VALIDITY OF BIOLOGY ITEMS IN 2006, 2007, AND 2008 STUDENT SELECTION TEST IN TURKEY

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

BY

FULYA KOYUNCU

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

JANUARY 2011

Approval of the thesis:

VALIDITY OF BIOLOGY ITEMS IN 2006, 2007, AND 2008 STUDENT SELECTION TEST IN TURKEY

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ABSTRACT

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January 2011, 211 pages

Student selection test in Turkey compose of two parts. The purpose of the first part is to assess students' higher order thinking skills like analytical thinking, interpretation and reasoning about elementary school curriculum and 9th grade curricula objectives. On the other hand, second part of the test aims to assess students' higher order thinking skills given in the high school curriculum.

The main aim of this thesis is to analyze to what extend 2006, 2007 and 2008 student selection tests biology items assess higher order cognitive skills. In accordance with this purpose, elementary and high school curriculum and the appropriateness of the questions in the student selection test with the educational objectives of the curriculum are examined. In addition, dimensions of 2006, 2007, and 2008 SST biology items are examined by Exploratory Component Analysis and Confirmatory Component Analysis techniques. The result of those analysis revealed that SST biology items mostly focus on remembering skill and fail to assess higher order thinking skills. Additionally, there is not any consistency among 2006, 2007, and 2008 SSTs biology items in terms of dimensions which means there is not any construct in biology subtests of SSTs.

The other aim of the present study is to identify how much academic and non-academic factors explain the biology achievement. While for academic factors reading comprehension, mathematics, physics, and chemistry achievements of students are used, age, gender, and school type are used for non-academic factors. Findings of the research revealed that academic factors, especially chemistry achievement, have significant affect on biology achievement. In terms of non-academic factors, graduating from selecting high school has important role for biology achievement. Additionally, older students and girls tend to have higher grades in biology.

Keywords: Content Analysis, Content Validity, Construct Validity, Item Analysis, Principle Component Analysis (PCA), Biology Test, Student Selection Test

ÖZ

2006, 2007 VE 2008 ÖĞRENCİ SEÇME SINAVI BİYOLOJİ SORULARININ GÜVENİLİRLİĞİ

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Tez Yöneticisi: Prof. Dr. Giray Berberoğlu

Ocak 2011, 211 sayfa

Türkiye'de düzenlenen Öğrenci Seçme Sınavı iki bölümden oluşur. İlk bölümün amacı öğrencilerin analitik düşünme, yorumlama ve akıl yürütme gibi üst düzey düşünme becerilerini ilköğretim ve 9. sınıf öğretim programlarının kazanımları kapsamında ölçmektir. Diğer taraftan, ikinci bölüm ise öğrencilerin üst düzey düşünme becerilerini ortaöğretim eğitim programları kazanımları kapsamında ölçmektir.

Bu çalışmanın esas amacı 2006, 2007 ve 2008 Öğrenci Seçme Sınavı'nın bu amaca ne kadar hizmet ettiğini saptamaktır. Bu amaç dahilinde ilköğretim ve ortaöğretim programları incelenmiş ve ÖSS biyoloji sorularının öğretim programlarının içeriği ile uyumluluğu araştırılmıştır. Ayrıca, Ayımlayıcı ve Doğrulayıcı Faktör Analizi teknikleri kullanılarak 2006, 2007 ve 2008 biyoloji testlerinin yapısal geçerliliği de incelenmiştir. Analiz sonuçları incelendiğinde ÖSS biyoloji sorularının genel olarak öğrencilerin bilgileri hatırlama düzeylerini ölçtüğü ve üst düzey düşünme becerilerini yoklamadığı sonucuna varılmıştır. Ayrıca, yapısal olarak ÖSS biyoloji testleri arasında herhangi bir tutarlılık bulunamamıştır.

Çalışmanın bir diğer amacı da, akademik ve akademik olmayan faktörlerin biyoloji başarısını açıklamada ne kadar etkili olduğunu saptamaktır. Bu amaç dahilinde, okuduğunu anlama, matematik, fizik ve kimya başarıları akademik faktörler olarak belirlenirken, cinsiyet, yaş ve okul türü de akademik olmayan faktörler olarak belirlenmiştir. Analiz sonuçları incelendiğinde akademik faktörler, özellikle kimya başarısı, biyoloji başarısı üzerine anlamlı sonuçlar vermiştir. Akademik olmayan faktörlerin sonuçları incelendiğinde de öğrencilerini seçerek alan ortaöğretim kurumlarından mezun olan öğrencilerin daha yüksek biyoloji başarısı elde ettikleri bulunmuştur. Ek olarak, yaşı büyük olan öğrenciler ve kız öğrenciler de biyolojide daha yüksek başarı gösterme eğilimindedirler.

Anahtar Kelimeler: Kapsam Analizi, Kapsam Geçerliği, Yapı Geçerliği, Madde Analizi, Temel Bileşenler Faktör Analizi, Biyoloji Testleri, Öğrenci Seçme Sınavı

To my parents Rabia and Eyüp Koyuncu,

and my sister Ayşe Seda Gülseven

ACKNOWLEDGEMENTS

I wish to express my deepest gratitude to my supervisor, Prof. Dr. Giray Berberoglu, for his guidance and warm support throughout my graduate and thesis studies. I have learned many things from him. Without his support and guidance this study would never be completed.

I would like to thank to Prof. Dr. Ömer Geban, Assoc. Prof. Dr. Esen Uzuntiryaki, Assoc. Prof. Dr. Jale Çakıroğlu, and Dr. Ömer Faruk Özdemir for their guidance and support in my thesis defense.

I wish to thank to Büşra Tuncay from Middle East Technical University and Dr. Çiğdem İş Güzel for their contributions to this study.

I would like to thank to Prof. Dr. Ceren Tekkaya, Assoc. Assist.Prof.Dr. Bülent Çetinkaya, and Assist.Prof.Dr. Elvan Şahin help and all kind of supports in this graduate study.

At last I also want to thank to my parents, sister, brother-in-law, grandmother, sister-in-law and cousins deserve my deepest and sincere acknowledgements for all their encouragements.

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INTRODUCTION

1. 1.University Entrance Examination in Turkey

Until 1960s, because of the limited number of high school graduates, universities accepted all applicants without any examination. However at the beginning of 1960s, number of high school graduates increased and the applications to universities exceeded the capacity of departments. To solve this problem, most of the universities started to administer their own selection examination. This new movement caused some problems. Firstly, evaluation of the thousands of applicants became the major problem because most of the departments administrated their exams in essay form. Moreover, independent administration of the exams caused overlapping the exam days of two or more institutions. For this reason, students could not be taken all university’s exams. To solve those, in 1963, Interuniversity Board instituted Interuniversity Entrance Examination Commission. First, centralized university examination was prepared by this commission. Within time, the number of applicants for university admission increased, therefore, a permanent center was instituted by the Interuniversity Board and named Interuniversity Student Selection and Placement Center in 1974. In 1981, Interuniversity Student Selection and

Placement Center was affiliated to Higher Education Council and named Student Selection and Placement Center (OSYM, 2006a; Berberoğlu, 1996).

Between 1981 and 1999, tests were applied in two stages. The name of the first stage was Student Selection Test (SST) which was administered in April. SST was an ability orientated test. Even though high school curriculums concepts and materials were used, the aim of SST was not to evaluate the curriculum objectives. The aim of SST was to select the students for the second stage of the examination which is called Student Placement Test (SPT). SPT was applied in June and aimed to assess students' achievement according to high school curriculum objectives. In 1999, the second stage of the examination was completely removed and students were selected and placed only by SST which was applied in June every year. This change caused serious problems for high schools and universities. Since the content of the SST is composed of only elementary school and first year of high school curriculum, most of the students did not endeavor the second and third year of the high school. Ultimately, students entered into the universities with imperfect knowledge. For this reason the content of the SST was changed at 2006 SST. New form of SSTs is administered again in two stages which are implemented in same day. The first stage of the test (SST-1) consists of same content with the previous SSTs, while the second stage (SST-2) involves whole high school curriculum (OSYM, 2006a).

1.2. Content of the Student Selection Test

SST aims to evaluate students' verbal and quantitative abilities. The verbal ability part of the test contains two subtests: 1) proficiency in the Turkish mother tongue, and 2) ability of using the basic concepts and generalizations of social science subjects. The quantitative ability test is composed of two parts: 1) ability to make use of basic mathematical concepts and rules, and 2) ability to reason using the basic concepts and principles of natural science subjects (OSYM, 2004; OSYM, 1984 cited from Berberoğlu, 1996). Content of the test is composed of higher order thinking skills like comprehension application, analysis, and synthesis according to Bloom's (1979) taxonomy of educational objectives. Turkish language subtest of the verbal ability section can be categorized as; items that assess the basic principles of grammar and items assess the reading comprehension skills. Social science subtest of the verbal ability section categorized into three basic content areas: history, geography, and philosophy. Similarly to the quantitative ability test items in mathematics subtest can be categorized into three groups as computation, word problems, and geometry which are selected from different subject areas. The natural science subtest of quantitative ability test is grouped into three basic content areas: physics, chemistry, and biology (OSYM, 2006a; Berberoğlu, 1996).

All of the items in SSTs are in multiple choice form with five alternatives. To prevent guessing, the raw score of the test is obtained by subtracting one of the correct answers out of four incorrect answers. Besides, for the test security reasons each year parallel forms of the test are administrated, yet as Berberoğlu (2006) cited this may cause equivalent form problem.

1.2.1. Content of the First Stage of the Student Selection Test

Until the end of the 9th grade (first year of the high school) all of the high school students take same courses. At the beginning of 10th grade students select their field of study which consists of science-mathematics (quantitative), Turkish-mathematics (equal weight), Turkish-social (verbal) and foreign language (language). For this reason first stage of SST (SST-1) includes items from elementary curriculum and the first year curricula of high school. This stage of the SST is also called “tests related to common courses”. The aim of this test is to evaluate students’ basic skills such as understanding, implicating and establishing according to curriculums objectives. SST-1 composed of four subtests respect to study fields such as Turkish (Tur), Social Sciences (Soc-1), Mathematics (Math-1), and Science (Sci-1). Number of items for each test and basic content areas are shown in Table 1.1 (OSYM, 2006a; OSYM, 2008a).

Table 1.1: Tests Related to Common Courses

Test name	Number of items
Turkish (Tur)	30
Social Sciences (Soc-1)	30
History	13
Geography	10
Philosophy	7
Mathematics (Math-1)	30
Science (Sci-1)	30
Physics	13
Chemistry	9
Biology	8
Total	120

1.2.2. Content of the Second Stage of the Student Selection Test

Second stage of the SST (SST-2) named as “tests related to field course” and covers the whole high school curriculum. For this reason, students are responsible for the subtests about their own field courses. Similarly to SST-1, SST-2 composed of four subtests: Literature-Social Sciences (Lit-Soc), Social Sciences-2 (Soc-2), Mathematics-2 (Math-2), and Science-2 (Sci-2). Number of items for each test and basic content areas are shown in Table1.2 (OSYM, 2006a; OSYM, 2008a).

Table 1.2: Tests Related to Field Courses

Test name	Number of items
Literature-Social Sciences (Lit-Soc)	30
Turkish Mother Tongue and Literature	17
Turkey Geography	8
Psychology	5
Social Sciences-2 (Soc-2)	30
History	13
Geography of countries	7
Sociology	5
Logic	5
Mathematics-2 (Math-2)	30
Mathematics	21
Geometry	9
Science-2 (Sci-2)	30
Physics	13
Chemistry	9
Biology	8
Total	120

1.3. Purpose of the Research

Present research has two main aims; first aim is to explore the content-related and construct-related validity of three years SSTs biology items which are 2006, 2007, and 2008. Content related validities of the biology items are examined by content analysis. Content analysis intended to determine consistency between OSYMs' aim for SST content and actual content of the SSTs. For construct-related validity analyses both exploratory and confirmatory factor analyses techniques were used to determine the dimensions of SSTs.

On the other hand other, the other aim of the study is to identify how biology achievement can be predicted by academic and non-academic factors by using students' SST scores. Reading comprehension, mathematics, physics, and chemistry achievement of the students were chosen for the academic factors and school type, age, and gender were determined as the non-academic factors.

1.4. Research Questions

As it is mentioned before present study has two main goals; first aim of the study was to explore the content-related and construct-related validity of the 2006, 2007, and 2008 SSTs. To accomplish this aim five main research questions were identified:

1. What are the content specifications of the biology items in 2006, 2007, and 2008 SSTs in terms of grade level, content types, and cognitive processes?
2. What are the reliability coefficients of reading comprehension, mathematics, physics, chemistry and biology subtests of 2006, 2007, and 2008 SSTs?
3. What are the item characteristics of biology items in 2006, 2007, and 2008 SSTs in terms of difficulty level and point biserial correlation values (*r*)?
4. What are the factorial structure, dimensions, of biology items in the 2006, 2007, and 2008 SSTs?

Other aim of the study was to identify how biology achievement can be predicted by academic and non-academic factors by using 2006, 2007, and 2008 SSTs. To accomplish this aim, three main research questions were identified:

1. What are the relationships between biology achievement and other academic factors which are reading comprehension achievement, mathematics achievement, physics achievement, and chemistry achievement?

2. What are the relationship between biology achievement and non-academic factors which are age, gender, and school type?

3. How much do academic factors and non-academic factors contribute biology achievement with other academic and non-academic factors?

1.5. Significance of the Research

The aim of the achievement tests can vary but they should acquire some important characteristics. According to Gronlund (1981) the most essential characteristics of a test are validity and reliability. Reliability gives the consistency of test scores when the same individuals are tested again under similar circumstances (Crocker& Algina, 1986), whereas validity of a test gives how better the evaluation procedure serves to the desired aim (Gronlund, 1981). Due to this reason, examinations should be reliable and valid.

The number of high school graduates in 1998 was increased four times than 1983 (OSYM 1986 as cited in Köksal, 2002). The number of students who applied to take SST in 2006, 2007, and 2008 are 1.678.383, 1.641.403, and 1.644.073 respectively. (OSYM, 2006b; OSYM, 2007; OSYM, 2008b). All of the information gives us the important demand to higher education.

To be accepted in higher education institution SST is the most, even the only, important requirement for Turkish pupil. When the importance of SST in Turkey and the number of application for higher education is considered, applying a reliable and valid SST is unavoidable. Therefore, the validity of the SST should be analyzed which is the main goals of this study.

1.6. Definition of Key Terms

1.6.1. Content Related Definitions

1.6.1.1. Biology Achievement

According to Haladyna (1997) achievement is defined as the cognitive behavior which easily changeable. Those cognitive behaviors can vary from simple memory of facts to more complex types of thinking. There are two basic types of achievement, knowledge, and skill.

By OSYM, biology achievement is not defined but it is cited that students are asked to reveal their reasoning ability by using the basic concepts and principles of natural science subjects which also includes biology (OSYM, 2004; OSYM, 1984 cited from Berberoğlu, 1996). Therefore, the definition of biology achievement for this study is determined as the ability to make reasoning by using the basic concepts and principles of biology subjects.

1.6.1.2. Content Type

The content of any program or assessment frameworks have been categorized in various ways. Among them, Haladayna's general approach of categorizing the content of an assessment framework as facts, concepts and principles seem quite suitable for a science test. Thus, in the present study, this categorization was used in the content analysis. Haladayna (1997) categorizes content types as:

Facts: are undisputed basic knowledge, like water boils at 212 degrees Fahrenheit at standard atmospheric pressure.

Concepts: are classes of objects or events which have common set of defining characteristics, like plants need water.

Principles: are used to explain the relationship between concepts, like cause and effect relationship, relationship between two concepts, laws of probability and axiom.

Procedure: consists of sequential mental or physical act to achieve a result.

1.6.1.3. Cognitive Processes

Categorizing the cognitive processes is rather a more complicated task. In 1970s behavioristic approach was a general theoretical framework for any educational assessment. In this respect Bloom, Engelhart, Furst, Hill, and Krathwohl (1956) categorizes cognitive processes as knowledge, comprehension, application, analysis, synthesis, and evaluation. On the other hand, cognitive approach does not consider a hierarchical structure of the cognitive processes. It rather considers cognitive processes under different groups of constructs. Marzano et. al. (1988) name cognitive processes as core thinking skills and classifies as focusing skills, information gathering skills, remembering skills, organizing skills, analyzing skills, generating skills, integrating skills, and evaluating skills. Additionally, Marzano and Kendall (2007) categorize cognitive processes as three systems of thinking. First system, called cognitive system, consists of retrieval, comprehension, analysis, and knowledge utilization. Monitoring, evaluating, and regulating the functions of all other type of thought are in the responsibility of the second system, called metacognitive system. Finally the third system, called self-system, consists of interrelated arrangement of attitudes, beliefs, and emotions. Even though the two approaches seem different, both Bloom and Marzano talk about and define the same skills for the cognitive processes.

In the present study the following cognitive skills were defined and used in the content analysis based on Bloom et.al and Marzano et. al.'s approaches. For this study all of those cognitive processes were interpreted and categorized as:

Remembering: transferring stored knowledge to working memory.

Comparing: identifying similarities and differences of information.

Classifying: categorizing information according to established criteria.

Ordering: determining the sequence of information according to established criteria.

Transferring: changing the form of the information.

Predicting: indicating the expected outcomes of given statement by the help of prior knowledge.

Analyzing errors: determining the errors of given information based on reasoning.

Inferring: identifying legitimate truth by the help of given information.

Generating: connecting stored and new experienced information to form new knowledge structure.

Specifying: deducing new applications from known generalization or principle.

Evaluating: making judgments on a given criterion or standard.

Generalizing: constructing new information by the help of stored or new experienced knowledge.

Additionally to the cognitive skills, science process skills are also crucial for science education (MoNE, 2006). According to Klopter (1971) traditional science courses focus on the knowledge of science facts, laws, theories, and technological applications. In modern science courses, main focus is given to nature, structure, and unity of science, and the process of scientific inquiry. In addition, the aim of the modern science courses shifted to discovery investigation which emphasizes the importance of skills used during scientific experiments. Those processes of scientific inquiry are categorized as observing and measuring, seeing a problem ways to solve it, interpreting data and formulating generalizations, and building, testing, and revising a theoretical model.

For the present study Klopfer (1971) process of scientific inquiry were analyzed. Than those processes were interpreted and categorized as science process skills in eleven main dimensions by the researcher:

Observing: collecting information by the help of senses.

Recognition of a problem: determining the problem which can be investigated experimentally.

Determination of variables: determining the changeable factors which can affect the problem.

Measuring: determining the dimensions of the observed phenomenon objects by using appropriate instrument.

Hypothesizing: stating an appropriate and reasonable statement about the problem.

Selection of suitable tests: choosing a series of experiments which verify the hypothesis logically.

Designing procedures: determining suitable instruments to test the hypothesis.

Interpreting data: organizing the findings of the experiments by creating tables, graphs, or diagrams.

Interpreting result: formulating a concrete statement which signifies result of the test.

Evaluating hypothesis: determining whether the result is corresponds with the result.

Formulating generalization: applying conclusions to new situations by generalization.

Before ending this section, the difference between cognitive processes and science process skills should be explained. Most outstanding feature of science process skills is they constructed on experiments while cognitive skills are constructed on conceptual understanding skills. As an example in both categorizations of skills interpreting has an important place. However, in inferring under cognitive skills are required to identify legitimate truth by given information. In science process skills, two skills require interpreting skill which are interpreting data and interpreting result. In these definitions students are required to make an experiment and interpret the experiments' data and results of the specific experiment.

In addition, it can be said science process skills are special to skills used in science experiments while cognitive skills are more conceptual in nature.

1.6.2. Statistic Related Definitions

1.6.2.1. Reliability

Reliability is the consistency of test scores when the same individuals are tested again under similar circumstances (Crocker& Algina, 1986).

1.6.2.2. Validity

Validity of a test gives how much the evaluation procedure serves to the desired aim (Gronlund, 1981). There are three types of validity:

Content-Related Validity: gives how well test measures a representative sample of the domain of tasks under consideration (Gronlund, 1981).

Criterion-Related Validity: is used to predict future performance or to estimate current performance on some valued measures other than the test (Gronlund, 1981).

Construct Validity: gives the extent to which test performance can be interpreted in terms of certain psychological constructs (Gronlund, 1981).

1.6.2.3. Factor Analysis

To identify the factors that statistically explain the variation and covariance among measurement instrument factor analysis technique is commonly used (Green & Salkind, 2008). For this study Exploratory and Confirmatory Factor Analysis techniques were preferred.

1.6.2.3.1. Exploratory Factor Analysis (EFA)

EFA is the technique used to identify dimensions that statistically explain the variation and covariation among variables (Green & Salkind, 2008).

1.6.2.3.2. Confirmatory Factor Analysis (CFA)

CFA is a statistically test which is used to acquire significance and validity of hypothesized model (Schumacker & Lomax, 2004).

1.6.2.4. Multiple Linear Regression Analysis

Multiple linear regression analysis is the statistical technique used to predict the contribution of the multiple independent variables linear combination on a dependent variable. For this study, stepwise multiple linear regression analysis was preferred.

CHAPTER 2

REVIEW OF RELATED LITERATURE

In this chapter, important points and major findings of studies in the literature related to this study are presented. Studies related to validity such as construct validity, content validity, criterion related validity, and cultural validity in the literature are introduced.

In addition to validity of biology items of SSTs the present study also concerns with the academic and non-academic factors contribution on biology achievement. Therefore, important points and findings of previous studies on this issue was analyzed and presented in the chapter.

2.1. Studies on Validity

In general, the aim of the assessment is to identify what cognitive behavior and content knowledge students have and by the help of this information deciding about the further education program or classroom instructions can be given. To achieve this aim "… what the test measures and how well it does so" (Anastasi & Urbina, 1997, p.108), which is called validity, should be known and be provided for every test. Gronlund (1968) emphasizes the importance of validity as "test scores are valid to the extent to which they serve the use for which they are intended" (p, 105). Briefly validity of a test gives how much the evaluation procedure serves to the desired aim (Linn & Gronlund, 1995).

