rich frames of thinking talents of an individual (Moran, Kornhaber, Gardner, 2006). Some researchers changed the view of intelligence from thinking intelligence as a single unit to thinking intelligence as different modules. Without doubt, Howard Gardner is important one among these investigators. Gardner states that although there is no consensus on explanation of intelligence concept or how to test it, there is indisputable reality that classical approach to intelligence which is thought as single entity is debated (Gardner, Siegel & Shaughnessy, 1994). Gardner defined intelligence as a biopsychological potential to process information that can be activated in a cultural setting to solve problems or create products that are of value in a culture (Gardner & Moran, 2006). Gardner brought new approaches to intelligence concept. Gardner (1991a) thinks that intelligence is not only a biological entity but also it has cultural dimensions. Therefore intelligence cannot be measured accurately since it is not an independent and definite concept for all people living in the world.

Gardner didn't deal with the measurability of intelligence. Unlike traditional intelligence theorists, he thought that intelligence concept is so complex that measuring it is not an easy task. There are lots of variables like culture, genetic, environment etc. affecting intelligence (Kornhaber, Krechevsky & Gardner, 1990). Gardner (1991a) states that contextualization is an important factor to determine the intelligence characteristics of a person. Values, life styles, and economical conditions of a society are important entities for the development of intelligence of a person.

Gardner didn't limit his study to only psychometry and experimental psychology while studying intelligence concept. He also collected evidence from different disciplines like neuroscience, anthropology, cultural studies, cognitive and developmental psychology, differential psychology (Gardner & Moran, 2006). In order to define an intelligence type Gardner (1998) developed some criteria drawn from different fields:

- Psychology: Correlations or lack of correlations between capacities having unique developmental history throughout growth of an individual who are gifted or normal.
- Case studies of learners: Observation of abnormal people who need special education like prodigies, savants or mentally disabled learners
- Anthropology: Cultural differences about development, ignorance or rewarding of different abilities
- Cultural studies: Symbol systems like language, arithmetic and maps encoding some meanings
- Biological sciences: Ability or a capacity is represented in a defined neural structure in brain and it has a definite evolutionary path.

Defined intelligence must meet these criteria otherwise it is not defined as intelligence formally. For example Gardner added eighth intelligence which is natural intelligence in 1995 after finding evidences that fit into given criteria (Gardner, 1998).

Gardner (1983) defined seven types of intelligences. These are linguistic, logical-mathematical, spatial, bodily-kinesthetic, musical, interpersonal, intrapersonal intelligences. Later, he described one more intelligence "naturalist" and one possible intelligence "existential". These intelligences can be defines as follows (Gardner, 1997; Gardner, 1998):

Linguistic intelligence is related with the capacity to use words effectively whether orally or in writing. One whose linguistic intelligence is strong loves dealing with languages and words. He is also successful in completing tasks related with linguistic field. He tries to explore relationship between linguistic structures with a strong desire. Poets, writers and linguists are potential people

who have dominant linguistic intelligences. T. S. Eliot, Noam Chomsky, W. H. Auden can be example of some famous individuals having distinguished linguistic intelligence.

Logical-mathematical intelligence is the capacity to use numbers effectively and to reason well. One who has strong logical-mathematical intelligence likes making assessment and evaluations between objects and abstractions. These people try to reveal principles behind mathematical phenomena and approach events and situations from logical perspectives. Mathematicians, scientists and philosophers have a dominant Logical-mathematical intelligence. Stanislaw Ulam, Alfred North Whitehead, Henri Poincaré, Albert Einstein, Marie Curie are some examples of people who have highly developed logical-mathematical intelligence.

Spatial intelligence is the ability to perceive the visual-spatial world accurately. People having strong spatial intelligence can easily transform and change visual perceptions. They are good at reforming visual experiences even if they are not stimulated by any visual excitation. Architects, artists, sculptors, mapmakers, navigators, chess players have very improved spatial intelligence. Michelangelo, Frank Lloyd Wright, Garry Kasparov, Louise Nevelson, Helen Frankenthaler are known people who have strong spatial intelligence.

Bodily-kinesthetic intelligence is the capacity to use body to express ideas and feelings. People having a dominant bodily-kinesthetic intelligence can control and administer kinesthetic movements. They also use objects with a high skill. Dancers, athletes, actors are potential individuals who have strong bodily-kinesthetic intelligence. Marcel Marceau, Martha Graham, Michael Jordan are among people having distinguished bodily-kinesthetic intelligence.

Musical intelligence is the capacity to perceive, discriminate, transform and express musical forms. One who has strong musical intelligence is good at in listening and discerning. They are talented in composing and performing music. Musical intelligence may also have interactions with some other intelligence like linguistic and bodily-kinesthetic intelligence. Without doubt Composers, conductors, musicians, and music critics have potentially highly developed musical intelligence. It is not difficult to say that Ludwig van Beethoven, Leonard Bernstein, Midori, John Coltrane have very strong musical intelligence.

Interpersonal intelligence is the ability to perceive and make distinctions in the moods, intentions and feelings of other people. People having strong interpersonal intelligence can easily and accurately make inferences from others' emotions, behaviors and moods. They can use information which they obtain from others to behave and communicate with them. Politicians and religious leaders are very successful people who use their dominant interpersonal intelligence in an efficient way. Mahatma Gandhi and Eleanor Roosevelt very well know leaders who have strong interpersonal intelligence.

Intrapersonal intelligence is self knowledge and the ability to act adaptively on the basis of that knowledge. People who have strong intrapersonal intelligences have ability to realize and use their own feelings and thoughts. Autobiographers and entrepreneurs are people having strong intrapersonal intelligences.

Naturalistic intelligence is the expertise in the recognition and understanding of nature. People who have strong naturalist intelligence can easily identify and classify natural structures. However, in today' world this ability is not limited to only natural objects. For example individuals having dominant naturalistic intelligence can also distinguish human-made objects like cars. Biologists and naturalists have obviously strong naturalistic intelligence. Charles Darwin, Rachel Carson and John James Audubon can be stated as people having highly developed naturalistic intelligence.

Existential intelligence is human response to being alive in all ways. People who have relatively high existential intelligence try to get and put forward questions related with existence. Spiritual leaders and philosophical thinkers are possible individuals having a developed existential intelligence. Jean-Paul Sartre and Søren A. Kierkegaard can be given as an example of people

having strong existential intelligence. On the other hand Gardner has not been satisfied evidences for existential intelligence. That is why he declares that many more evidences are needed to define it as intelligence.

Gardner (1998) claims two important facts about MI. One of them is every individual has all types of these intelligences and second one is each individual has unique combination of these intelligences. I.e. every individual even identical twin has different profiles of intelligences as each individual has different appearance or personality. According to Gardner (1998) each type of intelligence is as important as the other ones. Logical intelligence is not more important than musical intelligence. Some argued that musical or kinesthetic intelligence should be thought as ability not intelligence. On the other hand Gardner thinks that this approach devalues the intelligences other than logical and linguistic. If musical intelligence should be called ability then we must call logical intelligence as logical ability (Gardner, 1998).

Gardner (1997) also thinks that an intelligence profile of an individual is not static rather it is dynamic. An individual's intelligence profile may change during life of a person. The development level of some of these intelligences may differ from age to age. For example bodily kinesthetic and personal intelligence may improve when the children become matured compared to younger ages (Armstrong, 1994).

Every individual does not have to have capacity to perform all the tasks and skills. A person may be good at certain skills but may not be good at some other skills (Gardner 1991a). If a person is talented in a specific area lets think that art. This doesn't mean that this person has only good spatial intelligence and the other ones are weak. This person may have a combination of more than one intelligence types like logical-mathematical and intrapersonal intelligences with differentiating ratios that yield his or her drawing ability. In conclusion intelligences are not isolated from each other rather they interact with each other resulting in a unique capability (Moran, Kornhaber, & Gardner, 2006).

It is not logical to think that psychometric instruments can measure intelligence but MI theory cannot do. How do we know that these instruments can measure whole brain capacity of an individual? We can only say that these instrument may measure what g theory claims general intelligence which is only limited to linguistics and mathematical ability (Gardner & Moran, 2006). Cultural differences may affect score differences between two cultures related with memory. For example memory span for words in Libyan and Dutch students are different. The study showed that the difference is due to language structure Arabic words need longer pronunciation leading Libyan students have slow reading. If this equated than no memory differences occur between two countries (Shebani, Van de Vijver, & Poortinga, 2008).

Gardner himself didn't deal with the measurement of MI. But he accepts that there may be studies dealing with one's powerful intelligences as long as instruments must be intelligence fair. Even so Gardner have worries that results of these measurements can be used wrongly labeling pupils music smart but interpersonal stupid like IQ tests label as smart or dumb (Gardner & Moran, 2006). Although Gardner didn't deal with the assessment of multiple intelligences, there are a lot self report inventories developed by other researchers to assess one's multiple intelligences. On the other hand self report inventories are not always good to use because of its validation problem (Visser, Ashton, & Vernon, 2006).

General intelligence theory cannot explain different examples that individuals who have unique performances like savants, brain damaged persons and the performances within individual and among individuals. MI can better explain these situations. MI does not also underscore average persons that most of the people constitute this portion of population. When we think from cultural perspectives, a person who is very competent in his cultural context may be thought average person in another culture (Gardner & Moran, 2006).

Gardner's theory attracted people attentions from different disciplines like psychology and education. There have been lots of researches, comments and applications that potentially

produced some myths and misconceptions about the theory. He didn't immediately react these misunderstandings in order to provide discussion environment and to challenge traditional view of intelligence (Gardner, 1995). Gardner (1995) later responded these myths:

Myth 1. One can --and perhaps should -- create seven tests and secure seven scores.

Actually Gardner' principal antithesis against traditional concept of intelligence is using psychometric tools to measure one's intelligence in numbers. Most of classical intelligence tests favor logical and verbal abilities. On the other hand Gardner thinks that if needed, measurement should be "intelligent fair". i.e each intelligence should be evaluated in a contextualized and cultural settings. For example if we want to asses the musical capabilities of a person, we should make him listen a melody and repeat it. We shouldn't ask him questions about musical theory in a paper pencil test. We should also consider cultural differences while evaluating one's ability. A test may be suitable or meaningful for a culture but may not be appropriate for another culture. For example think about a situation that forest ecosystem is thought as a context for a person living in a desert environment.

Myth 2. An Intelligence is the same as a domain or a discipline.

Intelligence is a different concept than a discipline or a domain. For example gardening and chess are disciplines. One can use several intelligences to perform these disciplines or one intelligence type may be used more than one discipline for example spatial intelligence may be used not only for painting but also for sculpting.

Myth 3. Intelligence is the same as a "learning style," a "cognitive style," or a "working style."

Learning style is thought that one's general strategy that brain uses while learning a facility. It can be said that this style fit to every topic like music, mathematics e.t.c. On the other hand intelligence is the capacity for a specific ability like music. Gardner thinks that the concept of learning style should be investigated empirically for example one can use different styles while learning in different disciplines and domains. So we cannot guarantee that one can use same style while learning every topic.

Myth 4. MI theory is not empirical.

One of the most common myths about MI is that this theory hasn't been studied empirically or studied but not to be proved. Actually MI is totally based on empirical evidences and the theory is revised or developed according to new findings and research results. Gardner used empirical evidences from several sources.

Myth 5. MI theory is incompatible with g (general intelligence),] with hereditarian accounts, or with environmental accounts of the nature and causes of intelligence.

Actually Gardner has not tried to disprove g theory or the existence of g theory but he questioned adequacy of g theory for explaining every concept of intelligence. Gardner thinks that g theory is not enough to explain some concept about intelligence. Gardner never denies the effect of genetic and environment on intelligence but he is against to discussions "learned or inherited". He doesn't think that it can be discussed like black or white. Rather the interaction between them should be investigated.

Myth 6. MI theory so broadens the notion of intelligence that it includes all psychological constructs and thus vitiates the usefulness, as well as the usual connotation, of the term

Gardner thinks that traditional intelligence concept restricts meaning or use of intelligence by using numbers to designate the one's intelligence. Moreover Gardner thinks that talent and intelligence are similar concepts intelligence is just a set of talents in a given area. So we

shouldn't try to make distinction between talent and intelligence. Gardner didn't deal with the other aspects of intelligence like relation with motivation, attitude, and moral values etc. he just try to investigate the cognitive aspects of intelligence.

Myth 7. There is an eighth (or ninth or 10th) intelligence.

As Gardner said he revises his theory according to findings. He thinks that there is an eight intelligence called naturalist intelligence related with distinguishing about natural objects or today classifying cars etc. Gardner tries to understand the spiritualist intelligence proposed other psychologists. But he didn't accept it as a different intelligence.

Gardner never asserted that MI theory is the best and perfect explanation of human intelligence concept. Rather MI theory explains the intelligence concept better compared to alternative approaches (Gardner & Moran, 2006).

2.3 MI Theory and Instruction

Gardner has also followed the efforts of practical use of MI as well as dealing with theoretical perspectives of MI (Gardner, Siegel, & Shaughnessy, 1994). Gardner surprised when his theory of intelligences got attention of educators so much because he didn't intend to propose his theory for educational purposes (Gardner, 1995). Although MI theory is not proposed for educational purposes, it can be said that traditional view of intelligence is not enough to prepare curriculums, make educational policies and creating environments for every student. MI proposes a different view of intelligence suggesting applications suitable for every student which has a unique composition of intelligences (Moran, Kornhaber, & Gardner, 2006). MI can be used for several purposes in education like exploring learning styles, individualizing teaching and learning, designing integrated curricula, broadening assessment, and developing lessons plans (Goodnough, 2001). Although MIT's born is not for education, MI can encourage radical changes about schools and education. MI theory suggests some fundamental ideas for educational settings alternative to current applications (Blithe, & Gardner, 1990):

1- Range of abilities addressed. Intelligences other than logical and verbal should be emphasized in schools.

2-Learning environment: To promote other intelligence like musical or spatial we should change the environment or conditions of classes, school environment and context and general appearance of physical medium.

3- Assessment measures: Traditional paper pencil tests favors only linguistic and logical intelligences and exclude other intelligences.

4- Concept of learner. Teaching same subjects with same methods or ways to every individual is not effective because each individual have unique learning pattern that instruction should be personalized.
Gardner says "No human understands everything; every human being understands some things" (Gardner, Siegel, & Shaughnessy, 1994). In conventional educational settings, students are labeled at the beginning of education life like he is not good at mathematics or science or language. However, maybe if lessons are presented to students in his way of learning or dominant intelligences he may succeed in that area but unfortunately this does not happen leading to demoralization of the student. On the other hand, if we introduce complex environments that reach each student, he himself feels motivated for life long learning (Gardner, 2009).

There is a common fact known in education. Students mostly can memorize information in a way but when they are asked to apply the memorized information they really got problems. They have difficulty to elaborate information and apply in new settings (Mansilla & Gardner, 2008). In traditional school settings teachers read, tell and write on the board, ask students to write written

things on the board, ask questions and deliver handouts and wait. On the other hand MI teacher try to use different activities, methods, materials and techniques addressing different intelligences and sometimes combine different intelligence and this is good for different learners (Stanford, 2003). In traditional school settings students mostly memorize information and they are tested whether they recall the information or not. This is the easy way of education both for teachers and school. You can easily present plain knowledge. That is why classical view of teaching encourages rote learning. On the other hand how can we be sure that students are ready for future life and use his mind (Mansilla & Gardner, 2008)?

Our world is changing continually and educational systems should adapt itself to these changes and make necessary revisions otherwise they will not be enough for new century and maybe other alternatives may replace educational institutions which is not wanted. For example schools may not be attractive for students anymore and they don't want to go to school (Gardner, 2000b). It is not logical to say that a student didn't learn the subject and to blame the student because of his failure to learn the subject. Rather we should say that we couldn't provide appropriate context for that student. We should provide personalized strategy for that learner to make him to learn better (Gardner, Siegel, & Shaughnessy, 1994). It is teacher's responsibility that to consider each student's need and meet these needs for better learning (Johnson, 2006). MI theory has brought a new approach in education that each individual can realize his potentials and others instead of evaluating himself and others either smart or dumb. Rather he can think that potentially I am good and the others good in a way (Moran, Kornhaber, Gardner, 2006).

Developments in computer technology made personalized education more possible compared to past. In past, only rich people had opportunity for personalized education. By means of computers we can easily arrange programs for different pupils. On the other hand internet has lots of information that reaching reliable information may be a problem for students. This issue should be dealt with carefully (Gardner, 2000b). Each learner is unique and has a special learning profile. Although technological developments make personalized education more possible or easier, children do not have cookbook with themselves. i,e it is not possible to reach each individual to address his or her unique learning needs (Gardner, 1997). Not only differentiating teaching strategies but also differentiating curriculum content may be another alternative for different types of learner profiles (Johnson,2006). Technology is developing in a high speed. So the purpose of education should be to donate students with qualifications to overcome issues and to prepare students for future (Gardner, 1999). We are now in technology and internet millennium. It is very easy to find information from search engines easily. So today rote learning or memorizing information is less admirable compared to last. So actually students do not have to memorize. They have cellular phones, tablets and internet access to learn new information. Rather now it is important to think interdisciplinary in today's modern life (Mansilla & Gardner, 2008).

Gardner thinks that there is no single perfect method based on MI which is useful and effective for educational settings. Actually MI theory doesn't give recipe for educational settings. Educators are the authority that decides how to apply theory to educational purposes (Gardner & Moran, 2006). Although MI schools have some common features, it doesn't give fixed menu for all school settings (Gardner, 1999). Providing opportunities for students to find different activities in order to learn the concepts is an important aspect of MI-based instruction. In traditional classrooms, teachers presents topic to students mostly by using methods addressing linguistic or logical intelligence. However teachers in MI classes use several types of methods by combining all kinds of intelligence (Stanford, 2003). Mettetal et al., (1997) state that students find opportunity to see their at least one strong ability in MI classes. In traditional classrooms, students having linguistics or logical-mathematical intelligences are dominant. Therefore, other students feel that they are down. Hoerr (2003, p.94) summarized the main differences between traditional classroom and MI classroom in table 2.1

Table 2.1 Main differences between a traditional classroom and a MI classroom

In a traditional classroom	*In a Ml classroom*
The kids with strong scholastic intelligences are smart and the other kids are not.	Everyone has a different profile of intelligences; we are all smart in different ways.
Teachers create a hierarchy of intellect.	Teachers use all students' intelligences to help them learn.
The classroom is curriculum-centered.	The classroom is child centered.
Teachers help students acquire information and facts.	Teachers help students create meaning in a constructivist way.
The focus is on the scholastic intelligences, the 3 R's.	The personal intelligences are valued: Who you are is more important than what you know.
Teachers work from texts.	Teachers create curriculum-lessons, units, themes.
Teachers assess students by paper and pencil "objective" measures.	Teachers create assessment tools-Projects, Exhibitions, Portfolios (PEPs)-which incorporate Ml.
Teachers close the door and work in isolation.	Teachers work with colleagues in using Ml**,** developing collegiality.

In MI based schools, school take the responsibility to provide environment for students to develop themselves both academically and personally but they may use different applications of MI based instruction in implementation of MI based instruction (Campbell, 1997). Teacher and students work cooperatively for best learning that students must inform their teachers about how they learn best and teachers introduce several activities for students resulting in motivation for learning (Johnson, 2006). MI-based instruction doesn't make changes only in students' attitudes toward both themselves and instruction but also in teachers' attitudes towards their profession. They feel more satisfied since they think that they are able to make changes in students' lives. Teachers think that success on tests shouldn't be the core of education. Students should also gain skills and competencies to become successful for their future lives. By the help of application of MI theory, teachers guide students to gain these skills (Hoerr, 2002). In their study Mettetal et al., (1997) found that students' self-esteem and self confidence increased considerably throughout the application of MI-based instruction.

While making lesson plans for MI based instruction, teachers do not have to prepare eight different lesson plans for eight different intelligences for every topic. Instead he should prepare a rich environment that each student having unique combination of intelligences can express himself and find possibility to experience ways addressing his learning (Moran, Kornhaber,& Gardner, 2006). Grouping students according to their intelligences from the results of MI tests is against the spirit of the MI theory (Moran, Kornhaber,& Gardner, 2006). MI theory doesn't propound that each topic should be taught by activities based on eight intelligences and students dominant intelligences should be determined by applying tests in schools (Gardner, 1998).

MI theory provides opportunities both for combining existing pedagogical strategies and also offering new strategies for teachers to apply practical methods in real classroom environments (Stanford, 2003). One method, for example using pictures, may be a good strategy for one student

yet it may not show the same effect on another student who have ability to understand the concepts by using words. Mettetal et al. (1997) stress that some of the intelligences are not better than some others. I.e. all of the intelligence types have equal value. Thus teachers should include as many as possible intelligence types in the lesson plans. Although musical, spatial and bodily – kinesthetic intelligences are included in courses like art and physical education, these are not adapted to other courses like science (Mettetal et al., 1997).

The major role of the teacher is to provide opportunities for all students who have different dominant intelligences (Stanford, 2003). By changing strategies during the lesson will make it possible for different learners to find an activity for his dominant intelligence (Stanford, 2003). In fact some good teachers have already been used activities like saying songs or using pictures which are musical and spatial intelligence. What MI theory done is they are now aware of what they are doing consciously (Stanford, 2003). In their study Mettetal et al (1997), found that teachers adopted the concept of MI strongly, even though they couldn't get the practical aspects of the theory easily. This is also true for students. They become aware of their potential ability by understanding the MI concept.

If teachers have little autonomy for educational applications, unfortunately like in Turkey, then applying MI in a school adopted traditional approaches may be difficult and tiring (Goodnough, 2001). Teachers always feel pressure to complete curriculum content in time and that is why most of the time teachers sacrifice other important educational goals in order to complete curriculum. In this environment MI based instruction may take longer time for same curriculum content compared to traditional instruction. This may make teachers reluctant to use MI based instruction (Goodnough, 2001). Mettetal et al. (1997) found that teachers are willing to implement MI based instruction. However, they need time to acquire skills required to develop MI-based lesson plans. They also need more models to get new ideas concerning MI based methods.

Campbell (1989) proposed the use of learning centers corresponding to intelligences types. These are reading center, math center, music center, art center, building center, working together center, and personal work center. Every student will spend certain amount of time in these centers for a given lesson unit. Consequently, each student will find possibility to expose all types of intelligences. Students can be encouraged to write, read and give oral reports to use linguistic intelligence. Teachers can use pictures, photographs, drawings, overheads, diagrams, films e.t.c to make students benefit from spatial intelligences. Teacher may give projects to students to make them working together for the use of interpersonal intelligence (Nolen, 2003). Abdulkarim and Al Jadiry (2012) used MI theory with previous achievements of 9^{th} grade science students to group students for cooperative learning resulting in improved scientific thinking skills. Some examples stated above are just few practical examples of application of MI theory in classroom settings. Teachers who adopted MI theory can increase the number of examples. Although teachers concentrate on the preparation of lesson plans coinciding with MI theory, most of the time they don't focus on the assessment process of learning. The next topic is related with assessment in MI based instruction.

2.4 Assessment in MI Based Classes

Assessment of intelligence is not an easy task. Gardner (1991a) thinks that appropriate techniques must be used to reveal students' hidden intelligences. Therefore, classical paper-pencil tests may not be proper for determining intelligence characteristics of children. Students learn the same concept by using different learning styles. Therefore, they can only show what they have learned by using different assessment techniques (Stanford, 2003). For example, applying a multiple choices test to a student whose dominant intelligence is kinesthetic doesn't sound logical. Teachers should find appropriate assessment techniques to apply for students having different dominant intelligences.

In MI based classes learning factual knowledge and assessing whether student memorized these knowledge is not important rather it is important that students get cognitive skills leading them to

use higher order thinking skills. Moreover, in MI classes, instruction and assessment are used cooperatively together i.e assessment is not the result rather it is also a part of processes (Stanford, 2003).

There are several assessment techniques addressing different intelligences like logs and journals, graphic organizers, observational checklists, video samples, rubrics, miscue analyses, and portfolios (Stanford, 2003). One of issues in evaluation of students' achievement is self evaluation. Students should get abilities to evaluate themselves continuously to monitor themselves throughout teaching and learning process (Penick, 1995).

Assessment should be for learning not for a product. Actually it should be a part of learning. The main thing for assessment for learning is making students improve higher order thinking skills. Therefore biology or science teachers should be competent about asking higher order thinking questions which finally lead students to take responsibility for their own learning. To make this in-service teacher training is very important (Gioka, 2007).

In this study, the effectiveness of MI based instruction on learning basic components of living organisms unit in biology which is one of the areas of science education was investigated.

2.5 Science Education, Biology education and MI theory

Classrooms are very boring atmosphere in classical school settings, and students don't get excited to learn science. Classrooms should be so well equipped and fruitful that someone in the classroom becomes more enthusiastic to learn science Effective science lessons are laboratory centered and students-centered. Students find possibilities to perform hands on activities everyday (Penick, 1995). Although authorities consider K12 science education reform all the time, they never think about changes in science education curriculum at university level. However, teachers want to take courses related with science education in something different format in order to use science knowledge in a more funny and an excited way in school settings (Penick, 1995).

Penick, (1995) states that outstanding science teachers' expectations from students are as follows: use science knowledge, identify and resolve problems, communicate effectively, like science and feel successful at it, be creative, and continue learning science. Students cannot get a general scientific literacy in order to use in solving daily life problems by only taking tests (Penick, 1995). People should recognize some natural issues like climate change, food safety and human health as a result of science education without depending on use of science in their career or not (Reiss, & Tunnicliffe, 2001).

Factors affecting students learning are various like performances of teachers, instructional methods and materials, motivational aspects and students' misconceptions (Bahar, 2003). The communication in science classes is one–way; teacher talks and students listen. Students should be more active to get an effective communication in science classes (Penick, 1995). One of the important issues in science education is attitudes of students towards science. We may not sure to make students have positive attitudes towards science by making students memorize scientific terms and applying traditional paper- pencil tests (Penick, 1995).

Although the first half of the century was years of physics, second half of the 20th century have been years of biology that lots of new findings in life sciences changed the way of humanity especially molecular biology, genetics, neuroscience etc. We see lots of news related with biology and new findings in biology on newspapers journals, newspapers, magazines everyday (Blake & Gardner, 2007). Biology is a continuously developing science open to new developments and connected to life (Aşılıoğlu & Aytaç, 2002). Among main science fields biology is one of the most attractive one since it is relatively easy to understand and it is possible to make connection between subject matter and daily life or to relate subject matter to daily life (Roth, 2008).

Biology education has a central role in science education (Reiss, & Tunnicliffe, 2001). Tranter (2004) states that biology lessons in traditional classrooms are very boring and lifeless since students are constrained in the walls of classrooms. Students are exposed to boring dialogs of teachers and evaluated by tests. They don't go out to explore nature, to make observation, touch organisms, and face wildlife e.t.c. On the other hand, Biology is a potentially colorful lesson that it is easy to use different methods and to perform different types of activities (Atıcı & Bora, 2004).

Within last 50 years after discovering structure of DNA, developments in biology sharply increased in all areas from cell biology to ecology. There are lots of research papers in educational literature for effective biology instruction and results show that traditional methods presenting facts to students are not effective. Rather for deeper understanding asking questions like scientist and involving discovery processes like scientist is better (Morse, 2003). Remembering factual knowledge or procedural knowledge shouldn't be the only purpose of biology teaching. In addition, students' higher order thinking skills like analyzing, synthesizing and evaluation should be developed by asking questions that requires skillful teachers who can ask higher order thinking question resulting in stimulation of students who can think critically and creatively (Chin, 2004). Research results show that the purpose of biology education is to make students learn biology subjects permanently instead of rote learning and to make students gain skills to elaborate knowledge and apply in new context (Aşılıoğlu & Aytaç, 2002).

Reforms in biology education like changing textbook formats and including more laboratory sessions are not enough to get a complete success in biology education. Mentality of teachers should also be changed, because students don't understand biology by using only traditional methods (Penick, 1995). Sharp increase in development of communicational technologies for last few decades changed paradigm for teaching and learning lasted tens of years in past century. Students can easily reach information by using mobile phones or iphones. However teachers are still at the core of teaching-learning process (Matterson, 2005). Moreover, teachers still continue to use traditional techniques primarily. Atıcı and Bora (2004) state that biology teachers use presentation of subjects in 67.4 %, demonstration in 34,8 % and questioning techniques in 32.6 %. Teachers generally state that using new methods is not easy since classes are too crowded, laboratory environments are inadequate, and there are economical problems in schools. Some of these reasons are also stated by high school students. They think that crowded classes, lack of necessary laboratory equipment, the effect of biology lesson on university entrance exam, lack of enough practical activities in biology lessons are major problem in biology education in Turkey (Kaya & Gürbüz, 2002).

Although there are common problems both teachers and students specified in Turkish biology education, teachers must try to the best to abondon traditional teaching methods and try to use methods based on constructivist and student centered approaches. Reserch results show that techniques based on constructivism are better than traditional ones. For example Cooperative learning strategies is more successful compared to traditional teaching strategies in biology education (Hevedanlı , Oral, & Akbayın, 2004). 5E method compared to traditional teaching method is more successful with respect to achievement in the unit of cell in highschool (Saygın, Atılboz, & Salman, 2006). Discussion of controversial issues in biology increase students' interest resulting in motivation for learning. Teachers can take the advantage of using controversial issues by asking questions in a controversial topic (Leonard, 2010). Recent developments in technology brought new techniques that teacher can use in classroom like computers and projectors. However, the use of these materials can not be replaced by the use of nature itself in biology lessons (Tranter, 2004).

Factors affecting students learning are various like performances of teachers, instructional methods and materials, motivational aspects and students' misconceptions (Bahar, 2003). One of the factors affecting biology education is biology teachers. Traditional teaching methods for biology do not only dominate secondary schools or high schools but also dominate undergraduate biology programs in universities. Nevertheless, Innovative teaching methods should be shared among faculty members to spread these techniques (Stagg, 2008). Pre-service biology teachers

have misconceptions about some basic biology subjects (Tekkaya, çapa, & yılmaz, 2000). Even, they have not enough conceptual knowledge in some biology subjects (Dikmenli, Türkmen, Çardak, & Kurt,). Pre-service science teachers state that making biological concepts more concrete, reinforcing theoritical knowledge with experiments and relating subjects to daily life are strategies helping preservice science teachers to learn biology permenantly and to make biology more intersting (Güneş, & Güneş, 2005).

The other factor affecting students' learning is curriculum of biology. The speed of changing biology curriculums and textbooks doesn't reach the speed of biological developments in 21 century. Therefore it is very important for teachers to follow new developments in biology and present these new developments to students by using different sources (Atıcı & Bora, 2004). Curriculums are important guides for teachers and curriculums should be constructed and revised according to new emerging modern educational approaches (Yıldırım, Sinan, & Güngör, 2005). Biology curriculum should be revised and updated from the points of content and objectives and it is important to rearrange the number of hours for biology lesson (Yeşilyurt & Gül, 2008).

The other issue in biology education is misconceptions which are very common also in other science lessons. It is common to see misconception among students even after instruction (Bahar, 2003). In fact, pre-service biology teachers have also some misconceptions. Types of misconceptions that pre-service biology teachers hold are parellel with the results of studies conducted abroad (Tekkaya, Çapa,. & Yılmaz, 2000). There are several reasons for emerging of misconceptions among students. One of them is textbooks. There are several misconceptions in biology related topics of science textbooks in Turkey leading students to have misconceptions (Dikmenli, Çardak, & Öztas, 2009). The other reason is that language used in science is different language used in daily life resulting in misconceptions. For instance, in daily life we use respiration for the meaning of breathing (Tekkaya, Çapa,. & Yılmaz, 2000). It is not easy to remove misconceptions (Bahar, 2003). New misconceptions arise if teaching methods cannot remove misconceptions that students have. Surely, traditional methods are not succcesful to remove misconceptions (Tekkaya, Çapa,. & Yılmaz, 2000). Conceptual change strategies can be used for diagnosing and modifying misconceptions (Bahar, 2003).

The other issue in biology education like in other science lessons is gender difference. Some topics of biology are interesting both for students and teachers and some of them are boring. For instance human biology is interesting for students and plant biology is boring for students. Actually teacher themselves were bored from plant biology. Activities used for plant biology are limited to boring activities. Therefore teachers of biology must be competent about both biology and developing activities for biology education (Slingsby, 2006). Nevertheless there is gender difference in some topics. Boys are mostly interested in basic process in cell and girls are mostly interested in human biology and health education due to out-of- school experiences that boys and girls have different experiences affecting students' interest to biology topics. In order to increase students' motivation and interest, teachers should make connections between students' out-of-school experiences and subject matter (Uitto, Juuti, Lavonen, & Meisalo, 2006).

Having considered issues about biology education mentioned above there have been alternative methods used in biology classes instead of traditional methods. Needless to say one of them is MI based instruction. After Gardner's (1983) proposal his theory, there have been lots of projects and studies reflecting spirit of MI theory in different educational settings from kindergarten to university. There have been lots of studies conducted by researchers from different disciplines to examine the effectiveness of MI based instruction on achievement and attitude.

There are MI studies conducted in early childhood education level (Ekşi, 2009; Gürbüz & Gürbüz, 2010). There are MI studies conducted in different disciplines other than science. Kutluca (2009) stated that MI based instruction increased students achievement in geometry lesson in 7^{th} grade students. According to results of the study conducted by Temiz and Kiraz (2007) MI implementation had positive effects on first grade students' tendency toward the course and teachers. According to study of Baş (2010) MI based instruction had more positive effect on elementary school students' achievement in English lesson and attitudes toward English lesson.

Dillihunt and Tyler (2006) investigated the effectiveness of MI based instruction compared to traditional instruction on third and fifth grade students' Math performance. The results of the study revealed that students instructed by MI based instruction scored significantly higher than students instructed by traditional instruction on math post tests. Tabuk (2009) found that there is no significant effect of MI based instruction in project based learning on students' achievement in math and attitudes toward math. Temur (2007) found that MI based instruction compared to traditional instruction had significant effect on 4th grade students' mathematics achievement. Buschick, Shipton, Winner and Wise (2007) used MI based instruction to increase elementary and middle school students' motivation in reading. The result of the study showed that MI based instruction is successful to increase students' reading motivation. Moreover students' reading at home and visiting a library frequencies increased at the end of the MI based instruction. Kayıran (2009) conducted a study to investigate the effect of project based learning method supported by multiple intelligences theory (MIT) compared to traditional method on students achievement, retention of understanding and attitudes toward social sciences lesson. Results revealed that although there was a significant mean difference between post test achievement scores of experimental and control group favoring experimental group, there was no significant mean difference between retention scores of experimental and control group. Uzunöz and Akbaş (2011) revealed that MI based instruction compared to traditional instruction had significant effect on students' achievement in the subject of atmosphere and climate in 9th grade geography lesson. Bellflower (2008) reported that there was a significant mean difference between experimental and control group in favor of experimental group instructed by MIBI with respect to 5th grade students' achievement in the subject of civil war. Douglas, Burton and Reese-Durham (2008) found that MIBI compared to direct instruction produced considerable improvement in students' mathematics achievement.

Gürçay (2003) compared the effect of multiple intelligences based instruction versus traditional instruction on ninth grade students' physics achievement. Compared to traditionally designed instruction MI based instruction made significant effect on students' achievement in the subject of Coulomb's Law. On the other hand, MI based instruction compared to traditional instruction didn't make a significant change on students' attitude toward the subject of Coulomb's Law.

Bilgin (2006) investigated the effect of MIBI compared to traditional instruction on 9th grade students' understanding of chemical bonding concepts and attitude toward chemistry. One class of the same teacher was assigned as a control group and the other one as an experimental group. Each group was consisted of 25 students. Students in experimental group were taught by MIBI while students in control group were taught by traditional instruction. The implementation period was three weeks. An achievement test related with subject matter was administered as a pre-test at the beginning of the study and as a post test at the end of the study. In addition science process skills test was administered to students. The results indicated that MIBI had significant effect on both students' achievement in the unit and attitude toward chemistry. On the other hand there was no significant effect of gender difference on achievement and attitude. Moreover science process skills had no effect on students' success.

There are studies conducted in science education. In their study, Owolabi and Okebukola (2009) revealed that MI based instruction is the most effective one promoting students achievement in science compared to study groups and traditional method. They stated that MI based instruction is a chance for students to express their potential abilities and also MI based instruction made the lesson more interesting and enjoyable.

Davis (2004) conducted a one-group/pretest-posttest research design model to investigate the effect of instructional model formed by integration of MI theory and brain-based learning on 4th grade students' science achievement. The implementation of the instructional model lasted for three months. Students were administered by a pretest at the beginning of the study and by a post-test at the end of the study. The results of the study revealed that MI based instruction with brain-based learning had significant effect on students achievement. The results of the study also indicated that students had improvements in behavior and self esteem.

Akbaş (2004) investigated the effect of MI based instruction on students' science achievement and attitudes toward science. Totally fifty 6th grade students from two intact class in a private elementary school participated the study. One of the classes was assigned experimental group instructed by MI based instruction and the other class was assigned as control group instructed by traditionally designed instruction. Although MI based instruction had significant effect on students' achievement in science compared to traditional instruction, there was no significant mean difference between attitude scores of experimental and control group. Moreover the teacher and students had positive opinions about MI based instruction

Şahin, Öngören, and Çokadar (2010) investigated the effectiveness of MI based instruction on students' attitudes toward science lesson compared to traditional instruction. Totally sixty 7th grade students from two different classes participated the study. Students in one of the classes exposed to MI based instruction and students in the other class exposed to traditional instruction. Results indicated that there is no significant mean difference between attitudes scores of experimental and control group. Nevertheless, the results of interviews conducted with students revealed that students in MI based classroom had more positive opinions about instruction compared to students in traditional classroom.

Kaya, Doğan, Gökçek, Kılıç and Kılıç (2007) examined the effectiveness of MI based instruction on students' achievement in science and students' attitudes toward science. Two intact classes each consisting of 30 eight grade students selected to perform the study. One of the classes was assigned as an experimental group in which MI based instruction was used and the other class was assigned as a control group in which traditional instruction was used. MANCOVA results showed that there were significant mean difference between achievement and attitudes scores of experimental and control group in favor of experimental group.

Akamca and Hamurcu (2005) conducted a study lasted five weeks to investigate the effectiveness of MI based instruction on 5th grade students' achievement and retention of knowledge in the unit of "heat" and students attitudes toward science as a school subject. The teacher used MI based instruction in experimental group and traditional instruction in control group. Statistical analysis showed that MI based instruction had significant effect on students' achievement and retention of knowledge though no significant effect on students' attitudes toward science.

A study was conducted with two classes of thirty five 4th grade students in the unit of 'Diversity of Living Things' by Özdemir, Güneysu and Tekkaya (2006) one of the classes was assigned as a control group and the other class was assigned as an experimental group. While MI based instruction was used in experimental group, traditional instruction was used in control group during the study. Compared to traditional instruction MI based instruction had significant effect on both students' achievement and retention of knowledge in the subject. Moreover the results of Teele Inventory of Multiple Intelligences (TIMI) showed that logical-mathematical intelligence was the most dominant intelligence among students both before and after the study.

Can, Altun and Harmandar (2011) examined the effectiveness of MI based instruction on 5th grade students' achievement, retention of knowledge in science lesson and students attitudes toward science. There was a significant mean difference between achievements, retention of knowledge and attitudes scores of experimental group in which MI based instruction was used and control group in which traditional instruction was used.

A study was conducted by Ucak, Bağ and Usak (2006) to investigate the effectiveness of MI based instruction on students' understanding of "the structure of material and its transformation" unit and students attitudes toward science. Two 7th grade intact classes each consisting of 27 students were selected for the study. One of the classes was assigned as an experimental group and the other one as a control group. Students in experimental group exposed to MI based instruction, whereas students in control group instructed according to traditional methods. Results of the study indicated that MI based instruction had positive effects on both students understanding and attitudes toward science.

There are MI based studies conducted in biology education. Aşcı (2003) indicated that MI based instruction is more effective than traditional designed instruction in 9th grade biology students' ecology achievement.

Presley (2005) conducted a study to examine the effect of multiple intelligences based instruction (MIBI) and learning styles on ninth grade students' attitudes toward biology, biology achievement, and overall multiple intelligences. The sample consisted of 64 students from two different intact classes instructed by the same teacher in a public high school. One of the classes was assigned as an experimental group taught by MI based instruction and the other class was assigned a control group instructed by traditionally designed instruction. According to results, there was a significant mean difference between experimental and control group with respect to students' achievement in the unit of diversity and classification of living organisms and students' attitudes toward biology. However there was no significant effect of MI based instruction compared to traditional instruction on students' overall multiple intelligences. In addition, according to results of interviews with students and the teacher and observation of experimental group, MI based instruction improved educational process in the classroom.

A study was conducted with two classes of 10th grade Anatolian high school students in the reproductive system unit by Kurt and Temelli (2011). One of two classes of the same teacher was randomly assigned as a control group and the other one as an experimental group. The control group was instructed by traditional instruction while the experimental group was taught by multiple intelligences instruction for four weeks. At the beginning of the study both group were administered by reproductive system achievement test. The same test was used as a post test at the end of the study to reveal the effect of different teaching methods on students' achievement in the unit. Obtained data was analyzed by SPSS. According to results of t-test, MI instruction had significant effect on students' achievement compared to traditional instruction.

Gürbüzoğlu (2009) investigated the effect of MI based instruction on students' achievement and retention of understanding in unit of protein synthesis and students opinions about effectiveness of MI based instruction. The study conducted over three weeks with second year students of department of elementary science education in a public university. Two classes was selected randomly and one of them was assigned as a control group consisting of 30 students and the other one as an experimental group consisting of 34 students. Students in experimental group exposed to MI based instruction and students in control group exposed to traditionally designed instruction. The results of the study indicated that MI based instruction had significant effect on both achievement and retention of knowledge compared to traditional instruction. Moreover students in experimental group thought that MI based instruction is beneficial for understanding topics and retention of knowledge gained throughout instruction.

Kurt (2009) examined the effect of MI based instruction compared to traditional instruction on students' achievement in the unit of nervous and endocrine system. Two 11th grade public high school classes taught by the same teacher were selected for the study. One of them was assigned experimental group and the other one was assigned as a control group randomly. The study was conducted 6 week of which four weeks as instruction and two weeks as implementation of instruments. Experimental group was instructed according to MI based instruction and the control group was instructed according to traditional instruction. Results of the study revealed that MI based instruction had significant effect on students achievement compared to traditionally designed instruction.

Köksal and Yel (2007) investigated the effect of MI Based instruction on students' achievement in unit of respiratory systems, retention of knowledge and attitudes toward course compared to traditionally designed instruction. Two intact classes consisting of fifty 10th grade students from an Anatolian high school was selected for the study. One of the classes was assigned as control group and the other one was assigned as experimental group. Students of experimental group exposed to MI based instruction and students of control group exposed to traditional instruction. The results of the study revealed that MI based instruction had significant effect on students achievement and retention but no significant effect on attitudes toward course.

Biology is an independent lesson that started to be taught in Grade 9 in Turkey. One of first fundamental biology subjects in 9th grade biology is basic compounds of living organisms.

2.6 Basic Compounds of Living Organisms

In biology, one has to know some basic knowledge in order to understand further topics, especially for the topics that students have difficulty to understand like hormones, genes and chromosomes, mitosis and meiosis, nervous system, and Mendelian genetics (Tekkaya, Özkan, & Sungur, 2001; Bahar, Johnstone, & Hansell, 1999). Some of these topics like cell division and genetics are percieved as difficult subjects also by elementary school students (Güneş, & Güneş, 2005b). Without doubt, cell biology is one of the basic subjects in biology since the basic unit of life is cell.

Students experience difficulty in understanding cell concept. There may be several reasons for this. Separating subjects as cellular or multicellular can create misconceptions and misunderstandings because students get difficulty to relate cellular level with organ or multicellular or system level. And students think that these are separate processes. Therefore teachers must be careful to make connections between cellular processes with organism level (Flores et. al., 2003). Misunderstandings and misconceptions about cell are common among high school students. There are misconceptions stemmed from textbooks and curriculum in the concept of cell among high school students (Yörek, 2007). There are misconceptions in 9th grade biology texbooks in the unit of cell. These misconceptions are similar to students' misconceptions confirming the fact that misconceptions may arise from textbooks (Dikmenli & Çardak, 2004). Traditional teaching methods may also lead to misuderstandings or misinterpretations. For example high school students mostly favor animal cell type. i.e when they are asked to draw a cell they draw an animal cell (Yörek, 2007). On the other hand, constructivist teaching methods compared to traditional teaching method is more successful with respect to achievement in the unit of cell in highschools (Saygın, Atılboz, & Salman, 2006). For example, integrating games based on cooperative strategies to lesson plans beside theoretical and practical activities increase students motivation to learn the subject and increase cooperation among students to achieve a goal together with team mates in the subject of cell and molecular biology (Spiegel et al.,2008).

Some of the topics related with cell are cell components, cell physiology, cell metabolism, and cell biochemistry. Students must understand these topics very well in order to learn other biological concepts like respiration, reproduction, nutrition or genetic regulation mechanisms and organelle composition. One has to know biochemistry of cell very well in order to understand other subjects of biology. In high school biology curriculum, biochemistry of basic compounds of cells is one of the first subject matters instructed by teachers. The subject is basically classified as organic compounds and inorganic compounds. Inorganic compounds are water, acids, bases, salts, and minerals. Organic compounds are carbohydrates, proteins, lipids, enzymes, vitamins, and nucleic acids. Bahar and Özatlı (2003) reported that students generally have very common knowledge which is not specifically related to the topic but related to different areas before teaching basic compounds of living organisms unit. After teaching the subject students have gained more scientific and accurate knowledge about basic compounds of living organisms. Moreover concept maps prepared according to pretest results of word association test (WAT) showed that students have not learned the relationship among concepts as a network of concepts (Bahar, & Özatlı, 2003). Among the topics of basic compounds of living organisms nucleic acids and enzymes are so abstract subjects that students get difficulty to understand the topics completely (Stolarsky Ben-Nun, & Yarden, 2009; Atav, Erdem, Yılmaz, and Gücüm, 2004).

Enzymes are one of the basic molecules which play crucial role in cell metabolism. Students should know the enzymes very well in order to understand basic physiological processes of organisms like digestion, and biosynthetic pathways (Meatyard, 1999). Therefore there are several studies conducted by researchers about teaching of enzymes. Enzymes is one of the topics that student have a lot of misconceptions. There are several reasons for this like instructional

methods, textbooks, teachers e.t.c. Most of misconceptions are particularly related with activation energy, enzyme kinethics and enzyme inhibition (Atav, Erdem, Yılmaz, and Gücüm, 2004). Some students have confusions about substarte and enzyme concepts and also some students percieve enzyme as alive molecules. The construction of an experiment itself may lead to these misconceptions like using liquid substrate and solid enzyme source (Selvi, & Yakışan, 2004). Meatyard (1999) states that teachers usually use commercially available bottled enzymes in school laboratory. Therefore, students think enzymes as chemicals like other chemical solutions. Teachers should use organisms to get enzymes in order to make students learn enzymes as important molecules for the life of organisms.

Selvi and Yakışan (2004) found that even university students have several misconceptions about enzymes. They found four main misconceptions students have about enzymes: First, students confuse substrate concept with enzyme. Second, students think that surface of enzymes can be increased by pounding the enzyme source. Third, students see enzymes as living molecules. They think that when enzymes are heated they die. However enzymes are protein molecules they don't die. They just become denatured. Fourth, students think that the characteristic of enzyme source can effect enzyme action. They think that potato is harder than liver so enzymes in liver are more effective than enzymes in potatoes. However, the reason is there are much more enzyme in liver than in potato. Moreover, Pre-service biology teachers have confusions between denaturation and inactivation. 43% of teachers think that protein structure of enzyme become denaturated when the temperature close or below to zero (Tekkaya, Çapa,.& Yılmaz, 2000).

Some research results showed that some methods like V-diagrams and concept maps can contribute to removal of misconceptions about enzymes (Selvi, & Yakışan, 2004). And some methods like Analogy method compared to traditional method is successful in the learning of enzyme subject (Atav, Erdem, Yılmaz, ve Gücüm, 2004).

2.7 Attitude Toward Biology

Although students perceive biology as a useful and important science, they perceive themselves as not successful enough in biology achievement and they have some prejudice against teachers and biology lesson. Moreover they do not like biology lesson much (Gül, & Yeşilyurt, 2010). There are several factors affecting students attitude toward biology like gender, socio economic status (SES), grade level, etc.

Most of the research results indicate that generally girls compared to boys have more positive attitude toward biology (Pehlivan, & Köseoğlu, 2010; Ekici, & Hevedanlı, 2010). On the other hand some research results state that there is no significant mean difference between males and females with respect to students' attitudes toward biology (Gül, & Yeşilyurt, 2010).

The other variable is school type. There is a significant mean difference among different types of highschools with respecrt to students' attitudes toward biology favoring general public highschools (Ekici, & Hevedanlı, 2010). Nevertheless (Gül, & Yeşilyurt, 2010) state that there is no significant mean difference with respect to school type for high school students' attitude toward biology.

The other factor is grade level. There is a significant mean difference among different grades with respecrt to students' attitudes toward biology favoring grade 10 (Ekici, & Hevedanlı, 2010). Higher grade students compared to lower grade students have less positive attitudes in science high schools (Pehlivan, & Köseoğlu, 2010). On the other hand some research results show that there is no significant mean difference with respect to grade level for high school students' attitude toward biology (Gül, & Yeşilyurt, 2010).

The other factor is academic success. General academic success of students is a factor affecting students attitudes. Students having high GPA have more positive attitude compared to students

having low GPA (Ekici, & Hevedanlı, 2010). On the other hand some research results show that there is no relationship between academic achievement and attitude in science high schools (Pehlivan, & Köseoğlu, 2010).

The other factor is SES level. Students having moderate SES level have more positive attitude compared to low or high SES students (Ekici, & Hevedanlı, 2010).

It is important to make students have positive attitude toward biology and in order to realize this, teachers should be away from making students to memorize information. Rather they should relate topics to daily life and use practical activities often (Gül, & Yeşilyurt, 2010). Biology teachers should prefer activities attracting students' interest and encouraging students' curiosity. Moreover, subjects should be related with students' daily life interests (Pehlivan, & Köseoğlu, 2010).

CHAPTER 3

EXPERIMENTAL DESIGN OF THE STUDY

In this chapter, description of research design, population and sample, instruments, treatment, data analyses method, treatment fidelity and treatment verification, internal validity threats and assumption and limitation of the study will be mentioned.

3.1 The Experimental Design

This study was conducted based on non-equivalent control group design as a part of quasi experimental design (Gay & Airasian, 2000). Table 3.1 shows the research design of the study.

In this study, the quasi experimental design was used. Multiple intelligences based instruction was used in the experimental group and traditionally designed instruction was used in control group. Two classes were instructed by the same teacher. He was informed about the aim of the study and multiple intelligences based instruction before the treatment. There were two 45-minute sessions per week for each group and the treatment was conducted over ten weeks.

Before the treatment, basic compounds of living organisms achievement test (BCLOAT) and attitude scale toward biology (ASTB) were given to both groups in order to check whether the groups were equal in understanding of basic compounds of living organisms concepts, and in attitudes toward biology, Moreover to check students' intellectual abilities science process skill test (SPST) was administered to groups at the beginning of the treatment.

Table 3.1 Research design of the study

Groups	**Pre-test**	**Treatment**	**Post-test**
Experimental Group (EG)	BCLOAT ASTB SPST	MIBI	BCLOAT ASTB
Control Group (CG)	BCLOAT ASTB SPST	TDBI	BCLOAT ASTB

In the above table: BCLOAT represents Basic Compounds of Living Organisms Achievement Test. ASTB is Attitude Scale Toward Biology as a School Subject. MIBI represents Multiple Intelligences Based Instruction and TDBI Traditional Designed Biology Instruction. SPST refers to Science Process Skill Test. EG is Experimental group and CG is Control Group.