In the literature validity is categorized as content-validity, construct-validity, and criterion-related validity (Anastasi & Urbina, 1997; Linn & Gronlund, 1995; Gronlund, 1968). Broadly content validity gives information about how well test measures a representative sample of the domain of tasks under consideration (Linn & Gronlund; 1995). Even though all standardized achievement tests should have high content validity in a general sense, there is not any simple statistical procedure for determining content validity (Gronlund, 1986).

Whereas criterion-related validity is used to predict future performance or to estimate current performance on some valued measures other than the test (Linn & Gronlund; 1995). Due to this reason, performance on a test is checked against a criterion, like designing another test to predict or estimate the performance of the students (Anastasi & Urbina, 1997).

Construct validity gives the extent to which test performance can be interpreted in terms of certain psychological constructs (Linn & Gronlund; 1995). To achieve construct validity of a test all factors which influence test performance and the degree of influence of each factor should be identified.

Even, most of the researchers category the validity Messick (1989, cited from Klassen, 2006) oppose this ctegorization and states that validity is a unitary concept. Hence, the validity does not vary, does not have kinds, it should be accepted as comprises with many aspects like face validity, construct validity, and so on. He also stressed that the most fundamental aspect of validity is construct validity.

Despite the importance of validity of the test there is not much research about tests validity (Klassen, 2006), though researches on the tests validity in the literature were summarized briefly.

2.1.1. Studies on Construct Validity

2.1.1.1. Studies on Construct Validity with Large-scale Assessment

Most extensive research on the validity of assessment was conducted by leadership of Hamilton, Nussbaum, Kupermintz and Snow. They conducted a series of researches with the goal of distinguishing dimensions of NELS:88 8th, 10th, and 12th grade science and mathematics exams. First study focused on the NELS:88 8th and 10th graders mathematics exams, second one aimed to analyze science exams of the same participants with the previous study. Next two studies also had the same aim but the third research was conducted by 12th graders on mathematics exam and the last one focus on the science exam of 12th graders. Since the aim of the present study was to analyze research on science education results of second and fourth studies on NELS:88 were analyzed.

In the study of NELS:88 Science Achievement to 8th and 10th Grade, which was conducted by Hamilton, Nussbaum, Kupermintz, Kerkhoven, and Snow (1995), the aim was to distinguish dimensions of students' performance in NELS:88 8th and 10th grade science exams, and modeling the ability development in these domains across the high school.

For this aim they used 24,600 8th grade examinees data from 1,052 schools, also another data was collected from same examinees when they were in 10th grade. For 8th grade exam 25 multiple-choice items were applied, and seven of the questions were dropped and replaced at 10th grade. The content of the test was so broad it was consisted of environmental, biological and physical sciences. To interpret the dimensions of the science tests the exploratory principal component factor analysis were conducted. At the end of the analysis researchers preferred to use three factor solutions for 8th grade and four factor solutions for 10th grade, because those solutions were more interpretable and also fit chi-squared statistical criteria.

As researchers cited, for 8th grade science subtest, items did not clustered on the basis of subject matter clearly. In first factor 12 items, which consisted of scientific knowledge that could easily be learned outside of school, were clustered together and this factor was named as Everyday or Elementary Science (ES). Distinctly than other factors, second factor items clustered according to subject matter. All of those items required knowledge of chemistry terms. To this end, this factor named as Chemistry Knowledge (CK). Five items which require manipulation of numerical equations, interpretation of graphs, or hypothesis formulation loaded in the third factor, Scientific Reasoning (SR). Rests of the four items were loaded in the fourth factor. Common point of those four items were they all involve formal scientific concepts and requirement to apply reasoning skills (Hamilton, Nussbaum, Kupermintz, Kerkhoven, & Snow,1995).

Distinctly than 8th grade test, 10th grade test identified in three factors as Quantitative Science (QS), Spatial-Mechanical Reasoning (SM) and Basic Knowledge and Reasoning (BKR). 12 items in first factor, QS, mainly related to areas of science which were mostly quantitative in nature. Five items involved interpreting diagrams or reasoning about physical systems loaded in the second factor, therefore this factor called Spatial-Mechanical Reasoning factor. Items loaded in ES in 8th grade mostly loaded in the third factor of the 10^{th} grade, Basic Knowledge and Reasoning (BKR) factor. All of the items in BKR were assessing knowledge of scientific concepts and some of them were assessing ability to apply concepts to simple reasoning situations (Hamilton, Nussbaum, Kupermintz, Kerkhoven & Snow, 1995).

As a further step Nussbaum, Hamilton, and Snow (1997) carried a further study to analyze the 12^{th} grade NELS: 88 test dimensions. In the test of 12^{th} graders five items were common with the 8^{th} and 10^{th} grade tests. One of the 10^{th} grade items was dropped and all other items were administered in 12^{th} grade test. Besides, two physics items were added. Sample of the research consisted of the examinees from the previous studies. Similarly with the previous studies the aim was to identify the dimensions of the science test and exploratory principal component factor analysis was run. The result of the analysis seemed like replication of the 10^{th} grade test. 8 items were loaded in the first factor, named as Quantitative Science (QS), five items were clustered in the second factor, Spatial-Mechanical Reasoning (SM), and 12 items were loaded in Basic knowledge and reasoning (BKR) factor. As it can be seen the names of the factors, dimensions of this test were exactly same with 10^{th} grade tests dimensions. However, there were some differences with the items of the factors. For example, three items from 10^{th} grade QS was seen in 12^{th} grade BKR factor. Although, some differences were revealed in general the factors were similar to each other. Due to this reason, researchers concluded that those two studies provide evidence of robustness of three dimensions, QS, SM, and BKR (Nussbaum, Hamilton & Snow, 1997).

Li, Ruiz-Primo and Shavelson (2006) conducted a study with TIMSS 1999 to describe and implement a framework for assessing science achievement. They had two main research questions. First, can the science achievement measured by the TIMSS 1999 items be decomposed as four types of knowledge? And the second one was constructed to identify whether students' instructional experiences affect their science achievement or not. Since the aim of the present study was similar with the first aim, only the first part of the study was analyzed in this part of the literature review.

As a first step four interdependent types of knowledge was categorized for science achievement, declarative knowledge or 'knowing that', procedural knowledge or 'knowing how', schematic knowledge or 'knowing why' and strategic knowledge or 'knowing when, where, and how knowledge applies' by the researchers. Then two coders identified item characteristics, according to task demands, cognitive demands, item openness, and complexity, of TIMSS-R science items and classified into knowledge types according to the four knowledge types. It was found that test assesses three of the four proposed types of knowledge, and none of the items were measuring the strategic knowledge. Additionally, approximately 50 % of the items focused on the declarative knowledge whereas the rest focused on procedural and schematic knowledge in a balance. As a further step, confirmatory factor analysis was used to confirm the underlying patterns of the model. Results indicated that the model obtained by the exploratory factor analysis, according to the knowledge types, exactly corresponded in the CFA analysis.

In addition, relationship between each pair of the three hypothetical knowledge factors was analyzed and a significant result was attained. Researchers explained this correlation between knowledge types as in three factors. Firstly moderately correlation could be accounted because different types of knowledge are interdependent aspects of science understanding that students can achieve. The second reason was proposed as an individual's general ability affects the performance on each item. Lastly, the format and the content of the items could be distributed in an unequal manner.

Besides, alternative models to knowledge type model were presented and analyzed in CFA such as one factor as general ability, two factors as format (multiple-choice and short answer), or three factors using the performance expectation framework by TIMSS 1999. Even all of those models also fit well, knowledge model was significantly superior to the other models. In brief TIMSS 1999 test distinguished as in different types of knowledge rather than the other item characteristics such as task demands, cognitive demands, item openness, and complexity.

By the aim of identifying the dimensional structure of a large-scale science assessment, by using nonparametric and parametric techniques, and determining whether a content-based or psychologically-based framework could be used to identify, define, and explain the dimensions underlined the SAIP Science Assessment administered in 1999 Leighton, Gokiert, and Cui (2007) conducted a study. Since the first part of this research matched by the aim of this present study only identifying the dimensional structure of a large-scale assessment with different techniques of the study was identified.

The aim of the SAIP Science Assessment is to define 8th and 11th grade (13 and 16 years old) Canadian students' knowledge and concepts of science, nature of science, and relationship of science to technology and societal issues. Test could also be categories according to domain of skills as conceptual, procedural, and use. SAIP Science Assessment is administered in a two-stage testing procedure. In the first stage of the test, test A, is given to the students which constitutes of moderate difficult 12 items. Then dependent on students score in test A students are routed to an easier second-stage test, test B, or more difficult second-stage test, test C. Since the test is administered in two different aged students and there are two different test documents, AB and AC, the data files were divided according to those criteria as AB-13-year-olds, AB-16-year-oldys, AC-13 year-olds, and AC-16-years-old.

As a first step of the analysis reliability of the four tests was analyzed by split half method and results showed that all tests are reliable. Then, to determine the dimensional structure of SAIP Science Assessment DIMTEST, DETECT, and exploratory factor analysis were used. The result of the DIMTEST gave that test has more than one dimension. Due to this result, to identify the number of dimension for the SAIP DETECT was used, but DETECT did not partition the items into consistent clusters because of the complex structure of SAIP. As a last step, exploratory factor analysis was conducted. The result of the exploratory analysis of the SAIP Science assessment indicated a multi-dimensional structure with a range of two to four factors. Therefore, six different models were determined to test in confirmatory factor analysis. Since SAIP data exhibit complex structure all of the models fit to the data. But the best fitted model was Lawson's hypothetico-deductive model. By this result researchers concluded that SAIP items have two different types of items, abductive and deductive.

2.1.1.2. Studies on Construct Validity with Performance Assessment

To analyze whether Nussbaum, Hamilton, and Snow's (1997) reasoning dimensions were unique only to National Education Longitudinal Study of 1988 (NELS:88) multiple-choice test or could those dimension be generalized to other multiple-choice tests and alternative assessments Ayala, Shavelson, Yin and Schultz (2002) conducted a study. They used 13 items from National Education Longitudinal Study of 1988 (NELS:88), 6 items from the Third International Mathematics and Science Study (TIMSS), and 11 items from National Assessment of Educational Progress (NAEP) items and they also selected performance assessment tasks as Electric Mysteries, Daytime Astronomy, and Aquacraft.

Since Nussbaum, Hamilton, and Snow's (1997) categorized reasoning dimensions of science achievement as basic knowledge and reasoning (BKR), quantitative science (QS), and spatial–mechanical reasoning (SM); researchers prefered to choice performance assessment according to those three dimensions. They selected Electric Mysteries performance assessment for BKR, Aquacraft for QS, and Daytime Astronomy for SM.

Even though 343 students were completed the achievement test, performance assessment tasks were administered to 35 students who were also completed the achievement test. As a result, researchers concluded that three dimensions of science assessment was not unique for NELS:88 and a moderate correlation between all dimensions were detected. Besides, in general performance assessments were highly correlated with other dimensions which indicated that those different science achievement measurements are convergence in some aspects of science achievement (Ayala, Shavelson, Yin & Schultz, 2002).

A case study was conducted to identify the validity of science performance assessment for English language learners by Shaw (1997). 96 elementary English learners from five different schools were applied four day assessment based activity on the physical science concept of heat transfer, called Rate Cooling Performance Assessment (ROC). ROC consisted of open-ended inquiry and hands-on investigation work. The aim of the Day 1 task was to elicit the students' abilities to interact with the other group member and function as a member of a team, so they were given a problem to solve it by group-work. Day 3 task aimed to find out the group productivity by allowing students to conduct a cookbook-type experiment. In Day 2 students were given opportunity to creating an experiment design, whereas in Day 4 students' were asked to analyzing data gathered by experiment. In Day 2 and Day 4 tasks the aim was to investigate how an individual student can perform after learning from group collaboration.

All of the data were gathered both with qualitative and quantitative techniques. Main aim of the research was to find out whether the sample assessment functioned as a measure of scientific literacy or English language proficiency. To this aim, the analysis of variance analysis was conducted with English language proficiency and science proficiency to identify their interaction. Result of the analysis showed that experimental procedures were significantly affected by students' level of English language proficiency, whereas science proficiency significantly affects graphs, calculations, and final question (Shaw, 1997).

To develop a valid and reliable instrument for assessing science process skills Marshall (1991) conducted a multitrait-multimethod (MTMM) construct validation technique. The main idea underlined in MTMM is, multiple measures of the same construct should be significantly correlated with each other, but less correlated with measures of other constructs. To implement this technique at least four instruments should be used. Two instruments measure the same characteristics, and the other two instrument measures the different characteristics then the first two tests should be used. For this reason, a multiple-choice test and performance-based instrument of Test of Basic Process Skills in Science (BAPS), which have same characteristics as aiming to assess science process skill, were used to assess trait of interest. Test of Logical Thinking (TOLT) and Bending Rods (RODS) Piagetian manipulation task were used to measure the different trait then interest. All of four instruments were applied to 151 7^{th} grade students. The result of this study revealed a high correlation between different forms of BAPS test. Correlation between BAPS multiple-choice test and TOLT test, BAPS multiple-choice test and RODS, and RODS and TOLT tests were all around .3, which shows a low correlation. Marshall concluded two statements with those results. One of them was, since the correlation between different forms of BAPS is high; those tests are valid in terms of construct validity. Other conclusion was, since both tests were assessing the same content, there would be no difference to implement students a multiple-choice test, which is less costly, than using performance assessment instrument.

2.1.1.3. Studies on Content Validity

To fill the gap of validity lack on science achievement tests O'Neil, Sireci and Huff (2003-2004) conducted a study with two state-mandated 10^{th} grade science assessments. The aims of their study were to evaluate the content and cognitive domain representation of a state-mandated 10^{th} grade science assessment and to evaluate the consistency of the tests with respect to the content and cognitive domain measured. As they stated, since they were not science experts, 10 at least four year experienced teachers were asked to interpret the similarities and differences among two assessments.

The results showed that Earth Space sciences, Life sciences, and Physical sciences were well represented on test, Technology was not congruence across years, and for both tests only 7% consisted of Inquiry, which was unsupported. In general, even though the content structure of the test was similar to each other, tests were favorable for only three of the five content areas, Earth Space sciences, Life sciences, and Physical sciences. Another finding of the study was lower level skills were measured by both of the two tests and there were consistency of those skills across two tests (Sireci & Huff, 2003-2004).

2.1.1.4. Studies on Criterion-Related Validity

Moody (2001) conducted a case-study on predictive validity, or called criterion-related validity. In his study he used the linear regression analysis between Key Stage 2 test, teacher assessments, Key stage 3 tests, and the National Foundation for Educational Research (NFER) Cognitive Abilities Test (CAT). The aim of the Key Stage 2 test is to assess English students Mathematics, English, and Science knowledge at the age of 11. At the age of 14, students take Key Stage 3 test which also has the same subjects with the Key Stage 2. On the other hand, CAT aims to assess cognitive skills of students more than their knowledge. For his study he used 131 students CAT data, Key Stage 3 test results, teacher assessment results in the year of 1994. Also he used 153 students' Key Stage 2, CAT, Key Stage 3, and teacher assessment results for the year of 1995. Correlation between English, Mathematics, and Science scores for all test were analyzed. Since the aim of present study was to give information about researches conducted on science education, the results related to science was analyzed.

For both years the average CAT score and the average Key Stage 3 tests were significantly correlated whereas no significant correlation found between average Key Stage 2 test and average Key Stage 3 or teacher assessment results. Additionally, no statistically significant correlation found between Key Stage 3 science tests, Key Stage 2 tests, CAT average scores, and teacher science assessments in all years. According to those results, researcher concluded that average CAT scores and average Key State 3 scores can be used to predict performance of a student on another test, but any of those science tests cannot be used to predict another science tests. Due to this reason, those tests were not valid from the aspect of criterion-related validity.

2.1.1.5. Studies on Cultural Validity

Solano-Flores and Nelson-Barber (2001) introduced another aspect of validity which is called cultural validity. They stressed that culture and society has a critical role in cognitive development because learning occurs at school and informally in society. Both of the learning environments affects the way of individuals making sense and solving science items. In their study they demonstrated that, to improve the assessment quality students' epistemology, language proficiency, cultural world views, cultural communication and socialization styles, and student life context and values should be regarded.

Figure 2.1:
NAEP (1996) Erosion Item
(as cited in Solano-Flores and Nelson-Barber, 2001, p. 558)

One of the impressive examples for the study was on students' epistemology. A 4th grade Latino girls was given two pictures seen in Figure 2.1 and asked which of the picture shows the view of the mountains and river for today and which one is for millions of years ago. She selected the alternative B as the view of mountains for today, which was the wrong answer. During the interview, she was asked to explain her answer and it was understood that she answered the item by her daily life experiences not with her knowledge gained from school. She uttered that only mountain she had seen was similar with the one in picture B. They also provided examples for the other four areas of cultural validity.

With the results of these studies present study aimed to analyze content and construct validity of 2006, 2007, and 2008 SST biology items by content analysis, principal component analysis and confirmatory factor analysis.

2.2. Factors Effecting Biology Achievement

2.2.1. Effect of Academic Factors on Biology Achievement

2.2.1.1. Effect of Reading Comprehension on Biology Achievement

The relationship between reading comprehension achievement and science achievement has been studied over the last few years and there is not any research conducted on biology achievement and reading comprehension achievement. Due to this reason, studies conducted with science achievements were interpreted for the present study.

To identify the correlation between scientific literacy and reading literacy Cromley (2009) conducted a study. PISA 2000, PISA 2003, and PISA 2006 data sets across countries used to obtain the reading-science relationship. For the first study 172, 896 fifteen-year-old students from 43 countries selected by two-stage sampling method from 15,959,166 students. Reading test was administered which composed of five aspects as measure information retrieval, broad understanding of information, interpretation development, content reflection, and form reflection. Science test had three dimensions as grasping scientific concepts, engaging in scientific processes, and application of science. Result of the study showed that correlation between reading and science scores was very large with the coefficient of .840.

Same methods were applied for PISA 2003 test. 276,192 fifteen-year-old students from 41 countries were sampled from a total of 19,155,864 students. The instrument used in PISA 2003 was slightly different than PISA 2000. Reading test were designed to measure searching for information and interpretation and evaluating texts, whereas science test covered key concepts such as biological diversity, motion, and physiological change drawn from biology, chemistry, Earth science, physics, and technology. Similarly with study one, high correlation between reading comprehension and science proficiency found, with a mean correlation of .805.

Third study was conducted by PISA 2006 test with 389,750 fifteen-year-old students from 57 countries and same steps as in previous studies conducted. Reading and science test were little modified to clearly distinguish between scientific literacy and reading literacy by decreasing the reading parts of science test. Although, the test consisted of less reading than previous PISAs, on PISA 2006 same high correlation between reading comprehension and science proficiency found with a mean of .819.

By those high correlations between reading comprehension and science achievement score Cromley (2009) explained three possible explanations as reading comprehension causes science proficiency, science proficiency causes reading comprehension, or a third factor cause both reading comprehension and science proficiency. Researcher cited that the first explanation was most intuitively appealing to interpretation because reading comprehension should lead to good understanding of science texts and tests. Another finding is, strengthens this interpretation, it was found that when the reading comprehension score got higher in a country, the correlation between reading and science proficiency also got higher.

To find out what is the nature of the relationship between the reading achievement and the science achievement of fifth grade students test Ratliff (2007) conducted a study by using the Texas Assessment of Knowledge and Skills (TAKS) as the research instrument. The participants of the study were administered either the English versions of the reading and science TAKS tests, or both the Spanish versions of the reading and science TAKS tests. To estimate the relationship between reading achievement and science achievement Pearson product-correlation technique was used in both English and Spanish versions of the test. The result of those analysis revealed that there was a moderate to strong relationship exists between variables no matter with the language of the tests. Due to those finding, Ratfill (2007) cited that science achievement is influenced by a student's reading achievement and those tests may not be a valid instrument to assess students' science knowledge but a good instrument of assessing combination of both their reading and science ability.

To examine how well cognitive abilities predict high school students' science achievement O'Reilly and McNamara (2007) conducted a study by assessing students' science knowledge, reading skill, and reading strategy knowledge. 1,651 students from four high schools in three states were selected as the sample. The dependent measure of science achievement was assessed in terms of comprehension of science passage, students' science course grades, and a statewide measure of students' science achievement. Besides science knowledge, reading skill, and knowledge of metacognitive reading strategies were determined as the independent variables.

Result of the study revealed that both science knowledge and reading skills had moderate to high correlations with the science achievement measures. Besides, there was a significant correlation between metacognitive reading strategies but it was not as high as the science knowledge and reading skill correlations. Furthermore, the relation between science knowledge and reading skill with comprehension of science passages was analyzed by multiple-choice and open-ended comprehension questions. It was found that both reading skill and science knowledge reliably contributed to the model, whereas reading strategy knowledge was marginally significant. Afterward, whether reading skill improved achievement for both lower and higher science knowledge students was also analyzed. It was found that reading skill is greater for higher knowledge participants, and it had a broad impact for lower knowledge students as well on science achievement.

In summary, in all studies moderate to high correlations were found between reading comprehension and science achievement of the students which leads us to Ratfill (2007) citation, with science achievement tests we cannot evaluate students' science achievement purely. Those tests gives us the combination of students reading comprehension and science achievement.

2.2.1.2. Effect of Physics, Chemistry, and Mathematics Achievement on Biology Achievement

In some studies the relationship between physics, chemistry, and mathematics with biology achievement was analyzed separately. On the other hand, in some studies these relationships were examined together. Due to this reason, for this part of the thesis all of those studies gathered together in the same title.

The importance of physics and chemistry in biology brought forward firstly by "Physics First" movement, which emphasizes that physics should be taught in the first year of high school follow by chemistry and then biology. This teaching sequence of the courses defended because it is thought that physics is a need for chemistry and biology while chemistry is a need for biology to achieve and understand deeply those sciences.