3.2. Population and Subjects of the Study

Target population of the study was identified as all ninth grade students from Anatolian high schools in Kırşehir. However, it is not easy to reach the whole target population. Therefore accessible population was defined. All ninth grade students from Anatolian high schools in Kırşehir city center were defined as accessible population. Convenience sampling was used to

choose sample from accessible population. The results of this study will be generalized to the accessible population.

This study was consisted of fifty nine 9th grade students (25 male and 34 female) from two intact classes of a biology course from Kırşehir Sıddık Demir Anatolian High School taught by the same teacher in the first semester of 2011 - 2012 academic year. Since the groups had already been formed by the school administration at the beginning of the semester, random assignment of individuals to the group could not be possible. However one of the classes was randomly assigned as experimental group and the other class was assigned as control group.

The data analyzed for this research were taken from 29 students (12 male and 17 female) participating in multiple intelligences based instruction and 30 students (13 male and 17 female) participating in the traditionally designed instruction. Students' ages ranged from 15 to 16 years old.

3.3 Variables

3.3.1 Independent Variables

The independent variables were two different types of treatment; multiple intelligences based biology instruction and traditionally designed biology instruction. Another independent variable is gender difference. The types of instruction and gender were taken as categorical variables and measured on nominal scale. Science process skills were taken as predictor for achievement. Science process skill test score was considered as continuous variable and measured on interval scale.

3.3.2 Dependent variables

The dependent variables were the students' achievement in basic compounds of living organisms concepts and their attitudes toward biology as a school subject. The first one was measured by basic compounds of living organisms achievement test (BCLOAT) and the second one was measured by attitude scale toward biology (ASTB). These variables were considered as continuous variables. The summary on characteristics of the variables is given in the table 3.2 below.

Table 3.2 Identification of the variables

Name	Type	Continuous / categorical	Scale
Type of treatment	IV	categorical	nominal
Gender	IV	categorical	nominal
SPST	IV	continuous	interval
BCLOAT	DV	continuous	interval
ASTB	DV	continuous	interval

BCLOAT: Basic Compounds of Living Organisms Achievement Test, ASTB: Attitude Scale toward Biology, SPST: Science Process Skill Test.

3.4 Instruments

There are three tools that were used to collect data in addressing the research questions of the present study. These are Basic Compounds of Living Organisms Achievement Test (BCLOAT), Attitude Scale toward Biology as a School Subject (ASTB) and Science Process Skills Test

(SPST). Moreover interview questions were prepared for students and teacher to get their opinions about the MIBI instruction.

3.4.1 Basic Compounds of Living Organisms Achievement Test (BCLOAT)

This test was developed by the researcher to assess students' achievement in the unit of basic compounds of living organisms. The questions of this test were developed by considering 9th grade high school biology curriculum. The researcher used 9th grade biology textbook, University Entrance Examination (YGS) questions, and YGS preparation books. During test development process firstly objectives of the unit were defined (See appendix A). The test consisted of 25 multiple-choice items. Each item had five alternatives and four of them were distracters and one was desired answer. Each correct answer was assigned as 1 point, so total maximum score is 25. Having higher score means better learning of concepts. The test can be reached in Appendix B

The test was examined by two professors in the department of science education and three biology teachers from different types of high schools. The researcher reviewed the test according to experts' comments and suggestions. At the beginning, there were 34 items. After revision the final test consisted of 25 items. A pilot application of the test was performed during the second semester of 2010-2011 education years. The test was administered to totally 116 9th grade students from two different high schools one of them is public high school and the other one is Anatolian high school. The cronbach alfa reliability of the test was found as 0,73. The test was administered to the students of both experimental and control groups as a pre-test to assess their knowledge of basic compounds of living organisms concept and used as a post-test after the treatment to determine the effect of MIBI on students' achievement of basic compounds of living organisms concepts.

3.4.2 Attitute Scale toward Biology Test

This scale was developed by Koçakoğlu and Türkmen (2010) to measure students' attitudes toward biology as a school subject. The test consisted of 36 items in five points likert type scale: strongly disagree, disagree, undecided, agree, and strongly agree (See Appendix C). There are both positive and negative statements in the test. The scores range from 1 to 5. Having higher scores means positive attitudes and having lower scores means negative attitudes. The reliability of the scale was found to be 0,941. This test was given to students in experimental and control groups both before and after the treatment.

3.4.3 Science Process Skill Test (SPST)

This test was developed by Okey, Wise and Burns (1982). It was translated and adapted into Turkish by Geban, Aşkar and Özkan (1992). The test consisted of five subsets designed to measure five different intellectual abilities which are identifying variables, stating and identifying hypotheses, defining and designing investigations operationally, graphing and interpreting data. The reliability coefficient of the test was found to be 0.85. The test consisted of 36 items (See Appendix D). Each item has one correct answer and three distracters. Each question answered correctly was assigned as one point. Total maximum score could be 36. This test was given to students in experimental and control groups before the treatment.

3.4.4 Interviews

Semi-structured interviews were conducted to get opinions of both the teacher and students about multiple intelligences based instruction. Five students who were interviewed selected randomly from volunteer students. The interview schedule was implemented by the researcher. The data was recorded by using a tape recorder. The interviews conducted at the end of the study. Group

interview were conducted due to time limitation. In general, students are asked to evaluate the activities used during lesson period and to compare these activities with previous ones used in their science lessons. The teacher was asked to evaluate MIBI techniques and methods and compare with his methods and techniques. Moreover, usability of MIBI and difficulties experienced during MIBI instruction were asked. (The interview questions for students was given in Appendix E and for the teacher in Appendix F)

3.4.5 Classroom observation checklist

The classroom observation checklist was used to check the implementation of methods in the control group and the experimental group to confirm treatment verification. Multiple intelligences based instruction in experimental group and traditional instruction in control group were observed by the researcher. The observation checklist prepared by the researcher according to main characteristics of instruction types consisted of 18 items in three point likert type scale: (No – Partially – Yes) (see appendix G). Besides using checklist the researcher took notes during lesson. The researcher started to observe the lessons one week ago before the treatment started to make students familiarize observation process. Interactions among students, interaction between the teacher and the students, students' participation to activities, students' interest to activities were observed. The researcher observed the lessons as a non-participant observer.

3.5 Procedure

This part is dedicated to explain all steps from the beginning to the end of the study.

A detailed literature research were started by the researcher before the determination of research problem and identification of keywords and continued to the end of the study. Some of these keywords are multiple intelligences, Howard Gardner, intelligence, multiple intelligences based instruction, traditional instruction, biology instruction, science education, basic compounds of living organisms, attitude, attitude toward biology, attitude toward science.

In order to perform literature research, Educational Resources Information Center (ERIC), METU Library Theses and Dissertations, International Dissertation Abstracts, ProQuest (UMI) Dissertations & Theses, Turkish Higher Education Council (YÖK) National Dissertation Center, Social Science Citation Index (SSCI), Ebscohost, Taylor & Francis, Wiley Inter Science, Science Direct, Google scholar were searched by using keywords defined by the researcher. National journals like Hacettepe Üniversitesi Egitim Fakültesi Dergisi and Milli Egitim Dergisi and books related with multiple intelligences were also investigated.

Instruments used in the study were determined. One of the instruments was developed by the researcher. The other instruments obtained from literature. The pilot study of the instrument developed by the researcher was conducted. According to results of the pilot study, necessary revisions were made by the researcher. After validity and reliability analysis final version of the test were completed.

A Public Anatolian high school in the city center of Kırşehir was selected to perform the study. This school was selected due to convenient reasons. In order to realize application processes necessary permissions taken from related institutions.

The researcher prepared the lesson plans according to MIBI. All the necessary materials that would be used for activities were prepared before the treatment started. The teacher was informed about MI theory and MIBI by the researcher

The total application period of this study was ten weeks except test administrations. As it is known, to form classes consisted of randomly selected students was not possible since the classes had already been formed by the school administrator. Therefore two classes of the same teacher

were selected to conduct the study. One of the classes was assigned as experimental group and the other one was assigned as control group randomly.

This study was conducted during first semester of 2011-2012 education years. First of all, the teacher was asked to administer related instruments to the students in experimental and control groups. After completion of test the main study were started. The teacher used lesson plans prepared according to MIBI in experimental classroom and used traditional methods in control classroom. Each week the researcher met with the teacher before lessons to talk about lesson plans and after lessons to evaluate the lesson and to discuss next week lesson.

After completion of study post tests were given to students by the teacher. Moreover interviews were conducted with the teacher and selected sample students. All the data collected from pretests and posts were entered to SPSS program. In addition interviews recorded by tape recorder were transcribed by the researcher. Collected data were analyzed by using statistical program for social sciences (SPSS).

3.6 Treatments

In this study two types of treatments were implemented. One of them was MIBI in the experimental group and the other one was traditional instruction in the control group.

3.6.1 Multiple Intelligences Based Instruction

The multiple intelligences based instruction introduced to the students in the experimental group was prepared as a result of a detailed examination of literature and a variety of biology textbooks. The teacher was informed by the researcher about all aspects of MIBI in a detailed way. The teacher used lesson plans prepared by the researcher. The researcher prepared the lesson plans to involve different types of intelligences. Gardner (1997) states that there are 8 types of intelligences and each individual has different combinations of these intelligences in different proportions. There were not all types of intelligences in each activity. Each activity contained only some of intelligences. The basic philosophy behind MIBI is to include as possible as different types of intelligences throughout the instruction. For example in one of lesson plans visual, logical mathematical and linguistic intelligences were included in the activities but in another lesson plan interpersonal, intrapersonal, kinesthetic intelligences were included. Throughout the study all types of intelligences were included in lesson plans. Some of activities for each intelligence type were singing a song related with the topic, role playing, dramatization of a topic, self reading or puzzles, listing, preparing a product by group etc. Inorganic-organic compounds, water, acids-bases-salts, minerals, carbohydrates, lipids, proteins, enzymes, vitamins, nucleic acids and ATP are main topics instructed throughout the study. For example in one lesson plan for the topic of acids-bases, salt and minerals (A detailed lesson plan was given in Apppendix H):

Six groups were formed randomly for interpersonal activities. Firstly, the teacher asked the students to tell any words that they heard or know about acids-bases and salts (intrapersonal). The teacher wrote all the words on the blackboard coming from the students without checking correctness of responses. Then, the teacher asked the students to look at the name of substances listed in previous lesson from the labels of food package the teacher delivered to students. The teacher asked students to find the words called acid, base or salt and circle these words by writing "İ" near the circle symbolizing inorganic (intrapersonal, naturalist). The teacher delivered sample pictures of daily life products like cream, soap, and lotion to show the words acid, base and pH on the labels of products and asked students to talk about pictures with group friends (visual, interpersonal). These activities were to attract students' interest and to increase their motivation for learning the topic. Then the teacher talked about ionization of water, acid, base and pH concepts. Students dramatized the ionization of water (kinesthetic, visual). The teacher gave some information about acid, base and pH concepts. Then the teacher delivered material for the activity of preparing sample pH scale. Each group had a styropor, one red paper stripe and one blue paper

stripe, drawing pins, pictures of daily life products or foods like bleach, lemon, tea, milk etc. and pH list of these products. Students were asked to place the products on the pH scale according to their pH value (visual, naturalist, logical mathematical, interpersonal, kinesthetic). After all groups completed pH scale then the teacher checked whether they prepared correctly or not. One of the groups explained how they prepared the pH scale. The whole class checked the correctness of scale together (interpersonal, linguistic). The teacher gives brief information about properties of acids and bases. Then, neutralization process was shown by dramatization (kinesthetic, interpersonal, and visual). The teacher selected volunteer students. Each student got a paper of element involved in reactants of the reaction NaOH + HCI → H_20 + NaCI. Students are asked to form molecules of an acid and a base. They formed HCI and NaOH by standing side by side. Then the teacher asked students to realize neutralization reaction and form the products. Students changed their places and formed H_2O and NaCI. The teacher repeated the activity by selecting second group of volunteer students. The next topic was minerals. The teacher made a short explanation about each important mineral for living beings. Then, the teacher delivered the papers on which lyrics of Ali Baba's mineral farm song written prepared by the researcher (musical-rhythmic, intrapersonal, interpersonal and linguistic). Firstly, students were asked to read by oneself. Then the teacher asked volunteer students to sing the song loudly. Finally whole class sang the song together. The final activity is acid-base, salt-mineral game (interpersonal, logical-mathematical). Each group chose a surprise egg box and opened it. There is a sentence in the box related with acid-base-salt-mineral. Each group was asked to give response whether the sentence written on the paper is correct or not. After this activity, word puzzle was delivered to students to complete puzzle individually (intrapersonal, visual). Finally newspaper cuttings related with subjects were read and hanged on the board.

3.6.2 Traditional Instruction

Although student centered activities were mostly used in MIBI, the instruction in traditional group was teacher-centered. Most of time, students were just passive listeners. The teacher started lesson by giving names of main topics that would have been instructed during lesson. Then the teacher began to explain topics. The main instrument that the teacher used was white board. He sometimes used different color board markers to make drawings more visual. After explanations the teacher asked students some questions related with the topic. Sometimes he selected volunteer students for answering questions but sometimes he asked some students to give answers of questions. If a student could not give correct answer then he selected another student to get correct answer. This went on until finding correct answer. If none of students gave correct answer then he explained the answer of question that he asked. Moreover, the teacher answered the questions coming from students. Students asked questions sometimes directly related with subject matter and sometimes related with daily life.

The teacher used the board to write summary of concepts. Sometimes he wrote questions on the board and chose some students to solve the questions and write the answer on the board. The teacher asked the students follow the subjects from the textbook. Sometimes he dictated some important notes on students' notebook. Sometimes the teacher answered the questions that students asked from OSS exam books during break times. The teacher didn't perform any different activity other than giving lecture, using board and asking questions.

3.7 Analysis of Data

Basic compounds of living organisms achievement test (BCLOAT), science process skills test (SPST) and attitude scale toward biology (ASTB) instruments were used to collect quantitative data. SPSS and Microsoft excel program were used for coding necessary data and to get some total scores of each student. Each student was coded as a number from 1 to 59 and written on rows. Variables were placed on columns. Group membership, gender, pre-BCLOAT, pre ASTB, SPST, post BCLOAT, post ASTB were written to each column. Then identification and scores of each student were typed to related cells. Descriptive and inferential statistical analyses were

performed by using SPSS. The next step was missing data analysis. There were not any missing data for pretests both in experimental and the control group. However a student in the experimental group changed his classes in following week after pretests. Therefore this student was excluded from data analysis. There were not any missing data in post tests both in experimental and control groups. After missing data analysis descriptive statistics were conducted. Finally inferential statistical analyses were conducted to test the hypothesis of the study. Since there were more than two dependent variable multivariate analysis of covariance (MANCOVA) were conducted. MANCOVA is a powerful statistical technique that equates groups on more independent variables. In addition, this analysis can control type one error. Before conducting MANCOVA, firstly assumptions of MANCOVA were checked. After MANCOVA, follow-up ANCOVAs were conducted to analyze the effect of independent variables on each dependent variable separately. Interview recordings were transcribed by the researcher. Data obtained from interviews were interpreted based on codes and categories.

3.8 Treatment Fidelity and verification

Treatment fidelity is a very important issue in experimental studies that differences in dependent variables were due to treatments not due to any other factors. The experimental group students were instructed according to MIBI. Howard Gardner didn't develop MIBI. He just proposed the theory of multiple intelligences and aimed for psychology and development. He was very surprised that his theory got attention of mostly educators. Therefore there are no strict procedures for MIBI based instruction. There are several types of MIBI in literature. In this study one of approaches based on MI were used. A detailed review of literature was conducted to prepare lesson plans prepared according to this approach. Two experts from science education and three biology teachers examined lesson plans and made some recommendations. According to these recommendations the researcher made some revisions on lesson plans. After completing all lesson plans the teacher were informed about MIBI in a detailed way. The researcher informed the teacher about what he should do and should not do for traditional instruction. The researcher asked the teacher to feel free to ask any question about anything during the study.

Treatment verification is important to ensure that treatments were carried out as planned way. An observation checklist mentioned before was used by the researcher both for experimental and control group.

3.9 Unit of Analysis

If unit of analysis and experimental unit would be same in an experimental study independence of observation were guaranteed. On the other hand the unit of analysis and experimental unit were different in this study since unit of analysis is each student and experimental unit is each intact class. Therefore independence of observation was not met. However the teacher was asked to make students avoid interacting with each other during data collection process. So we can say that independence of observation was met at least for measurement processes of the study.

3.10 Assumptions and Limitations

3.10.1 Assumptions

Assumptions of this study were stated below.

1. The teacher was not biased during instructional periods for both experimental and control groups.
2. There was not any interaction between the students of control group and experimental group.
3. The students in control group and experimental group answered questions given in tests seriously and honestly.

4. The instruments were administered under standard conditions
5. The teacher and students were responded interview questions sincerely and honestly.

3.10.2 Limitations

Limitations of this study were stated below.

1. This study is limited to "basic compounds of living organism" unit in 9th grade biology lesson.
2. This study is limited to 9th grade Anatolian high school students.
3. This study was performed with 59 students who is a small proportion of accessible population.
4. The duration of the study was limited to ten weeks.
5. Random selection of students to groups was not provided.
6. The researcher was the only person who observed the lessons

CHAPTER 4

RESULTS

In this chapter the results of data analysis were explained in three sections. Descriptive statistics and related statistical analysis for pretests were presented in the first section. Secondly inferential statistics were carried out to test hypothesis of the study. The results of interviews conducted with students and the teacher were stated in third section. Lastly results of classroom observation checklist and summary of findings were presented.

4.1 Descriptive statistics

As it was mentioned in procedure part there was no missing data in this study. Only one student who took pretest in experimental group is excluded from the study since he changed his class at the beginning of the study. Descriptive statistics were given in table 4.1 for pretest and posttest results.

Table 4.1 Descriptive statistics for pretests and posttests.

Group	Test	N	Min	Max	Mean	SD	skeweness	curtosis
CG	Pre-BCLOAT	30	5	11	7,23	1,89	0,594	-0,753
CG	Post BCLOAT	30	6	16	9,50	2,78	0,746	-0,139
CG	Pre ASTB	30	1,92	3,97	3,39	0,51	-1,233	1,714
CG	Post ASTB	30	1,92	4,53	3,37	0,61	-0,659	0,251
CG	SPST	30	8	25	14,57	4,07	0,726	0,411
EG	Pre-BCLOAT	29	3	12	6,72	2,14	0,387	0,092
EG	Post BCLOAT	29	5	17	12,48	2,90	-0,737	0,148
EG	Pre ASTB	29	1,92	4,06	3,43	0,49	-1,207	1,809
EG	Post ASTB	29	2,78	4,69	3,73	0,53	-0,154	-0,772
EG	SPST	29	11	23	16,72	3,39	-0,135	-0,921

The mean score of CG for Pre-BCLOAT is 7,23 and the mean score of EG for Pre-BCLOAT is 6,72. This shows that prior knowledge about the topic was close to each other for experimental and control group. The mean score of CG for pre ASTB is 3,39 and the mean score of EG for pre ASTB 3,43 showing that attitudes of students in experimental and control groups were very close to each other before the treatment. Finally the mean score of CG for pre-SPST is 14, 57 and The mean score of EG for pre-ASTB is 16, 72. This results show that students in experimental group have higher levels of science process skills than students in the control group before the treatments.

4.2 Statistical analysis of pre-BCLOAT, SPST and pre-ASTB

Independent sample t-tests were used in order to test whether there was a significant mean difference between experimental and control groups with respect to students' achievement in basic compounds of living organism concepts measured by basic compounds of living organisms achievement test BCLOAT, students' attitudes toward biology measured by attitude scale toward biology (ASTB) and students science process skills measured by science process skill test (SPST).

Firstly assumptions of t-test were verified. These are normality, independence of observation, equality of variances. The skeweness and kurtosis values for three pre-tests were in the range of -2 and +2 (table 4.1) indicating that the distribution was normal. Therefore first assumption was met. The teacher was asked to make students avoid interacting with each other during test administration. Therefore it was assumed that second assumption was also met. Levene's test of equality of variances in table 4.2 shows that population variances of experimental and control group were equal.

Table 4.2 Levene's test of equality of variances

	F	*p*
Pre-BCLOAT	0,201	0,656
Pre- ASTB	0,041	0,839
SPST	0,503	0,481

t-test analysis was conducted after all assumptions were met. Table 4.3 shows the results of t-tests. There was no significant mean difference between experimental and control group with respect to students' achievement in basic compounds of living organisms concepts $t(57)= -0,971$, $p>0,05$; students' attitude toward biology $t(57) = 0,324$, $p >0,05$. On the other hand, there was a significant mean difference between experimental and control group with respect to students' science process skills $t(57) = 2,210$, $p<0,05$. Since there was significant mean difference between experimental and control group, SPST scores were used as covariate for post test analysis in order to control the effect of students' science process skills on dependent variables.

Table 4.3 Results of independent sample t-tests

	t	*df*	*p*
Pre-BCOLOAT	-0,971	57	0,336
Pre- ASTB	0,324	57	0,747
SPST	2,210	57	0,031

4.3 Statistical analysis of post test scores

There were two dependent variables and one covariate in this study. Therefore, multivariate analysis of covariance (MANCOVA) was used for statistical analysis of post tests in order to test hypothesis of the study. Post- BCLOAT and Post-ASTB were dependent variables, SPST was covariate, treatments and gender were independent variables in this study. Table 4.4 and table 4.5 shows descriptive statistics for dependent variables across treatment groups and gender respectively.

Table 4.4 Descriptive statistics of post test scores across experimental and control groups

	Mean	Mean	Std. dev.	Std. dev.	Skew.	Skew.	Kurt.	Kurt.
	CG	EG	CG	EG	CG	EG	CG	EG
Post-BCLOAT	9,5	12,48	2,78	2,90	0,746	-0,737	- 0,139	0,148
Post-ASTB	3,37	3,73	0,61	0,53	-0,659	-0,154	0,251	-0,772

Mean scores of experimental group on Post-BCLOAT and post ASTB were higher than mean scores of control group on post BCLOACT and Post ASTB. Skewness and kurtosis values were in the range of – 2 and +2 indicating normal distribution.

Table 4.5 Descriptive statistics of post test scores across gender.

	Mean	Mean	Std. dev.	std. dev.	Skew.	Skew.	Kurt.	Kurt.
	male	female	male	female	male	female	male	female
Post-BCLOAT	10,32	11,44	2,48	3,59	0,528	-0,304	-0,012	-1,306
Post-ASTB	3,54	3,56	0,56	0,63	-0,018	-0,802	-0,813	0,914

There were 25 male and 34 females in the sample. Mean scores of females on Post-BCLOAT and post ASTB were higher than mean scores of males on post BCLOAT and Post ASTB. Skewness and kurtosis values were in the range of – 2 and +2 indicating normal distribution.

4.3.1 Assumptions of MANCOVA

First assumption was enough sample size to conduct MANCOVA. Number of cases should be greater than dependent variables for each cell (Pallant, 2007). Since the number of cases was greater than dependent variables for each cell in this study, this assumption was met.

Second assumption was univariate and multivariate normality. Skewness and kurtosis values of all dependent variables were checked to examine univariate normality. Since all values for skewnesss and kurtosis were between the range of -2 and +2, it was considered that univariate normality assumption was met. Mahalanobis distances procedure were performed to control the assumption of multivariate normality and to check outliers (Pallant, 2007). The critical value for two dependent variables is 13,82 given in Pallant (2007). The mahalonobis value for this study was 12,36. Since this value is smaller than critical value, multivariate normality assumption was met and it was considered that there were no outliers in the data.

Third assumption was linearity. There should be a straight line relationship between each pair of dependent variables. Pallant (2007) states that producing scatter-plot matrix between each pair of dependent variables is the easiest way to check linearity assumption. Linearity assumption for this study was met since the scatter-plots do not indicate any clear evidence of non –linearity.
Fourth assumption was homogeneity of regression. Homogeneity of regression assumption means regression between covariate and dependent variables in one group must be the same for other groups. MRC was used to test homogeneity of regression assumption for each dependent variable. Firstly, three sets (Set A, Set B and Set C) were formed. Set A was the covariate (SPST).

Independent variables were included in set B. Set C was obtained by multiplying covariate with each independent variable. Finally, MRC was conducted through SPSS. The results of MRC for each dependent variable were shown in Table 4.6 and table 4.7 According to results of MRC, homogeneity of regression assumption was satisfied for all dependent variables since R^2 change for set C was not significant at the 0,05 significance level.

Table 4.6 MRC analysis for the post BCLOAT

Change Statistics for the Post-BCLOAT

Model	R2 Change	F Change	df1	df2	Sig. F Change
Set A	0.095	6.012	1	57	0.017
Set B	0.180	6.849	2	55	0.002
Set C	0.040	1.551	1	54	0.221

Table 4.7 MRC analysis for the post-ASTB

Change Statistics for the Post-ASTB

Model	R2 Change	F Change	df1	df2	Sig. F Change
Set A	0.083	5.167	1	57	0.027
Set B	0.056	1.801	2	55	0.175
Set C	0.087	2.992	1	54	0.059

Fifth assumption was multicollinearity and singularity. Dependent variables should be moderately correlated. High correlation between dependent variables called multicollinearity (Pallant, 2007). If correlation between dependent variables is around 0.8 or 0.9, this is a problem for MANCOVA and indicates violation of the assumption. Table 4.8 show correlation values between dependent variables.

Table 4.8 correlations between dependent variables

	Post-BCOLOAT	Post-ASTB
Post-BCOLOAT	---	0,391
Post-ASTB	0,391	----

Table 4.8 shows that dependent variables were moderately correlated. Therefore the assumption of multicollinearity and singularity was satisfied.

Sixth assumption was homogeneity of variances-covariance matrices. Box' test was used to check this assumption. According to results given in table 4.9, It can be concluded that the covariance matrices of the dependent variables were equal across groups F (9, 23698.174) = 1,638, p = 0,098. The assumption of homogeneity of variance/covariance matrices was met.