After the "Physics First" movement in the USA Sheppard and Robbins (2003) analyzed the history of American high school science sequence. In late 19^{th} century and early 20th century physics and chemistry priority of chemistry and biology was obscure, whereas biology thought before chemistry and physics. The sequence of science courses was biology-physics-chemistry (BPC) or biology-chemistry-physics (BCP). Even though, there was a clear preference for placing physics before chemistry among educators, students preference of BCP sequence was higher. Besides, chemists also supported the idea of teaching physics before chemistry because physic was a prerequisite of chemistry in most of the chemistry concepts (Smith & Hall, 1902; cited from Sheppard & Robbins, 2009).

According to Lederman (2005) science should be thought in a sequence of physics-chemistry- biology because of the hierarchical nature of the science. He explained the reason of this idea by some simple examples. One of those examples was, physic studies atoms and the basic principles of atomic structure which should be used to explain the gas laws, the periodic table, the chemical behavior of elements, or the formation of compounds-molecules. Later on, the knowledge of structure in the behavior of molecules is crucial to molecular biology.

Meanwhile, there have been some other studies which suggest that chemistry and physics should be given before biology. One of them was conducted by Haber-Schaim (1984; cited from Lederman, 1998). Two popular high school biology texts selected and searched for the need of chemistry and physics knowledge for biology. Then some concepts like photosynthesis, activation energy, catalysis listed which give that the idea of chemistry is a prerequisite for, biology. Afterward some chemistry textbooks searched to find physics prerequisite in chemistry such as atomic size, energy level transitions, and radioactivity. Those searches leaded Haber-Schmaim a conclusion, physics is prerequisite of chemistry where they both are prerequisite of biology. If students have inadequate physic and chemistry knowledge then they would be forced to memorize some concepts even in biology which also would prevent to learn science like scientists learn science.

Lederman (1998) defended that science should be studied as physics knowledge applied to chemistry and biology, and chemistry knowledge is applied to biology. Matter, energy and organization in living systems content was chosen to explain the importance of chemistry for biology. All energy used by living systems comes from the sun through its electromagnetism where energy transformation can be explained by chemical concepts. Due to those reason, Lederman (1998) emphasized that in the first year of high school physics should be taught, chemistry should be taught in the second year and biology for the third year of the high school. However, he also suggested that first year curriculum should built blocks for the chemistry and biology year where chemistry curriculum should built blocks for biology year.

The importance of biological concepts such as genetics, evolution, metabolic processes, and ecosystems with physics was also pointed out by Berthelsen (cited from Özcan, 2003). This importance related with the reasons of misconceptions in biological sciences. According to Berhelsen, students misconceptions in those biological concepts derived from students physical science misconceptions. To deepen, her view she cited that students conceptualize that living things are made up of cells, but they do not have the concept that cells are made up of atoms and molecules. In addition, same relation should be done by food web, photosynthesis and respiration, and the concept of conservation of energy. By the help of that information she concluded that the lack of prior knowledge in chemistry and physics contributes to low achievement in biology. Similar to her, Liras (1994; cited from Özcan, 2003) denoted that biology must be understood as a complementary discipline to other sciences providing formal thought which can then be transferred to other knowledge areas. Özcans' (2003) study also revealed that teachers have the same opinion. In her study teachers also cited that students had difficulties to relate biology concepts with other disciples. With those statements and opinions Özcan (2003) concluded that one of the reasons for students' difficulty in biology can be derived from the inappropriate sequence of topics in biology curriculum.

Özcan (2003) analyzed the reason of students' low achievement in biology according to university entrance examination between the years 1996-2002. To this aim she explored students' and teachers' perceptions with respect to biology education at high school level. Data were collected with qualitative approach from 45 high school biology teachers and 45 eleventh grade science students in 10 private, Anatolian and public high schools by two separate interview schedules. Even results gave some other explanations for the low biology achievement for this study only the responses which attribute the low biology achievement to physics, chemistry and mathematics were analyzed. One of the teachers in the study directly cited that student's difficulties biology topics was related to other science courses. This assertion was supported with an example. It was indicated that photosynthesis and respiration is related to both physics and chemistry. Another teacher also cited the same example and explained the difficulty as students gaps between disciplines. In addition, another example was given from organic molecules and students' difficulty for this topic was associated with not learning organic chemistry before teaching students organic molecules. This sequence of teaching science leads students to memorize concepts about organic molecules. Teachers were also asked whether they relate biology with other disciplines during teaching process. One of the teacher cited that she relates biology with chemistry and physics. Besides, she indicated that in previous years she did not have adequate knowledge on other disciplines and she compensated her missing knowledge by taking special courses from physics and chemistry teachers. Researcher concluded that teachers relate biology especially with chemistry for example in teaching nervous system and photosynthesis. On the other hand, in students' interviews none of the students mentioned the importance of other disciples in learning biology. In summary, researcher concluded that most of the concepts in biology are closely related concepts both in chemistry and in physics.

Ma and Ma (2005) examined the relationship between growth in mathematics and science achievement, to explore whether students who grew in mathematics achievement also did so in science achievement and what students and school characteristics influences this consistency. For this study 2215 7th grade students from 52 schools (approximately 60 students from each school) randomly selected and students were followed for six years till 12th grade by Longitudinal Study of American Youth program (LSAY). All of the 2215 students were asked to complete a student questionnaire annually. In addition, information about students and school characteristics were collected from parents and teachers. For academic achievement of the students seven variables collected (basic skills, algebra, geometry, and quantitative literacy for math score and biology, physics, and environmental sciences for science sore) every year by LSAY achievement tests. By that information, a multivariate multilevel model with latent variables to estimate the consistency of growth between "true" mathematics and science achievement were modeled.

Result of the study revealed that students on average made progress through grade 7 to grade 12 in both mathematics and science achievement during middle and high school. On the other hand, standard deviations for mathematics and science achievement also increased in most of the 7 subject which showed that achievement gap among students as well increased across levels in mathematics and science. Even students' achievement increased on average 5.14 and 3.10 in mathematics and science respectively, both student and school characteristics did not have significant effect on achievement. Afterward Ma and Ma (2005) examined the relationship between the rates of growth in mathematics and science. It was found that the correlation between those growths was moderate, because the *r* value was 0.58, among all 52 schools.

Other known studies on biology achievement and other science areas were conducted by college biology courses. To identify the effect of students' high school preparation for college biology course 1735 college students information about number of years of biology in high school, number of years taking chemistry course in high school, achievement in biology and in chemistry in high school, degree of liking high school biology, the kind of high school biology, whether or not they had laboratory block, whether or not they had Advanced Placement, SAT scores, performance in various measures of college biology, college grade point average, cognitive performance and attitudes during the years of the study were collected by Tamir (1969). Correlation coefficients among variables in both fall and spring semesters were computed. Analysis revealed that academic achievement in biology was generally explained by cognitive variables whereas attitudes and interests had low correlation by academic achievement with some exception. It was also found that having no biology in high school was a district disadvantage for college biology. But, interestingly, having chemistry was as important as having biology at highs school for college biology.

Loehr (2005) also designed a study to investigate the relationship between students’ achievement in introductory to biology course at college and students’ high school biology preparation and mathematics experiences. A survey with 66 questions were administered to the 7,617 students to have information about demographic factors, student educational background factors, and specific pedagogical factors from students’ last high school biology course. Sample of the research was selected randomly from the four-year colleges and universities throughout the United States. The outcome measure of the study was selected as students’ final introductory biology course grades. For the predicted variables high school science course taking, high school mathematics course taking, high school biology content, and laboratory experiences were selected. Race/ ethnicity, gender, student academic ability, year in college, prior academic achievement, socioeconomical status, high school environment, public/private designation, college or university designation, college or university selectivity, college or university size, and percent of in-state students were controlled for as the extraneous variables. In the analysis Multi-Level Modeling with SAS was used. Findings about the effect of high school mathematics course on the introductory biology course achievement revealed that only significant difference in introductory biology course achievement was observed between students who enrolled in high school Calculus courses as part of high school. On the other hand, taking AP Calculus AB, and taking AP Calculus BC did not have any effect on introductory biology course achievement. Besides, taking greater number of Honor

Level science, AP Biology, and AP Chemistry courses earned higher grades in introductory biology course than peers who did not take these courses in high school.

Nagy, Trautwein, Baumert, Köller and Garrett (2006) conducted a study to reveal the relation between domain-specific achievement, self-concept, intrinsic value, and advanced course selection in mathematics and biology academic choices in upper secondary school. 1,148 students were tested at the end of 10th grade and in the middle of 12th grade. Students' mathematics achievement scores were taken from the First and Second International Mathematics Study and the Third International Mathematics and Science Study. Second International Science Study and the Six Subjects Survey were used to determine students' biology achievement score. In addition to those scores, students' domain-specific self-concepts of ability, intrinsic value of mathematics and biology, and course level in mathematics and biology attained by different tests. Even the study had a different aim than this thesis also relation between mathematics and biology achievement was analyzed. Construct correlation based on the confirmatory factor analyses showed that there was a significant positive correlation between mathematics and biology achievement of the students, with .31 of r value ($p < .01$).

To determine whether there is a difference in terms of mathematics and science achievement in different sequences of high school science courses Williams (2009) conducted a study. Course sequence comparisons were made between the honors and regular students in the Physics First program (PCB) and traditional science program (BCP). EXPLORE, PLAN, and ACT and ISBE Developed Science tests were used to determine students' academic performance in science and mathematics. EXPLORE was administered in the fall of 9th grade, PLAN was administered in the fall of 10th

grade, and ACT was administered in the spring of 11th grade. 1,150 students were selected as the subject of the study. One of the aims of the study was to identify whether there are between-groups (honors and regular biology; honors and regular Physics First) differences on standardized, secondary academic measures of science achievement. Moreover, another aim was to identify whether there are between-groups (honors and regular biology; honors and regular Physics First) differences on standardized, secondary academic measures of math achievement. Even researcher analyzed those differences in terms of gender differences those results did not analyzed for this thesis. Honors Biology students study honors Biology in 9th grade, Honors Chemistry in 11th grade and honor physics in 11th grade, where regular biology students got the same course sequence but in regular forms. Honors physics first students got honors physics course first in 9th grade, honors chemistry in 10th grade and, advanced placement of biology or honors biology in 11th grade. On the other hand, regular physics first students got physics course first in 9th grade, chemistry in 10th grade and biology in 11th grade. ANOVA analysis technique was used for the study. Result of the study revealed that there is no significant difference between the groups and each academic measure; however, there was a significant difference between students who experienced a Physics First sequence, either honors or regular, compared to students who experienced the traditional science sequence in terms of their growth in science reasoning skills as measured from ninth to eleventh grade. For mathematics achievement no significant effect of science sequence was found; however, there was a significant difference between honors students and regular students. Honors students also had higher gains in math achievement compared to regular students.

To determine whether there is a significant difference in General College Biology achievement according to taking elementary high school chemistry, elementary high school physics, high school algebra (Math-12), high school trigonometry (Math-14), high school analytic geometry, and calculus (Math-114) courses and attending extracurricular high school science activities Johnsten (1967) conducted a study. General Biology achievements of the students were attained by Advanced Placement Biology Examination which was given as pretest and posttest. 680 freshman and sophomore general biology students were selected for the study and in addition to Advanced Placement Biology Examination, they were also administered a survey to collect other information needed for the study such as their high school and college courses in science and mathematics, year they had high school biology and their participation in extracurricular science activities.

Results of the study revealed that students who had taken elementary high school chemistry course and college chemistry courses had statistically higher grades in college biology than students who had taken elementary high school chemistry course but not college chemistry courses. In addition, students who had taken elementary high school chemistry course got statistically significant higher grades in college biology than students who had not taken any chemistry course. Same finding was found in also physics which is, taking high school physics increases the success in college biology. For the effect of taking mathematics in high school on college biology was analyzed by three different mathematics courses at high school (Math-12, Math-14, Math-114). For all of those three mathematics courses statistically significant differences were found with biology achievement. Students, who took

Math-114, in other word who took three or more years of high school mathematics, got highest score than students took Math-14 and Math 12, respectively.

Watkins, Hall, Redish, and Tod (2010) investigated students' views on the role of physics and mathematics in undergraduate introductory biology courses. The brief summary of the biology course (Organismal Biology) was explained by the researchers as learning fundamental principles governing the diversity, structure, and function of all organisms. For the study two researchers observed the lecture during the semester and write descriptive narratives and rough transcriptions of the instructors' presentations. Filed notes were also collected which concentrated on how the instructors presented the use of physics and equations in the context of the biology. Besides, eleven students were interviewed through the semester on their different conceptual and epistemological issues of the course as found in the field notes. In the field notes it was written that instructor used diffusion equation and emphasized the importance of effect of changing a variable on the equation.

$$\mathrm{J} = -\mathrm{D}\frac{\Delta C}{\Delta x}$$

J =the diffusion rate

D=the diffusion coefficient

ΔC=the change in concentration

Δ*x*=the distance.

Figure 2.2: Diffusion Equation

Then instructor asked students what happens to the rate of diffusion when a change is made to the biological system. Researchers explained this field note as the proof of the importance of physics in Organismal Biology course. After the analysis of the field notes in the interviews, students were also asked to explain their thoughts on the use of equations in the course and the role of equations in biology. One of the students cited a negative response for using equations in biology because she did not want to think biology in terms of numbers and variables. Even her response showed a negative attitude she also accepted the relation of biology with physics and calculus because she cited that she felt that the course like physics or calculus course. Another student, May, responded to the question as she saw equations as an assist to understand the specific aspect of life as a scientist. Researchers emphasized by this response May made a distinction between scientists, unlike the differences between physics and biology that other student brought up. This also gives the importance of physics in biology. With those results Watkins et. al. (2010) concluded that efforts should be done to integrate physics and mathematics into biology courses is a requirement which could be done by the collaboration of biologists, physicists, and other scientists.

As a summary, all of the studies discussed above reveal that there is a relationship between students' biology achievement and other academic achievements. When the relation between those factors and biology achievement compared to each other it can be concluded that chemistry is the most effective factor than physics and mathematics.

2.2.2. Effect of Non-Academic Factors on Biology Achievement

2.2.2.1. Effect of Gender on Biology Achievement

Hacıeminoğlu, Yılmaz-Tüzün and Ertepınar (2009) conducted a study to identify the relationship among students' learning approaches, motivational goals, previous semester science grades, and their science achievement with the effects of gender and Sociodemographic variables (SDV) on students' learning approaches, motivational goals, and their science achievement. For this thesis, findings about the difference between students' science achievement and gender were analyzed.

A Science Achievement Test (focuses mostly on atomic theory), a Learning Approach Questionnaire and an Achievement Motivation Questionnaire were administered to 416 seventh grade Turkish students. Results of the study revealed that there is a significant main effect of gender on students' science achievement which favors girls. Additionally, the effect of gender on science achievement was much higher than socio-demographic variables such as family income, mother educational level, and father educational level.

To identify whether hands-on science performance assessment has an effect in scores among gender and racial/ethnic groups Klein et.al. (1997) examined science achievement of 2,400 students from 90 classrooms across 30 schools (fifth, sixth and ninth grade) by both performance assessments and traditional multiple-choice tests. Besides, whether certain types of performance tasks are more likely than others to affect these disparities and whether these results are consistent across grade levels was also analyzed. All of those tasks and tests were selected according to the grade levels of the students. Scoring of the hands-on performance task was done by a team of readers, which has 5 to 16 readers. No significant difference in mean scores between readers was found and the median correlation between two independent readers on a shellbased tasks was 0.95.

As the result of the analysis it was revealed that sixth grade girls had slightly higher performance assessment scores than boys even though girls and boys had nearly identical distributions of multiple choice science tests. On the other hand, this difference in performance assessment in grade five and nine was not statistically significant. Only on grade nine multiple choice test boys had significantly higher mean scores than girls. Correlation among the measures at each grade level was identical in girls and boys.

Nowell and Hedges (1998) indicated that there is an agreement in the literature that females have slight advantage on average in verbal abilities and males have advantage in average in mathematics. Due to this reason, they conducted a meta-analysis study with seven surveys (Project Talent, Equality of Educational Opportunity, the National Longitudinal Study of the High School Class of 1972, both the 1980 base year senior cohort and the 1982 follow-up of the 1980 sophomore cohort of High School and Beyond, the National Longitudinal Survey of Youth, the 1992 follow-up to the National Education Longitudinal Study of the Eighth Grade Class of 1988, and all waves of the National Assessment of Educational Progress) to identify the gender differences on academic achievement. It was found that on mathematics and science tests males had higher score than females, especially in NAEP but this difference was not valuable. Additionally to this result, the difference in extreme score according to gender was identified. It was detected that males are overrepresented in the upper tail and females were overrepresented in the lower tails of the science score distributions. Nowell and Hedges (1998) cited that even though this study explained the gender differences in academic achievement it does not provide any explanation about the underlying reason the differences. However, they asserted that the difference might be caused from socialization.

Harker (2000) investigated the gender differences in English, mathematics and science achievement in 37 secondary schools of New Zealand. Besides, another aim of the study was to seek the gender differences in coeducational and single-sex schools. Data from The Progress at School project was used, which is a longitudinal programme to investigate the effectiveness of New Zealand secondary schools (Nash, 2001) and those students' school certificate results were also used in the study. It was found that girls in New Zealand were highly achieved that boys in English, Mathematics, and Science. Then, difference of gender in science was analyzed in chemistry, physics, and biology separately. In chemistry and biology girls got higher scores than boys, but in physics difference was higher than chemistry and biology where the ratio in favor of boys. Another finding of the study was, which is more intriguing, girls at the single-sex schools scored higher than the girls at coeducational schools according to English, mathematics and science scores.

To explore the students' achievement in photosynthesis and respiration in plants with relation to their reasoning ability, prior knowledge, and gender Yenilmez, Sungur, and Tekkaya (2006) conducted a study. One of the aims of the study was to investigate whether the mean achievement scores for students with different reasoning abilities are same or different in the units of photosynthesis and respiration in plants. However, this aim does not have any relation with the aim of the thesis. Other aim of the study was to find out the best predictors of achievement in the units of photosynthesis and respiration in plants. To achieve the goals 117 eighth-grade students (59 female, 58 males, mean age = 13.5 years) who mostly come from middle-class families were selected. Besides, same content was taught by the same teacher. Data was collected by two instruments, responses to the two-tier diagnostic test, and responses to the test of logical thinking. Even though, this study explored more evidences then gender differences in photosynthesis and respiration in plants unit, findings with this relation was focused for this thesis. First of all results of the two-tier test gave that girls outperformed than boys. However, when the mean scores of the students were analyzed it was found that even, statistically significant difference in gender to achievement was observed, it did not give a large difference among achievement scores.

Huppert, Lomask, and Lazarowitz (2002) conducted a study to reveal whether computer simulation's has an impact on students' academic achievement and their mastery of science process skills in relation to their cognitive stages. With this aim 181 students from five 10^{th} grade classes were divided into two groups, experimental and control groups. Computer Assisted Learning mode of instruction, with a combination of classroom teaching, laboratory experiments, and computer-simulated experiments were implemented to experimental group with a computer simulation program 'The Growth Curve of Microorganisms'. Meanwhile, traditional classroom and laboratory methods were used in control group. The content of the instruction in both groups was the characteristics of the microorganisms, their structure, the life processes, and their uses in daily life in industry and medicine. In addition to the difference in students' achievement in Computer Assisted Learning mode and traditional methods, the difference in gender in both types of instruction was also analyzed.

Four instruments were used in the study. Firstly a pre-test was administered to all students, which includes 40 multiple choice questions: 30 were on general knowledge in biology and 10 questions were about previous knowledge on the topic of the growth rate of microorganisms. Then as a post-test 15 multiple choice and five essay questions were asked to students to analyze students' knowledge on the population growth rate of microorganisms mastered during the learning process related to the topic of microorganisms in instructions. Besides Video-Taped Group Test with 12 tasks test was administered to students to determine their cognitive stages. Finally, by Biology Test of Science Processes students science process skills was also investigated.

In pretest no significant difference was found between females and males; within each group and between the groups. However science process skill of girls in transitional stage in the experimental group was statistically higher than the girls in control group in transitional stage. Besides, males in experimental group and concrete stage had statistically higher score than the males' counterparts in control group. Finally, there were higher scores in all other experimental group than control group (concrete stage-girl, transitional stage-boy, formal stage-boy, and girl) but those differences were not statistically significant.

Briefly, in terms of gender difference on science and biology achievement, there is an inconsistency between the results of in those six studies. However, most of the studies revealed that girls got higher scores than boys in both science and biology.

2.2.2.2. Effect of Age on Biology Achievement

In almost all education systems there is a persuasion that for school eligibility there is a single cut-off date to allow a child to enter a kindergarten which is 5 year-old. This idea brings an opinion that oldest students are likely to be substantially more mature than the youngest students which is known as relative age effect. In addition to this Heckman, Cuhna, Heckman, Lochner, and Masterov (2006; cited from Bedard and Dhuey, 2006) cited that skills accumulated in early childhood would directly affect later learning of the students. Relative age differences at the start of formal schooling may be long-lasting, if relatively older students have more skills in the early grades because of their maturity advantages. To identify whether there was still an effect of age in higher grades of mathematics and science achievement Bedard and Dhuey (2006) compared the test scores of children with older and younger assigned relative ages at the different grades and with different examinations. 1995 and 1999 Trends in International Mathematics and Science Study (TIMSS) and National Education Longitudinal Study (NELS) data for the United States was used for both fourth and eighth graders. 2,857 students from 10 countries for third and fourth graders and 18 counties for seventh and eighth graders, who indicated their demographic information such as day of birth, was used for 1995 and 1999 TIMSS examination. 15,155 students selected for the analysis of NELS among eighth graders.

Results of the study revealed that youngest students score substantially lower than the oldest students at both fourth and eighth graders in both mathematics and science achievement. Youngest fourth grade student's score was 1.2 to 3.5 points lower than the nationally standard score among 19 OECD countries. This mean difference corresponds to 4-12 percentiles difference among youngest and oldest students. The difference between the youngest student and nationally standard score was 0.8 to 2.6 point difference, which corresponds to 2-9 percentile difference, for eighth grades. Those results showed the persistence of relative age effect among adolescence.

Like Bedard and Dhuey (2006), Langer, Kalk and Searls (1984) also investigated the change of achievement among students at 4, 8, and 11 grades from National Assessment of Educational Progress (NAEP) achievement data in mathematics, science, and reading achievement. However, only 97,000 Caucasian and 17,000 black 9-, 13-, and 17- year-old students were selected for the study. Data were analyzed by stepwise multiple regressions. For both Caucasian and black 4th grade students older students had higher scores than the younger students', with somewhat steeper slopes for blacks. The difference between young and old Caucasian students at 8th grade was still obvious but the difference was not as higher as in the 4th grade. Even, this difference was disappeared by the 11 graders. For black students the difference between young and old students did not decrease at 8th grade but it also disappeared at age 17.

Lyons-Shenk (2006) thesis also focused on the difference of age on academic achievement but on college students. She also sought the effect of family educational backgrounds and academic self-efficacy of the students, for the present study only the results of the effect of age on academic achievement were investigated. 166 college students from a large state university or a community college in New York State were selected for the sample of the study with a mean age of 22.04 and mean GPA of 3.08. About the effect of age on academic achievement it was found that non-traditional age students (older than 24-year-old) had higher GPA than traditional age students among all schools and at the community college level, but, only statistically significant result was obtained from the community college. Yet, university school traditional age and non-traditional age students GPAs were same, 3.24.

To identify the contribution of age, gender, verbal reasoning ability, and mathematical reasoning ability on success of science course Gustin and Corazza (1994) conducted a study. 765 the Center for Talented Youth courses in biology, chemistry, or physics during the summer of 1988, 1989, and 1990 participants were selected. Students' pretest, posttest scores, and demographic information were used for the analysis. Because of the high correlation between pretest and posttest scores two regression analysis were conducted. In the first analysis age, gender and the Talent Search SAT score were used, whereas in the second analysis all of the first analysis variables with pretest were used. Before conducting the regression analysis, correlation among variables were checked and it was found that, interestingly, correlations with Scholastic Aptitude Test verbal scores (SAT-V) were stronger than SAT-M scores. For both regressions analysis student age was not found as an important factor for science achievement, but there was a tendency for older students to have higher scores on the posttest in biology and chemistry with significant correlation but low proportion of variation in the posttest, r^2 was 0.018. On the other hand, verbal ability had more contributions on understanding science achievement than mathematical ability, gender, or age, especially in biology.

Smith (1992) conducted an interesting study on the effect of age for science achievement. He designed a study to identify the gender difference on science achievement under the influence of age and parental separation factors for different races. 2,236 seventh and ninth grade students in 14 public schools were administered academic achievement tests and a questionnaire to have the non-educational information needed for the study. Because of using listwise deletion method the data decreased to 1,747 students. Even the aim of the study was to use science achievement as the dependent variable; overall achievement was also treated as a dependent variable in parallel analyses to compare science achievement with academic achievement in general by Comprehensive Tests of Basic Skills (CTBS). As the independent variable in the questionnaire information about gender, year in school (grade level), race, employment of the mother and parental separation was collected. Study had five hypotheses on the disadvantage of females in science achievement. First this disadvantage would be greater among ninth grade students (14 and 15 years old). Second hypothesis was, the disadvantage would be less among adolescents whose parents had separated than those live with their parents. The disadvantage of females would increase less with age among adolescents whose parents had separated than among those living with both parents was the third hypothesis. Fourth hypothesis was the disadvantage of females would be less among adolescents whose were employed full-time outside the home than among those whose mothers were not. The last hypothesis was disadvantage of females would increase less with age among adolescents whose mothers were employed full-time outside the home than among those whose mothers were not.

For the analysis, multiple regression analysis was chosen. Two different analyses were conducted. In the first regression analysis science achievement was used as the dependent variable, whereas in the second analysis overall achievement was chosen as the dependent variable. For this thesis only the result about science achievement was analyzed and indicated. Result of the analyses revealed that hypothesis 1 through 3 was confirmed significantly but hypothesis 4 and 5 were not significant. In summary, it found that among students who live with both parents females had lower achievement in science at the ninth-grade than at the seventh-grade level. Females who live with their both parents had an advantage in science achievement in seventh grade on contrary males who live with both parents had advantage by the ninth grade. Researchers also cited that the reason of having an advantage of males over females in science achievement at an earlier age, whose parents were separated, decreases in science achievement among female at an earlier age.

Çepni, Özsevgeç and Cerrah (2004) conducted a study to determine 7^{th} and 8^{th} grade school students' cognitive development level and to reveal the relationships between students' cognitive development levels and their profiles such as age, gender, and science achievement. 445 7^{th} and 8^{th} grade students at private and public middle schools from five cities of Turkey were selected randomly from their classes. Science cognitive development test (SCDT) which consists of 30 questions covering the motion and energy units in the middle school science curriculum was prepared. The aim of the SCDT was to differentiate the students according to their cognitive levels, concrete and formal operational stages. Besides, students' science achievement test results from each science teachers in the sample were obtained to define students' science achievement. Even though there were different findings of the study, only results which are associated with the aim of the thesis were analyzed. First important finding is private school students were more successful for both concrete and formal questions than their counterparts at public school since they gave more correct answer than the public school in both 7^{th} and 8^{th} grade levels. However, interestingly, no significant result found by the age and gender of the students' and their cognitive levels. In addition, significant difference found between cognitive development and science achievement. Also, researchers cited that socio-economic and cultural factors affect individuals' cognitive development.

In summary, like gender, there is inconsistency among results about the effect of age biology or science achievement. Some studies found that there is not any age effect on the achievement of the student, where some studies revealed that age is a statistically significant factor on achievement. Noteworthy result found by Langer, Kalk and Searls (1984), which obtained that age is a significant factor for lower grades (between 4th and 8th grade) solely the effect of age concealed in higher grades (between 8th and 11th grade).

2.2.2.3. Effect of School Type on Biology Achievement

To model the factors affecting 6th, 7th, and 8th grade students' science achievement in state primary school, primary regional boarding schools, and private primary schools Kalender (2004) conducted a study. 29.952 in 6th, 7th, and 8th grade students' (from 573 primary schools in 47 provinces including 7 geographical regions) who took the Study for Determination of Student Achievement (OBBS)-2002 examination were selected as the sample of the study. OBBS-2002 covers mathematics, science, social sciences and Turkish achievement tests as well it gives the information about the students' socioeconomical status, classroom activities (student-centered, teacher-centered), perception of success and interest. In his thesis, Kalender used principal components analyses and structural equation modeling to model the factors affecting students' science achievement in different school types and different grades. Even though there had been varies findings in the thesis the most significant finding for the present study is, Kalender (2004) found that socioeconomical status is the strongest effect on the science achievement on all grade levels investigated than other factors such as classroom activities (student-centered, teacher-centered), perception of success and interest.

By the Student Selection Examination and PISA results Turkish students' achievement differences according to the school type were analyzed by Berberoğlu and Kalender (2005). All of the students' who took the PISA 2003 and all students who took Student Selection Examination between 1999 and 2002 were selected as the sample of the study. PISA 2003 was administered to the students who were studied in Private High Schools, Anatolian High Schools, Science High schools, Elementary Schools, Vocational High Schools, Anatolian Vocational High School, Polis Academy, and General High Schools. On the other hand, for the study General High School, Science High School, Anatolian High School, Private High School, Anatolian Teacher High School, Religious Vocational High School, Anatolian Religious Vocational High School, Technical High School, Anatolian Technical High School, Business High School, Anatolian Business High School, Industrial High School, Anatolian Vocational High School, Girls' Vocational School, Anatolian Girls' Vocational High School, Health Vocational High School, and Anatolian Hotel Management and Tourism High School students who took Students Selection Examination between 1999 and 2002 first time were selected.

Students' social sciences achievement and science achievement were analyzed according to the school types and annual percentage changes in achievement were analyzed with Student Selection Examination test analysis. Result of the MANOVA analysis for both studies revealed that there was a significant difference in students' achievement in all areas. It can be concluded that Science High School, Anatolian

High School, Anatolian Teacher High School, and Private High School students' got higher grades in science subtest of Student Selection Examination. Besides in social science subtest of Student Selection Examination Private High School, Anatolian High School, Science High School, Anatolian Religious Vocational High School, Anatolian Teacher High School, Anatolian Business High School, and Anatolian Girls' Vocational High School students' had higher scores than the other schools. In addition, in PISA 2003 Science High School, Anatolian High School, Private High School, and Polis Academy students' got higher score than the average in Mathematic Literacy.

In addition to the content-related and construct-related validity evidences of science test in Student Selection Test 2006 Uygun (2008) also analyzed the mean differences across high school types. For her thesis she selected 126,245 students who were graduated from High Schools Science field and did not take the test previously. Mean differences of six school type was analyzed which were General High School, General Private High School, Anatolian High School, General Private High School with Foreign Language Instruction, Science High School, and General High School with Intensive Foreign Language Program. It is found that there was a statistically significant mean difference in science scores of those six school types. Achievement levels of the schools from lowest to highest was General High School, General Private High School, General High School with Intensive Foreign Language Program, General Private High School with Foreign Language Instruction, Anatolian High School, Science High School, respectively.

To determine whether there is a difference of fifth grade public and private primary in terms of students reaching cognitive objectives Bay and Tugluk (2004) conducted a study. To 55 private school and 127 public school students' were administered a pretest and posttest which was developed by the researchers. Since the aim of the study was to measure the students' cognitive objectives test, test was developed according to the cognitive objectives of fifth grade Turkish science curriculum. Also test was plotted by 55 students. Pretest and posttest results gave those primary school students has more cognitive objectives than their counterparts in public school. Besides, the progress of private school students was higher than the public school students.

In general, students who study in selecting schools get higher scores than private and general schools. Besides, general school students get lowest scores in science and mathematics examinations.

CHAPTER 3

METHODOLOGY OF THE RESEARCH

The aim of this chapter is to give information about the methodology of the study. Therefore; population and sample, instruments, and statistical analysis used in the study are presented respectively in the chapter.

3.1. Subject of the Research

2006, 2007, and 2008 Student Selection Test examinees are categorized into three which are 11^{th} grade students, students who had graduated previous years but did not placed in a higher education program, and university students who prefer different program. For this study examines who did not take Student Selection Test before were selected.

In addition Turkish High Schools consists of General High Schools and Vocational and Technical High Schools, for the present study Vocational and Technical High School students did not include as the subject of the research, because of the high amount of missing values.

Further, for this study, six types of high schools` students were used which are General High School, General Private High School, Anatolian High School, General Private High School with Foreign Language Instruction, Science High School, Private

Science High School, and Teacher Education High School. In Turkey some high schools select their students by examination at the end of 8th grade, which are Anatolian High School, Teacher Education High School, and Science High School. For this study these three school types were analyzed under "selecting high school". Besides, there are private schools which are General Private High School, General Private High School with Foreign Language Instruction, and Private Science High School. Those three school types were analyzed under the name of "private high schools". General High Schools were analyzed separately than other six school types.

In addition, examinees who studies science field in high school were selected to handle with the missing values and who did not answer less than four items did not included into the analysis.

In Student Selection Examinations each year different ten booklets are used to prevent cheating. All of the ten booklets consist of same questions but orders of the questions are differ in each booklet, and students are randomly selected for the booklets. To this end, because of the sufficient size of the subject only students who were selected for the first booklet of test was selected.

For 2007 and 2008 regression analysis, influence of age on students' biology achievement was analyzed. Due to this reason, students born in 1988, 1989, 1990, and 1991 were selected for the analysis of 2007 SST, whereas students born in 1990, 1991, and 1992 were selected for the analysis of 2008 SST. Students born in other years were not taken into analysis because of the larger amount of missing values. Besides, since the information about examinees for 2006 SST was not possessed, analysis could not be conducted by the age of the students.

Moreover, in 2005-2006 academic year high schools year was raised from three years to four years. As a result, in 2008, no pupil was graduated from general high schools which caused a high decrease in applications to university selection examination. Consequently, differently than previous years', for 2008 SST analyses, general high schools was not taken to the analyses because of the insufficient number of examinees. In addition, for 2008 analysis sample selection procedure, all of the data from all ten booklets were used.

Additionally, all of those steps were conducted on 2006, 2007, and 2008 Student Selection Test examinees, independently. The number of the subject present in the study is shown in Table 3.1.

Table 3.1: Number of Subject according to year

	2006	2007	2008
Number of the subject	10175	11686	10359

2.2. Instrument of the Research

2006, 2007, and 2008 Student Selection Test (SST) were used as the instruments of the study. All of the SSTs are composed of two stages which are consisted of four subtests. The first stage of the test (SST-1) consists of four sections Turkish, Social Science-1, Mathematics-1, and Science-1. Comparably the second stage of the test (SST-2) consists of four sections as Literature-Social Science, Social Sciences-2, Mathematics-2, and Science-2. Each subtest of the test has 30 items which means all SSTs have 240 items.

This study aims to identify content validity, and construct validity of biology items; therefore, all of the SST-1 biology items and SST-2 biology items were used for the study. Besides for the regression analysis reading comprehension, mathematics, physics, and chemistry achievements were used to identify their relationships with biology achievement. To this respect, items which assess those areas were also included to the research. Normally all of the science subtests include 13 physics, 9 chemistry, and 8 biology items. Merely, one chemistry item in the second section deleted from data by the Student Selection and Placement Center. Numbers of items used for the study according to the years are shown in Table 3.2.

Table 3.2: Numbers of items selected according to the years

	2006	2007	2008
SST-1 reading comprehension items	24	22	24
SST-1 mathematics items	30	30	30
SST-2 mathematics items	30	30	30
SST-1 physics items	13	13	13
SST-2 physics items	13	13	13
SST-1 chemistry items	9	9	9
SST-2 chemistry items	8	9	9
SST-1 biology items	8	8	8
SST-2 biology items	8	8	8
Total	143	142	144

3.3. Data Analyses

All of the data from 2006, 2007, and 2008 Student Selection Tests were analyzed separately for content analysis and statistical analyses.

3.3.1. Content Analysis

As a first step of content analysis, three years SST biology items were examined in accordance with high school biology, elementary school textbooks by the researcher to interpret the grade level and knowledge needed to solve the items. Besides, those items were analyzed according to content type and cognitive level by the researcher. Furthermore a research assistant from Middle East Technical University Elementary Science Education department was examined the content type and cognitive processes of the items for the expert opinion. If there were some inconsistencies between the researcher and the research assistant those differences were discussed and concluded for the final decision.

3.3.2. Statistical Analyses

In addition to missing values, mean, standard deviation, skewness, and kurtosis value of the all items used in the study were analyzed and given in the Appendixes.

In all SSTs, there were items higher than %20 missing data. To overcome the high level of missing data, pairwise and listwise deletion methods of cases are not recommended, since they cause lost of large number of subjects, so pairwise deletion method is preferred. In pairwise deletion method, deletion of the subjects with missing data on only the two variables is used, which causes less subject lost than listwise deletion method (Schumacher & Lomax, 2004).

3.3.3. Reliability Analysis

Cronbach’s alpha coefficients of tests were analyzed to interpret the reliability of the tests by SPSS 17.0.

Since biology items were used in factor analysis, reliability of 16 biology items was analyzed. Besides, one of the aims of this study was to investigate the relationship with biology achievement and reading comprehension skills, mathematics, physics and chemistry achievements. Therefore, reliability of reading comprehension skills, mathematics, physics and chemistry achievement tests reliabilities were also analyzed for each year.

3.3.4. Item Analysis

To interpret the item difficulty and point-biserial correlations of the SST-1 and SST-2 biology items Item and Test Analysis Program, ITEMAN 3.0 was used.

According to Crocker and Algina (1986) proportion of examinees who answer the item correctly can be used to examine the item difficulty (*p*). Item difficulty can range between 0.0 and 1.0 but the ideal value to maximize the test score variance for dichotomously scored items is .50. If *p* value is between .48 and .59, this item is accepted as ideal in terms of difficulty. When its value gets closer to 1, this shows that item gets easier. Meanwhile, if it gets closer to 0, it interpreted as a difficult item (Crocker & Algina, 1986).

Pearson-product-moment correlation coefficient gives the relationship between one item and the whole test scores. To estimate this relationship point biserial correlation and biserial correlation coefficient, can be used. In this study point biserial correlation (*r*) was chosen, since in point biserial correlation, correlation between one individual item and the rest of other test items were analyzed.

A discriminating item would have a high probability to be answered by high scoring examinees and would have a low probability to be answered by low scoring examinees, in an achievement test. Additionally, another feature of discriminating item is the key option should be selected by high achievers, whereas distracters of an item should be selected by low achievers. In addition, high achievers should not prefer to omit the item (Crocker& Algina, 1986). If the *r* value of an item above 0.4, this item is interpreted as a discriminated item. If the value is lower than 0.4, this can be explicate as it does not function as it is required then item should be improved (Crocker& Algina, 1986).

3.3.5. Factor Analysis

3.3.5.1. Exploratory Factor Analysis

According to (Gorsuch, 1983) EFA commonly used to explore the interrelationships among a set of variables. Principle component analysis technique was preferred for this study since as Tabachnick and Fidell (2007) cited it allows obtaining an empirical summary of the data than other factor analysis techniques. Principal component analysis includes two stages. The aim of the first stage is to determine the number of factors underlying the measurement instrument. Relative magnitude of the eigenvalues, scree plot test, and prior conceptual beliefs can be used to decide about the number of the factors. Meanwhile, the aim of the second stage is to make the factors more meaningful by factor rotation. Varimax rotation was preferred since it gives more interpretable results (Green & Salkind,2008).

To have valid information about Exploratory Factor Analysis Bartlett's test of Sphericity should be statistically significant at $p < .5$ and the Kaiser-Meyer-Olkin value should be at or above .6 (Gorsuch, 1983)

Principal Component Analysis with Varimax Rotated Solution was conducted to explain factor structures of biology items of 2006, 2007, and 2008 SSTs by SPSS 17.0. SST-1 and SST-2 biology items were analyzed together for each year's SSTs.

3.3.5.2. Confirmatory Factor Analysis

After exploring interrelationships among a set of variables, the specific hypotheses should also be confirmed. This aim can be satisfied by Confirmatory Factor Analysis. Due to this reason, after Principle Component Varimax Rotation, Confirmatory Factor Analysis was conducted to test the structure underlying the SSTs biology variables (Gorsuch, 1983)

The Characteristic of Applications of CFA: Schumacker and Lomax (2004) and Schumacker and Lomax (2004) cited five steps characteristics of application of structural equation modeling as model specification, identification, estimation, testing fit and respecification. First step of CFA, model specification, includes the formulating the model basis on other theories or past research in the area. After the model is specified as a next step, identification, researcher should find unique values for the parameters of the specified model. In the third step, estimation, researcher should select the estimation technique to solve the distributional properties of the variables being analyzed. The aim of the next step, model fit, is to determine the consistency between the model and the data. Additionally, fit of the data can be improved by modification on the model in the last step, respecification.

Path Diagrams: gives the structural relations which form the model. In the path diagram variables are linked by unidirectional or bi-directional arrows (Kelloway, 1998).

Observed, Indicator or Manifest Variables: are the variables which can be observed or measured directly (Schumacker & Lomax, 2004).

Latent or Unobserved Variables: are the variables which are not observed or measured directly. They can be inferred from a set of directly observed or measured variables (Schumacker & Lomax, 2004).

Types of Model Fit Criteria for Structural Equation Modeling: even though there are various Confirmatory Factor Analysis programs to test the structural equation models, LISREL 8.54 for Windows with SIMPLIS command language was preferred to formulate and estimate the models of each year SSTs. As it is indicated above to have significant theoretical model, model fit criteria should be provided. Schumacker and Lomax (2004) suggest three main criteria in judging the statistical significance and substantive meaning of a theoretical model:

- Global fit measures, non-statistical significance of the chi-square test and the root-mean-square error of approximation (RMSEA) values should be checked.
- *t* values or critical values, critical values computed by dividing the parameter estimates by their respective standard errors, should exceed 1.96 at for two-tailed test at .05 level.
- Magnitude and the direction of the parameter estimates should paid attention.

Other than those main criteria there are some other commonly used model fit indices such as the goodness-of-fit index (GFI), the adjusted goodness-of-fit index (AGFI), and root-mean-square residual (RMR) (Schumacker & Lomax, 2004). Those criteria were also checked for the study and are defined as following:

Chi-Square (X^2): A non-significant X^2 value indicates that the observed and estimate variance-covariance matrices are similar. Non-significant X^2 means that the model fits the data (Schumacker & Lomax, 2004).

Goodness-of-Fit Index (GFI): is the ratio of the sum of the squared differences between observed and reproduced matrices to the observed variances. The value close to .95 reflects a good model fit (Schumacker & Lomax, 2004).

Adjusted Goodness-of-Fit Index (AGFI): is adjusted GFI for the degrees of freedom of a model relative to the number of variables. As similar to GFI, the value close to .95 reflects a good model fit (Schumacker & Lomax, 2004).

Root-Mean-Square Residual (RMR): is the square root of the mean-squared differences between the implied and observed covariance matrices. To interpret a good fit to the data values less than .05 are generally accepted (Kelloway, 1998).

To confirm the dimensions of biology subtest of 2006, 2007, and 2008 SSTs acquired by Exploratory Factor Analysis, Confirmatory Factor Analysis run by LISREL 8.8.

3.3.6. Multiple Regression Analysis

The aim of the Multiple Linear Regression analysis is to establish the predictability of a dependent variable more than one independent variable (Hinkle, Wiersma & Jurs, 2003). Due to this reason, to identify the relationship with biology achievement and school type, gender, reading comprehension skill, mathematics achievement, physics achievement, and chemistry achievement multiple linear regression analysis by SPSS 17.0 was computed.

To evaluate relationship between the predicted criterion score and actual criterion score multiple correlation (R) and squared multiple correlation (R^2) were used. According to Hinkle, Wiersma and Jurs (2003) multiple correlation is the correlation coefficient which gives how well the predicted criterion variable identifies the criterion variable by using linear combination of the predictor variables. The value of R may be squared and multiplied by 100 to make the result more interpretable, which is called R^2. R^2 can be interpreted as the percent of the criterion variance which is counted by the linear combination of the predictors (Green&Salkin, 2008).