Table 4.9 Box's test of equality of covariance matrices

Box's M	15.818
F	1,638
df1	9
df2	23698.714
sig	0,098

Table 4.10 shows the results of Levene's test. It can be concluded that each dependent variable has the same variance across groups. Therefore, homogeneity of variance assumption was met.

Table 4.10 Levene's test of equality of error variances

	F	df1	df2	Sig
Post BCLOCAT	0.654	3	55	0.584
Post-ASTB	2.636	3	55	0,059

There should be significant correlation between covariate and dependent variables for MANCOVA analysis. Table 4.11 shows that the correlation between covariate and dependent variables was significant. Therefore this assumption was met.

Table 4.11 Correlations between covariate and dependent variables

	SPST
Post-BCLOACT correlation *p*	0.309* 0.017
Post-ASTB correlation *p*	0.288* 0.027

* Correlation is significant at the 0,05 level

The final assumption was reliability of covariates. In this study there is only one covariate and as it was mentioned in instruments section SPST is a reliable instrument (Cronbach alpha: 0,85).

Having checked all assumptions, MANCOVA was conducted.

4.3.2 MANCOVA

Post- BCLOAT and Post- ASTB were dependent variables, treatment and gender were independent variables and SPST was covariate for MANCOVA. Based on these variables MANCOVA was run. The result of main analysis was given in Table 4.12

Table 4.12 MANCOVA results

	Wilks' Lambda	F	Hypothesis df	Error df	Sig.	Eta Squared	Observed power
SPST	0,943	1.600	2	53	0.211	0.057	0,324
gender	0,968	0.872	2	53	0.424	0.032	0.192
treatment	0.812	6.131	2	53	0.004	0.188	0.871
Gender* treatment	0.986	0.372	2	53	0.691	0.014	0.107

According to MANCOVA results given in table 4.12 there was a significant mean difference between experimental and control group on the collective dependent variables of post-BCLOAT and post-ASTB when the covariate was controlled ($F(2, 53) = 6.131$, Wilks' Lambda = .812, $p < 0.05$)). This difference was in favor of experimental group. The partial eta squared value is 0.188 indicating a relatively high effect size since it is larger than 0.14. Effect size indicates that 19 % of variance of dependent variables was associated with the treatment.

There was no significant mean difference between males and females on the collective dependent variables of post-BCLOAT and post-ASTB when the covariate was controlled (F (2, 53) = 0.872, Wilks' Lambda = .968, p > 0.05)). The partial eta squared value was 0.032 indicating a small effect size. Effect size indicates that only 3% of variance of dependent variables was associated with gender. There was no interaction between gender and treatment (F (2, 53) = 0.372, Wilks' Lambda = .986, p > 0.05)).

Science process skills scores was not a significant contributer of students' collective dependent variables on basic compounds of living organisms concepts (F(2, 53) = 1,600, Wilks' Lambda = 0,943, p > 0.05). Follow-up ANCOVAs were conducted to investigate the effect of treatment and gender on each dependent variable separately. Bonferroni adjustment was made in order to reduce Type 1 error rate (Tabachnick & Fidell, 2007). Alpha level was divided by 2 since there were two dependent variables. The new alpha level is 0.025. Table 4.13 shows the results of follow-up ANCOVAs

Table 4.13 Univariate ANCOVA results based on dependent variables

	Dependent variable	df1	F	Sig.	Eta squared	power
treatment	Post-BCLOACT	1	11.580	0,001	0.177	0.916
treatment	Post ASTB	1	3.270	0.076	0.057	0.427
gender	Post-BCLOACT	1	1.566	0.216	0.028	0.233
gender	Post ASTB	1	0.014	0.907	0.000	0.052
Gender*treatment	Post-BCLOACT	1	0.650	0.424	0.012	0.124
Gender*treatment	Post ASTB	1	0.280	0.599	0.005	0.081

Null Hypothesis 1 was "There is no significant mean difference between post-test mean scores of the students taught with multiple intelligences based biology instruction and students taught with traditionally designed biology instruction with respect to students' achievement in basic compounds of living organisms concepts when science process skill is controlled as a covariate." According to results of ANCOVA given in Table 4.13, there was a statistically significant mean difference between post test mean scores of students exposed to MIBI and traditional instruction with respect to students' achievement in basic compound of living organisms concepts, when SPST was controlled as a covariate (F= 11.580, p = .001). This difference was in favor of experimental group since population mean score of EG is higher than CG. Therefore this hypothesis was rejected

Null Hypothesis 2 was "There is no significant mean difference between post-test mean scores of males and females with respect to their achievement in basic compounds of living organisms concepts when science process skill is controlled as a covariate." There was no statistically significant mean difference between post test mean scores of males and females with respect to students' achievement in basic compounds of living organisms concepts, when SPST was controlled as a covariate (F= 1.566, p = .216). According to this result it was failed to reject second null hypothesis

Null Hypothesis 3 was "There is no significant effect of interaction between gender difference and treatment with respect to students' achievement in basic compounds of living organisms concepts when science process skill is controlled as a covariate." There was no interaction between treatment and gender with respect to students' achievement in basic compounds of living organisms concepts, when SPST was controlled as a covariate (F=0,650, p = .424). As a result, it was failed to reject this null hypothesis.

Null Hypothesis 4 was "There is no significant mean difference between post-test mean scores of students taught with multiple intelligences based biology instruction and traditionally designed biology instruction with respect to students' attitudes toward biology as a school subject when

science process skill is controlled as a covariate?" There was no statistically significant mean difference between post test mean scores of students exposed to MIBI and traditional instruction with respect to students' attitudes toward biology when SPST was controlled as a covariate (F= 3.270, p = .076). Therefore it was failed to reject this null hypothesis.

Null Hypothesis 5 was "There is no significant mean difference between post-test mean scores of males and females with respect to their attitudes toward biology as a school subject when science process skill is controlled as a covariate." There was no statistically significant mean difference between post test mean scores of males and females with respect to students' attitudes toward biology when SPST was controlled as a covariate (F= 0.014, p = .907). According to this result it was failed to reject fifth null hypothesis.

The last null hypothesis was "There is no significant effect of interaction between gender difference and treatment with respect to students' attitudes towards biology as a school subject when science process skill is controlled as a covariate." There was no interaction between treatment and gender with respect to students' attitudes toward biology when SPST was controlled as a covariate (F=0,280, p = .599). Therefore it was failed to reject this null hypothesis.

4.4 Results of the interviews

Semi-structured interviews were conducted with 5 students from the experimental group and the teacher to get their opinions about MIBI at the end of the treatment. Students were asked to compare MIBI with previous years science lessons since this was the first year of high school and at the beginning of semester. i.e they did not have experience with high school biology lesson instruction. Instead of using students' original names numbers were used to define each student. Since there were 5 students to be interviewed numbers from one to five were used to define each student.

4.4.1 Results of interviews conducted with students

Three dimensions were specified after coding students' responses according to interview questions. The codes may be categorized as 1) differences between traditional instruction and MIBI 2) student centered instruction 3) effectiveness of learning in MIBI.

1) Differences between traditional instruction and MIBI

All the students preferred MIBI based instruction to traditional instruction. Student 1 stated that "this is the first time that different teaching style I have experienced. There were lots of activities during lesson which are different from previous science lessons that we only listened to teacher and answered questions the teacher asked." Student 2 stated that "this was the most enjoyable lesson period I have experienced. I wasn't bored during lesson. The activities were very nice and enjoyable. I wish all the lessons were like this." According to Student 3 previous science lessons were boring. "We only listened to the teacher, took notes and solved test questions. But in this biology lesson we performed different activities which helped me learn subjects better. Moreover we used different resources other than textbooks and university exam preparation books." Student 4 stated that "I was agree with my friends this biology lesson was different from other science lessons. The time passed quickly during lesson since we dealt with some activities. We were active during lesson. But in previous science lessons most of the time we were passive and that was very boring for me." Student 5 stated that "I prefer this kind of lesson to previous science lessons. We read textbook, memorized information and solved test questions in previous science lesson but in this biology lesson I have experienced different activities that I firstly saw." Student 3 stated that this was the first lesson other than music that he sang a song with his friends. "I like listening to music and singing a song about biology was very helpful for me to memorize some important knowledge." Student 2 stated that "reading newspaper cuttings made me more interested in subjects because if I know that how this information is related with daily life I feel

more enthusiastic to learn more about the topic, for example I was very surprised that the volume of water increases when it freeze and this is important for life in lakes or rivers."

All the students thought that MIBI doesn't look like traditional lesson. The main point for difference between MIBI and traditional ones is enjoying lesson. They think that activities performed during lesson are different and interesting that is why they liked the lesson.

2) Student centered instruction

One of the main points students expressed is they were active during lesson. For example student 4 stated that "time passed very quickly during biology lesson. We performed activities both individually and cooperatively with my friends." Student 1 stated that "in traditional science lesson there were no surprise everything was routine. But in this biology lesson I always felt excited because I was always waiting for dealing with different activities. That is why I liked biology lesson much." Student 2 stated that "I like dealing with pictures and drawings. During acid-base topic we categorized pictures and listed pictures according to their pH. That was really wonderful activity."

Some students preferred individual activities some of them preferred group activities and still some of them preferred mixed one. Students 3 stated that "I prefer individual activities because in group activities there were sometimes noise and problems among students. Some of friends tried to do all parts of activities. Therefore sometimes I became passive during some activities." Student 2 stated that "I liked activities done by group. For example I hesitate to sing a song in front of people but if we sing a song as a group then I feel more confidence to sing a song. Moreover it is more fun to sing a song as a group."

One of main reasons that student liked biology lesson is they are not passive. Student 4 stated that "I liked this kind of instruction. If I only listen to teacher and take notes this is very boring and I don't concentrate on understanding topic. I just dream about different things. On the other hand I increase my concentration if I deal with a task." Student 5 stated that "I experienced most of activities first time in biology lesson. The lesson was colorful."

Students thought that they had positive opinions about the lesson since the lesson was not boring and they were active during lesson. They think that if they were passive then the lesson would have been boring.

3) Effectiveness of learning in MIBI.

Students think that they understand subjects better if they are active in learning process. Only listening to information is not enough to grasp concepts. Student 2 stated that "I liked puzzle activities. This was very good because at the end of topic I rethink what I learned by performing a fun activity. I wish there would have been puzzles at the end of each subject. Moreover it would be better if the style of puzzle would have been different." Student 3 stated that "it was interesting that I learn and I enjoy at the same time. I saw that it is possible to learn some knowledge while you were enjoying lesson. Most of time I think that ok no problem when I go to home I study by myself and try to understand concepts but in biology lesson I experienced that I can understand concepts during lesson."

Student 4 stated that "I asked by myself why all lessons were not like biology because I learn better if the instruction is like biology. I feel not motivated if the lesson was boring. If I like lesson then I feel more energy to study that lesson." Student 5 expressed that "I don't have to spend too much time at home to repeat and study the topic for exams. Because I already understand most of subjects during lesson that is why I just repeat what I learned during lesson." Student 1 mentioned that "I don't know the reason but I felt more confidence to ask questions about topics that I didn't understand. Sometimes I asked questions which is not directly involved in topic but I wonder by using question corner."

Students stated that they learn better in MIBI type of instruction since they are not passive during lesson and they enjoy performing activities related with lesson. As a result they are more concentrated on learning concepts compared to traditional lessons.

4.4.2 Results of the interview conducted with the teacher

At the end of the treatment an interview was conducted with the teacher to get his opinions about MIBI. Two dimensions were specified after coding the teacher's responses according to interview questions. The codes may be categorized as 1) Benefits of MIBI for students 2) Difficulties to implement MIBI.

1) Benefits of MIBI for students

The teacher believes in benefits of MIBI for students both theoretically and practically. He already has some information about multiple intelligences theory. He stated that "I know that MIBI is superior to TI. In traditional lessons students are passive but in MIBI students are active and I know that the more students are active the better they learn." He thinks that students were more comfortable in MIBI that is why they felt free to ask any kind of questions. "Question corner activity was very helpful to make students who hesitate ask questions during lesson, because all students are not the same. Some students have more self confidence than the others. Therefore they don't hesitate to ask questions during lesson. On the other hand some students feel not free to ask questions about points that they didn't understand or to ask questions about daily life that they wonder."

He mentioned that exposing different kind of activities makes learning better. "One of main points in MIBI is variety of activities. Students are exposed to different types of learning activities. Some of them are verbal, some of them are visual." He also stated that three dimensional molecule modeling activities were very helpful. "In fact we try to explain three dimensional molecule worlds in two dimensions by only drawing molecule models on the board. However it was very beneficial for students to construct molecules by using three dimensional molecule models. They used their hands and touched models and saw molecules in a three dimensional way."

He thinks that visual activities and dramatization or role playing activities were the best ones. "In my opinion to see something concretely make it easy to understand it. In traditional classrooms visual and kinesthetic activities are not common. But in MIBI there were several visual activities and kinesthetic activities." He believes that cooperation among peers is very important issue for peer learning and MIBI make it possible. "One of crucial points of MIBI is balance of activities. i.e MIBI didn't concentrate on a specific types of activities. Sometimes group activities were taken place some times individual activities were taken place. I know from my experiences that it is boring to perform activities always individually or the opposite. Students like variety and MIBI is a good method to balance between different types of activities."

According to the teacher if students see relevance of subjects with daily life they are more interested in learning. The more they are interested in subject matter the more they learn. He thinks that "newspaper cuttings activity at the end of each subject was very useful. Students found possibility to see relationship between subject matter and daily life by reading real newspaper cuttings."

2-) Difficulties to implement MIBI

The teacher believes and accepts the benefits of MIBI for students' learning. On the other hand he thinks that it is not easy to implement MIBI throughout whole academic year. He states several reasons for this. One of them is general education system. He stated that "the general education system is the main problem. The system doesn't favor this type of teaching learning process. There is a university entrance exam. This exam is very important for students' life. Unfortunately

this exam favors only verbal and mathematical talents. That is why in traditional lessons we as a teacher mostly do activities feeding verbal and mathematical abilities. Moreover time is very important in the exam. Students who solve questions practically are successful. That is why we suggest students to solve lots of questions to gain speed and to learn question styles in the exam. Unfortunately our main purpose is to prepare students for exam"

He believes that there is conflict between regular education and final evaluation. "High school education is important to pass university entrance exam. The main purpose of high school education for students is to enter a high quality university or department. Therefore students mostly concentrate on university entrance exam. They go to private courses and buy lots of test books. As a teacher I have responsibility to make sure students to teach subjects which are important for university entrance exam and to make them solve questions related with the subject."

The other problem is curriculum. According to the teacher curriculum is too loaded and time is limited. "I believe that MIBI is very useful but it requires more time compared to traditional instruction. In traditional lesson I finish teaching subjects earlier and allocate time to solve sample test questions. MIBI activities requires more time. As a teacher I have to finish subjects given in curriculum in time."

The other factor is students' approach to MIBI. He thinks that students liked MIBI much but since they are not used to these kinds of activities sometimes we couldn't use time efficiently. Students have been used to traditional instruction for eight years. First time in their education life they were exposed to a different type of teaching style. Therefore it is not easy for students to adapt a new different teaching style. I believe that if students were used to MIBI in previous years it would have been easier both for me and for students."

He believes that this kind of changes should be from a wide perspective. "In this school only lesson that apply MIBI is biology. After biology lesson, students turn back to traditional instruction. This make them confused. If whole school and all other teachers apply MIBI at the same time then everything would be much easier and more effective. Moreover conditions in school should be appropriate to apply MIBI. Classes are relatively crowded to apply MIBI and equipments and other things are not enough to apply MIBI effectively."

The teacher is aware of benefits of MIBI and he defends that traditional instruction is not the ideal one. On the other hand he thinks that it is not easy to implement student-centered instructional methods like MIBI unless education system changes radically.

4.5 Classroom Observation Results

Treatment part of this study lasted ten weeks in a public Anatolian high school in Kırşehir. There were two 45-minute instruction period per week both for experimental and control group. Two groups were taught by the same teacher and the same curriculum and text book were used in two groups.

The researcher visited the classroom one week before the implementation process began in order to make students familiar for the researcher observation. The researcher didn't participate in any part of instruction. He just sat silently at the back of the classroom. He observed the classroom environment, teacher and students and took notes for treatment verification.

The teacher used multiple intelligence based instruction in experimental group. He followed the lesson plan given by the researcher. The teacher asked students to arrange desks for group activities before lesson. Each week students arranged desks to form six groups before lesson and rearranged desks after lesson during break times to make the classroom ready for the other lessons, because teachers of other lessons after biology didn't prefer group arrangement. In order to prevent loss of time all these arrangements were taken place during break times. Students were

not used to student centered and activity based instruction. Therefore, at the beginning students sometimes got difficulty to understand directions given by the teacher and confused what they should do. However the teacher explained directions a few times to make students' minds clear about the procedure of activities. In further lessons, students were used to perform activities and didn't experience any difficulty to perform activities. There were several activities like role playing and singing a song related with lesson that students met for the first time resulting in hesitation to take part in the activity. However the teacher was successful to encourage students to participate in this kind of activities. For further lessons the teacher had difficulty to select students among volunteer students who wanted to perform the activity since most of students wanted to participate in activities. The teacher was always alert for appropriate implementation of treatment. For example he often warned students to perform activities individually for the activities addressing intrapersonal intelligences, because some students tried to get help from their friends to complete activities that they should have to do individually. He also warned students who performing activities individually for group works. He encouraged students to do activities cooperatively by group friends for activities addressing interpersonal intelligences.

Students seemed to enjoy MIBI instruction. They all involved activities willingly. After they get used to doing activities, they asked the teacher to give activities for the parts of lesson that the teacher have to give some information about subject. They often asked "teacher, are there any other activities that we are going to do in this lesson".

Students are asked if they have any question that they don't want to ask in the classroom, they can write questions without writing their names and put question corner envelope. At the end of lesson the teacher controlled the envelope whether there were any question papers or not. The teacher answered all questions written on question corner at the beginning of next lesson. He first repeated questions loudly to make sure all students hear questions and answered questions. The teacher encouraged students to use question corner. He told students not to hesitate asking any kind of questions related with lesson.

The teacher used traditional instruction in control group. He started lessons by writing topics of lesson on the board. Then he began to give related information by using lecturing method. He sometimes asked questions related with the topic and made students try to tell answers of these questions. He told students that they can use notebooks if they like to write information written on the board. He answered questions coming from students. He solved sample university entrance exam questions related with subjects at the end of lesson. Most of time students were passive. They just listened to what the teacher said and took notes during lesson. Sometimes the teacher opened a discussion by asking questions related with daily life.

In conclusion, students were much more active in MIBI classroom and seemed to be happy and enjoy doing activities related with subjects. On the other hand, students were passive most of the time in traditional instruction and seemed not to be involved in lesson willingly. It could be stated that MIBI compared to traditional instruction was more successful to make students interested in lesson actively.

4.6 Summary of Results

Summary of results were stated below

- According to pre-test results, There was no significant mean difference between experimental and control group with respect to Pre-BCLOAT and pre-ASTB scores. On the other hand, there was a significant mean difference between experimental and control group with respect to SPST scores.

- Post test results revealed that there was a significant mean difference between experimental and control group with respect to post-BCLOAT in favor of experimental group, when Students' SPST scores were controlled. However, there was no significant mean difference between experimental and control group with respect to post-ASTB.

- There was no significant effect of gender on students' achievement in the unit of basic compounds of living organisms and students' attitudes toward biology

- There was no significant effect of interaction between gender and treatment on students' achievement in the unit of basic compounds of living organisms and students' attitudes toward biology

- Results of interviews conducted with experimental group students and the teacher showed that both students and the teacher had positive opinions toward MIBI.

CHAPTER 5

DISCUSSION, IMPLICATIONS, AND RECOMMENDATIONS

This chapter includes discussion of the results, internal validity and external validity. Moreover conclusion and implications were presented. Recommendations for further research were given at the end of the chapter.

5.1 Discussion

This study investigated the effect of multiple intelligences based instruction compared to traditional instruction on 9th grade students' achievement in the unit of basic compounds of living organisms and students' attitudes toward biology as a school subject. Pretests for students' achievement in the unit of basic compounds of living organisms and students' attitude toward biology and science process skills test were given at the beginning of the study to reveal their prior learning, attitudes toward biology and science process skills. t tests were conducted to see whether there were significant mean differences between control group and experimental group.

The results of t test analysis showed that there were no significant mean differences between experimental and control group with respect to students' achievement in the unit and students' attitude toward biology. On the other hand there was a significant mean difference between experimental and control group with respect to students' science process skills. The mean score on pre-BCLOAT was 6,72 for experimental group and 7.23 for the control group. The maximum score for pre-BCLOAT could be 25. The results showed that students in both the control group and the experimental group had low level of prior knowledge before the treatment. Prior knowledge that students have is very important to understand related subject matter (Lowerry, 1998). Prior knowledge affects students' performance positively (Dochy, Segers, and Buehl, 1999; Marzano, 2004). Therefore it could be a factor for differences in achievement between experimental and control group. Since there is no significant mean difference between experimental and control group for this study, it could be safely stated that differences between experimental and control group were not resulted from previous knowledge of students.

There is also no significant mean difference between the control group and experimental group in terms of students' attitudes toward biology. The mean score on pre-ASTB was 3,39 for control group and 3,43 for the experimental group. The maximum score for pre-ASTB could be 5.00. The results indicated that students both in the control group and the experimental group had neither positive nor negative attitudes toward biology before the treatment. This may result from the time the instrument was given to students. The time the ASTB were given was the beginning of the semester. 9th grade was the first year that student would attend biology lesson independently. In previous years students attended science lesson which include three science area chemistry, physics and biology. Therefore 9th grade is the first year students would attend biology lesson. They don't have enough awareness or knowledge about what biology lesson is or will be. This may make students uncertain about some issues related with biology lesson. Pre-attitude score may be a confounding factor for post attitude scores. Since there is no significant mean difference between groups, it could be concluded that post differences will not result from pre-differences.

Although there were no significant mean differences between the control group and the experimental group with respect to achievement and attitude, there was a significant mean difference between the control group and the experimental group in terms of SPST in favor of experimental group. The mean score on Pre-SPST was 14,57 for the control group and 16,72 for the experimental group. The maximum score for SPST could be 36. The mean score for experimental group was higher than control group. Science process skills have crucial roles for

meaningful learning (Harlen, 1999). Thus, science process skills may be an important confounding factor for students' achievement in science. Therefore the effect of SPST scores should be controlled to prevent the confounding effect on post achievement scores. For this reason SPST scores was taken as a covariate in MANCOVA.

At the end of the treatment, post-BCLOAT test were given to students to investigate the effect of the treatment on students' achievement in the unit of basic compounds of living organism concept; post-ASTB were given to students to reveal the effect of the treatment on students' attitude toward biology. These two tests were used as dependent variables. SPST was used as a covariate since there was a significant mean difference between two groups at the beginning of the treatment. Treatment and gender were used as independent variables in the study. Since dependent variables had moderate correlations (r = .391) they used together in MANCOVA analysis in order to decrease the probability of having type I error.

When the descriptive results of post-BCLOAT test examined, it is obvious that the experimental group had higher mean score than the control group. The mean post-BCLOAT score is 9.50 for the control group and 12.48 for the experimental group. When these score compared to maximum score which is 25.00 it can be concluded that the achievement is in moderate level. On the other hand statistical analysis showed that experimental group compared to control group had significant improvement in achievement due to treatment. The proportion of variance in students' achievement in basic compounds of living organisms concept explained by the treatment is 18% indicating a large effect size. The results of this study are consistent with the findings of other national and international studies supporting the significant effect of MIBI on students' achievement in learning concepts (Glenn, 2010; Owolabi & Okebukola, 2009; Bellflower, 2008; Douglas, Burton, & Reese-Durham, 2008; Dillihunt & Tyler, 2006; Davis, 2004; Presley, 2005; Balım, 2006; Ucak, Bag & Usak, 2006; Bilgin; 2006; Temur, 2007; Gürbüzoğlu, 2009; Kurt, 2009; Köksal & Yel, 2007; Kaya, Doğan, Gökçek, Kılıç, & Kılıç, 2007; Akamca, & Hamurcu, 2005; Can, Altun, & Harmandar, 2011; Kurt & Temelli, 2011; Uzunöz & Akbaş, 2011; Gözüm, 2011). This result might be attributed to several characteristics of MIBI which are superior to traditional instruction. In traditional classrooms, students are not active. They listen to what the teacher lecture and take notes. Teachers come to classrooms with single approach and teach at a single pace (Tomlinson and Kalbfleisch, 1998). On the other hand, in a MIBI classroom presentation methods of topics shifts regularly. Moreover students are not just passive listener but also they perform different activities (Stanford, 2003). It is a common wrong assumption that all students learn in the same way. Each student has different types of abilities and competencies even different combination of these potentials. MIBI gives opportunity for every student who has different abilities to reveal their potentials (Owolabi & Okebukola, 2009). Therefore students can use their innate potentials to learn concepts resulting in more achievement. If students are given the opportunity to use their strengths they take more responsibility for learning. MIBI provides opportunities for students having different types of strengths that every student can experience success (Erb, 1996). Brain does not have a static but a dynamic structure. Its functioning ability may change according to environment. Different activities as a part of enriched learning environment can stimulate students' excitement for learning which indirectly effect better understanding (Wolfe & Brandth, 1998). In experimental group students were exposed different types of activities addressing different types of intelligences. Therefore every student found possibility to involve activities concerning his dominant intelligences or combination of dominant intelligences. Activities addressing interpersonal intelligence give opportunity to students to work with their friends cooperatively which is very important for students who learn better by peer cooperation. On the other hand MIBI also gives opportunity to students who learn better by personal learning by means of activities addressing intrapersonal intelligence. As a result MIBI doesn't favor only one type of learning style. In experimental group students sometimes worked together with their peers and sometimes worked individually. Students who are competent in logical-mathematical and linguistic-verbal intelligences are favored in traditional classroom (Hickey, 2004). Although these students may perform improved achievement while learning subjects, other considerable numbers of students who are competent in different intelligences are ignored. This is consistent with the result of this study. There were also high achievers in CG but when overall mean scores of groups compared MIBI was superior to TI. This may explain why

MIBI classroom mean achievement was larger than traditional classroom mean achievement. MIBI doesn't favor only few students but it provides an effective learning environment for all students. As Erb (1996) stated at the beginning, students may hesitate to take part in or performing activities but once they are used to MIBI lesson most of students would want to participate in activities. According to classroom observation results the same situation happened in experimental classroom. Students were not used to be instructed by methods other than traditional method. Therefore at the beginning teacher spent much energy to encourage students to take part in some activities. However once students got used to MIBI style, they performed activities willingly. Some of important problems identified by Turkish students in biology education are "biology lesson is based on memorizing", "there is no enough information about recent developments in biology books" and "lack of practice in biology lessons". In fact, students see characteristics of traditional instruction as a problem (Kaya & Gürbüz, 2002). Teacher-based lecturing increases students' unwillingness toward biology lesson (Trumper, 2006). Students also express similar reasons for getting difficulty while learning some biological concepts perceived as difficult. Teaching style of teacher, memorizing facts, relation of topics with daily life, teacher centered instruction are some of main reasons that student experience difficulty for learning these concepts. Students also expressed that they are lack of materials for student centered learning resulting in teacher domination in lessons (Çimer, 2012). Since student-centered instruction is dominant in MIBI classrooms, MIBI eliminates all these problems resulting in students' active involvement in lesson. The results of classroom observations and interviews have confirmed this situation in experimental group. Learning atmosphere is also important in education (Wolfe, 1998). Routine is always boring. That is why traditional instruction is perceived as boring by students (Tomlinson, 2002). On the contrary MIBI classes are joyful and colorful making the lesson interesting (Owolabi & Okebukola, 2009). Students who think biology is fun show positive attitudes toward biology resulting in better achievement in biology lesson (Nasr & Soltani, 2011). Schaefer and McDermott (1999) stated that students who are engaged in learning with desire and enthusiasm perform better achievement. In experimental group students were willing to do activities. Students were sure that they will be exposed different activities during lesson. According to interview results, students stress on the words "fun" and "enjoy". They perceive most of activities done in MIBI class as enjoyable activities. That is why students are more concentrated on lesson and interested in learning in MIBI classrooms. Interest is one of the affective variables for constructing knowledge in brain. Students learn better if they are interested in subject (Lawrence, 1998). Students in experimental group were interested in learning activities which might have caused better achievement.