The general form of multiple linear regression is symbolized as:

$$\hat{Y} = b_1X_1 + b_2X_2 + \ldots + b_kX_k + a$$

Where X is the predictor, $\hat{Y}$ is the predicted score from X scores, b is the slope of the line which is defined as the amount of change in X corresponds to a change in Y. Additionally, a is the value of Y when all predictors equal to 0, which is called the intercept (Green & Salkin, 2008).

The contribution of age, gender, school type, reading comprehension, mathematics, physics, and chemistry achievements to biology achievement were analyzed by SPSS 17.0.

CHAPTER 4

RESULTS OF THE RESEARCH

The aim of the chapter is to present results obtained from content analysis and statistical analysis of the study. In the first section of the chapter results related to 2006 SST analysis are presented. The results of the 2007 SST analyses are given in the second part while in the third part of the chapter results of 2008 SST analyses are given. In addition, for all year's analysis firstly content analysis findings than statistical analysis findings are presented.

4.1. 2006 SST Analysis

4.1.1. Content Analysis of 2006 SST

Content of the 16 biology items, 8 from SST-1 and 8 from SST-2, were analyzed in terms of content analysis, biology items were analyzed in terms of content type, grade levels, cognitive processes, the unit from the curriculum chosen, the knowledge needed to solve the questions.

4.1.1.1. Content Analysis of 2006 SST-1

The result of the content analysis of 2006 SST-1 is shown in Table 4.1.

Since students choose their field of study at the end of 9th grade, aim of the first stage is to assess students' cognitive skills in the context of common courses. To this end, SST-1 should compose of elementary and 9th grade science curriculum.

Most of the biology items satisfied this aim. Four of them were chosen from elementary curriculum and three of them were chosen from 9th grade biology curricula. On the other hand, S1_30 was an item from 11th grade curricula.

All of those 8 items were analyzed according to four content types. It was found that none of those items focus on procedural knowledge, one items' type was concept, three of items types were principle, and four of the items types were facts.

Beyond, most of the SST-1 biology items were hard to interpret in terms of their content, even each of the all eight questions was chosen from one unit of curriculum. S1_23 assess more than one content knowledge at a time. To solve S1_23, students' need to know the essential feature of biochemical reactions and functions of enzymes in cellular reactions. To answer S1_26 students can only

Table 4.1: Content Analysis of 2006 SST-1

Item	*Unit*	Knowledge Needed	*Content Type*	Cognitive Process	*Grade Level*
S1_23	*basic components of organisms*	-energy is needed to start cellular respiration, metabolic reactions occur as in sequence of chemical reactions controlled -besides enzymes, optimal ph, temperature should also be provided to start a metabolic reactions	*facts*	remembering	*9*
S1_24	*cell*	-concepts of the turgor pressure, isotonic, hypertonic, hypotonic environment and osmotic pressure.	*principles*	remembering inferring	*elementary*
S1_25	*basic components of organisms*	-the roles of RNA types in protein synthesis.	*facts*	remembering	*9*
S1_26	*cell*	-enzyme using, ATP and organic substance producing, duplication of DNA occur in chloroplast.	*facts*	remembering	*elementary*
S1_27	*ecology*	-nitrification bacteria fixes atmospheric nitrogen into organic components	*facts*	inferring	*9*
S1_28	*excretory system*	-warm and dry air causes a rise in body temperature	*principles*	inferring	*elementary*
S1_29	*heredity*	-offsprings of two heterozygote individuals may have different genetic constitutions like: heterozygous, homozygous dominant or homozygous recessive.	*principles*	inferring	*elementary*
S1_30	*population genetics*	-concepts of natural selection, adaptation, mutation and genetic variations	*concepts*	remembering	*11*

answer the question by eliminating the four true alternatives, then decide the last alternative is not a correct statement. In addition, to identify the true alternatives they should know that enzyme are used, ATP and organic substance are produce, and DNA is duplicated in chloroplast. Even though, other items compose of one acquisition, those contents are also very broad to assess students' knowledge and skills.

4.1.1.2. Content Analysis of 2006 SST-2

Second stage of SST aims to measure students' cognitive skills of filed courses. To this aim, those items should include the entire elementary school and high school science curriculum. The result of the content analysis of 2006 SST-1 is shown in Table 4.2.

All of the 2006 SST-2 biology items were chosen from high school curriculum. According to grade level, four of them were from 10^{th} grade, and three of them were from 11^{th} grade of biology curriculum. Yet, S2_26 consists of 9^{th} and 10^{th} grade curriculums' content at the same time.

In terms of content type most of the items consist of facts and principles only S2_26 focus on concept. Comparably to SST-1 none of the SST-2 biology items was in procedural form.

Although seven of the items were chosen from one unit of high school biology curricula, biology knowledge needed to answer the items correctly and the cognitive skills were very complicated.

Table 4.2: Content Analysis of 2006 SST-2

Item	Unit	Knowledge Needed	Content Type	Cognitive Process	Grade Level
S2_23	*photosynthesis*	-electron transferring in Electron Transport Chain (ETC) provide to usage of every chlorophyll molecule over and over again	*facts*	remembering	*11*
S2_24	*tissues*	-since stomatal closing occurs at night when photosynthesis does not take place, CO_2 accumulate in the cell. -principles of diffusion.	*principle*	remembering inferring	*10*
S2_25	*reproduction in flowering plants*	-the mitosis of the zygote results in to the formation of the embryo. -the mitosis of the microspore results in to the formation of the tube nucleus. -the mitosis of the generative nucleus results in to the formation of the sperm nucleus.	*facts*	remembering	*10*
S2_26	*cell* *excretory system*	-cause of osmotic pressure. -role of kidneys is to balance the water in the body.	*concept*	remembering inferring	*9* *10*
S2_27	*digestive system*	-pathways for removal of bile from the liver -pathway of generating vitamin A from stored pre-vitamin A and sending vitamin A into the blood	*facts*	remembering	*10*
S2_28	*nervous system*	-motor neurons conduct respond signal of central nervous system to the responder organ	*facts*	remembering inferring	*10*
S2_29	*heredity*	-X-linked recessive gene causes the phonotypical expression in males. -expression in females occurs if the individual has homozygous gene, but if female has a heterozygous then they are the carrier of the gene.	*principles*	remembering transferring inferring	*11*
S2_30	*population Genetics*	-modification is a phenotypical change caused by environmental factors and do not effect genotype of the individual	*principles*	remembering inferring	*11*

As it is in SST-1, SST-2 biology items mostly focus on student remembering and inferring skills. S2_23, S2_25, and S2_27 focus on one cognitive process which is remembering. All of the other items assess more than one cognitive level. S2_24, S2_26, S2_28, and S2_30 focus on remembering and inferring skills at the same time. Meanwhile, S2_29 assess three cognitive processes which are remembering, transferring, and inferring skills.

Additionally, to answer S2_23, S2_28, and S2_30 correctly students should know one concept. However students should know two concepts or facts to solve four items, S2_24, S2_26, S2_27, and S2_29. In fact, to answer S2_25 three concepts should be known.

4.1.2. Statistical Analysis of 2006 SST

4.1.2.1. Preliminary Analysis of 2006 SST

As a first step of the data analysis, missing values analysis, descriptive statistics, frequency distributions as skewness and kurtosis values of 16 biology items, 24 reading comprehension items from SST-1, 60 mathematics, 26 physics, 17 chemistry items, school types, and gender were examined. Analyses were run with 10175 examinees. Means, standard deviations, skewness, and kurtosis values of the SST 2006 according to school type, and gender were presented in Table 4.3 and Table 4.4, respectively. Skewness-kurtosis values of all reading comprehension, mathematics achievement, physics achievement and chemistry achievement items were presented in Appendix A.

Table 4.3: Descriptive Statistics for Total Biology Score on Six School Types of 2006 SST

School Type	Number of examines	Mean	Standard Deviation	Skewness	Kurtosis
General High School	6011	,7515	2,24923	,760	,606
Private High School	716	,2556	3,38616	,287	-,863
Selected High School	3448	,7880	3,08952	-,214	-,791

Table 4.4: Descriptive Statistics for Total Biology Score on Gender of 2006 SST

Gender	Number	Mean	Standard Deviation	Skewness	Kurtosis
Boy	5848	,1450	3,27673	,629	-,450
Girl	4327	,4990	3,21900	,489	-,630

4.1.2.2. Reliability Analysis of 2006 SST

Since biology items were used in factor analysis, reliability of 16 biology items was analyzed. Besides, other aim of this study was to investigate the relationship between biology achievement and reading comprehension skills, mathematics, physics and chemistry achievements the reliability of those tests were also analyzed. In addition, it should be noted that all of the analysis for chemistry were analyzed with 9 SST-1 chemistry and 8 SST-2 chemistry items because one of the chemistry items were omitted from the test.

Before conducting the reliability analysis, normality of the all biology items were checked. According to Hinkle, Wiersma, and Jurs (2003) to have a normal distribution skewness and kurtosis values should be between -2 and +2. Since skewness and kurtosis values of subtests were between this range, distribution was considered as normal distribution as shown in Table 4.5.

Table 4.5: Skewness and Kurtosis values of 2006 SST Subtests

Subtest	*Number of examinees*	*Skewness*	*Kurtosis*
Turkish	10175	,406	,673
Mathematics	10175	,268	1,109
Physics	10175	,628	,406
Chemistry	10175	,466	1,003
Biology	10175	,566	,538

According to Gable (1986), the criterion level for the effective measures can be reasonable set a minimum of .70. The 2006 SST biology, Turkish, mathematics, physics, and chemistry subtest's Cronbach's alpha coefficient were found 0.745, 0.801, 0.980, 0.907, and 0.858, respectively. Thus, the results were interpreted as in acceptable value. In addition, Cronbach's alpha coefficients can be interpreted as at least 74.5%, 80.1%, 98.0%, 90.7%, and 85.8% of the true score variance were explained in the observed score variance of 2006 SST biology, Turkish, mathematics, physics and chemistry subtests respectively (Crocker & Algina, 1986).

4.1.2.3. Item Analysis of 2006 SST

As it is mentioned in Chapter 2 item characteristics were analyzed in terms of item difficulty (*p*) and discrimination (point biserial correlation, *r*). All *p* and *r* values of 16 biology items were presented in Appendix A.

When *p* values of ITEMAN were taken into consideration there were only two items which can be considered as ideal items in terms of item difficulty, S1_26 (p=.590) and S1_28 (*p*=.558). S1_26 was also an ideal in terms of discrimination (r=.530) while S1_28 needs little revision (r=.330).

S1_23 was the only easy biology item in 2006 SST (*p*=.653) and it was also a discriminated item (r=.460). Only S1_24 can be considered as neither easy nor difficult, because its *p* value is .457. According to Crocker and Algina (1986) if the *p* value is between .48 and .39 than those items can be interpreted as neither easy nor difficult in terms of difficulty. Additionally, S1_24 was one of the ideal items in terms of functioning (r= .538).

There were two very difficult biology items in 2006 SST, S1_29 (*p*=.082) and S2_26 (*p*=.181). Even S2_26 functions quite well (r=.474), S1_29 should be rejected because its *r* value is .095 and one of the alternative works better than the key.

Except S2_26, all of the SST-2 biology items *p* values were between .40 and .19, therefore these items were difficult items. In addition to SST-2 items, S1_25, S1_27, and S1_30 items' *p* values were in this range, so those items were also difficult. Through these questions, S1_30 need to be revised since its *r* value was .287. All other nine items *r* value was higher than .40 which means they all function as required (Crocker & Algina, 1986).

Briefly, two of the 2006 SST biology items were very difficult, one of them was neither easy nor difficult, one of them was easy, ten of them were difficult items, and only two items were ideal in terms of item difficulty. Even most of the items functions well, two items were reasonably good but needs improvement, and one item should be rejected because one of its alternatives functions better than the key.

4.1.2.4. Factor Analysis of 2006 SST

4.1.2.4.1. Explanatory Factor Analysis of 2006 SST

As it was mentioned in Chapter 2 both Exploratory and Confirmatory factor analysis were conducted. For Exploratory Factor Analysis (EFA) Principle Component Analysis with Varimax Rotation was preferred to explore the interrelationships among a set of variables. Then Confirmatory Factor Analysis was conducted to test the structure underlying the 2006 SST biology items.

Firstly, Barlett's test of Sphericity was checked and Kaiser-Meyer- Olkin found 0.874, which means factorability of correlation matrix was satisfied.

Then 16 biology items were analyzed with principle component analysis. Even though four factors were obtained by this analysis, by using scree test and interpretability of factor solution criteria 3 factors were rotated by Varimax rotation procedure.

Table 4.6: Rotated Component Matrix of Factor Analysis of 2006 SST

Items	*Factor Loadings*		
	Factor 1	*Factor 2*	*Factor 3*
S2_27	,596	,189	-
S1_26	,566	,103	-
S2_23	,517	-	-
S1_27	,514	,336	-
S1_23	,499	-	-
S1_24	,448	,242	,156
S2_26	,411	,219	-
S1_28	,285	-	-,117
S2_29	,109	,560	-,130
S2_25	-	,551	-
S1_25	,370	,443	-
S2_24	,240	,419	-
S2_28	,368	,382	-
S2_30	,142	,252	-
S1_29	-	-,248	,844
S1_30	,428	-,326	-,491

Table 4.7: Rotation Sums of Squared Loadings of 2006 SST Biology Items

Factor	*Total*	*% of Variance*	*Cumulative %*
1	,069	19,181	19,181
2	1,044	6,526	25,707
3	1,027	6,417	32,124

19,181 of the total variance of the test was explained by Factor 1, and it includes S1_23, S1_24, S1_26, S1_27, S1_28 S2_23, S2_26, and S2_27. All of those items' loadings were between .596 and .285. Factor 2 explains the 6,526 of the total variance of SST 2006 biology subtest and it includes S1_25, S2_24, S2_25, S2_28, S2_29, and S2_30. S1_29, and S1_30 compose Factor 3 and it explains 6,417 of the total variance. Total variance explained for each factor was shown in Table 4.7.

There was not any resemblance in terms of difficulty, knowledge domain, cognitive process, and grade level within any factor. Due to this reason, it was not possible to entitle the factor according to those criteria. Only difference between factors could be observed in terms of distinctiveness. Items in factor 3 were items which need to be improved or rejected from the test. Items in first two factors' were items which function as they were required. Since the basic feature of the first two factor were same, they were combined in a factor. Besides, S1_28 was analyzed with factor three because its *r* value was .327 which means this item also does not function as it was required like the two items in Factor 3. According to Gable (1986) if an item is loaded on two variables with a difference less than 0.2, this interpretation can be done. New total variance explained for each factor is also shown in Table 4.8.

Table 4.8: Rotation sums of Squared Loadings of 2006 SST Biology Items with the combination of first two factors.

Factor	Total	% of Variance	Cumulative %
1	,113	25,707	25,707
2	,079	6,747	31,162

4.1.2.4.2. Confirmatory Factor Analysis of 2006 SST

The path from the latent variables, DISCR and NDISCR, to the observed variables, all of the biology items of 2006 SST, was constructed. The syntax of Biology Cluster of 2006 SST was given in the Appendix A. LISREL estimates of parameters in confirmatory factor analysis coefficients in standardized values and LISREL estimates of parameters in confirmatory factor analysis coefficients in estimate and t-values were given in Figure 4.1 and Figure 4.2.

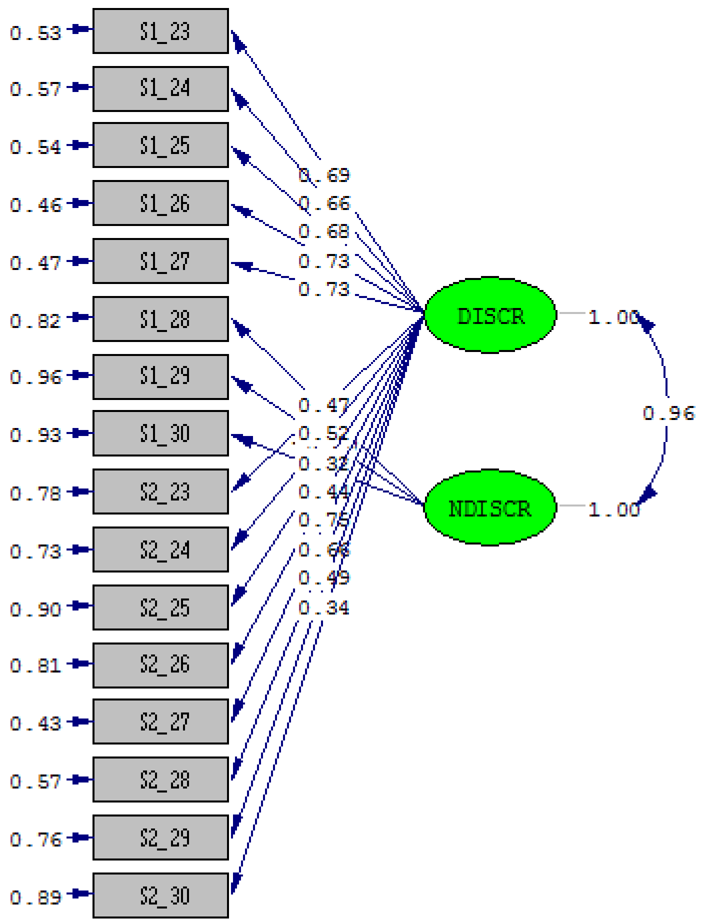

Figure 4.1: LISREL estimates of parameters in confirmatory factor analysis coefficients in estimate (SST 2006)

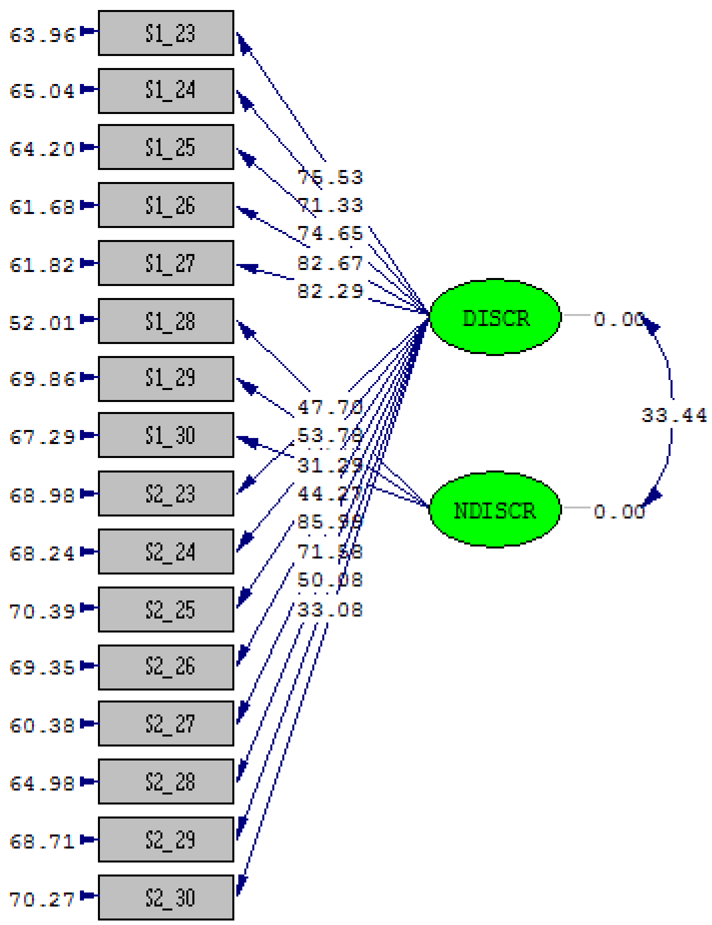

Figure 4.2: LISREL estimates of parameters in confirmatory factor analysis coefficients in t-values (SST 2006)

There were two latent variables and sixteen observed variables in confirmatory factor analysis of the 2006 SST. As it can be seen in Figure 4.1, latent variable of DISCR represents the items which have higher point-biserial correlation values than .40, discriminative items, and NDISCR composes of items which were not discriminative.

In tested model all the path coefficients were significant at 0.05 significance level which means there was no non-significant t-value as it can be seen from Figure 4.2.

In CFA, firstly chi-square test and root-mean-square error of approximation (RMSEA) should be paid attention. Then, t values, and magnitude and the direction of the parameter estimates should be checked. Finally, goodness-of-fit index (GFI), the adjusted goodness-of-fit index (AGFI), and root-mean-square residual (RMR) of the test should be checked. Also, goodness-of-fit criteria of 2006 SST Biology items were given in Appendix A and the meaning of those statistics were explained below.

Chi-square test: χ^2 = 1855.75 is significant at p = 0.000 with degrees of freedom (df) of 103. Normed Chi-Square (NC) can be calculated by χ^2/df and the result should be less than 5 to indicate a good fit to the data (Schumacker & Lomax, 2004). By this equation NC of model of 2006 SST Biology was 18.02 which is too high to indicate a good fitness of the model. However, chi-square test is very sensitive to the sample size. Large sample size can cause a high result. To eliminate this dependence other goodness-of-fit measures such as GFI and AGFI are proposed and those measures were also computed (Jöreskog & Sörbom,2003).

Root-Mean-Square Error of Approximation (RMSEA): According to Steiger (1990) smaller values of RMSEA indicate a better fit to the data. Value below 0.10 indicates a good fit and values below 0.05 indicates a very good fit. Since RMSEA value of the SST 2006 Biology model was 0.047, this shows that this criteria was satisfied for suggested model with 2006 SST.

Goodness-of-Fit Index (GFI) and Adjusted Goodness-of-Fit Index (AGFI) were .96, .95 respectively. Since higher values than .95 for GFI and AGFI indicates a good fit of the data, it can be said that model had a good fit to the data. Additionally, values less than .05 were accepted for Root-Mean-Square Residual (RMR) and SST 2006 Biology models' RMR is .034.

4.1.2.5. Multiple Linear Regression Analysis of 2006 SST

By multiple linear regression analysis contribution of gender, school type, reading comprehension skill, mathematic achievement, physics achievement, and chemistry achievement to biology achievement was analyzed.

As a first step, descriptive statistics of interval independent variables for academic factors, reading comprehension skill, mathematic achievement, physics achievement, and chemistry achievement were examined and shown in Table 4.9. Besides, correlation between biology achievement and non-academic factors were significant at $p<0.01$.

Table 4.9: Descriptive statistics of independent variables for academic factors

	Mean	*Standard Deviation*	*Skewness*	*Kurtosis*	*Correlation with Biology Achievement*
Reading Comprehension Skill	14,0739	5,47609	-,406	-,673	,512*
Mathematics Achievement	8,9084	4,46068	,268	1,109	,703*
Physics Achievement	9,7199	5,50661	,628	-,406	,721*
Chemistry Achievement	6,9875	4,86788	,466	-1,003	,751*

* Correlation is significant at the 0.01 level (2-tailed).

Since all of the variables for academic factors correlation was significant with biology achievement ($p<0.01$) regression analysis was conducted by all of the independent variables.

As it was mention in Chapter 2 first of all, the regression coefficients of multiple correlation (R) and squared multiple correlation (R^2) were interpreted. Analysis results showed that 61.5% of gender, school type, reading comprehension skills, mathematic achievement, physics achievement and chemistry achievement of the students could be used to predict the biology achievement (R^2=0,615). Additionally, since the R was .784, it could be interpreted that there was a medium relationship between predicted biology achievements and the actual biology achievements of students by using gender, school type, reading comprehension skills, mathematic achievement, physics achievement, and chemistry achievement as independent variables (Green & Salkind, 2008).

Table 4.10: Correlation of non-academic factors and biology achievement

	Selecting High School	*Private High School*	*Gender*
Biology Achievement	,548	,081	,054

* Correlation is significant at the 0.01 level (2-tailed).

Additionally, three different school types were coded as selected high school, private high school, and general high school. Because of this reason, for regression analysis dummy coding was used to identify how the contribution of school type could be used to predict students' biology achievement.

Even correlation between biology achievement and the variables were checked and all of the correlations were found significant, the effect of the private high schools was not significant when other independent variables were taken into account ($p= ,399$ at $p<0.05$).

As last step, the regression equation of biology achievement with the linear combination of the predictors was computed. The variable of Private School was not taken in the equation since its effect was not significant.

Analysis results showed that intercept, *a*, was, 047 and *b* values of the predictors were shown in Table 4.11.

Table 4.11: Beta values of predictors

	Gender	*Selected*	*Reading*	*Math*	*Physics*	*Chemistry*
b value	,464	,350	,046	,007	,181	,266

As a result the regression equation of biology achievement was computed as:

Bio = 0.047 + 0.464*gender + 0.350*selected + 0.046*reading +0.007* math + 0.181*phy + 0.266* che

As a summary, it can be concluded that physics, chemistry, reading comprehension achievement of the students, their gender, and, whether they graduated from selecting high school or not had significant effect on biology achievement. When the standardized coefficients of the independent variables were interpreted, it was found that mostly non academic factors affect students' achievement in biology because standardized coefficients of gender, in favor of girls, and selected high school were 0,464 and 0,350, respectively. For academic factor it was found that chemistry achievement is the most effective variable on biology achievement (*B*=, 266), whereas physics (*B*=0.181) and reading comprehension (*B*=0.046) achievement comes right after chemistry achievement respectively.

For the effect of mathematics achievement on biology achievement it can be said that even it has a significant effect, this significance is very low and the effect of mathematics achievement has the lowest effect on biology achievement among all other academic and non-academic variables (B=0.07).

4.2. 2007 SST Analysis

4.2.1. Content Analysis of 2007 SST

4.2.1.1. Content Analysis of 2007 SST-1

Summary of content analysis of 2007 SST-1 was shown in Table 4.12. As it was mentioned before the aim of the first stage of SST is to evaluate students' cognitive skills in the context of common courses. For this aim the content of the SST-1 should be chosen from elementary and 9^{th} grade curriculum. All of the 2007 SST-1 biology items satisfy this aim. Four of them were selected from the elementary curriculum and four of them were chosen from 9^{th} grade curricula.

All of the 8 items were also analyzed in terms of content type. It was found that only S1_30 was the item which focuses on procedure whereas S1_27 was the only item in principle form. Three items content type was fact and the other three items' was in concept form.

Regarding the cognitive level 2007 SST-1 biology items cover remembering skills. In fact, as it can be seen from Table 4.12, S1_23 and S1_29 were focusing on only remembering skill. On the other hand, all other six items were measuring at least one more cognitive process besides remembering. Items focus on remembering and inferring skills were S1_25, S1_26, S1_27, and S1_28. S1_24 and S1_30 were assessing transferring skill in addition to remembering. Even all items were measuring remembering skill knowledge needed to solve S1_23, S1_24, S1_24, S1_25, and S1_29 were simpler whereas deep knowledge was needed to solve S1_27, S1_28, and S1_30.

Even all of the items were selected from only one unit of the curriculum; in terms of content category interpretation of some items was not easy. As an example S1_24 was assessing more than one content knowledge in the same item. Same situation was observed in S1_28 to solve this item three concepts should be known and those concepts were deeper than the ones needed for S1_24. Additionally, even students need to know one concept to solve S1_26, this concept can be formed by combination of two different units from elementary curriculum which are Cell Division and Heredity.

Table 4.12: Content Analysis of 2007 SST-1

Item	*Unit*	Knowledge Needed	*Knowledge Domain*	Cognitive Process	*Grade Level*
S1_23	*taxonomic categorization*	-taxonomic categories ranges from species to kingdom which forms a hierarchy and as you move up the hierarchy, each group is more inclusive.	*facts*	remembering	*9*
S1_24	*nucleic acids*	-DNA can replicate itself. -DNA synthesis RNA. -RNA synthesis protein.	*facts*	remembering transferring	*9*
S1_25	*growth and development*	-aim of photosynthesis is to produce chemical energy of organic molecules.	*concept*	remembering inferring	*Elementary*
S1_26	*cell division / heredity*	-DNA of offsprings are exactly the same with the parents in asexual reproduction	*concept*	remembering inferring	*Elementary*
S1_27	*passage of materials through cell membranes*	-iodine and glucose can pass through from cell (intestine) membrane but starch cannot.	*principles*	remembering inferring	*9*
S1-28	*taxonomic categorization*	-number of chromosome do not give information about the taxonomic affinity the class of the individual developmental level of the species	*concept*	transferring inferring	*9*
S1_29	*systems*	organ system of circulatory system	*facts*	remembering	*Elementary*
S1_30	*ecology*	temperature of rainforest biome is generally high, winters are mild and summers are cool, and receive rain highly through the year	*procedure*	remembering transferring	*Elementary*

4.2.1.2. Content Analysis of 2007 SST-2

The result of the content analysis of 2006 SST-1 is shown in Table 4.13. Since the aim of the SST-2 was to evaluate students' cognitive process in the content of field course, items of SST-2 should be selected from high school curricula. Result of the analysis revealed that even S2_28 was selected from elementary curriculum, most of the items satisfy this aim. Other three items were selected form 10^{th} grade curricula, rest of the four items were selected from 11^{th} grade curricula.

In terms of content type, all four content types were assessed in SST-2 biology items. Forms of S2_26 and S2_27 were facts; S2_23, S2_25, and S2_29 were in concept form. S2_28 was in principle form where two items' content types were procedure, S2_24 and S2_30.

Regarding the cognitive processes most of the items were measuring remembering and inferring skills. Similarly to SST-1, almost all of the items were focusing on more than one cognitive skill. Only three items were focusing on one cognitive process which are S2_24, S2_27, and S2_30. S2_24 and S2_27 were assessing remembering skill where S2_30 was assessing transferring skill. Another important feature of S2_30 is, it was the only item which do not require any information to solve. S2_23, S2_25 and S2_28 aimed to assess remembering and inferring skills, S2_29 was measuring remembering and transferring skills. In addition, S2_26 was focusing on three different cognitive processes; remembering, inferring, and comprehending skills.

Table 4.13: Content Analysis of 2007 SST-2

Item	*Unit*	Knowledge Needed	*Knowledge Domain*	Cognitive Process	*Grade Level*
S2_23	*tissues*	-stem of the plant grows outward in width -stem of the plant grows lengthwise from the head of the stem.	*concept*	remembering inferring	*10*
S2_24	*biotechnology*	-steps in DNA recombination.	*concept*	remembering	*11*
S2_25	*energy transfer through living system*	-during physical activities cellular respiration increases.	*concept*	remembering inferring	*11*
S2_26	*support and movement system*	-length of actin filament change during muscular relaxation whereas myosin filament do not change	*facts*	remembering inferring comprehending	*10*
S2_27	*nervous system*	-neurons only respond when the neuron is sufficiently stimulated to reach the neural threshold and do not raise the respond even the stimuli is much higher than the threshold level.	*facts*	remembering	*10*
S2_28	*heredity*	-difference between phenotype and genotype. -there are three different alleles for human blood type as A, B -and 0 which are located in different homologues chromosomes. -A and B blood types are co-dominant and they both are dominant to 0 type.	*principle*	remembering inferring	*elementary*
S2_29	*reproduction*	-LH hormone secretion rises right after the ovulation to a graphical representation.	*concept*	remembering transferring	*11*
S2_30	*population genetics*	(do not need extra knowledge)	*procedure*	transferring	*11*

4.2.2. Statistical Analysis of 2007 SST

4.2.2.1. Preliminary Analysis of 2007 SST

Before conducting the reliability analyses missing values of 16 biology items and descriptive statistics, and frequency values of 60 mathematics items, 26 physics items, 18 chemistry items, 16 biology items, 22 reading comprehension items, gender, year of birth and school types were examined. Analyses were run by 11,686 examinees. There were no missing values in terms of school type, year of birth and gender. Descriptive statistics as means, standard deviations, skewness, and kurtosis values of the SST 2007 according to school type, year of birth and gender were presented in Table 4.14, Table 4.15, and Table 4.16 respectively. Missing values and skewness-kurtosis values of all items were presented in Appendix B.

Table 4.14: Descriptive Statistics for Total Biology Score on Gender of 2007 SST

Gender	*Number*	*Mean*	*Standard Deviation*	*Skewness*	*Kurtosis*
Boy	6566	7,1739	4,09152	,310	-,999
Girl	5120	7,5527	4,09374	,193	-1,094

Table 4.15: Descriptive Statistics for Total Biology Score on Six School Types of 2007 SST

School Type	Number	Mean	Standard Deviation	Skewness	Kurtosis
General High School	6602	5,0648	2,88675	,655	,008
Private High School	852	8,7218	4,03496	-,108	-1,096
Selected High School	4232	10,6108	3,30309	-,643	-,243

Table 4.16: Descriptive Statistics for Total Biology Score on Year of Birth of 2007 SST

Year of Birth	*Number*	*Mean*	*Standard Deviation*	*Skewness*	*Kurtosis*
1988	677	7,9010	4,32352	-,001	-1,215
1989	8,9687	8,9687	4,02734	-,269	-1,036
1990	6,0738	6,0738	3,63998	,687	-,250
1991	5,6488	5,6488	3,63866	,781	-,048

4.2.2.2. Reliability Analysis of 2007 SST

As it was conducted in SST 2006 analysis, reliabilities of reading comprehension, mathematics, physics, chemistry, and biology item were analysis. As a first step of this analysis normality of those items were checked. Because the skewness and kurtosis of values were found between -2 and +2, as it is shown in below Table 4.17, it was conclude that those items are normally distributed.

Table 4.17: Skewness and Kurtosis values of 2007 SST Subtests

	Number of examinees	*Skewness*	*Kurtosis*
Turkish	11686	-,738	-,135
Mathematics	11686	-,033	-1,239
Physics	11686	,420	-,601
Chemistry	11686	,250	-1,187
Biology	11686	,258	-1,047

Reliability of the SST 2007 subtests were analyzed by calculating Cronbach's alpha coefficient for internal consistency of the score. According to Gable (1986), the criterion level for the effective measures can be reasonable set a minimum of .70. Since the 2007 SST Turkish, mathematics, physics and chemistry, biology items Cronbach's alpha coefficients were computed as 0.791, 0.981, 0.920, 0.892, and 0.812 respectively, the result was interpreted as an acceptable value for every subtest.

Crocker and Algina (1986) defines reliability coefficient as the ratio of true score variance to observed score variance. By this definition it was conclude that at least 79.1%, 98.1%, 92.0%, 89.2%, and 81.2% of the true score variance were explained in the observed score variance of 2007 SST Turkish, mathematics, physics and chemistry, biology subtests, respectively.

4.2.2.3. Item Analysis of 2007 SST

As it was conducted in item analyses of SST 2006, point-biserial and item difficulty values were examined in analyzing SST 2007 biology items. All *p* and *r* values of 16 biology items were presented in Appendix B.

In terms of item difficulty S1_23, S1_24, S1_26, and S2_28 were ideal items, their *p* values were .581 .515, .517 and .558, respectively. Besides all of those items *r* values were higher than .40, which gives that all of those items were also function as required.

Four of the 2007 biology items, S1_25, S2_25, and S2_26, can be considered as not neither difficult nor easy items. Their *p* values were .454, .431, .429. In terms of item discrimation all items functions as required because their *r* values were higher than .40.

Three of the SST-1 biology items, S1_28, S1_29, and S1_30 had higher *p* values than .59 than those items were considered as easy items. Even S1_28 (r=.540) and S1_30 do not need any revision (r=.546), S1_29 needs little revision because its *r* value was .362.

There was only one very difficult item S2_23 (p=.167) which also need to be revised because it do not function as desired (r=.266).

Rest of five SST 2007 biology items *p* values ranges between .257 and .338, this means all of those items were difficult. Moreover, even they were all difficult items they function well because their *r* values were higher than .40.

Briefly, one biology item of the 2007 SST was very difficult, three of them were neither easy nor difficult, three of them were easy, five of them were difficult, and four items were ideal in terms of item difficulty. Even most of the items functions as required, one item need to be improved, and one item was reasonably good but needs little improvement.

4.2.2.4. Factor Analysis of 2007 SST

4.2.2.4.1. Explanatory Factor Analysis of 2007 SST

In factor analysis firtly Barlett's test of Sphericity was checked. The value of Kaiser-Meyer-Olkin value of the 16 biology items was 0.925, at $p<.05$. Since this test was significant and the Kaiser-Meyer-Olkin value was higher than the .6 it was concluded that factorability of correlation matrix is satisfied.

Then 16 biology items in 2007 SST were analyzed through the principle component analysis. Two factors were obtained by this analysis. Then those two factors were rotated by Varimax rotation procedure.

Table 4.18: Rotated Component Matrix of Factor Analysis 2007 SST

Items	*Components 1*	*Components 2*
S2_28	,677	-
S2_26	,614	,101
S1_24	,604	-
S1_28	,579	-
S1_25	,544	,178
S2_25	,533	,209
S1_23	,525	-
S1_27	,516	,301
S1_30	,498	-
S2_29	,488	-
S1_26	,475	,164
S2_27	,407	,128
S1_29	,365	-
S2_24	,360	,242
S2_30	,311	,151
S2_23	-	,924

Table 4.19: Rotation sums of Squared Loadings of 2007 SST Biology Items

Factor	*Total*	*% of Variance*	*Cumulative %*
1	4,074	25,463	25,463
2	1,001	6,258	31,721

As it can be seen from Table 4.19, factor one explained 25,463 of the total variance of the test, and it included all of the items from both SST-1 and SST-2 biology tests, except S2_23. All of those items loadings were between .677 and .311. 6,258 of the total variance was explained by the factor 2, which includes S2_23.

There was not any resemblance in terms of knowledge domain, discrimination, cognitive process, and grade level within the items in factor one and S2_23. The only distinctive feature of the S2_23 is it was the hardest item among SST 2007 biology items. Additionally, S1_27 and S2_24 loaded on both of the two factors with a lower than .2 value difference. Those two items were also other difficult items in the test.

Due to this reason, these two items were interpreted in Factor 2 instead of Factor 1 (Gable, 1986).

In summary, biology items of 2007 SST were categorized according to difficulty level. Most difficult three items were grouped together and rest of the grouped apart.

4.2.2.4.2. Confirmatory Factor Analysis of 2007 SST

The path from the latent variables, NORMAL and DIFFICULT, to the observed variables, all of the biology items of 2007 SST, was constructed. The syntax of Biology Cluster of 2007 SST was given in the Appendix B. LISREL estimates of parameters in confirmatory factor analysis coefficients in standardized values and LISREL estimates of parameters in confirmatory factor analysis coefficients in t-values were given in Figure 4.3 and Figure 4.4 respectively.

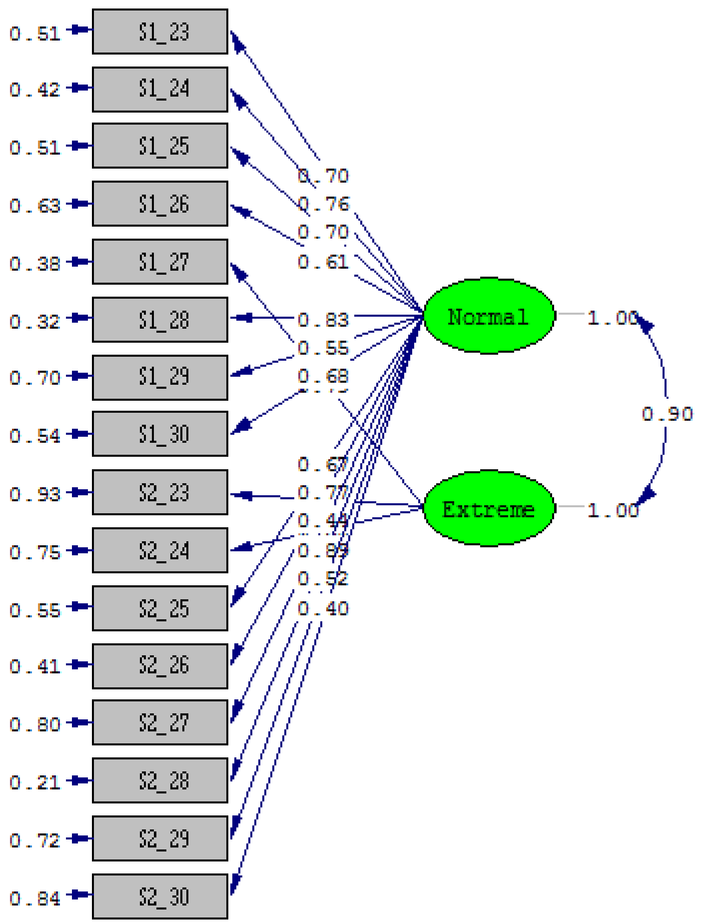

Figure 4.3: LISREL estimates of parameters in confirmatory factor analysis coefficients in estimate (SST 2007)

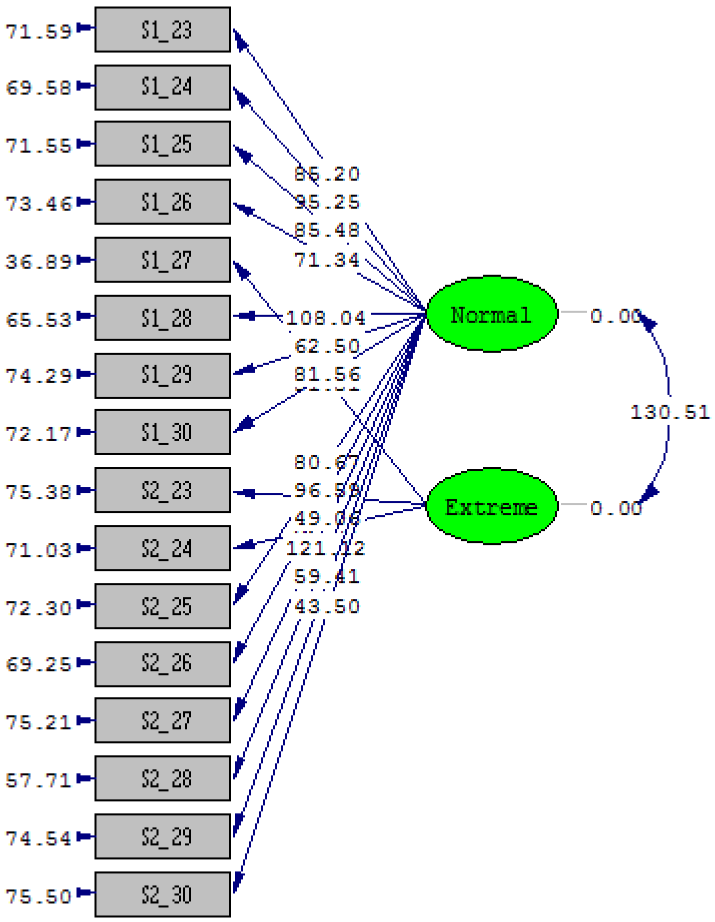

Figure 4.4: LISREL estimates of parameters in confirmatory factor analysis coefficients in t-values (SST 2007)

As it can be seen the Figure 4.3 there are two latent variables and sixteen observed variables in confirmatory factor analysis of the 2007 SST. Latent variable of DIFFICULT represents the difficult items, whereas NORMAL represents the items which are closer to desired difficulty level and easy items.

In tested model all the path coefficients were significant at 0.05 significance level which means there was no non-significant t-value, as it can be seen from Figure 4.4

As it was mentioned before Schumacker and Lomax (2003) suggest checking chi-square test and root-mean-square error of approximation (RMSEA) firstly. Then, t values, and magnitude and the direction of the parameter estimates should paid attention. Furthermore, goodness-of-fit index (GFI), the adjusted goodness-of-fit index (AGFI), and root-mean-square residual (RMR) of the test should be checked. Also, goodness-of-fit criteria of 2007 SST Biology items were given in Appendix B and the meaning of those statistics were explained below:

Chi-square test: $\chi 2 = 4519.57$ was significant at $p = 0.000$ with degrees of freedom (df) of 103. According to Schumacker & Lomax (2004), Normed Chi-Square (NC) can be calculated by χ^2/df and the result should be less than 5 to indicate a good fit to the data. By this equation, NC of model of 2007 Biology was computed as 43.88 which is too high to indicate the good fitness of the model. However chi-square test is very sensitive to the sample size and large sample size can cause a high result. To eliminate this dependence other goodness-of-fit measures such as GFI and AGFI are proposed and those measures were also computed (Jöreskog & Sörbom,2003).