The other independent variable was gender. According to the results of statistical analysis, there was no significant mean difference between males and females with respect to students' achievement in the unit of basic compounds of living organisms. Moreover there was no interaction between gender and treatment. This means that the effect of the treatment did not change according to gender difference. Gender issue in science achievement has been discussed for a long time from different perspectives such as ethnicity, ability, response format, socio economic status (SES) and subject matter (Dimitrov, 1999; Greenfield, 1996; Thomson, 2008). Greenfield (1996) found that there were no significant gender differences in science achievement. In their meta-analysis study Nowell and Hedges (1998) found small gender difference for mean academic achievement of boys and girls. Sungur and Tekkaya (2003) found that there was no statistically significant mean difference between males and females in human circulatory system unit. In a meta-analyses study Becker (1989) found that there were significant differences with small effect sizes in achievement for biology, general science, and physics in favor of males but there were no significant differences in achievement of mixed science content, chemistry, geology and earth sciences. Wang and Staver (1997) found a significant mean difference between Chinese male and female students in science achievement in favor of male students. In conclusion, gender itself has no significant large effect on science achievement compared to other variables. Although there are research studies showing gender differences in science achievement the amount of differences is not as large as for other variables like ethnicity (Greenfield, 1996). For example, Sungur and Tekkaya (2003) also found no significant effect of gender difference but significant effect of reasoning ability on students' achievement in human circulatory system unit. Gender difference in science achievement can also change according to grade level. According to

TIMMS 2003 results, Thomson (2008) reported that although there was no significant gender difference in science achievement of Australian students for junior primary school level, there was a significant gender difference favoring males for early secondary school level. One more thing that should be noted, most of studies investigating gender-achievement relationship used relatively small number of samples that do not represent nation-wide population. Therefore it is not easy to make a decision about relationship between gender and achievement for a given national population (Nowell, & Hedges, 1998). Literature needs more research studies using representative samples for a specific population.

The other issue in science education is affective variables. One of them is attitude. Students' attitude may be an important factor in achievement of students in a specific lesson. According to post test results of this study, there was no significant mean difference between experimental and control group with respect to students' attitude toward biology. The mean score of post ASTB is 3,37 for control group and 3,73 for experimental group. Although there was no significant mean difference between experimental and control group there was a difference between EG and CG in favor of EG. When the post-ASTB and pre-ASTB compared for each group it can be concluded that students' attitude toward biology changed positively in EG (pre-ASTB: 3.43 and post-ASTB: 3.73) but students' attitude toward biology did not change in CG (pre-ASTB: 3.39 and post-ASTB: 3.37). There are research studies in literature showing significant effect of MIBI increasing students' attitudes toward course (Presley, 2005; Kaya et al. 2007; Baş, 2010). On the other hand there are also considerable numbers of research in literature showing no significant effect of MIBI on increasing students' attitudes toward course. (Akbaş,2004; Köksal & Yel, 2007; Şahin, Öngören, & Çokadar, 2010; Akamca, & Hamurcu, 2005). Changing affective variables significantly is not as easy as changing cognitive variables. In this study although there is difference between experimental and control group with respect to students' attitudes toward biology, this difference is not significant. However, students' responses to interview questions revealed that students had positive opinions for biology lesson. Şahin, Öngören and Çokadar, (2010) found no significant mean difference for students' attitudes toward science but qualitative part of the research showed that experimental group students have positive opinions for the course.

There was also no significant mean difference between males and females with respect to students' attitude toward biology. In addition, there was no significant interaction between gender difference and treatment types. That means that the effect of treatment on students' attitude didn't change according to gender. Gender is a controversial issue in attitude like in achievement in science education. Greenfield (1997) found that both males and females have similar attitudes and interest toward science. Weinburgh (1995) reported the result of a meta-analysis study boys have more positive attitudes toward science than girls. Some research studies found that there are significant difference between males and females with respect to their attitudes toward course (Pehlivan, & Köseoğlu, 2010; Ekici, & Hevedanlı, 2010). On the other hand, there are research studies showing no significant effect of gender on students' attitudes toward course (Usak et al., 2009; Altınok, 2004; Gül, & Yeşilyurt, 2010; Nasr & Soltani, 2011; Kan & Akbaş, 2006; Prokop, Tuncer, & Chudá, 2007). This study also supports findings showing no significant effect of gender on students' attitudes toward biology. Like in achievement some other factors like ethnicity compared to gender may have more effect on students' attitude toward science (Greenfield, 1996). For example, Altınok (2004) found that although there was no significant effect of gender difference on 5^{th} grade students' attitudes toward science, there was a significant effect of student achievement level on students' attitude toward science.

Results of interviews conducted with students in experimental group and the teacher revealed that both the teacher and students had positive opinions toward MIBI. Students thought that MIBI was different from classical science lessons. There were different activities which are interesting and fun resulting in students' involvement in lesson. Interest has a considerable effect on facilitation of learning (Hidi, 1990). Boys and girls may show different interest to different science topics (Dawson, 2000; Jones, Howe, & Rua,2000). Bellflower (2008) stated that students had positive attitude toward MIBI lesson. Moreover, students think that MIBI had positive effects on their achievement in Biology. Although the teacher believes in benefits of MIBI he thinks that it is not

easy to use MIBI types of teaching strategies in a traditional school. He thinks that the other factors must also be suitable for application of MIBI in classrooms. In fact these opinions are generally consistent with opinions of other biology teachers in Turkey. Biology teachers think that physical conditions of school, lack of necessary equipments and materials, loaded curriculum with less class hours limits teachers to apply different methods or activities (Altunoğlu & Atav, 2005). University entrance examination is also other important factor (Altunoğlu & Atav, 2005). Heavy curriculum with too much content with not enough time have always been complained by science teachers and school principals resulting in allocating less or no time for different activities encouraging students' scientific thinking (Dicarlo, 2006; Trumper, 2006). Schools are resistant to differentiated education. Decision makers in education like uniformity to be able to make comparisons easily (Eisner, 2004). The teacher also stresses that scores for university entrance exam is the most important variable to make evaluations for teacher and school success. That is why teachers mostly concentrate on students' achievement in university entrance examination which is very important to be accepted for a high quality university.

5.2 Internal Validity

In a research study, internal validity means differences observed on dependent variables are directly arose from independent variables not from other confounding factors (Fraenkel & Wallen, 2006). There are some threats to internal validity. These are subject characteristics, mortality, location, instrumentation, testing, history, maturation, attitude of subjects, regression, and implementation. Controlling these threats as much as possible is necessary for preventing the effects of these factors on dependent variables.

Subject characteristics: The ideal sampling method to limit the effect of subject characteristics is random sampling. Nevertheless random sampling could not be used in this study since the classes had already been formed by school administration at the beginning of the semester. Differences like age, gender, intelligence, socioeconomic status, etc. may be possible threats for the results of the study. Pre-achievement and pre-attitudes scores were obtained at the beginning of the study to check whether there were significant mean differences between two groups. Moreover science process skill test scores used as a covariate in MANCOVA since there was a significant mean difference between experimental and control group at the beginning of the study. Students in both groups were in similar ages, same grades and same school.

Mortality: Some of subjects may drop out of the study or absent during data collection process. There were no missing students during data collection time. Nevertheless one of students in experimental group is excluded from the study since he changed his classroom during study.

Location: Location threat was seemed to be controlled since both experimental and control group were in the same school and instructed in regular classrooms.

Instrumentation: Procedures for application and scoring of instruments were same for two groups throughout the study resulting in controlling instrument decay threat. Instruments used in the study were either multiple choice test questions or likert-type selection items. There were no instruments containing open ended questions. There was only one teacher who administered instruments to students in both groups and he was trained to implement standard procedures during data collection in order to prevent data collector bias.

Testing: Pre-tests and post-tests were the same in this study. Therefore post-tests results might be affected from implementation of pre-tests since students may recall the answers that they gave in pretests. Nevertheless there were ten weeks between pretests and posts which is quite enough time to minimize the effect of testing. Moreover both groups were administered by pretests and posttests. Therefore both groups were affected from testing in the same way.

History: History threat was assumed to be controlled since any unexpected or unusual events that may affect students' performance were not observed throughout the study.

Maturation: Maturation was not a serious problem for this study since all students were in similar ages and implementation of treatments lasted only ten weeks which was not a long time period for changes in participant characteristics. Moreover subjects of this study were not very young individuals.

Attitude of subjects: Students in experimental group may show superior performance compared to students in traditional group just because of novelty of treatment not due to treatment itself. On the contrary, students in control group may be demoralized due to not applying the same treatment in their classroom. It was difficult to control attitude threat in this study since students in both groups were in the same school building and they may have interacted with each other during break times or other free times in the school. On the other hand the teacher told experimental group that implementing treatment was not a privilege for them. He also told students in control group that this was just a result of random assignment and not because of specialty of experimental group. Moreover 9th grade was first year of high school and treatment started at the beginning of first semester. Therefore students might have thought that this was not a special application just a regular application in a high school.

Regression: Students in both control and experimental group were from the same school. They were not selected from low or high achieving students. Moreover pre-test achievements were compared whether there was a significant mean difference between experimental and control group. In addition regression threat is generally a serious problem for one group studies. There were two groups in this study and it was assumed that threat of regression was controlled.

Implementation: There was only one teacher who implemented multiple intelligences based instruction and traditional instruction. Therefore both groups were instructed by the same teacher. The teacher was trained for implementation of treatments. Moreover classroom observation checklist was used to ensure treatment verification (see section 3.4.5 and 4.5).

5.3 External validity

All 9th grade Anatolian high school students in Kırşehir were the target population of this study. All 9th grade Anatolian high school students in city center of Kırşehir were accessible population of the study. Random sampling could not be used in this study since classes had already been formed at the beginning of semester by school administration. Therefore convenience sampling was used in the study. There were five Anatolian high schools in city center of Kırşehir. One of them was selected due to convenient reasons. There were five 9th grade classes in the school. Two intact classes of the same teacher were selected as a sample. One of them was assigned as a control group and the other one as an experimental group. Most of students were low or medium achievers. The sample was consisted of 59 students which was approximately 10 % of the accessible population. Although the number of students in sample was close to 10 % of the accessible population, the generalizability of this study was limited due to convenience sampling and relatively low proportion of sample to accessible population. The school is located in the city center of Kırşehir. Students' ages were in the range of 15 to 17 years old. Socioeconomic status of families was low or medium. The results of this study can be generalized to other populations having similar characteristics mentioned in this study.

5.4 Implications

- Curriculum changes reforms started in 2004 in Turkey with the aim of shifting teacher centered instruction to student centered instruction. MIBI provides concrete examples for student centered instruction. Therefore the results of this study can contribute to teachers, textbook writers, curriculum developers and related researchers.

- Although Biology is a colorful lesson teachers may find it difficult to prepare activities for student centered instruction. Teachers can use materials prepared in this study and may inspire to prepare their own activities.

- MIBI is more effective than traditional instruction for improving students' achievement in the unit of basic compounds of living organism concepts. Moreover it seems that MIBI affects students' opinions for lesson positively. Therefore teachers should try to use as possible as different kinds of activities addressing different types of intelligences to reach every students having different combination of abilities in order to improve students' achievement in the classroom.

- If students like and enjoy a lesson they are more concentrated on lesson and more interested in activities. Therefore teachers should try to use different and interesting activities to engage students in lesson resulting in students' active participation to lesson.

5.5 Recommendations for further study

- Further studies can collect more detailed qualitative data to reveal students and teacher attitudes toward MIBI in a more extended way

- Further research studies can be conducted to analyze the effect of MIBI on retention of biological concepts.

- MIBI can be used for different school types, grade levels and topics.

- Larger sample sizes can be used to increase generalizability

- Different types of assessment methods addressing different types of intelligences can be used to make intelligence-fair evaluation of MIBI on achievement of students in biological subjects.

- Further studies can be performed to analyze the effect of MIBI on remediation of misconceptions in biological subjects.

- Further studies can investigate the effect of MIBI on different affective variables other than attitude.

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APPENDIX A

OBJECTIVES OF THE UNIT

1. İnorganik maddelerle organik maddeleri listeler.
2. Organik maddelerle inorganik maddeler arasındaki farkları açıklar.
3. Suyun hangi özelliklerinin canlılar için önemli olduğunu açıklar.
4. Suyun önemiyle ilgili doğadaki yaşamdan örnekler verir.
5. pH değerleri verilen maddeleri asit-baz şeklinde sınıflandırır.
6. pH değişimlerini hangi faktörlerin etkilediğini açıklar.
7. Uygun pH değerlerinin değişik hücre çeşitleri ve canlı türleri için farklı olabileceğini fark eder.
8. Suyun iyonlaşmasının ortamın pH'ını nasıl etkilediğini açıklar
9. Asit ve bazların birleşmesiyle nötrleşme reaksiyonu sonucu tuz ve su oluştuğunu bilir.
10. Nötürleşme reaksiyonuna örnekler verir.
11. Hangi mineral eksikliğinde hangi önemli rahatsızlığın oluşacağını bilir.
12. Önemli minerallerin görevlerinin neler olduğunu bilir.
13. Karbonhidrat çeşitlerini sınıflandırır.
14. Dissakkarit ve polisakkaritlerin oluşum reaksiyonlarını yazar.
15. Yağların oluşum reaksiyonlarını yazar.
16. Yağların canlılar için önemini bilir.
17. Doymuş ve doymamış yağlar arasındaki farkalrı ayırt eder.
18. Doymuş ve doymamış yağlara örnekler verir.
19. Amino asitin hangi bölümlerden oluştuğunu çizer.
20. Protein farklılığına yol açan faktörleri listeler.
21. Proteinlerin oluşum reaksiyonlarını yazar.
22. Karbonhidrat, protein ve yağlar arasındaki temel farkları açıklar.
23. Karbonhidrat, protein ve yağların monomerlerini bilir.
24. Enzimlerin çalışmasına etki eden faktörleri listeler.

25. Enzimlerin yapısını oluşturan maddeleri listeler.
26. Enzim ve substrat miktarının reaksiyon hızını nasıl etkilediğini açıklar.
27. Enzimlerin çalışma hızına etki eden faktörleri listeler.
28. Vitamin çeşitlerinin temel görevlerinin ne olduğunu bilir.
29. Hangi vitamin eksikliğinde hangi önemli rahatsızlığın oluşacağını bilir.
30. DNA nın hangi maddelerden oluştuğunu şekil çizerek gösterir.
31. RNA'nın hangi maddelerden oluştuğunu listeler.
32. DNA ile RNA arasınkai farkları ayırt eder.
33. DNA' nın özelliklerini açıklar.
34. ATP molekülünü şekil olarak çizer.

APPENDIX B

BASIC COMPOUNDS OF LIVING ORGANISMS ACHIEVEMENT TEST

Açıklama: Bu test canlıların temel bileşenleri konusundaki başarınızı ölçmeyi ve değerlendirmeyi amaçlamaktadır. 25 tane çoktan seçmeli sorudan oluşmaktadır. Aşağıdaki her bir soru için size en uygun seçeneği işaretleyiniz. Başarılar.....

1-) Aşağıda verilen bilgilerden hangisi doğrudur?

A) Karbon içeren bütün moleküller organik bileşiklerdir.

B) Hücre bütün organik moleküllerden enerji elde edebilir.

C) Hücrede düzenleyici olarak sadece inorganik bileşikler kullanılır.

D) İnorganik bileşikler karbon atomu içermezler.

E) Bütün organik bileşikler karbon atomu içerirler.

2-) Asit ve bazlarla ilgili verilen bilgilerden hangisi *yanlıştır*?

A) Derinin doğal pH'ı 5,5'tir. Elleri kuruyan birisi asidik bir nemlendirici krem kullanmalıdır.

B) Gözyaşı asidik bir salgıdır. İlaç olarak alınan göz damlasının pH'ı 7 olmalıdır.

C) Fazla asit salgılanması sonucu midesi yanan bir kişiye bazik bir içecek verilmelidir.

D) Bazik ortamda yaşamayı seven bir balığın akvaryum suyunun pH'ı 7 den yukarı olmalıdır.

E) X bitkisi pH: 3,5-4,5 olan toprakta iyi yetişiyor. Bu bitkiye asidik bir gübre verilmelidir.

3-) Aşağıda verilen bilgilerden hangisi doğrudur?

A) Nötr çözeltilerde H^+ ve OH^- iyonları yoktur.

B) Bütün asit ve baz çeşitleri birleşince ortam nötr olur.

C) Amonyakta (NH_3) OH^- iyonu olmadığı için baz değildir.

D) Bütün hücre çeşitleri için optimum (ideal) pH : 7 dir.

E) pH : 7.4 olan kanda OH^- iyonları H^+ iyonlarından daha fazladır.

4-) Aşağıda verilen organik bazlardan hangisinin olması bu nükleik asitin DNA olduğunun <u>kesin</u> kanıtıdır?

A) Timin

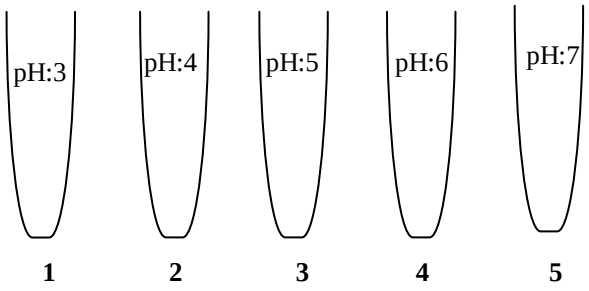
B) Sitozin

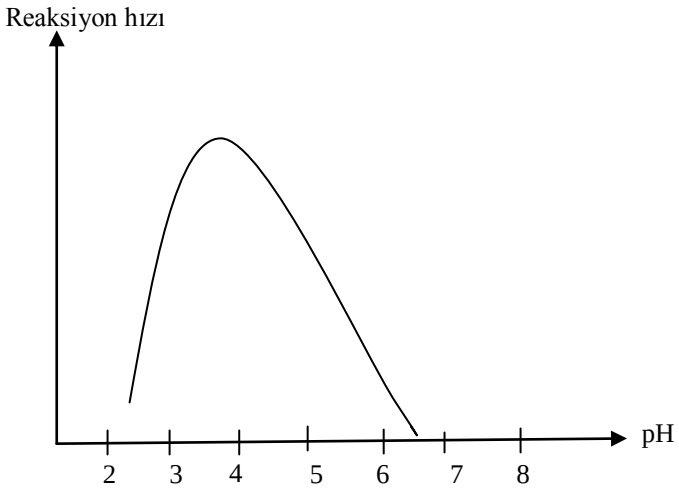
C) Urasil

D) Guanin

E) Adenin

5-)





Yukarıdaki özdeş deney tüplerinin hepsinde X maddesi vardır. X maddesinin yapı taşı Y dir. X maddesini yapı taşına parçalayan enzim Z dir. Yukarıdaki tüplerin içerisine eşit miktarda X maddesi çözeltisi ve Z enzimi konulmuştur. Y maddesinin değişik pH düzeylerinde oluşma hızını gösteren grafik yukarıda gösterilmiştir. Bu bilgilere göre aşağıdaki ifadelerden hangisi doğrudur?

A) Z enzimi nötr ortamda çalışmaz.

B) Z enzimi en iyi nötr ortamda çalışır.

C) Z enzimi bazik ortamlarda daha iyi çalışır.

D) 5. deney tüpünde çok az Y maddesi oluşmuştur.

E) En az Y maddesi 2. deney tüpünde oluşmuştur.

6-) I. Su II. Glikoz III. Sakkaroz

Bir bitki tohumunun çimlenmesi sırasında tohumdaki nişasta enzimler tarafından parçalanırken *(hidroliz)* yukarıdaki moleküllerden hangisi <u>oluşmaz</u>?

A) Yalnız I

B) Yalnız III

C) I ve III

D) I ve II

E) I, II ve III

7-) Aşağıdaki ifadelerden hangisi <u>yanlıştır</u>?

A) DNA'nın baz dizilişi türler arası farklılık gösterir.

B) DNA'yı oluşturan nükleotitlerde fosfat ve şeker yapısı aynıdır.

C) Bir canlının farklı vücut hücrelerindeki DNA baz dizilişi aynıdır.

D) Canlıların DNA baz dizilişleri yaşa, beslenmeye ve çevre şartlarına bağımlıdır.

E) DNA moleküllerini birbirinden ayıran fark bazların sayısı ve dizilişidir.

8-) I. Aminoasit II. Glikoz III.Vitamin IV. Yağ asidi V. Mineral

Enzimler yapıtaşlarına ayrıldığında (hidroliz edildiğinde) yukarıdakilerden hangisi <u>kesinlikle oluşmaz</u>?

A) I ve III

B) III - V

C) IV - V

D) II ve IV

E) II, III ve IV

9-) Karbonhidrat, yağ ve proteinlerin özellikleri ile ilgili verilen bilgilerden hangisi doğrudur?

A) İçerdikleri karbon, hidrojen ve oksijen oranları aynıdır.

B) Üçü de enerji verebilir.

C) Hücre içerisindeki miktarları aynıdır.

D) Verdikleri enerji miktarı aynıdır.

E) Üçü de sadece C, H ve O elementlerinden oluşmuştur.

10-) Omurgalı canlılarda hidrolizi gerçekleştiği halde sentezi yapılamayan madde hangisidir?

A) Nişasta

B) Yağ

C) Vitamin

D) ATP

E) Protein

11-) Aşağıdaki tabloda bir biyokimyasal reaksiyonun 5 ayrı deney tüpünde gerçekleşmesi sırasında kullanılan enzim ve substrat miktarları gösterilmiştir. Hepsinde de enzim ve substrat çeşidi aynı olup sadece miktarları farklıdır. Reaksiyonların hepsi tamamlandığında <u>en çok</u> ürün hangi deney tüpünde oluşur?

Reaksiyon	***Substrat miktarı***	***Enzim miktarı***
1	+++	+++
2	++	++++
3	+	++++++
4	+++++	+
5	++++	++

A) 1. deney tüpü

B) 2. deney tüpü

C) 3. deney tüpü

D) 4. deney tüpü

E) 5. deney tüpü

12-) 100' er nükleotitlik bir DNA ve bir RNA molekülünde toplamda aşağıdakilerden hangisi <u>en çok</u> bulunur?

A) Riboz

B) Timin

C) Fosfat

D) Adenin

E) Guanin

13-) Kemik erimesi, gece körlüğü ve diş etlerinde problem olan bir hastaya doktor hangi mineral ve vitaminleri içeren tableti ilaç olarak vermelidir?

A) Kalsiyum (Ca), A vitamini, D vitamini, C vitamini

B) Sodyum(Na), C vitamini, B vitamini, E vitamini

C) Kalsiyum (Ca), E vitamini, K vitamini, B vitamini

D) Demir (Fe), B vitamini, K vitamini, C vitamini

E) Sodyum (Na), C vitamini, D vitamini, E vitamini

14-) Canlılıkta önemi çok fazla olan su, aşağıdaki olaylardan hangisi için kullanılamaz?

A) Besinlerin çözünmesinde.

B) Besinlerin taşınmasında.

C) Zehirli atıkların seyreltilmesinde.

D) Polisakkarit yıkımında.

E) Dehidrasyon olaylarında.

15-) Glikojen sentezinin *(üretiminin)* gerçekleştiği bir hücrede hangilerinin miktarı artar, hangilerinin azalır?

A)

	Artar	Azalır	Değişmez
Glikoz	*		
ATP		*	
Su	*		
Enzim		*	

B)

	Artar	Azalır	Değişmez
Glikoz		*	
ATP		*	
Su	*		
Enzim			*

C)

	Artar	Azalır	Değişmez
Glikoz		*	
ATP			*
Su		*	
Enzim			*

D)

	Artar	Azalır	Değişmez
Glikoz		*	
ATP	*		
Su		*	
Enzim			*

E)

	Artar	Azalır	Değişmez
Glikoz		*	
ATP			*
Su		*	
Enzim	*		

16-) Eşit sayıda aminoasitten oluşmuş iki farklı polipeptit zincirinde aşağıdakilerden hangileri <u>her zaman</u> aynıdır?