Root-Mean-Square Error of Approximation (RMSEA): According to Steiger (1990) smaller values of RMSEA indicate a better fit to the data. Values below 0.10 indicate a good fit and values below 0.05 indicates a very good fit. Since RMSEA value of the SST 2007 Biology model was 0.059, this criteria was satisfied and there was good and close to very good fit of the data.

Higher values than .95 for Goodness-of-Fit Index (GFI) and Adjusted Goodness-of-Fit Index (AGFI) indicates a good fit of the data. Since the values of GFI and AGFI were .96 and .95 respectively, the model had a good fit to the data.

Besides, values less than .05 were accepted for Root-Mean-Square Residual (RMR) and SST 2007 Biology models' RMR was .028.

4.2.2.5. Multiple Linear Regression Analysis of 2007 SST

For this study the effect of age, gender, school type, reading comprehension skill, mathematic achievement, physics achievement, and chemistry achievement on biology achievement was analyzed by multiple linear regression analysis.

Before conducting those analysis descriptive statistics of interval independent variables, reading comprehension skill, mathematic achievement, physics achievement, and chemistry achievement, were examined, Table 4.20. In addition, correlation between biology achievement and non-academic factors were shown in Table 4.20.

Table 4.20: Correlation of non-academic factors and biology achievement

	Age	*Gender*	*Selecting High School*	*Private High School*
Biology Achievement	-,291*	,046*	,602*	,095*

*Correlation is significant at the 0.01 level (2-tailed).

Table 4.21: Descriptive statistics of independent variables for academic factors

	Mean	*Standard Deviation*	*Skewness*	*Kurtosis*	*Correlation with Biology Achievement*
Reading Comprehension Skill	14,8760	4,78120	-,738	-,135	,601*
Mathematics Achievement	32,7894	15,42584	-,033	-1,239	,765*
Physics Achievement	11,0254	5,65772	,420	-,601	,764*
Chemistry Achievement	8,7653	5,30448	,250	-1,187	,801*

* Correlation is significant at the 0.01 level (2-tailed).

Since significant correlations was found with biology achievement and academic and non-academic factors ($p<0.01$) regression analysis was conducted by all of the variables.

As a first step the regression coefficients of multiple correlation (R) and squared multiple correlation (R^2) were interpreted. Analysis results revealed that 70,6% of the biology achievement can be predicted by linear relationship with age, gender, school type, reading comprehension skills, mathematic achievement, physics achievement and chemistry achievement of the students ($R^2 = 0,706$). Besides, the R was .840 which means there was a high relationship between predicted biology achievements and the actual biology achievements of students by using gender, age, school type, reading comprehension skills, mathematic achievement, physics achievement and chemistry achievement values (Green & Salkind, 2008).

Same as 2006 SST analysis three different school types were coded as selecting high school, private high school, and general high school, therefore, dummy coding was used to identify the effect of school type on students' biology achievement.

Then the significance of each variable with the effects of other independent variables was examined. It was found that gender, school type, reading comprehension, mathematics, physics, and chemistry achievements were significant whereas age did not give significant effect with other seven variables considered (p= ,387 at p<0.05). Due to this reason, the variable age was not taken for the regression equation of biology achievement.

Analysis results showed that intercept, *a*, was,-532 and *b* values of the predictors were shown in Table 4.22.

Table 4.22: Beta values of predictors

	gender	*selected*	*private*	*Reading*	*mathematics*	*physics*	*chemistry*
b	,434	,882	,581	,092	,022	,196	,293

As a result the regression equation of biology achievement was computed as:

Bio = -0,532 + 0.434*gender + 0.882*selected +0.581*private + 0.02*reading + 0.022* math + 0.196*phy + 0.293*che

As a summary, it was concluded that even age is not a good predictable variable for biology achievement other two non-academic factors are most effective variables on biology achievement. In depth girls are more successful than boys in biology achievement. Besides, attending to selecting type high school higher the achievement than attending to private school or general high school whereas graduating from private school also gives higher probability of being successful than general high school. Among academic factors, chemistry was the most effective variable followed by physics, reading comprehension achievement, and mathematics.

4.3. 2008 SST Analysis

4.3.1. Content Analysis of 2008 SST

4.3.1.1. Content Analysis of 2008 SST-1

Results of 2008 SST-1 content analysis results was given in Table 4.22. As it explained before the aim of SST-1 is to evaluate students' cognitive skills in the context of common courses which includes the elementary and 9th grade curriculum. Even though 7 of the items in 2008 SST-1 items were selected from those curriculum content of S1_26 was selected from 11th grade curricula.

According to the content type, half of the SST-1 biology subtest comprised in facts form. Other three items were focusing in principle form S1_26, S1_28 and S1_30, meanwhile S1_29 was in concept form. Besides, there was not any item in procedural form.

Regarding the cognitive level of 2008 SST-1, S1_25, S1_27, and S1_29 were measuring only remembering skill. All of the other five items were focusing on at least one more cognitive process besides remembering skill. Items focus on remembering and inferring skills were S1_23 and S1_28. S1_24 was the only item which assesses transferring skills in addition to remembering skill. Further S1_26 and S1_30 were measuring three cognitive processes together. S1_26 focused on remembering, transferring, and generalizing whereas S1_30 focused on remembering, transferring, and inferring.

Table 4.22: Content Analysis of 2008 SST-1

Item	*Unit*	Knowledge Needed	*Knowledge Domain*	Cognitive Process	*Grade Level*
S1_23	*lymph and immunity system*	-after vaccinated or ones cause of disease enters the body it causes illness and immunizes	*facts*	remembering inferring	*elementary*
S1_24	*ecology*	-food source of producers, consumers, and decomposers	*facts*	remembering transferring	*9*
S1_25	*cell division*	-meiosis leads genetic variation by random align along of homologous chromosomes on equatorial plane and chromosomal crossing-over.	*facts*	remembering	*9*
S1_26	*relationship among living things*	-if the bacteria has a low resistance to the antibiotic then it cannot reproduce	*principle*	remembering transferring generalizing	*11*
S1_27	*cellular respiration*	-steps in cellular respiration	*facts*	remembering	*9*
S1-28	*Ecology*	-ecosystem includes both living and non-living environment, it is impressed after the non-living environment. Since non-living environment shelter the living things, destruction of non-living environment directly effects life.	*principle*	remembering inferring	*9*
S1_29	*cell membrane transport*	-if the substance movement occurs against the concentration gradient and if the substances are larger than the pores of cell membrane then for the transport of those substances cell uses chemical energy, ATP.	*concept*	remembering	*9*
S1_30	*ecology*	-type of food and biotope are the measure competition factor whereas breeding season is not	*principle*	remembering transferring inferring	*9*

To answer all items correctly students need to know some concepts or facts. Facts and concepts needed to known for S1_24, S1_27, S1_29, and S1_30 were very deep. Hence it can be concluded that 2008 SST-1 biology items mostly focus on remembering skill more than 2006 SST and 2007 SST.

4.3.1.2. Content Analysis of 2008 SST-2

Interpretation of 2008 SST-2 content analysis results were given in Table 4.23. Discretely SST-1, SST-2 aims to evaluate students' cognitive process according to the content of field course which means items of SST-2 should be selected from high school curricula. All of the 2008 SST-2 biology items satisfied this aim.

Regarding the content type none of the items were in procedural form and they mostly focused on facts and concept type. Items assess concept were S2_24, S2_25, and S2_26, whereas S2_23, S2_28, S2_29, and S2_30 focused on facts. As distinct from those seven items, S2_27 a principles type item.

Like 2006, 2007, and 2008 SST-1, 2008 SST-2 biology items were assessing students remembering skills. However, 2008 SST-2 biology items served to this purpose more than other SST-1 and SST-2 of 2006, 2007, and 2008, because half of the 2008 SST-2 biology items were measuring only remembering skills. Additionally, all of those required knowledge were deeper than other SST biology items.

On the other hand, to answer S2_24 students did not need any extra knowledge and it aimed to assess interpreting skills. Same in other SSTs, in 2008 SST-2 subtest there were two items which focus on at least one more cognitive process besides remembering. S2_25 was measuring remembering and inferring skills, whereas S2_27 was measuring remembering, transferring, and inferring skills.

Table 4.23: Content Analysis of 2008 SST-2

Item	*Unit*	Knowledge Needed	*Knowledge Domain*	Cognitive Process	*Grade Level*
S2_23	*population genetics*	-linear relationship between change in gene frequency and rate of reproduction.	*facts*	remembering	*11*
S2_24	*origin of life*	no extra knowledge is needed	*concept*	inferring	*11*
S2_25	*digestive system*	-urea is produced when the liver breaks down proteins. -since urea can dissolve in blood kidney absorb it from the blood and excreted it as a component of urine.	*concept*	remembering inferring	*10*
S2_26	*regulatory system*	-plant hormones are not secreted by a specialized glands	*concept*	remembering	*10*
S2_27	*heredity*	-X-linked recessive gene causes the phonotypical expression in males. -expression in females occurs if the individual has homozygous gene, but if female has a heterozygous then they are the carrier of the gene.	*principle*	remembering transferring inferring	*11*
S2_28	*photosynthesis*	-the steps in photosynthesis.	*facts*	remembering	*11*
S2_29	*cellular respiration*	-ATP mostly synthesized in Electron Transport Chain (ETC) reactions	*facts*	remembering	*11*
S2_30	*regulatory system*	-secretory of liver and pancreas functions in different organs of the body	*facts*	remembering	*10*

4.3.2.2. Statistical Analysis of 2008 SST

4.3.2.1. Preliminary Analysis of 2008 SST

As it was conducted in 2006, and 2007 SST statistical analysis, firstly missing values analysis of 16 biology 2008 SST items and descriptive statistics and frequency values of 60 mathematics items, 26 physics items, 18 chemistry items, 16 biology items, 24 reading comprehension items, age, gender, year of birth and school types were examined and presented in Appendix C. Analyses were conducted by 10,359 examinees. There were no missing values in terms of age, school type, year of birth and gender.

Descriptive statistics such as means, standard deviations, skewness and kurtosis values of the SST 2008 according to school type, year of birth and gender for biology achievement were presented in Table 4.24, Table 4.25, and Table 4.26 respectively.

Table 4.24: Descriptive Statistics for Total Biology Score on Gender

Gender	*Number*	*Mean*	*Standard Deviation*	*Skewness*	*Kurtosis*
Boy	5561	3,1174	2,84214	2,248	5,399
Girl	3,1799	2,82414	2,208	5,045	3,1799

Table 4.25: Descriptive Statistics for Total Biology Score on Six School Types

School Type	*Number*	*Mean*	*Standard Deviation*	*Skewness*	*Kurtosis*
Private High School	870	2,9126	2,67653	2,411	6,894
Selected High School	9489	3,1678	2,84701	2,214	5,108

Table 4.26: Descriptive Statistics for Total Biology Score on Year of Birth

Year of Birth	*Number*	*Mean*	*Standard Deviation*	*Skewness*	*Kurtosis*
1990	1110	3,2667	2,96737	2,153	4,670
1991	8720	3,1377	2,81708	2,214	5,178
1992	529	3,0359	2,82049	2,638	7,547

4.3.2.2. Reliability Analysis of 2008 SST

Since the aim of the SST 2008 analyses were same with the SST 2006 and SST 2007 analysis, same steps were conducted for 2008 SST reliability analysis. First of all normality's of the biology, mathematics, physics, chemistry, and reading comprehension achievement subtests were checked by their skewness and kurtosis values. As it can be seen from the Table 4.27 skewness of mathematics and biology subtests and kurtosis of all five subtests do not exists between -2 and +2, which means those tests were not normally distribute. Even though this assumption was not satisfied all of the analysis as well as reliability analysis were also conducted for 2008 SST analysis.

Table 4.27: Skewness and Kurtosis values of 2008 SST Subtests

	Number of examinees	*Skewness*	*Kurtosis*
Turkish	10359	1,958	2,894
Mathematics	10359	2,132	4,449
Physics	10359	1,556	2,250
Chemistry	10359	1,921	3,940
Biology	10359	2,229	5,232

Gable (1986) cited that .70 is the minimum criterion level for the effective measures for a reliable test. Cronbach's Alpha coefficients of 2008 SST biology, reading comprehension, mathematics, physics, and chemistry subtests were 0,798, 0, 887, 0,946, 0,867, and 0.810, respectively. Those values showed that those subtests can be interpreted as reliable. Additionally, by those values it can be concluded that 79.8%, 88.7%, 94.6%, 86.7%, and 81.0% of the true score variance were explained in the observed score variance of 2008 SST biology, reading comprehension, mathematics, physics and chemistry subtests respectively.

4.3.2.3. Item Analysis of 2008 SST

In item analysis difficulty and discrimination level of the biology items were analyzed as it was done in 2006 and 2007 SSTs analysis. All *p* and *r* values of 16 biology items were presented in Appendix C.

Differently than 2006 and 2007 SST biology items, 2008 SST biology items were all very difficult items because their *p* values were between 0.248 and 0.078. Moreover, there were two items which has lower than 0.1 *p* value. Only *p* value of Bio 1_3 was higher than 0.39 (*p*= 0.471) but this value can be interpreted as a description of difficult item.

In terms of item discriminateness twelve of the items' *r* values were higher than .4, which means they all functions as it was desired. However, S1_25, S2_24, and S2_28 needed to be improved because their *r* values were 0.200, 0,244, and 0.273. S2_27 functioned quite well but it would be better to improve it (*r*=355).

Briefly, most of the 2008 SST biology items were function as it is required but they were all difficult items.

4.3.2.4. Factor Analysis of 2008 SST

4.3.2.4.1. Explanatory Factor Analysis of 2008 SST

Principle Component Analysis with Varimax Rotation and Confirmatory factor analyses were conducted same as 2006 and 2007 SST factor analysis.

As a first step, Kaiser-Meyer-Olkin value was checked and the value of Kaiser-Meyer-Olkin value of the 16 biology items was 0.848, significant at $p<.05$. It was concluded that that factorability of correlation matrix is satisfied.

All of the 2008 SST biology items were analyzed through the principle component analysis. Even, four factors were obtained by this analysis, by interpretability of factor solution criteria 3 factors were rotated by Varimax rotation procedure. Factor loadings of items were presented in Table 4.28.

Table 4.28: Rotated Component Matrix of Factor Analysis 2008 SST

Items	Factor Loadings		
	Factor 1	Factor 2	Factor 3
S1_26	,818	-,218	,179
S2_23	,688	,121	-
S2_30	,683	-	,105
S1_24	,609	,116	-
S1_23	,496	,372	-,147
S1_25	-,207	,732	-,391
S2_29	,431	,586	,331
S1_29	,344	,529	,267
S1_27	,494	,497	,338
S2_26	,410	,474	,101
S1_28	,274	,472	,240
S2_28	-	,281	,110
S2_25	,151	-	,761
S1_30	-	,420	,621
S2_27	-,128	,247	,579
S2_24	-	-	,352

Table 4.29: Rotation sums of Squared Loadings of 2008 SST Biology Items

Factor	Total	% of Variance	Cumulative %
1	4,406	27,536	27,536
2	1,672	10,447	37,983
3	1,450	9,065	47,048

27,536 of the total variance of the test was explained by Factor 1, and it includes S1_23, S1_24, S1_26, S2_23, and S2_30 items. All of those items loadings were between .816 and .496. Factor 2 explained the 10,447of the total variance of SST 2008 biology subtest and it includes S1_25, S1_27, S1_28, S1_29, S2_26, S2_28, and S2_29. S1_30, S2_24, S2_25, and S2_27 composed Factor 3 which explains the 9,065 of the total variance.

While interpreting the factors; factor loading of S1_23 and S1_28 were changed according to Gable (1986) suggestion. In this criterion it is specified that if an item is loaded on factors with a difference less than 0.2 it can be interpreted as in one of the two factors. Those items were loaded by a less difference of 0.2 to both first and the second factor. By this change items of the second factor become S1_25, S1_27, S1_28, S1_29, S2_26, S2_28, and S2_29. As it can be seen from the Table 4.22 and Table 4.23, those items were assessing remembering skill.

Rest of the items in both factor 1 and factor 3 were assessing skills other than remembering or other cognitive processes besides remembering except S2_23 and S2_30 which focus on remembering. Due to this reason, Factor 1 and Factor 3 were combined in one factor and loadings changed of 2008 SST Biology Items were shown in Table 4.30.

Table 4.30: Changed Rotation sums of Squared Loadings of 2008 SST Biology Items

Factor	*Total*	*% of Variance*	*Cumulative %*
1	5,811	36,601	36,601
2	1,672	10,447	47,048

4.3.2.4.2. Confirmatory Factor Analysis of 2008 SST

The path from the latent variables, REMEMBERING and OTHER, to the observed variables, all of the biology items of 2008 SST, was constructed. The syntax of Biology Cluster of 2008 SST was given in the Appendix C. LISREL estimates of parameters in confirmatory factor analysis coefficients in standardized values and LISREL estimates of parameters in confirmatory factor analysis coefficients in t-values were given in Figure 4.5 and Figure 4.6.

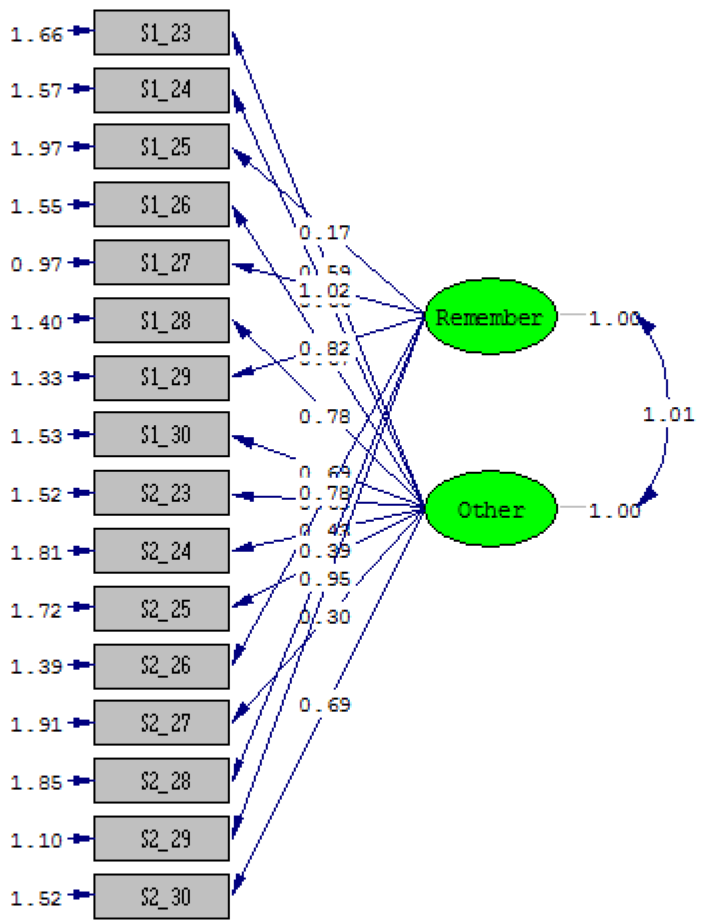

Figure 4.5: LISREL estimates of parameters in confirmatory factor analysis coefficients in estimate (SST 2008)

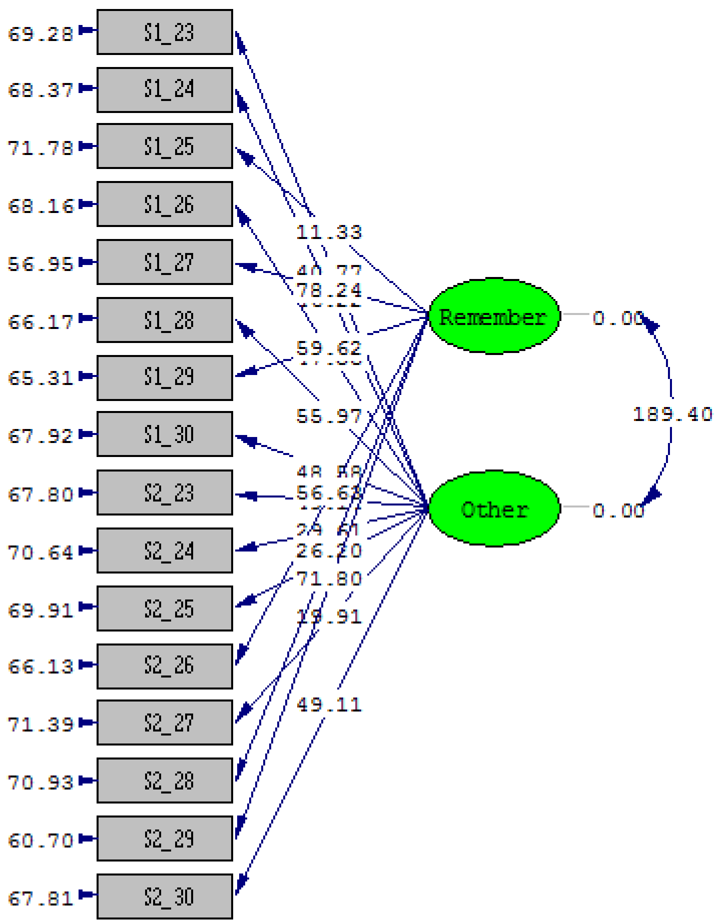

Figure 4.6: LISREL estimates of parameters in confirmatory factor analysis coefficients in t-values (SST 2008)

There were two latent variables and sixteen observed variables in confirmatory factor analysis of the 2008 SST, as it can be seen the Figure 4.5. Latent variable of REMEMBERING represents the items which generally focus only on the remembering skill, and OTHER composes of items which assess the skills not only remembering skill except S2_23 and S2_30.