I - Peptit bağ sayıları
II- Yapılarındaki karbon (C) atomu sayıları
III- Aminoasitlerin dizilişleri
IV- Aminoasitlerin çeşitleri

A) Yalnız I

B) Yalnız IV

C) I ve III

D) I ve II

E) II ve IV

17-) Doğada proteinlerin yapısına katılan 20 çeşit aminoasit bulunmasına rağmen sınırsız sayıda protein çeşidi üretilebilmektedir. Bu durumun oluşmasında, temel faktör olarak aşağıdakilerden hangisi düşünülebilir?

A) Bazı proteinlerin yapısında bütün amino asitlerin bulunmaması.

B) Protein sentezi sırasında amino asitler arasında peptit bağı kurulması.

C) Proteinlerin yapısındaki amino asitlerin; sayı, çeşit ve sıralanışlarının farklı olabilmesi.

D) Canlı vücudundaki bazı amino asitlerin dış ortamdan hazır olarak alınması.

E) Amino asitlerin yapısında azot bulunması.

18-) Kurak ortamlarda yaşamaya uyum sağlamış veya kış uykusuna yatmış hayvanlar vücutlarında bol miktarda yağ depo ederler. Hayvanların böyle bir adaptasyona sahip olmaları;

I - Nötral yağların sentezi sırasında üç molekül su açığa çıkar.

II - Yağlar, hafif olduklarından ve sulu ortamlarda çözünmediklerinden dolayı depolanmaları daha kolaydır.

III- Yağların hücresel solunumda kulanılmaları sonucunda, bol miktarda metabolik su, ATP ve ısı enerjisi açığa çıkar.

IV - Yağlar deri altında kalın bir tabaka oluşturarak vücudun ısı dengesinin korunmasına yardımcı olur.

Şeklindeki faktörlerden hangileriyle açıklanabilir?

A) I ve II

B) II ve III

C) I ve IV

D) I, III ve IV

E) II, III ve IV

19-) Mineral maddeler, insanların vücudunda, aşağıdakilerden hangisini gerçekleştirmek için <u>kullanılmaz?</u>

A) Hücre içi ve dışı sıvı dengesinin korunmasında.

B) Kaslarda kasılmanın sağlanmasında.

C) Sinirlerde uyartının oluşması ve iletilmesinde.

D) Solunumda , enerji hammadesi olarak.

E) Kemik ve dişlerin sertleştirilmesinde.

20-) Aşağıdaki organik moleküllerden hangisinin yapı taşlarına ayrılması *(hidrolizi)* sonucu glikoz dışında başka bir yapıtaşı molekülü de *(monomer)* oluşur?

A) Nişasta

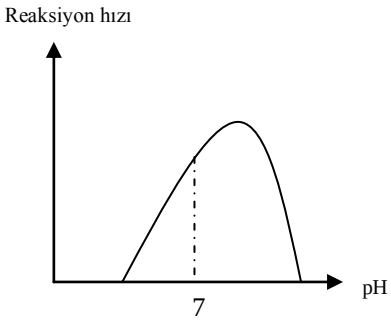
B) Selülöz

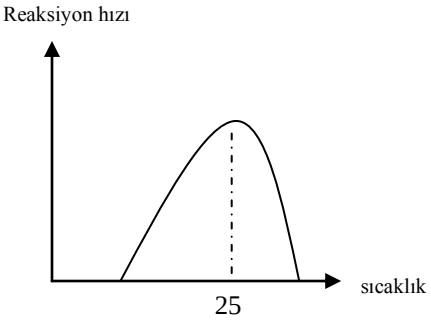
C) Maltoz

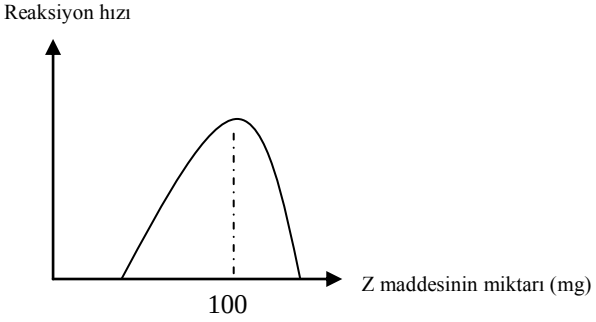
D) Laktoz

E) Glikojen

21-)







Yukarıdaki grafiklerde X enziminin gerçekleştirdiği bir biyokimyasal reaksiyonun değişik pH , sıcaklık ve Z maddesinin eklenmesi sonucu hızındaki değişimler gösterilmiştir. Bu grafiklere göre aşağıda yapılan değerlendirmelerden hangisi doğrudur?

A) X enzimi 25 derece sıcaklıkta, 100 mg Z içeren asidik bir çözeltide en yüksek reaksiyon hızını gösterir.

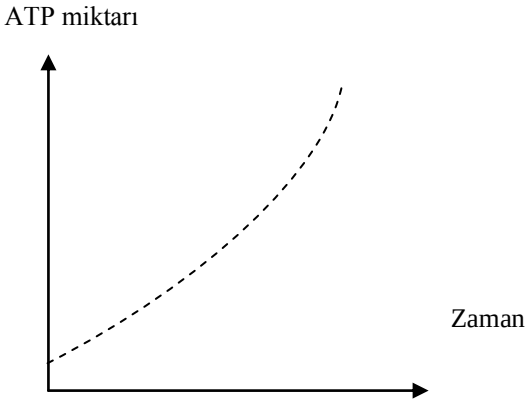
B) X enzimi 25 derece sıcaklıkta, 150 mg Z içeren bazik bir çözeltide en iyi çalışma gösterir.

C) Z maddesi bütün konsantrasyonlarda aktivatör etkisi gösterir.

D) X enzimi, pH ve sıcaklık sabit kalması koşuluyla eklenen Z madde miktarı arttıkça reaksiyon hızı artar.

E) X enzimi 25 derece sıcaklıkta, 100 mg Z maddesi içeren bazik bir çözeltide en iyi sonucu verir.

22-) Aşağıdaki grafikte, bir hücrede belirli zamanda gerçekleşen ATP miktarındaki değişim gösterilmiştir.



Bu grafiğe bakarak bu zaman diliminde aşağıdakilerden hangisinin olması mümkün <u>değildir?</u>

A) Ortamdaki Adenin nükleotidinde azalma görülmüştür.

B) Ortamdaki ADP moleküllerinin sayısında azalma görülmüştür.

C) Ortamdaki ATP moleküllerinin sayısında artış görülmüştür.

D) Ortamdaki fosfat moleküllerinin sayısında artış görülmüştür.

E) Fosfat bağlarının sayısında artış görülmüştür.

23-) Yapılan bir laboratuvar analizinde yüzde 90'ı

C – C – C = C – C – C – C = C – C – C

şeklindeki karbon zincirine sahip yağ asidinden oluştuğu tesbit edilen yağ aşağıdakilerden hangisi olabilir?

A) Tereyağı

B) Zeytin yağı

C) Margarin

D) Kuyruk yağı

E) Hayvan iç yağı

24-)

I- Hücre zarının yapısına katılma

II- Enerji kaynağı olarak kullanılma

III- Bazı hormonların yapısına katılma

IV- Soğuktan korumayı sağlama

Yukarıda belirtilen özelliklerden hangileri yağlara aittir?

A) I ve II

B) I ve III

C) II ve III

D) I, II ve IV

E) I, II, III ve IV

25-) Aşağıda belirtilen vitamin ikililerinden hangisinin <u>daha sık aralıklarla, düzenli</u> olarak vücuda alınması gerekir?

A) A ve D

B) A ve K

C) B ve C

D) D ve E

E) A ve E

APPENDIX C

ATTITUDE SCALE TOWARD BIOLOGY

Açıklama: Bu ölçekte biyoloji dersine yönelik tutumlarınızı ölçmek amacıyla cümleler yer almaktadır. Bu cümlelerin karşısında hiç katılmıyorum, katılmıyorum, kararsızım, katılıyorum ve tamamen katılıyorum olmak üzere beş seçenek verilmiştir. Her cümleyi dikkatlice okuduktan sonra size en uygun seçeneği çarpı işareti (X) ile işaretleyiniz. İşaretlediğiniz seçenek sizin duygu ve düşüncelerinizi yansıtacaktır, dolayısıyla doğru ya da yanlış cevap vermeniz söz konusu degildir.

Table C.1 Attitude scale toward biology.

CÜMLELER	**Hiç katılmıyorum**	**katılmıyorum**	**kararsızım**	**katılıyorum**	**Tamamen katılıyorum**
1) Biyoloji en sevdiğim derstir.	1	2	3	4	5
2) Canlılar ile ilgili belgeseller izlemeyi severim.	1	2	3	4	5
3) En kolay öğrendiğim ve başarılı olduğum ders biyolojidir.	1	2	3	4	5
4) Her öğrencinin biyoloji dersini almasına gerek yoktur.	1	2	3	4	5
5) Biyoloji dersi zorunlu değil seçmeli bir ders olmalıdır.	1	2	3	4	5
6) Grup çalısmaları biyoloji dersinde zaman kaybıdır.	1	2	3	4	5
7) Biyolog olmak istemiyorum.	1	2	3	4	5
8) Proje çalısmalarında biyoloji ile ilgili konuları tercih ederim.	1	2	3	4	5
9) Biyoloji derslerinin grup içinde çalışarak işlenmesi daha çok hoşuma gider.	1	2	3	4	5
10) Biyoloji dersinde konuları öğrenirken zorlanmıyorum.	1	2	3	4	5
11) Biyoloji dersinde grupla çalısmak hoşuma gitmez.	1	2	3	4	5
12) Biyoloji ile ilgili kitaplar okumaktan zevk alırım.	1	2	3	4	5
13) Biyoloji dersinde deney yapmayı sevmem.	1	2	3	4	5
14) Biyoloji öğretmeni olmak isterim.	1	2	3	4	5

Table C.1 (cont'd)

15) Laboratuarda biyoloji dersi işlemekten çok hoşlanırım.	1	2	3	4	5
16) Biyoloji ile ilgili bir kulübe üye olmak isterim.	1	2	3	4	5
17) Biyoloji konularını çalışırken çok zevk alırım.	1	2	3	4	5
18) Laboratuarda biyoloji dersi işlemek hoşuma gitmez.	1	2	3	4	5
19) Biyoloji ile ilgili konularda tartışmalara katılmak hoşuma gider.	1	2	3	4	5
20) Biyoloji derslerinde araştırma ödevleri almak hoşuma gider.	1	2	3	4	5
21) Biyoloji dersinin konularının deneylerle işlenmesi hoşuma gider.	1	2	3	4	5
22) Biyoloji ile ilgili bir meslek sahibi olmayı isterim.	1	2	3	4	5
23) Biyoloji konularında araştırma yapmayı severim.	1	2	3	4	5
24) Biyoloji ders konularını ögrenmek için uzmanlarla görüşme yapmak gereksizdir.	1	2	3	4	5
25) Biyoloji dersinde laboratuarda aktif rol almak isterim.	1	2	3	4	5
26) Fen bilimleri derslerinden en sevmedigim ders biyolojidir.	1	2	3	4	5
27) Biyoloji konularını ögrenmek gereksizdir.	1	2	3	4	5
28) Biyoloji ile ilgili TV programlarını izlemeyi sevmem.	1	2	3	4	5
29) Biyoloji konuları ile ilgili bilimsel dergiler okumayı severim.	1	2	3	4	5
30) Günlük hayatla bağlantılı olması nedeniyle biyoloji dersi çok ilgimi çekiyor.	1	2	3	4	5
31) Biyoloji dersi konularını öğrenmenin yararı yoktur.	1	2	3	4	5
32) Biyoloji dersinde başarılı olmak benim için diğer derslerden daha önemlidir.	1	2	3	4	5
33) Biyoloji dersi olduğunda sınıfa girmek istemem.	1	2	3	4	5
34) Büyüyünce biyolog olarak çalışmak isterim.	1	2	3	4	5
35) Biyoloji ile ilgili güncel bilimsel gelişmeleri takip ederim.	1	2	3	4	5
36) Biyoloji dersinde kendimi diğer derslere göre daha rahat hissederim.	1	2	3	4	5

2

APPENDIX D

SCIENCE PROCESS SKILLS TEST (SPST)

AÇIKLAMA: Bu test, özellikle Fen ve Matematik derslerinizde karşınıza çıkabilecek karmaşık gibi görünen **problemleri analiz edebilme kabiliyetinizi ortaya çıkarabilmesi açısından çok faydalıdır. Bu test içinde, problemdeki değişkenleri tanımlayabilme, hipotez kurma ve tanımlama, işlemsel açıklamalar getirebilme, problemin çözümü için gerekli incelemelerin tasarlanması, grafik çizme ve verileri yorumlayabilme kabiliyetlerini ölçebilen sorular bulunmaktadır. Her soruyu okuduktan sonra kendinizce uygun seçeneği işaretleyiniz.**

1. Bir basketbol antrenörü, oyuncuların güçsüz olmasından dolayı maçları kaybettiklerini düşünmektedir. Güçlerini etkileyen faktörleri araştırmaya karar verir. Antrenör, oyuncuların gücünü etkileyip etkilemediğini ölçmek için aşağıdaki değişkenlerden hangisini incelemelidir?

a. Her oyuncunun almış olduğu günlük vitamin miktarını.
b. Günlük ağırlık kaldırma çalışmalarının miktarını.
c. Günlük antreman süresini.
d. Yukarıdakilerin hepsini.

2. Arabaların verimliliğini inceleyen bir araştırmana yapılmaktadır. Sınanan hipotez, benzine katılan bir katkı maddesinin arabaların verimliliğini artırdığı yolundadır. Aynı tip beş arabaya aynı miktarda benzin fakat farklı miktarlarda katkı maddesi konur. Arabalar benzinleri bitinceye kadar aynı yol üzerinde giderler. Daha sonra her arabanın aldığı mesafe kaydedilir. Bu çalışmada arabaların verimliliği nasıl ölçülür?

a. Arabaların benzinleri bitinceye kadar geçen süre ile.
b. Her arabanın gittiği mesafe ile.
c. Kullanılan benzin miktarı ile.
d. Kullanılan katkı maddesinin miktarı ile.

3. Bir araba üreticisi daha ekonomik arabalar yapmak istemektedir. Araştırmacılar arabanın litre başına alabileceği mesafeyi etkileyebilecek değişkenleri araştırmaktadırlar. Aşağıdaki değişkenlerden hangisi arabanın litre başına alabileceği mesafeyi etkileyebilir?

a. Arabanın ağırlığı.
b. Motorun hacmi
c. Arabanın rengi
d. a ve b

4. Ali Bey, evini ısıtmak için komşularından daha çok para ödemesinin sebeplerini merak etmektedir. Isınma giderlerini etkileyen faktörleri araştırmak için bir hipotez kurar. Aşağıdakilerden hangisi bu araştırmada sınanmaya uygun bir hipotez **değildir?**

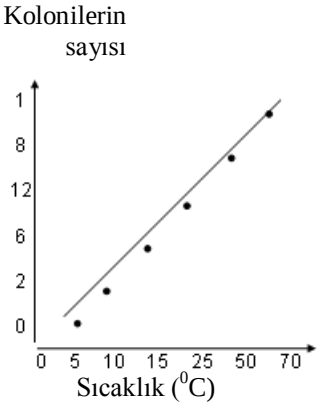
a. Evin çevresindeki ağaç sayısı ne kadar az ise ısınma gideri o kadar fazladır.
b. Evde ne kadar çok pencere ve kapı varsa, ısınma gideri de o kadar fazla olur:
c. Büyük evlerin ısınma giderleri fazladır.
d. Isınma giderleri arttıkça ailenin daha ucuza ısınma yolları araması gerekir.

5. Fen sınıfından bir öğrenci sıcaklığın bakterilerin gelişmesi üzerindeki etkilerini araştırmaktadır. Yaptığı deney sonucunda, öğrenci aşağıdaki verileri elde etmiştir:

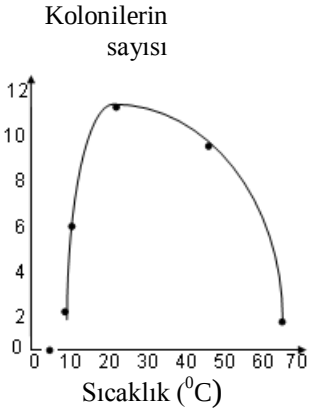
Deney odasının sıcaklığı (^{0}C)	Bakteri kolonilerinin sayısı
5	0
10	2
15	6
25	12
50	8
70	1

Aşağıdaki grafiklerden hangisi bu verileri doğru olarak göstermektedir?

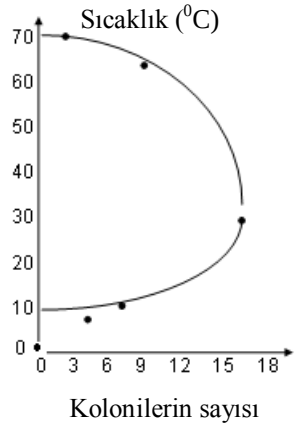
a.



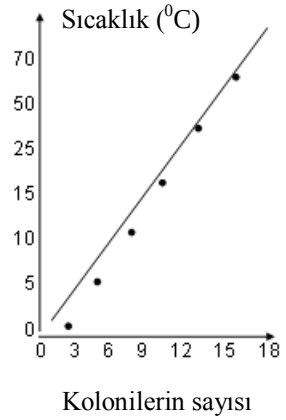
b.



c.



d.



6. Bir polis şefi, arabaların hızının azaltılması ile uğraşmaktadır. Arabaların hızını etkileyebilecek bazı faktörler olduğunu düşünmektedir. Sürücülerin ne kadar hızlı araba kullandıklarını aşağıdaki hipotezlerin hangisiyle sınayabilir?

a. Daha genç sürücülerin daha hızlı araba kullanma olasılığı yüksektir.
b. Kaza yapan arabalar ne kadar büyükse, içindeki insanların yaralanma olasılığı o kadar azdır.
c. Yollarda ne kadar çok polis ekibi olursa, kaza sayısı o kadar az olur.
d. Arabalar eskidikçe kaza yapma olasılıkları artar.

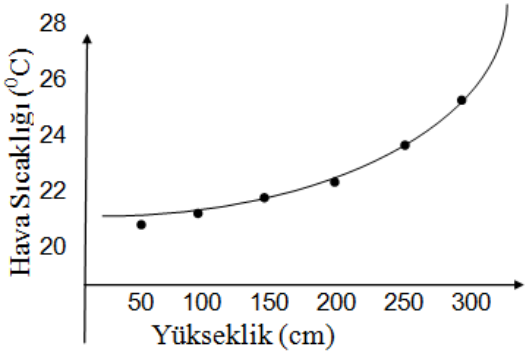
7. Bir fen sınıfında, tekerlek yüzeyi genişliğinin tekerleğin daha kolay yuvarlanması üzerine etkisi araştırılmaktadır. Bir oyuncak arabaya geniş yüzeyli tekerlekler takılır, önce bir rampadan (eğik düzlem) aşağı bırakılır ve daha sonra düz bir zemin üzerinde gitmesi sağlanır. Deney, aynı arabaya daha dar yüzeyli tekerlekler takılarak tekrarlanır. Hangi tip tekerleğin daha kolay yuvarlandığı nasıl ölçülür?

a. Her deneyde arabanın gittiği toplam mesafe ölçülür.
b. Rampanın (eğik düzlem) eğim açısı ölçülür.
c. Her iki deneyde kullanılan tekerlek tiplerinin yüzey genişlikleri ölçülür.
d. Her iki deneyin sonunda arabanın ağırlıkları ölçülür.

8. Bir çiftçi daha çok mısır üretebilmenin yollarını aramaktadır. Mısırların miktarını etkileyen faktörleri araştırmayı tasarlar. Bu amaçla aşağıdaki hipotezlerden hangisini sınayabilir?

a. Tarlaya ne kadar çok gübre atılırsa, o kadar çok mısır elde edilir.
b. Ne kadar çok mısır elde edilirse, kar o kadar fazla olur.
c. Yağmur ne kadar çok yağarsa, gübrenin etkisi o kadar çok olur.
d. Mısır üretimi arttıkça, üretim maliyeti de artar.

9. Bir odanın tabandan itibaren değişik yüzeylerdeki sıcaklıklarla ilgili bir çalışına yapılmış ve elde edilen veriler aşağıdaki grafikte gösterilmiştir. Değişkenler arasındaki ilişki nedir?

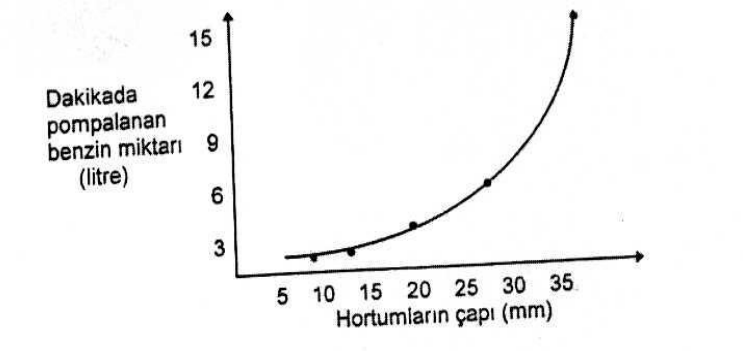


a. Yükseklik arttıkça sıcaklık azalır.
b. Yükseklik arttıkça sıcaklık artar.
c. Sıcaklık arttıkça yükseklik azalır.
d. Yükseklik ile sıcaklık artışı arasında bir ilişki yoktur.

10. Ahmet, basketbol topunun içindeki hava arttıkça, topun daha yükseğe sıçrayacağını düşünmektedir. Bu hipotezi araştırmak için, birkaç basketbol topu alır ve içlerine farklı miktarda hava pompalar. Ahmet hipotezini nasıl sınamalıdır?

a. Topları aynı yükseklikten fakat değişik hızlarla yere vurur.
b. İçlerinde farklı miktarlarda hava olan topları, aynı yükseklikten yere bırakır.
c. İçlerinde aynı miktarlarda hava olan topları, zeminle farklı açılardan yere vurur.
d. İçlerinde aynı miktarlarda hava olan topları, farklı yüksekliklerden yere bırakır.

11. Bir tankerden benzin almak için farklı genişlikte 5 hortum kullanılmaktadır. Her hortum için aynı pompa kullanılır. Yapılan çalışma sonunda elde edilen bulgular aşağıdaki grafikte gösterilmiştir.



Aşağıdakilerden hangisi değişkenler arasındaki ilişkiyi açıklamaktadır?
a. Hortumun çapı genişledikçe dakikada pompalanan benzin miktarı da artar.
b. Dakikada pompalanan benzin miktarı arttıkça, daha fazla zaman gerekir.
c. Hortumun çapı küçüldükçe dakikada pompalanan benzin miktarı da artar.
d. Pompalanan benzin miktarı azaldıkça, hortumun çapı genişler.

Önce aşağıdaki açıklamayı okuyunuz ve daha sonra 12, 13, 14 ve 15 inci soruları açıklama kısmından sonra verilen paragrafı okuyarak cevaplayınız.

Açıklama: Bir araştırmada, bağımlı değişken birtakım faktörlere bağımlı olarak gelişim gösteren değişkendir. Bağımsız değişkenler ise bağımlı değişkene etki eden faktörlerdir. Örneğin, araştırmanın amacına göre kimya başarısı bağımlı bir değişken olarak alınabilir ve ona etki edebilecek faktör veya faktörler de bağımsız değişkenler olurlar.

Ayşe, güneşin karaları ve denizleri aynı derecede ısıtıp ısıtmadığını merak etmektedir. Bir araştırma yapmaya karar verir ve aynı büyüklükte iki kova alır. Bunlardan birini toprakla, diğerini de su ile doldurur ve aynı miktarda güneş ısısı alacak şekilde bir yere koyar. 8.00 - 18.00 saatleri arasında, her saat başı sıcaklıklarını ölçer.

12. Araştırmada aşağıdaki hipotezlerden hangisi sınanmıştır?

a. Toprak ve su ne kadar çok güneş ışığı alırlarsa, o kadar ısınırlar.
b. Toprak ve su güneş altında ne kadar fazla kalırlarsa, o kadar çok ısınırlar.
c. Güneş farklı maddeleri farklı derecelerde ısıtır.
d. Günün farklı saatlerinde güneşin ısısı da farklı olur.

13. Araştırmada aşağıdaki değişkenlerden hangisi kontrol edilmiştir?

a. Kovadaki suyun cinsi.
b. Toprak ve suyun sıcaklığı.
c. Kovalara koyulan maddenin türü.
d. Her bir kovanın güneş altında kalma süresi.

14. Araştırmada bağımlı değişken hangisidir?

a. Kovadaki suyun cinsi.
b. Toprak ve suyun sıcaklığı.
c. Kovalara koyulan maddenin türü.
d. Her bir kovanın güneş altında kalma süresi.

15. Araştırmada bağımsız değişken hangisidir?

a. Kovadaki suyun cinsi
b. Toprak ve suyun sıcaklığı.
c. Kovalara koyulan maddenin türü.
d. Her bir kovanın güneş altında kalma süresi.

16. Can, yedi ayrı bahçedeki çimenleri biçmektedir. Çim biçme makinasıyla her hafta bir bahçedeki çimenleri biçer. Çimenlerin boyu bahçelere göre farklı olup bazılarında uzun bazılarında kısadır. Çimenlerin boyları ile ilgili hipotezler kurmaya başlar. Aşağıdakilerden hangisi sınanmaya uygun bir hipotezdir?

a. Hava sıcakken çim biçmek zordur.
b. Bahçeye atılan gübrenin miktarı önemlidir.
c. Daha çok sulanan bahçedeki çimenler daha uzun olur.
d. Bahçe ne kadar engebeliyse çimenleri kesmekte o kadar zor olur.

17, 18, 19 ve 20 inci soruları aşağıda verilen paragrafı okuyarak cevaplayınız.

Murat, suyun sıcaklığının, su içinde çözünebilecek şeker miktarını etkileyip etkilemediğini araştırmak ister. Birbirinin aynı dört bardağın her birine 50 şer mililitre su koyar. Bardaklardan birisine 0 °C de, diğerine de sırayla 50 °C, 75 °C ve 95 °C sıcaklıkta su koyar. Daha sonra her bir bardağa çözünebileceği kadar şeker koyar ve karıştırır.

17. Bu araştırmada sınanan hipotez hangisidir?

a. Şeker ne kadar çok suda karıştırılırsa o kadar çok çözünür.
b. Ne kadar çok şeker çözünürse, su o kadar tatlı olur.
c. Sıcaklık ne kadar yüksek olursa çözünen şekerin miktarı o kadar fazla olur.
d. Kullanılan suyun miktarı arttıkça sıcaklığı da artar.

18. Bu araştırmada kontrol edilebilen değişken hangisidir?

a. Her bardakta çözünen şeker miktarı.
b. Her bardağa konulan su miktarı.
c. Bardakların sayısı.
d. Suyun sıcaklığı.

19. Araştırmanın bağımlı değişkeni hangisidir?

a. Her bardakta çözünen şeker miktarı.
b. Her bardağa konulan su miktarı.
c. Bardakların sayısı.
d. Suyun sıcaklığı.

20. Araştırmadaki bağımsız değişken hangisidir?
a. Her bardakta çözünen şeker miktarı.
b. Her bardağa konulan su miktarı.
c. Bardakların sayısı.
d. Suyun sıcaklığı.

21. Bir bahçıvan domates üretimini artırmak istemektedir. Değişik birkaç alana domates tohumu eker. Hipotezi, tohumlar ne kadar çok sulanırsa, o kadar çabuk filizleneceğidir. Bu hipotezi nasıl sınar?

a. Farklı miktarlarda sulanan tohumların kaç günde filizleneceğine bakar.
b. Her sulamadan bir gün sonra domates bitkisinin boyunu ölçer.
c. Farklı alanlardaki bitkilere verilen su miktarını ölçer.
d. Her alana ektiği tohum sayısına bakar.

22. Bir bahçıvan tarlasındaki kabaklarda yaprak bitleri görür. **Bu** bitleri yok etmek gereklidir. Kardeşi "Kling" adlı tozun en iyi böcek ilacı olduğunu söyler. Tarım uzmanları ise "Acar" adlı spreyin daha etkili olduğunu söylemektedir. Bahçıvan altı tane kabak bitkisi seçer. Üç tanesini tozla, üç tanesini de spreyle ilaçlar. Bir hafta sonra her bitkinin üzerinde kalan canlı bitleri sayar. Bu çalışmada böcek ilaçlarının etkinliği nasıl ölçülür?

a. Kullanılan toz ya da spreyin miktarı ölçülür.
b. Toz ya da spreyle ilaçlandıktan sonra bitkilerin durumları tespit edilir.
c. Her fidede oluşan kabağın ağırlığı ölçülür.
d. Bitkilerin üzerinde kalan bitler sayılır.

23. Ebru, bir alevin belli bir zaman süresi içinde meydana getireceği ısı enerjisi miktarını ölçmek ister. Bir kabın içine bir litre soğuk su koyar ve 10 dakika süreyle ısıtır. Ebru, alevin meydana getirdiği ısı enerjisini nasıl ölçer?

a. 10 dakika sonra suyun sıcaklığında meydana gelen değişmeyi kaydeder.
b. 10 dakika sonra suyun hacminde meydana gelen değişmeyi ölçer.
c. 10 dakika sonra alevin sıcaklığını ölçer.
d. Bir litre suyun kaynaması için geçen zamanı ölçer.

24. Ahmet, buz parçacıklarının erime süresini etkileyen faktörleri merak etmektedir. Buz parçalarının büyüklüğü, odanın sıcaklığı ve buz parçalarının şekli gibi faktörlerin erime süresini etkileyebileceğini düşünür. Daha sonra şu hipotezi sınamaya karar verir: Buz parçalarının şekli erime süresini etkiler. Ahmet bu hipotezi sınamak için aşağıdaki deney tasarımlarının hangisini uygulamalıdır?

a. Her biri farklı şekil ve ağırlıkta beş buz parçası alınır. Bunlar aynı sıcaklıkta benzer beş kabın içine ayrı ayrı konur ve erime süreleri izlenir.

b. Her biri aynı şekilde fakat farklı ağırlıkta beş buz parçası alınır. Bunlar aynı sıcaklıkta benzer beş kabın içine ayrı ayrı konur ve erime süreleri izlenir.

c. Her biri aynı ağırlıkta fakat farklı şekillerde beş buz parçası alınır. Bunlar aynı sıcaklıkta

benzer beş kabın içine ayrı ayrı konur ve erime süreleri izlenir.

d. Her biri aynı ağırlıkta fakat farklı şekillerde beş buz parçası alınır. Bunlar farklı sıcaklıkta benzer beş kabın içine ayrı ayrı konur ve erime süreleri izlenir.

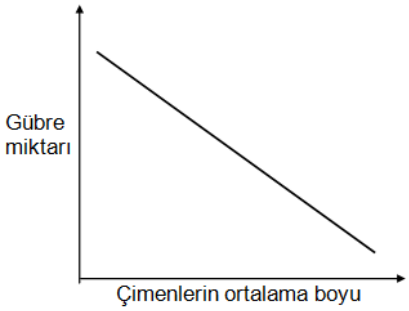
25. Bir araştırmacı yeni bir gübreyi denemektedir. Çalışmalarını aynı büyüklükte beş tarlada yapar. Her tarlaya yeni gübresinden değişik miktarlarda karıştırır. Bir ay sonra her tarlada yetişen çimenin ortalama boyunu ölçer. Ölçüm sonuçları aşağıdaki tabloda verilmiştir.

Gübre miktarı (kg)	Çimenlerin ortalama boyu (cm)
10	7
30	10
50	12
80	14
100	12

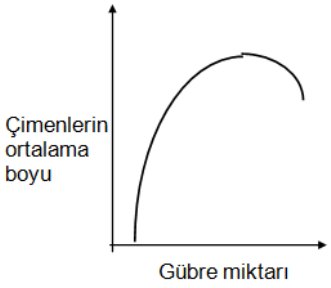
Tablodaki verilerin grafiği aşağıdakilerden hangisidir?

a.

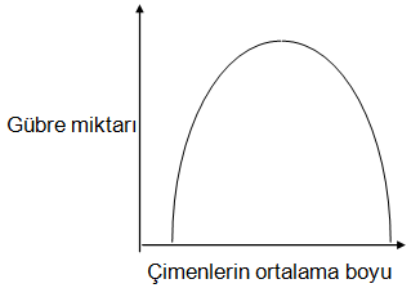
b.



c.



d.



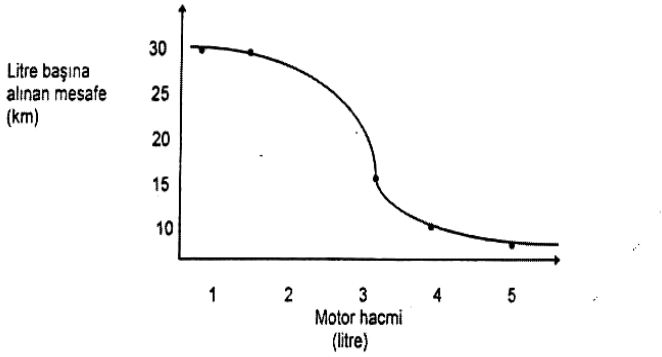
26. Bir biyolog şu hipotezi test etmek ister: Farelere ne kadar çok vitamin verilirse o kadar hızlı büyürler. Biyolog farelerin büyüme hızını nasıl ölçebilir?

a. Farelerin hızını ölçer.
b. Farelerin, günlük uyumadan durabildikleri süreyi ölçer.
c. Her gün fareleri tartar.
d. Her gün farelerin yiyeceği vitaminleri tartar

27. Öğrenciler, şekerin suda çözünme süresini etkileyebilecek değişkenleri düşünmektedirler. Suyun sıcaklığını, şekerin ve suyun miktarlarını değişken olarak saptarlar. Öğrenciler, şekerin suda çözünme süresini aşağıdaki hipotezlerden hangisiyle sınayabilir?

a. Daha fazla şekeri çözmek için daha fazla su gereklidir.
b. Su soğudukça, şekeri çözebilmek için daha fazla karıştırmak gerekir.
c. Su ne kadar sıcaksa, o kadar çok şeker çözünecektir.
d. Su ısındıkça şeker daha uzun sürede çözünür.

28. Bir araştırma grubu, değişik hacimli motorları olan arabaların randımanlarını ölçer. Elde edilen sonuçların grafiği aşağıdaki gibidir:



Aşağıdakilerden hangisi değişkenler arasındaki ilişkiyi gösterir?

a. Motor ne kadar büyükse, bir litre benzinle gidilen mesafe de o kadar uzun olur.
b. Bir litre benzinle gidilen mesafe ne kadar az olursa, arabanın motoru o kadar küçük demektir.
c. Motor küçüldükçe, arabanın bir litre benzinle gittiği mesafe artar.
d. Bir litre benzinle gidilen mesafe ne kadar uzun olursa, arabanın motoru o kadar büyük demektir.

29, 30, 31 ve 32 inci soruları aşağıda verilen paragrafı okuyarak cevaplayınız.

Toprağa karıştırılan yaprakların domates üretimine etkisi araştırılmaktadır. Araştırmada dört büyük saksıya aynı miktarda ve tipte toprak konulmuştur. Fakat birinci saksıdaki torağa 15 kg., ikinciye 10 kg., üçüncüye ise 5 kg. çürümüş yaprak karıştırılmıştır. Dördüncü saksıdaki toprağa ise hiç çürümüş yaprak karıştırılmamıştır. Daha sonra bu saksılara domates ekilmiştir. Bütün saksılar güneşe konmuş ve aynı miktarda sulanmıştır. Her saksıdan elde edilen domates tartılmış ve kaydedilmiştir.

29. Bu araştırmada sınanan hipotez hangisidir?

a. Bitkiler güneşten ne kadar çok ışık alırlarsa, o kadar fazla domates verirler.
b. Saksılar ne kadar büyük olursa, karıştırılan yaprak miktarı o kadar fazla olur.
c. Saksılar ne kadar çok sulanırsa, içlerindeki yapraklar o kadar çabuk çürür.
d. Toprağa ne kadar çok çürük yaprak karıştırılırsa, o kadar fazla domates elde edilir.

30. Bu araştırmada kontrol edilen değişken hangisidir?

a. Her saksıdan elde edilen domates miktarı
b. Saksılara karıştırılan yaprak miktarı.
c. Saksılardaki toprak miktarı.
d. Çürümüş yaprak karıştırılan saksı sayısı.

31. Araştırmadaki bağımlı değişken hangisidir?

a. Her saksıdan elde edilen domates miktarı
b. Saksılara karıştırılan yaprak miktarı.
c. Saksılardaki toprak miktarı.
d. Çürümüş yaprak karıştırılan saksı sayısı.

32. Araştırmadaki bağımsız değişken hangisidir?

a. Her saksıdan elde edilen domates miktarı
b. Saksılara karıştırılan yaprak miktarı.
c. Saksılardaki toprak miktarı.
d. Çürümüş yaprak karıştırılan saksı sayısı

33. Bir öğrenci mıknatısların kaldırma yeteneklerini araştırmaktadır. Çeşitli boylarda ve şekillerde birkaç mıknatıs alır ve her mıknatısın çektiği demir tozlarını tartar. Bu çalışmada mıknatısın kaldırma yeteneği nasıl tanımlanır?

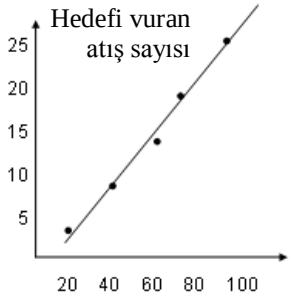
a. Kullanılan mıknatısın büyüklüğü ile.
b. Demir tozlarını çeken mıknatısın ağırlığı ile.
c. Kullanılan mıknatısın şekli ile.
d. Çekilen demir tozlarının ağırlığı ile.

34. Bir hedefe çeşitli mesafelerdeki 25'er atış yapılır. Her mesafeden yapılan 25 atıştan hedefe isabet edenler aşağıdaki tabloda gösterilmiştir.

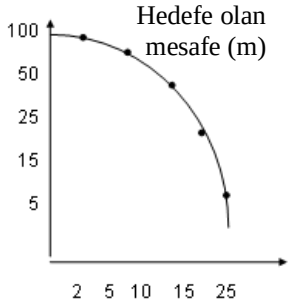
Mesafe(m)	Hedefe vuran atış sayısı
5	25
15	10
25	10
50	5
100	2

Aşağıdaki grafiklerden hangisi verilen bu verileri en iyi şekilde yansıtır?

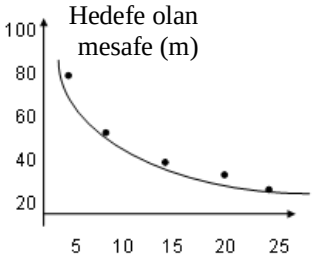
a.



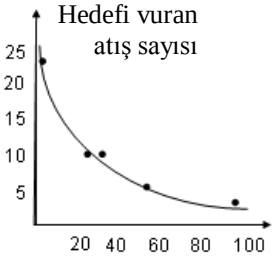
b.



c.



d.



35. Sibel, akvaryumdaki balıkların bazen çok hareketli bazen ise durgun olduklarını gözler. Balıkların hareketliliğini etkileyen faktörleri merak eder. Balıkların hareketliliğini etkileyen faktörleri hangi hipotezle sınayabilir?

a. Balıklara ne kadar çok yem verilirse, o kadar çok yeme ihtiyaçları vardır.
b. Balıklar ne kadar hareketli olursa o kadar çok yeme ihtiyaçları vardır.
c. Suda ne kadar çok oksijen varsa, balıklar o kadar iri olur.
d. Akvaryum ne kadar çok ışık alırsa, balıklar o kadar hareketli olur.

36. Murat Bey' in evinde birçok elektrikli alet vardır. Fazla gelen elektrik faturaları dikkatini çeker. Kullanılan elektrikmiktarını etkileyen faktörleri araştırmaya karar verir. Aşağıdaki değişkenlerden hangisi kullanılan Elektrik enerjisi miktarını etkileyebilir?

a. TV nin açık kaldığı süre.
b. Elektrik sayacının yeri.
c. Çamaşır makinesinin kullanma sıklığı.
d. a ve c.

APPENDIX E

INTERVIEW QUESTIONS FOR STUDENTS

1-) Önceki yıllarda aldığınız fen derslerinin işleniş şekliyle kıyasladığınızda uygulama yapılan biyoloji dersini nasıl değerlendirirsiniz?

2-) Biyoloji dersinin bu şekilde işlenilmesinin konuyu öğrenmenize ne gibi etkileri olduğunu düşünüyorsunuz?

3-) Uygulama süresince yapılan etkinliklerden en çok hangileri hoşunuza gitti? Nedenlerini açıklar mısınız?

4-) Uygulama süresince keşke olmasaydı dediğiniz şeyler var mıdır? İzah edebilir misiniz?

5-) Biyoloji dersine karşı olan tutumunuzda bir değişiklik oldu mu? olduysa bunun nedenlerinden bahsedebilir misiniz?

6-) Oluşturulan sınıf ortamının ders işlenişine etkisini değerlendirebilir misiniz?

7-) Dersin işleniş şeklinin o dersteki sergileyeceğiniz başarınıza ne ölçüde etki edeceğini düşünüyorsunuz?

8-) Eklemek istediğiniz ya da açıklama yapmak başka hususlar varsa belirtir misiniz?

APPENDIX F

INTERVIEW QUESTIONS FOR THE TEACHER

1-) Geleneksel biyoloji derslerinin işleniş şekliyle kıyasladığınızda çoklu zeka temelli biyoloji dersinin işlenişini nasıl değerlendirirsiniz?

2-) Biyoloji dersinin bu şekilde işlenilmesinin öğrencilerin konuyu öğrenmesine ne gibi etkileri olduğunu düşünüyorsunuz?

3-) Uygulama süresince yapılan etkinliklerden en çok hangileri hoşunuza gitti? Nedenlerini açıklar mısınız?

4-) Uygulama süresince keşke olmasaydı dediğiniz şeyler var mıdır? İzah edebilir misiniz?

5-) Öğrencilerin biyoloji dersine karşı olumlu tutum geliştirmelerinde bir değişiklik olduğunu düşünüyormusunuz? olduysa bunun nedenlerinden bahsedebilir misiniz?

6-) Oluşturulan sınıf ortamının ders işlenişine etkisini değerlendirebilir misiniz?

7-) Dersin işleniş şeklinin öğrenci başarısına nasıl etki edeceğini düşünüyorsunuz?

8-) Eklemek istediğiniz ya da açıklama yapmak başka hususlar varsa belirtir misiniz?

APPENDIX G

CLASSROOM OBSERVATION CHECKLIST

Table G.1 Classroom observation checklist

H: Hayır
K: Kısmen
E: Evet

SINIF GÖZLEM FORMU	H	K	E
1-) Öğretmen soru sorduğunda bireysel düşünme için yeterli zaman tanıyor mu?			
2-) Grup etkinliklerinde öğretmen grupları dolaşıyor mu?			
3-) Müzik etkinliklerinde bireysel ve grupça katılımı teşvik ediyor mu?			
4-) Soru köşesine gelen soruları dersin başında cevaplıyor mu?			
5-) Gündelik hayatla ilgili öğrencilerden örnekler geliyor mu?			
6-) Konunun günlük yaşamla ilgili bağlantısını öğretmen veriyor mu?			
7-) Gruplar eşit sayıda öğrencilerden oluşuyor mu?			
8-) Grup etkinliklerinde bütün öğrenciler etkin mi?			
9-) Öğretmen öğrencilerden gelen bireysel katkıları onaylıyor mu?			
10-) Öğrencilerin bireysel ürünleri sunma ve sunma şekli konusunda gönüllülük esası uygulanıyor mu?			
11-) Öğretmen bireysel sunum tarzlarını saygıyla karşılıyor mu			
12-) Müzik etkinliklerinde öğretmen bireysel performans farklılıklarını saygıyla karşılıyor mu?			
13-) Müzik etkinliklerinde öğrencilerin kendini rahat ifade etmeleri için uygun sınıf atmosferi oluşturuluyor mu?			

Table G.1 (cont'd)

14-) Etkinliklerin yönergesi açık ve net bir şekilde veriliyor mu?			
15-) Anlaşılmayan durumlarda etkinliğin yönergesini anlamayan gruplara yada anlamayan öğrencilere tekrar veriyor mu?			
16-) Konuyla ilgili gazete veya dergi küpürlerini sınıfa paylaşıp sonra panoya asıyor mu?			
17-) Bireysel paylaşımları sonuna kadar dinleyip öğrencilerin de dinlemesini sağlıyor mu?			
18-) Gösteri yada performans etkinliklerinde bütün öğrencilerin etkinliği rahat bir şekilde takip etmesini sağlıyor mu?			

APPENDIX H

SAMPLE LESSON PLAN

(ASİT-BAZ-TUZ-MİNERAL)

Öğrencilere asit-baz-tuz kelimeleri ile ilgili bildikleri ne varsa ya da asit-baz-tuz kelimelerini duyduklarında akıllarına hangi kelimeler geliyorsa onları söylemeleri istenir. Söylenenlerin hepsi doğru ve yanlışlığına bakılmadan öğretmen tarafından tahtaya yazılır *(özedönük zeka).*

Daha sonra öğrencilerden

Ünite başlangıcında listeledikleri gıda etiketlerindeki maddelere bakmaları istenir. O listede bulunan maddelerden asit-baz-tuz kelimesi geçen maddeleri bulmaları ve daire içerisine alarak yan tarafına inorganik kelimesini simgelemek üzere " **İ** "harfini belirtmeleri istenir *(özedönük zeka, doğacı zeka).* Böylelikle öğrenciler inorganik maddeler grubunda hangi maddelerin olabileceğini yediğimiz besinler üzerinden öğrenmiş olurlar.

Asit-baz-pH kavramlarının gündelik hayatta farklı yerlerde de karşımıza çıktığını göstermek için öğrencilere gündelik hayatta karşımıza çıkan krem, şampuan, sıvı sabun vb üzerinde pH, asit, baz kelimeleri geçen örnek etiketler gösterilir ve grup olarak fikir alışverişinde bulunmaları istenir *(görsel-uzamsal zeka / kişilerarası sosyal zeka).*

Şimdiye kadar yapılan etkinlikler konuyla ilgili merak uyandırma etkinlikleriydi. Böylelikle öğrenciler görecekleri konunun gündelik yaşamla ilgili olduğunu da fark etmiş olurlar.

Bütün bunlar gösterildikten sonra işte bu derste asit, baz, pH ve tuz kavramlarını öğrenecekleri öğretmen tarafından belirtilir.

Öncelikle suyun iyonlaşması anlatılır. Tahtaya gönüllü 3 öğrenci çağrılır bu öğrencilerden 2 tanesine hidrojeni temsil etmek üzere H bir tanesine de oksijeni temsil etmek üzere üzerin O harfi yazan A4 kağıdı verilir. Öğrenciler bu kağıtları boyunlarına asarlar. Öğretmen öğrencilere su molekülünü oluşturmalarını söyler. Öğrenciler su molekülünü oluştururlar. Daha sonra iyonlarına ayrışmayı göstermek için O yu temsil eden öğrenciyle H yi temsil eden öğrencilerden biri OH'ı oluşturur. Diğer öğrenci de H iyonu temsil eder *(bedensel/kinestetik zeka-görsel/uzamsal zeka).*

Daha sonra öğretmen şu açıklamayı yapar:

Su iyonlarına ayrılırken OH^- ve H^+ olarak ayrılır. OH^- ve H^+ iyonlarının derişimlerinin su içerisinde değişik miktarlarda olabileceği belirtilir. Örneğin saf su da bu iyonların derişimi eşittir. Suyun iyonlaşmasının asit-baz kavramını öğrenmek için önemli olduğu belirtilir. Öğretmen şu açıklamalarla devam eder:

Suda çözündüğünde H^+ iyonlarının artmasına neden olan maddelere asit; suda çözündüğünde OH^- iyonlarının artmasına neden olan maddelere ise baz denir. Örneğin HCl suda çözündüğünde H^+ iyonlarının artmasına neden olur. Dolayısıyla HCl bir asittir.

HCl --------- $H^+ + Cl^-$

NaOH ise suda çözündüğünde OH^- iyonlarının artmasına neden olur. Dolayısıyla NaOH bir bazdır.

$NaOH$ ------- Na^+ + OH^-

İlle de maddede OH^- yada H^+ olması gerekmediği örneğin NH_3'ünde suda çözündüğünde OH^- iyonlarının derişimini arttırdığı ve bazik özellik gösterdiği; CO_2' ninde suda çözündüğünde H^+ iyonlarının derişimini arttırdığı ve asidik özellik gösterdiği belirtilir.

İyon derişimini daha basitleştirmek için pH kavramının kullanıldığı belirtillir. pH çözeltide hidrojen iyonunun derişimini gösteren bir kavramdır.

pH'ın 7'den aşağı olduğu durumlarda H^+ iyonlarının derişimi OH^- iyonlarının derişiminden daha fazladır ve bu çözelti asidik olarak adlandırılır.

pH'ın 7'den yukarı olduğu durumlarda H^+ iyonlarının derişimi OH^- iyonlarının derişiminden daha azdır ve bu çözelti bazik olarak adlandırılır.

pH'ın 7 olduğu durumlarda H^+ iyonlarının derişimi OH^- iyonlarının derişimine eşittir ve bu çözelti nötr çözelti olarak adlandırılır. (***Nötr çözeltilerde de H^+ ve OH^- iyonlarının olduğunu fakat bunların derişiminin eşit olduğu özellikle vurgulanır.***)

pH değerleri 0-14 arasında olmak üzere pH cetvelinde belirtilir. 7'den 14'e doğru gidildikçe bazlık kuvveti artar; 7'den 0'a doğru gidildikçe asitlik kuvveti artar.

Bu açıklamalardan sonra pH cetveli yapma etkinliğine geçilir (*görsel-uzamsal zeka, doğacı zeka, kişilerarası-sosyal zeka, mantıksal-matematiksel zeka, bedensel-kinestetik zeka*). Bu etkinlik grup olarak yapılır. Her gruba uzun bir strafor verilir. Gündelik hayatta karşılaştıkları (kola, limon, kabartma tozu vb) maddelerin resimleri verilir ve bu maddelerin pH değerlerini gösteren bilgi kağıdı dağıtılır. Her gruba mavi ve kırmızı olmak üzere iki ayrı fon kartonu verilir. Bunlardan birer adet ok şeklinde kesmeleri istenir. mavi okun bazı, kırmızı okun ise asidi temsil edeceği belirtilir. Mavi ok' a 7 ile 14 arası rakamlar; kırmızı oka ise 0 ile 7 arası rakamları yazmaları istenir. straforun üzerine bu okları ve maddelerin resimlerini raptiye kullanarak sabitlemeleri istenir. pH bilgi kağıdını kullanarak her bir maddeyi uygun pH değerine yerleştirmeleri istenir. Bütün gruplar bitirdikten sonra bir gruptan nasıl hazırladıklarını anlatmaları istenir. Bu arada diğer gruplarda kendi çalışmalarının doğruluğunu kontrol ederler (*kişilerarası-sosyal zeka, sözel-dilsel zeka*). Böylece öğrenciler örnek bir pH cetveli yapmış olurlar. pH 7 den yukarı baz ve pH 7 den aşağı asit olduğunu görsel olarak görmüş olurlar. Ayrıca gündelik hayattta karşılaştığımız maddelerin hangisinin asit hangisinin baz olduğunu görsel olarak görmüş olurlar. Bu etkinliğin sonunda öğrenciler PH değerinin neyi ifade ettiğini kavramış olurlar.

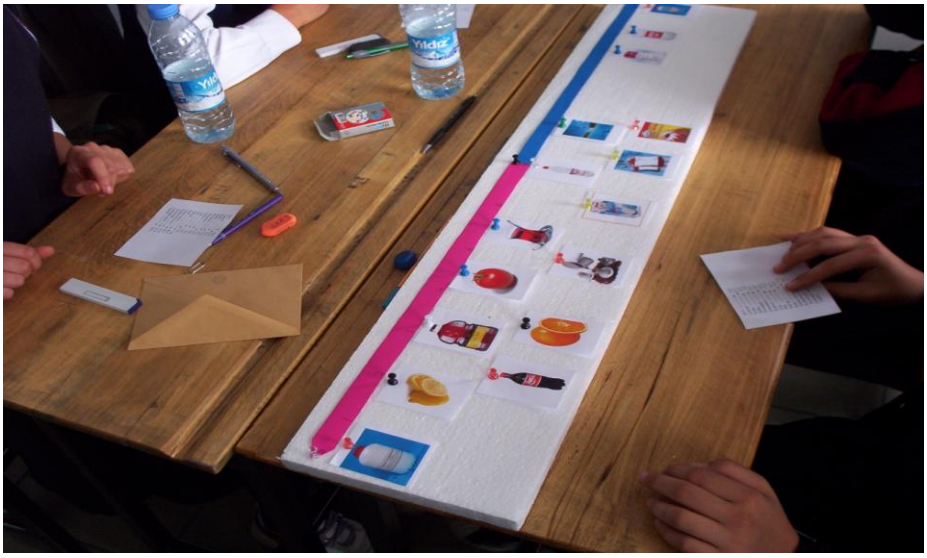


Figure H.1 pH scale activity

Daha sonra öğretmen pH değerlerinin canlılar için neden hayati derecede önemli olduğunu açıklar:

pH değeri organizma için yaşamsal önem taşır. Çünkü biyokimyasal tepkimelerin gerçekleşebilmesi için ortamın pH değerinin belirli bir düzeyde tutulması gerekir. pH değerindeki küçük bir değişme , biyokimyasal tepkimenin işleyişini değiştirir ve olumsuz sonuçlara yol açabilir. Örneğin; insan kanının pH'ı 7,4 olup bu değerin 7'ye düşmesi ya da 7,8'in üzerine çıkması ölümle sonuçlanır.

Her hücrenin en iyi faaliyet gösterdiği pH değerleri birbirinden farklı olabilir. Örneğin midenin pH'ı 3,5; bağırsağın pH'ı 8,5; derinin pH' 5,5 ve kanın pH'ı 7,4' tür.

Aynı insan vücudu gibi diğer canlılarda farklı pH değerlerinde yaşamayı tercih edebilirler. Örneğin bazı bitkiler asidik topraklarda yaşamayı severken bazıları ise bazik toprakları tercih ederler. Ya da bazı bakteriler asidik ortamları tercih ederken bazıları bazik ortamları tercih edebilir.

Daha sonra öğretmen asit ve bazların özelliklerinden bahseder:

Asitlerin bir takım genel özellikleri vardır. Tatları ekşidir, suda çözünürler, elektiriği iletirler. mavi turnusol kağıdının rengini kırmızıya çevirirler. Örnek asitler şunlardır: HCI, H_2SO_4, ayrıca limon, portakal, elmada da çeşitli asitler bulunur.

Bazların genel özellikleri ise: Tatları acımsıdır, suda çözünürler, elektiriği iletirler, ele kayganlık hissi verirler, kırmızı turnusol kağıdının rengini maviye çevirirler. Örnek bazlar: NaOH, KOH. Çamaşır suyu, sabun, nane ve patlıcanda da çeşitli bazik maddeler bulunur.

Daha sonra öğretmen tuz kavramına geçer ve canlandırma etkinliği yapılır (*bedensel-kinestetik zeka, kişilerarası sosyal zeka, görsel-uzamsal zeka*). Bir önceki bölümde asit ve baz örnekleri içerisinde HCI ve NaOH olduğunu hatırlatır. Gönüllü öğrencilerin tahtaya gelerek bu molekülleri oluşturmaları istenir. Toplam 5 öğrenci çağrılır. Herbir öğrencini H, CI, Na ve O yu temsil etmeleri istenir. Ve boyunlarına element sembollerinin yazıldığı A4 kağıtlarını asmaları istenir. Öğretmen asitle bazların birleşince su ve tuz oluşturduğunu söyler. Şimdi burada HCI ve NaOH'ın birleşince nasıl tuz oluşturduklarını görecekleri söylenir. Asitlerle bazlar birleşince tuz ve su oluşur. Örneğin,

$HCI + NaOH \rightarrow NaCI + H_2O$

öğrencilerden reaksiyona girmişler gibi yerlerini değiştirerek ürünleri oluşturmaları söylenir.

Bu etkinlik (KOH+HCl), ve (HBr + NaOH) kullanılarak diğer gönüllü öğrencilerle de yapılır.

$KOH + HCI \rightarrow KCI + H_2O$

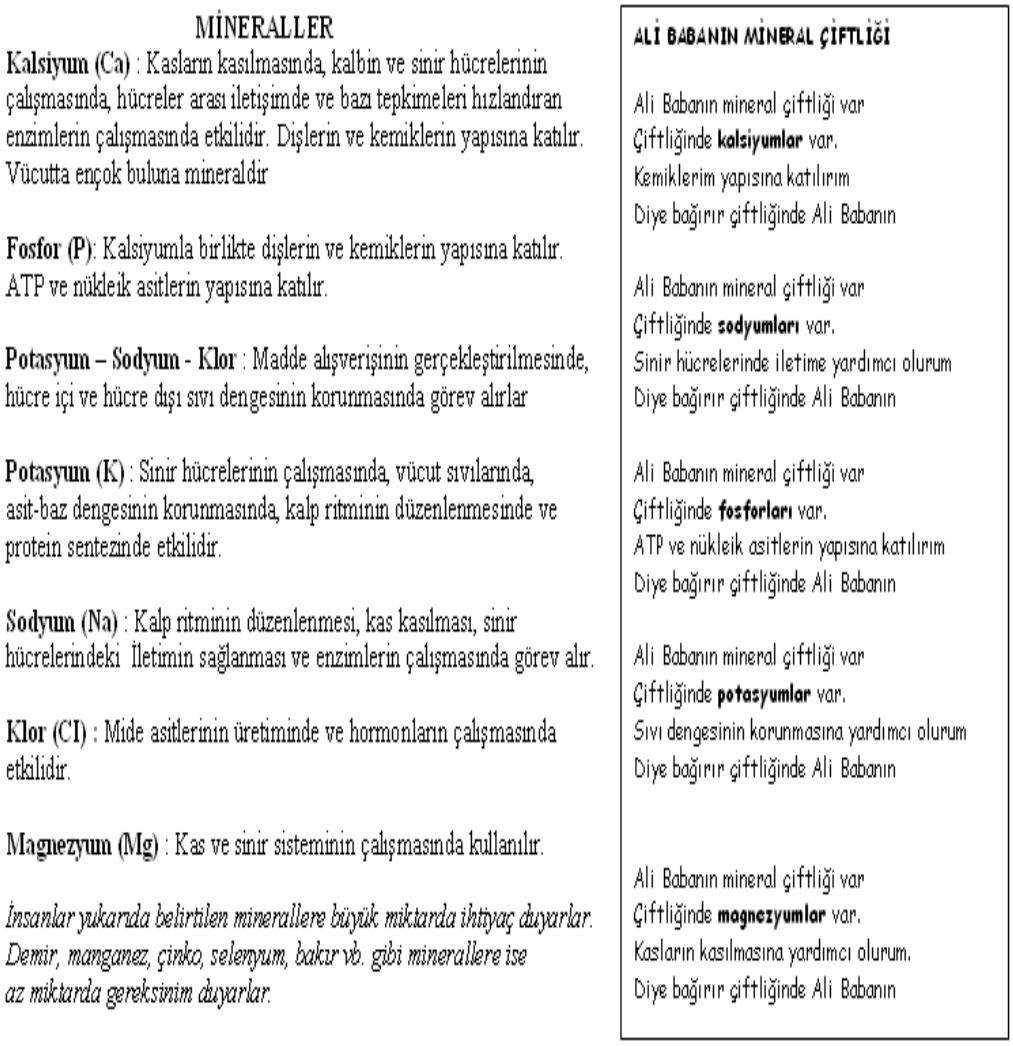
$HBr + NaOH \rightarrow NaBr + H_2O$

Tuz oluşturma etkinliği bittikten sonra bazı tuzların canlılar için önemli olduğu belirtilir örneğin sofra tuzunun (NaCI) çok önemli olduğu otçul olarak beslenen yabani hayvanlar sadece su kaynağı için değil tuz içinde yüzlerce km göç edebiliyorlar. Çiftçiler hayvanların tuz ihtiyacını karşılamak için tuz yalama taşları koyuyorlar. Hayvanlar bu taşları yalayarak tuz ihtiyacını karşılıyorlar.

Tuz oluşturma etkinliği bittikten sonra mineraller konusuna geçilir. Mineraller hakkında kısa bir açıklama yapıldıktan sonra:

"Ali baba'nın mineral çiftliği" şarkısının olduğu kağıtlar her öğrenciye dağıtılır *(müziksel-ritmik zeka, özedönük zeka, sözel-dilsel zeka, kişilerarası- sosyal zeka).* Bu kağıtta ayrıca her bir mineral

için kısa bilgiler de yer alır. Öğrenciler önce bu bilgileri bireysel olarak okur. Önce gönüllü öğrenciler arasından seçilen kişiler şarkıyı bireysel olarak yüksek sesle okurlar. Daha sonra gönüllü bir gruptan grup olarak şarkıyı yüksek sesle okumaları istenir. Son olarak da sınıfça hep birlikte şarkıyı yüksek sesle okumaları istenir.



MİNERALLER

Kalsiyum (Ca) : Kasların kasılmasında, kalbin ve sinir hücrelerinin çalışmasında, hücreler arası iletişimde ve bazı tepkimeleri hızlandıran enzimlerin çalışmasında etkilidir. Dişlerin ve kemiklerin yapısına katılır. Vücutta ençok buluna mineraldir

Fosfor (P): Kalsiyumla birlikte dişlerin ve kemiklerin yapısına katılır. ATP ve nükleik asitlerin yapısına katılır.

Potasyum – Sodyum - Klor : Madde alışverişinin gerçekleştirilmesinde, hücre içi ve hücre dışı sıvı dengesinin korunmasında görev alırlar

Potasyum (K) : Sinir hücrelerinin çalışmasında, vücut sıvılarında, asit-baz dengesinin korunmasında, kalp ritminin düzenlenmesinde ve protein sentezinde etkilidir.

Sodyum (Na) : Kalp ritminin düzenlenmesi, kas kasılması, sinir hücrelerindeki İletimin sağlanması ve enzimlerin çalışmasında görev alır.

Klor (Cl) : Mide asitlerinin üretiminde ve hormonların çalışmasında etkilidir.

Magnezyum (Mg) : Kas ve sinir sisteminin çalışmasında kullanılır.

İnsanlar yukarıda belirtilen minerallere büyük miktarda ihtiyaç duyarlar. Demir, manganez, çinko, selenyum, bakır vb. gibi minerallere ise az miktarda gereksinim duyarlar.

ALİ BABANIN MİNERAL ÇİFTLİĞİ

Ali Babanın mineral çiftliği var
Çiftliğinde **kalsiyumlar** var.
Kemiklerim yapısına katılırım
Diye bağırır çiftliğinde Ali Babanın

Ali Babanın mineral çiftliği var
Çiftliğinde **sodyumları** var.
Sinir hücrelerinde iletime yardımcı olurum
Diye bağırır çiftliğinde Ali Babanın

Ali Babanın mineral çiftliği var
Çiftliğinde **fosforları** var.
ATP ve nükleik asitlerin yapısına katılırım
Diye bağırır çiftliğinde Ali Babanın

Ali Babanın mineral çiftliği var
Çiftliğinde **potasyumlar** var.
Sıvı dengesinin korunmasına yardımcı olurum
Diye bağırır çiftliğinde Ali Babanın

Ali Babanın mineral çiftliği var
Çiftliğinde **magnezyumlar** var.
Kasların kasılmasına yardımcı olurum.
Diye bağırır çiftliğinde Ali Babanın

Figure H.2 Activity related with minerals.

Daha sonra asit-baz-tuz-mineral konularının hepsini içeren bir etkinlik yapılır (*kişilerarası-sosyal zeka, mantıksal-matematiksel zeka*). Sürpriz yumurta kaplarının herbirine asit-baz-tuz-minerallerle ilgili bir bilginin yazıldığı kağıtlar yerleştirilir. Bu bilgilerden bazıları doğru bazıları ise yanlıştır. Her grup sırayla bir sürpriz yumurta kabı çeker ve çıkan bilginin doğru veya yanlış olduğunu belirtir. Eğer doğru cevap verirlerse grup olarak 10 puan alırlar. Etkinlik sonunda en yüksek puan alan grup birinci olur. Bu etkinlikte kullanılan bilgiler aşağıda verilmiştir:

- *Suda çözündüğünde H^+ iyonlarının artmasına neden olan maddelere asit denir.*

- Suda çözündüğünde OH^- iyonlarının artmasına neden olan maddelere baz denir.

- NH_3'te (Amonyak) OH^- iyonu olmadığı için baz değildir.

- Bütün asit çeşitlerinin kuvveti aynıdır.

- Çeşme suyu nötr bir maddedir.

- Nötr çözeltilerde pH 7 olduğu için H^+ ve OH^- iyonları yoktur.

- Çay bitkisi asidik topraklarda daha iyi gelişir. Onun için çay yetiştirilen toprağın pH'ı 7' den aşağıda olmalıdır.

- Çamaşır suyu ile yıkanan fanusa konulan balıklar öldüğüne göre bu balıklar bazik ortamı sevmezler.

- Kuvvetli bir asitle zayıf bir baz birleştiğinde ortam nötr olmaz.

- Zayıf bir asitle kuvvetli bir baz birleştiğinde ortam nötr olur.

- Asit-baz nötrleşme reaksiyonlarında sadece tuz oluşur.

- Bütün tuz çözeltilerinin pH'ı 7' dir. Yani nötrdür.

- İnsan vücudunda bütün hücreler aynı pH değerinde en iyi etkinliği gösterirler.

- pH'ı 8,2 olan X maddesi pH'ı 11,4 olan bir maddeye göre daha zayıf bir bazdır.

- pH'ı 6,3 olan A maddesi pH'ı 2,7 olan bir B maddesine göre daha kuvvetli bir asittir.

- Vücutta ençok bulunan mineral kalsiyumdur.

- Kemiklerin ve dişlerin yapısında ençok bulunan mineraller kalsiyum ve fosfordur.

- Mineral maddeler hücre için aynı zamanda önemli enerji hammaddeleridir.

- İnsan vücudu bütün minerallere eşit miktarlarda ihtiyaç duyar.

- Potasyum (K) , sodyum(Na) ve klor(CI) iyonları hücre içi ve dışı sıvı dengesinin korunmasına yardımcı olurlar.

- Sodyum sinir hücrelerinde iletimin sağlanmasında rol alır.

- Fosfor ATP'nin ve nükleik asitlerin yapısına katılır.

Bu etkinlikten sonra öğrenciler asit-baz-tuz-minerallerle ilgili kelime bulmaca etkinliği verilir (*özedönük zeka, görsel-uzamsal zeka*). Bu etkinlikte öğrenciler konuyla ilgili sorulan kelimeleri bulmacada yukarıdan-aşağıya, aşağıdan-yukarıya, soldan-sağa, sağdan-sola veya çapraz şekilde bulmaları ve işaretlemeleri istenir.

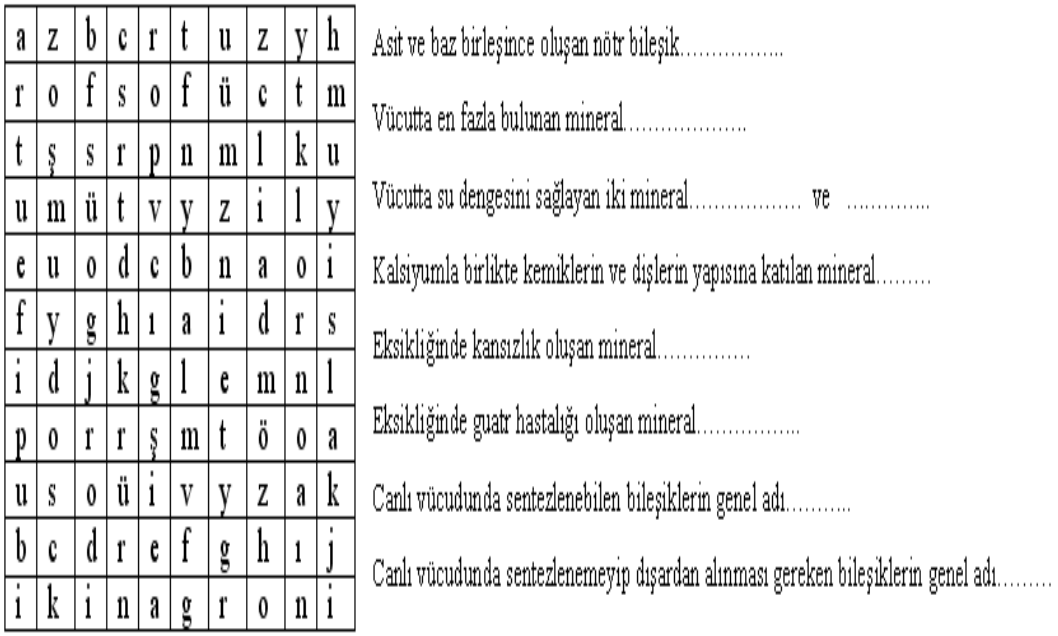


Figure H.3 Puzzle related with acid-base-mineral.

Son olarak asit-baz-tuz-minerallerle ilgili gazete küpürlerini öğretmen öğrencilere gösterir (Figures H.4, H.5, H.6, H.7). Herbir gazete küpürünü gönüllü bir öğrenci tüm sınıf duyacak şekilde okur. Okumalar bittikten sonra gazete haberleri sınıf panosuna asılır.

Tuzun azı değil çoğu yarar!

TUZUN sağlık için çok da zararlı olmadığı hatta eksikliğinin vücuta sorun yaratacağı açıklandı. Hollanda'daki Utrecht Tıp Fakültesi uzmanları, yetersiz tuz alımının halüsinasyon, sinir bozukluğu, kas krampı ve kalça kemiği kırıklarına yol açabileceğini açıkladı.

ŞİMDİYE kadar günde 6 gramın üzerindeki tuz tüketiminin zararlı olduğu dersi sürülüyordu. Ancak son araştırma 16 gramın altında kalan tüketimin dahi kan basıncı gibi çeşitli kriterler açısından fazla bir değişiklik yaratmadığını gösterdi. ■ DIŞ HABERLER

Figure H.4 Newspaper cutting I.

Ezber bozan tespit: Tuzu azaltmak riskli

TIP çevreleri yıllardır yaptıkları araştırmalarla tuz tüketiminin kalp krizi ve felç riskini artırdığına işaret ediyor. Tuz tüketimini azaltmaya yönelik kampanyalar, bilgilendirme toplantıları dünyanın birçok ülkesinde sürdürülüyor. Ancak önceki gün Danimarkalı bilim insanlarının sonuçlarını açıkladığı bir rapor ezber bozdu.

Şimdiye kadar bu konuda yapılan 167 araştırmanın sonuçları analiz edilerek hazırlanan rapora göre tuz tüketimini azaltmak kan basıncını yüzde bir oranında düşürüyor ancak aynı zamanda kolestrolün yükselmesine neden olduğu için kalp hastalıklarının ortaya çıkmasında ayrı bir risk faktörü oluşturuyor. Kopenhag Üniversitesi'nin hazırladığı rapora göre daha az tuz tüketimi kolesterolde yüzde 2,5 oranında ve kanda pıhtılaşmaya neden olan bir yağın yüzde 7 artışına neden oluyor. Tuzun azaltılması kan basıncını düşürse de ortaya çıkan yeni faktörler kalp hastalıkları ve diyabet riskini artırıyor.

Figure H.5 Newspaper cutting II.

SÜT VE YOĞURT ÇOCUK GELİŞİMİ İÇİN ÇOK ÖNEMLİ

KALSİYUM, KEMİK VE DİŞ OLUŞUMUNA YARDIMCI OLUR

Sütü sevmeyen bir çocuğun ne kadar zorlu olduğunu en iyi anneler bilir! Ancak süt ve ürünlerinin yararları saymakla bitmiyor. Mesela yoğurt kanserden korurken; süt gelişime yardımcı oluyor. İşte çocuğunuza sütü sevdirmenin yolları

Süt ve süt ürünleri çocuklar için önemli bir besin kaynağı. Ancak süt rağbet edilen içecekler arasında da yer almıyor. Çocuklar arasında "Ben bebek miyim süt içeyim?" inanışına ek olarak; aileler de "Çocuğum büyüdü, elimde sütle peşinde koşturacak değilim!" diyerek çocukların büyüme ve gelişme dönemlerinde bu eşsiz besin kaynağından faydalanması gerekliliğini göz ardı ediyor.

Sütün, başta çocuklar olmak üzere, 7'den 70'e herkesin vücudu için gerekli olan besinleri içinde bulunduran tek besin olduğunu belirten Memorial Şişli Hastanesi Beslenme ve Diyet Bölümü'nden Dyt. Yeşim Çelik, sütün beslenmemizdeki önemini; Uz. Dr. Gökhan Mamur ise sütü çocuklara nasıl sevdireceğinizi anlattı:

olan ihtiyacı büyük ölçüde artar.

Bir süt ürünü olan yoğurt da sağlığı geliştirici etkisi nedeniyle bolca tüketilmelidir.

KANSERDEN KORUYOR

Yoğurtta bulunan bakterilerin kanser, enfeksiyonlar, gastrointestinal hastalıklar ve astım gibi hastalıkları önleyici etkileri bulunuyor.

Yoğurdun içerdiği probiyotik ve prebiyotik maddeler; kabızlık, ishal, kalp hastalıkları, şeker, kemik erimesi ve kalın bağırsak kanseri gibi çeşitli rahatsızlıklara iyi geliyor.

Yoğurt, bağışıklık sistemini güçlendiren, özellikle immunoglobulin A'dan zengin bir besin. Ayrıca süt ürünlerinin içindeki laktoz, sindirimi kolaylaştırıyor ve ishali önlüyor.

Normal yetişkinlerde vücudun ihtiyacı 2 porsiyon süt veya yoğurt ile

Figure H.6 Newspaper cutting III.

GÜNLÜK İYOT İHTİYACIMIZ 150 MİKROGRAM

Deniz ürünleri, sebzeler ve sularda bulunan iyotun vücuttaki eksikliği; tiroit beziyle ilgili sorunların temel nedeni! Uzmanlar, "Günde 150 mikrogram iyota ihtiyacımız var" diyor

İyot eksikliği, Türkiye'de görülen tiroit hastalıklarının temel nedeni olarak gösteriliyor. Cerrahpaşa Tıp Fakültesi İç Hastalıkları, Endokrinoloji ve Metabolizma Hastalıkları Bilim Dalı Öğretim Üyesi Prof. Dr. Ahmet Sadi Gündoğdu, "Günlük tüketilen sebzelerden, deniz ürünlerinden ve içtiğimiz sudan iyot alıyor olmamız gerekir" diyor. Prof. Dr. Gündoğdu, tiroit tedavisindeki yenilikleri anlattı.

Prof. Dr. Ahmet Sadi Gündoğdu

TEŞHİSİ KOLAY

Ailede guatr varsa ve Türkiye'de guatr vakalarının yoğun olduğu bölgelerde yaşıyorsanız mutlaka bir endokrinoloğa başvurmanız gerekir. Hastalığın teşhisi kolaydır. İhmal edilmezse, mutlaka yakalanır ve tedavi edilebilir. Artık pek çok check-up programı da tiroit fonksiyonlarını araştırıyor.

ÇOK YAYGIN

Tiroit denince akla hemen guatr geliyor. Guatr ülkemizde çok mu yaygın?

Evet ama tiroit hastalıkları, guatrdan ibaret değil. Guatr, bir iç salgı bezi olan tiroit bezinin büyümesidir. Tiroit bezinin büyümesinin ve fonksiyonlarının bozulmasının, pek çok nedeni var ama ülkemiz açısından en temel neden; iyot eksikliği!

İyot ne işe yarıyor?

talıkların bu boyutta olması inanılmaz! İyodun az veya çok alınması dışında, kalp ritmini düzenleyici ilaçlar, psikiyatride kullanılan bazı ilaçlar, bazı kimyasal maddeler de tiroit bezinin işlevlerini bozar.

CİLDİ KURUTUR

Tiroit bezinin ne gibi görevleri var?

Tiroit bezi, metabolizmayı kontrol ediyor. Yeterli hormon üretilmezse, metabolizma yavaşladığı için kolay kilo alınır, kilo vermek zorlaşır, oksijen tüketimi azalır. Hastada, yorgunluk, kalp atışlarında yavaşlama, daha çok uyuma isteği, kolesterol artışı, deride kuruma ve saç dökülmesi gibi belirtiler ortaya çıkar.

Tiroit salgısındaki değişimlerin, kalp hastalıklarına neden olabildiği doğru mu?

Kalp fonksiyonlarının normal olması, tiroit hormonlarının normal çalışmasına bağlıdır. Tiroit hormonu eksikliğinde kalp atışlarında yavaşlama, faz-

İYOT ZENGİNLERİ

Yetişkin insanların günlük iyot ihtiyacı, yaşlarına göre 100 ile 300 mikrogram (mcg) arasında değişiyor. Bazı temel besinlerin 100 gramındaki iyot miktarı ise şöyle:

BEBEKLERİN İYOT AYARI

7-12 ay arası bebeklerin günlük iyot ihtiyacı 130 mikrogramdır. Bu

Figure H.7 Newspaper cutting IV.

CURRICULUM VITAE

PERSONAL INFORMATION

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MS	METU, Secondary Science and Mathematics Education	2005
BS	METU, Department of Biology	2003
High School	Bursa Agricultural Vocational High School	1997

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