As a first step chi-square and root-mean-square error of approximation (RMSEA) were checked as it was done in previous SSTs analysis. Afterwards t-values and magnitude and the direction of the parameter estimates were paid attention. As a final step goodness-of-fit index (GFI), the adjusted goodness-of-fit index (AGFI), and root-mean-square residual (RMR) of the test were checked. Also, goodness-of-fit criteria of 2008 SST Biology items were given in Appendix C and the meaning of those statistics were explained below:

Chi-square test: χ^2 = 7247.81 was significant at p = 0.000 with degrees of freedom (df) of 89. Normed Chi-Square (NC) can be calculated by χ^2/df and the result should be less than 5 to indicate a good fit to the data (Schumacker & Lomax, 2004). By this equation the NC of model of 2008 Biology was found 76,02 which is too high to indicate a good fitness of the model. However chi-square test is very sensitive to the sample size and large sample size can cause a high result. In those circumstances other goodness-of-fit measures such as GFI and AGFI are proposed and those measures were also computed (Jöreskog & Sörbom, 2003).

Root-Mean-Square Error of Approximation (RMSEA): According to Steiger (1990) smaller values of RMSEA indicate a better fit to the data as value below 0.10 indicates a good fit and values below 0.05 indicates a very good fit. Since RMSEA value of the SST 2006 Biology model is 0.097. This showed taht there is good fit of the data which is the only assumption satisfied to say that the model was fitted.

Goodness-of-Fit Index (GFI) and Adjusted Goodness-of-Fit Index (AGFI) are both .89 and.85. Since higher values than .95 for GFI and AGFI indicates a good fit of the data, those criteria did not satisfy. Additionally, values less than .05 are accepted for Root-Mean-Square Residual (RMR) and SST 2008 Biology models' RMR was .14.

Those results showed that an only satisfied criterion for CFA is RMSEA. Besides GFI can be also interpreted as satisfied because its value was very close to 0.90 and according to Kelloway (1998) GFI values exceeding 0.9 indicates a good fit to the data.

4.3.2.5. Multiple Linear Regression Analysis of 2008 SST

The effect of age, gender, school type, reading comprehension skill, mathematic achievement, physics achievement, and chemistry achievement on biology achievement was analyzed by multiple linear regression analysis by SPSS 17.0.

As it is conducted in previous SST analysis first of all descriptive statistics of interval independent variables reading comprehension skill, mathematic achievement, physics achievement, and chemistry achievement were examined, and result of this analysis was shown in Table 4.31. Additionally, correlation between biology achievement and non-academic factors were shown in Table 4.32.

Table 4.31: Descriptive statistics of independent variables for academic factors

	Mean	*Standard Deviation*	*Skewness*	*Kurtosis*	*Correlation with Biology Achievement*
Reading Comprehension Skill	6,5046	5,22328	1,958	2,894	, 771*
Mathematics Achievement	13,8172	10,66621	2,132	4,449	,806*
Physics Achievement	6,6720	4,75248	1,556	2,250	, 690*
Chemistry Achievement	4,3110	3,42981	1,921	3,940	, 784*

* Correlation is significant at the 0.01 level (2-tailed).

Table 4.32: Correlation of non-academic factors and biology achievement

	Age	*Gender*	*School Type*
Biology Achievement	,017	,011	,025*

*Correlation is significant at the 0.05 level (2-tailed).

As it can be seen from Table 4.31 all of the variables for academic factors correlation was significant with biology achievement ($p<0.01$) regression analysis was conducted by all of the variables. Additionally, correlation between biology achievement and school type was significant at $p<0.01$ but there was not any significant correlation between biology achievement and age and gender. Due to this reason, regression analysis was conducted by academic variables, school type and biology achievement.

Since regression coefficient of multiple correlation (*R*) was .842, it can be interpreted as there is a high relationship between predicted biology achievements and the actual biology achievements of students by using school type, reading comprehension skills, mathematic achievement, physics achievement and chemistry achievement values (Green & Salkind,2008). Additionally, 70.9% of school type, , reading comprehension skills, mathematic achievement, physics achievement and chemistry achievement of the students can be used to predicted the biology achievement because squared multiple correlation (R^2) was 0,709.

As it is cited in Chapter 2 differently from previous SST analyses only general and selecting high were used for regression analysis.

Even correlation between biology achievement and the variables were checked and all of the correlations were found significant, the effect of school type was not significant when other independent variables were taken into account (p= ,691 and p=.152 at $p<0.05$).

Due to this reason, the variable of school type was not taken for the regression equation of biology achievement. The equation was computed with significant variables which are reading comprehension, mathematics, physics, and chemistry.

Analysis results showed that intercept, *a*, was -,118 and *b* values of the predictors are shown in Table 4.33.

Table 4.33: Beta values of predictors

	reading	*math*	*phy*	*che*
Beta	, 137	, 077	, 046	, 241

As a result the regression equation of biology achievement was computed as:

Bio = -0.118 + 0.137*reading + 0.077* math + 0.046*phy + 0.241* che

If all of those results were summarized it can be concluded that whether attending to a selected high school or private high school does not make an significant difference on biology achievement. For academic factors it can be concluded that chemistry is the most effective variable followed by reading comprehension, mathematics, physics achievement.

CHAPTER 5

CONCLUSION, DISCUSSION AND RECOMMENDATIONS

This chapter includes the discussion and the conclusion of the results, the interpretation of the findings presented in the present study, and recommendations for the future researches and OSYM are presented.

5.1 Conclusion

In the conclusion part the results of the study were summarized by the order of research questions.

5.1.1. Conclusion about the Results of Content Analyses

First research question of the study aimed to identify the content specifications of the biology items in 2006, 2007, and 2008 SSTs in terms of grade level, content types, and cognitive processes. For this research question content analysis technique was used and content analysis was conducted by the researcher and a research assistant from Middle East Technical University.

As it was mentioned before, the aim of the SST-1 and SST-2 is different from each other. The aim of the SST-1 is to assess students' cognitive skills in the context of common courses so; those items should compose of elementary and 9th grade science curriculum. On the other hand, SST-2 aims to measure students' cognitive skills of filed courses. To this aim, those items should include the entire elementary school and high school science curriculum. The result of the content analyses revealed that most of the items in all three SSTs satisfied the aim, but S1_30 in 2006 SST and S1_26 in 2008 SST comprised of 11^{th} grade context.

In terms of content type, most items were in facts form (43.75%), while items in concept and principle form were both 25% of biology items in three years SSTs. It must be noted that only 3 of the whole 48 items were in procedural form.

In content analysis most time consuming and challenging part was deciding about the cognitive processes. Almost all items were assessing remembering skills and predominantly mastery knowledge was needed to understand the item. 18 of items out of 48 biology items were assessing remembering skills. More importantly 21 items were focusing on at least one more cognitive process additionally to remembering skill like comprehending, transferring, and inferring. Moreover, five of those 21 items were measuring three cognitive domains in same item. It should be noted that none of those fourth eight items were focusing on science process skills. To deepen, none of those items were assessing students' skills about scientific experiments such as determination of variables, selecting of suitable tests, interpreting data, interpreting result, and evaluating hypothesis.

5.1.2. Conclusion about the Result of the Reliability Analysis

The second research question of the research focused on the reliabilities of subtests used through the study which are reading comprehension, mathematics, physics, chemistry and biology subtests of all three years analysis. Results revealed that those subtests Cronbach's alpha coefficients were all higher than 0.7 and they were all reliable. Yet, before conducting the reliability analysis normality assumption of the tests were also checked. 2008 SST subtests do not satisfy the assumption because kurtosis values of the subtests were not between -2 and +2.

5.1.3. Conclusion about the Item Characteristics

Identifying the item characteristics in terms of difficulty level and distinctiveness of biology items in three years SSTs was the third research question of the study.

In terms of distinctiveness, most of the biology items were ideal. However, one item in 2006 SST-1 should be rejected because it’s one of the alternatives worked better than the key.

With regard to item difficulty 2006 SST biology items varied. One of them was neither easy nor difficult, one of them was easy, ten of them were difficult items, and only two items was ideal in terms of item difficulty. Same variety in difficulty was also seen in 2007 SST biology items. One biology item was very difficult, three of them were neither easy nor difficult, three of them were easy, five of them were difficult, and four items were ideal in terms of item difficulty. Unfortunately none of the 2008 SST biology items were ideal or easy, that test was composed of all very difficult items.

5.1.4. Conclusion about the Result of the Factor Analysis

Fourth and the main research question of the study aimed to identify the factorial structure, dimensions, of biology items in the three years SSTs. For this aim exploratory and confirmatory factor analysis techniques were used.

It should be mentioned that another hard and time consuming part of this study was deciding about the dimensions of the biology subtest. To interpret the dimensions of the tests scree plot, interpretability of factor solution, and Gable criteria were used.

There was not any resemblance in terms of difficulty, knowledge domain, cognitive process and grade level within any factor of 2006 SST. Only difference between factors could be observed in terms of distinctiveness. Besides, those factors were statistically confirmed by confirmatory factor analysis.

It was found that dimensions underlying in 2007 SST biology items were clustered in terms of item difficulty. Most difficult three items could be grouped together and rest of the grouped apart and those dimensions were proved by confirmatory factor analysis.

On the other side only acceptable and logical clusteration of biology items was observed in SST 2008 analysis because they clustered in terms of cognitive processes. As it was mentioned before 2008 SST items were generally focusing on remembering skill solely. Those items were clustered in one factor. However those dimensions could not be confirmed by confirmatory factor analysis. Only root-mean-square error of approximation and goodness-of-fit index criteria were satisfied.

5.1.5. Conclusion about the Multiple Linear Regression Analysis

The second aim of the research was to identify how biology achievement can be predicted by academic and non-academic factors by using 2006, 2007, and 2008 SSTs. For this aim, three research questions were formed. In the first research question relationship between academic factors and biology achievement aimed to reveal. Meanwhile, in the second research question aim was to identify the relationship between biology achievement and non-academic factors. The third and main research question of the second part of the study was to identify how much do academic factors and non-academic factors influence biology achievement with other academic and non-academic factors.

Before conducting the multiple linear regression analysis correlations between biology achievement and academic and non-academic variables were checked. For three years analysis all academic factors -reading comprehension, mathematics, physics, and chemistry achievement- were used and they all gave medium to high correlation with biology achievement. For non-academic factors age, gender, and school type were used. For school type three categorizations were generated, general high schools, private high schools, and selecting high schools. For 2006 SST analysis age did not include to the study because of the insufficient information about the birth of the examinees. Besides, in 2008 analysis general high school students did not include to the study because of the insufficient number of examinees. However, it should be mentioned that all of the non-academic variables used in all three years analysis gave medium to high correlation with biology achievement when those relationships were analyzed separately.

After checking the correlations of academic and non-academic variables multiple linear regression analysis was conducted. In 2006 SST results it was found that private high schools do not give significant correlation with biology achievement when other variables are taken into consideration. Even all school types gave significant correlation, age did not give any significant correlation with other variables on biology achievement in 2007 SST analysis. Meanwhile, in 2008 SST results revealed that only academic factors have significant correlation with biology achievement when all of those seven variables are used in the analysis.

If the result of all three years analysis are summarized it can be seen that chemistry achievement is the most effective factor among all academic variables through all three years analysis. In 2006 and 2007 SSTs analyses physics comes right after the chemistry achievement where in 2008 analyses reading comprehension came in the second order. In 2006 and 2007 SSTs analyses mathematics achievement was the least effective factor on biology achievement, whereas in 2008 analyses physic showed the minimum effective variable on biology achievement.

In terms of the effect of non-academic factor on biology achievement results varied in all SST analyses. Considering the effect of the gender in 2006 and 2007 SSTs revealed that girls tend to have higher scores in biology achievement whereas in 2008 analyses gender did not give statistically significant effect on biology achievement when other independent variables are taken into account. For the relationship between biology achievement and age it can be said that, even statistically significant correlations can be found when those variables are analysis separately from other variables, no significant correlation can be found if other independent variables are taken into account. Most remarkable the graduating from a selecting high school lead to have higher grades than graduating from a private high school and general high school, respectively.

5.2. Discussion

As it was done in result section of the chapter result of the research were discussed with the order of the research questions.

The first research question was dealing with the content analysis of 2006, 2007, and 2008 SSTs biology items. Content of the biology items are not described by OSYM. However, the aim of the science subtest was explained as to test ability to make use of basic mathematical concepts and rules, whereas the aim of the science subtest as to assess ability to reason using the basic concepts and principles of natural science subjects (OSYM, 2004; OSYM, 1984 cited from Berberoğlu, 1996). In addition, according to Berberoğlu (1996) the science items are assessing higher order thinking skills in Bloom’s (1979) taxonomy. However, 2006, 2007, and 2008 SSTs biology items mostly fail to assess those higher order thinking skills because they mostly focused on remembering ability of the students. In addition, more than half of the biology items include more than one single content or cognitive process. According to Haladyna (2004) higher order thinking skills should be emphasized in multiple choice items but complex chain of cognitive processes or content types should be avoided and each item should focus on a single mental behavior. In this way a clear connection between teaching and testing processes can be obtained. More importantly, if a complex, multistage process is used in an item to reach the correct answer and if the students miss the item than no information would be gathered which step or content in the process is not learned. As a summary, it can be concluded that most of the biology items of SSTs are not suitable to identify which knowledge or cognitive processes are achieved or not by students.

In addition and more importantly, according to Klopter (1971) traditional science courses focus on conceptual understanding skills where modern science courses mostly focus on scientific inquiry skills which are used during scientific experiments. For this study science process skills were defined according to Klopter’s categorizations. It was found that none of the biology items in 2006, 2007, and 2008 SSTs were assessing those science process skills. To deepen, even there were some items assess interpreting skills they focus on the interpretation of given information.

However, none of those items required interpretation of data or interpretation of result derived from an experiment. In addition, none of those items assess observing, recognition of a problem, determination of variables, measuring, hypothesizing, selection of suitable tests, designing procedures, evaluating hypothesis, or formulating generalizations.

Identifying the item characteristics of SSTs biology items in terms of difficult and distinctiveness was the aim of the second research questions. In terms of item difficulty, most of the biology items were difficult in 2006 and 2007 SSTs whereas in 2008 SST all of the items were very difficult. These results can be interpreted as those items does not devoted to the examinees. When items were analyzed according to distinctiveness it was found that in general most of the biology items were ideal.

The third research question of the study focused on reliability of the reading comprehension, mathematics, physics, chemistry, and biology subtest of three years SSTs, meanwhile in fourth research aim was to identify the dimensions of biology subtest for construct validity. According to Gronlund (1981) reliability is the necessary condition for validity. Due to this reason, it can be concluded that the third and fourth research questions of the study were somewhat related with each other. Before conducting the reliability analysis normality of the subtests were checked and it was found that in 2008 SST all subtests' kurtosis values were not between the range of -2 and +2. Therefore, those subtests cannot be interpreted as reliable and valid.

For validity analysis, exploratory and confirmatory factor analyses were used and for all three years biology subtests different dimensions were obtained. 2006 SST biology items were clustered according to distinctiveness, 2007 SST biology items were clustered in terms of difficulty where 2008 SST biology subtest was clustered in terms of cognitive level. However, in the literature most important findings revealed that mostly science subtests are clustered in terms of knowledge and cognitive domain in both multiple choice and performance assessment tests (Hamilton, Nussbaum, Kupermintz, Kerkhoven & Snow,1995, Nussbaum, Hamilton & Snow, 1997, Ayala, Shavelson, Yin & Schultz, 2002). However, there were not any consistent dimensions among the biology subtests. More importantly dimensions of 2006 and 2007 SST biology subtests were not logical and justifiable. In addition, dimensions determined in 2008 SST biology subtests were clustered in terms of cognitive processes but those dimensions could not be confirmed sufficiently in confirmatory factor analysis.

The other aim of the study was to identify the predicted biology achievement by academic and non-academic factors. As it was mentioned before reading comprehension, mathematics, physics, and chemistry achievements were determined for academic factors whereas age, gender, and school types were used for non-academic factors.

In the literature there was not any research about the correlation between biology achievement and reading comprehension skill but there were some studies conducted with science and reading comprehension skills. The result of those studies revealed that there is a high correlation between science and reading comprehension achievement. Therefore, it is interpreted that reading comprehension should lead to good understanding of science texts, in addition, tests and science tests used to identify students science achievement may not be a valid instrument to assess students' science knowledge but a good instrument to assess combination of reading and science ability (Cromley, 2009, O'Reilly & McNamara, 2007, and Ratliff, 2007).

Similar findings were found in the present study, correlation with biology achievement and reading comprehension achievement of the students varied between .512 and .771 in three years analysis. In addition, in every year analysis significant results were also found in multiple linear regression analysis which means reading comprehension achievement is an important factor on biology achievement, even, other independent factors are taken into account.

According to Lederman (1998; 2005) science should be thought in a sequence of physics-chemistry- biology because of the hierarchical nature of the science and studied as physics knowledge applied to chemistry and biology, and chemistry knowledge applied to biology. This view is also seen in Physics First Movement in the literature. The findings of the present study revealed that chemistry achievement is the most effective academic factor on biology achievement when all other academic and non-academic variables are taken into account. In addition, in 2006 and 2007 analysis physics was the second important factor among academic variables. Therefore, it can be concluded that logic behind the Physics First Movement is somewhat proved by this research. However, still there is not enough information to identify those relationships between those variables.

About the effect of mathematics achievement on predicted biology achievement results of the study showed that there is a higher correlation with mathematics achievement than reading comprehension achievement, even all of those academic and non-academic variables are taken into account. However, in the literature high correlation with reading comprehension (Cromley, 2009, O'Reilly & McNamara, 2007, and Ratliff, 2007) and medium to low correlation with mathematics achievement was found (Nagy, Trautwein, Baumert, Köller & Garrett, 2006, Ma &

Ma, 2005). The reason behind this finding can be derived from the value of mathematics and Turkish subtest scores on science field students overall SST scores. If a science field students answers a mathematic question gets higher score than a Turkish subtest question (OSYM, 2008a). Therefore, students may prefer to answer mathematics questions than Turkish literacy questions.

Similar findings with the literature found about effect of school type and biology achievement. As it was mentioned before three general highs school types were determined for the present study, general high school, private high school, and selecting high school. When the literature is reviewed it can be seen that students from selecting high school get higher scores in science achievement than other two school types while general high school students tend to get lowest scores (Berberoğlu & Kalender, 2005, Uygun, 2008, and Bay & Tugluk, 2004). Also, result of present study revealed that students who graduate from selecting high school tends to get higher scores in biology achievement when this relationship was analyzed separately than other independent variables. However, if the effects of other independent variables were taken into account different results were found in each year analysis. Graduating from selecting high school, followed by private high school, was found as the most effective factors in 2006 and 2007 analysis, while no significant effect was found in 2008 analysis. The reason behind this result can be derived from the lack of general high school students in 2008 SST analysis. Overall this result can be interpreted as students who graduated from selecting high school tend to get higher score but the difference between private and selecting high school is much lower than the difference with general high school.

Findings about the relation between gender and biology achievement is also inconsistent with the literature. In some studies girls tend to get higher score (Hacıeminoğlu, Yılmaz-Tüzün & Ertepınar, 2009, Yenilmez, Sungur, & Tekkaya, 2006), while in some studies it was found that boys tend to have higher scores than girls (Nowell & Hedges, 1998). The result of the present study revealed similar inconsistency. Result of multiple linear regression analysis with 2006 and 2007 analysis revealed that girls tend to have higher scores while no significant gender difference found with 2008 data.

The last non-academic variable determined for the study was the effect of age on predicted biology achievement which is the least effective variable on biology achievement. Yet, in none of the three years data age gave a significant relationship in multiple linear regression analysis. According to Langer, Kalk and Searls (1984) the effect of age on achievement disappears when students gets older and the subjects of the present study were all 11th grade student. The reason of this non significance on this study may be explained by, among this grade cognitive development may not be effective in one year old.

In conclusion it can be said that chemistry is the most effective variable on academic achievement followed by physics, mathematics, and reading comprehension achievement. Meanwhile, graduating from selecting high school followed by private high school is the most effective variable on biology achievement among non-academic factors. In addition, age does not give significant correlation with biology achievement because students used in this research are all mature.

5.3 Recommendations

Some recommendations are provided to the test developers in Turkey, researchers who study on validation of tests and biology educators.

- First of all the content and construct definitions of biology items should be clarified by OSYM. Preparation of a table of specification would be useful for this purpose.
- Since most of the items focus on remembering skill and there is not any item assess science process skills, higher order thinking skills and science process skills should be given attention.
- Most of the items focus on more than one concept or cognitive level, this situation should be avoided and items should be prepared with one content and one cognitive level.
- Since there are lots of difficult items, especially in SST 2008, test developers should take into account the students ability level.
- Academic factors, especially chemistry, have an important effect on biology achievement and those relationships should be analyzed deeply by other tests.
- In regression analysis only some factors on biology achievement could be analyzed. However, other factors effect on biology achievement, like social economical level of the family, should be analyzed by further researches.
- Effect of school type should be analyzed deeply and some researches should be conducted to prevent this great difference between school types.
- Multiple linear regression analysis does not give any information about the cause of academic and non-academic factors on biology achievement. Due to this

reason, deep analysis should be conducted to identify the underlying reasons of those effects.

- Similar research should be conducted by subsequent SSTs to identify whether other SSTs has the same features with 2006, 2007, and 2008 SSTs.

5.4 Limitation

Because of the large amount of missing value decimation of subjects could not be included in the test which is the major limitation of this study. In addition, by multiple regression analysis only some academic and non-academic factors effect on biology achievement could be interpreted because of the insufficient information about other factors.

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APPENDIX A

ANALYSIS OF 2006 STUDENT SELECTION TEST

Missing Values of Items

Science 1_23		
	Frequency	*Percent*
0	2442	24,0
1	6642	65,3
Missing	1091	10,7
Total	10175	100,0

Science 1_24		
	Frequency	*Percent*
0	3749	36,8
1	4652	45,7
Missing	1774	17,4
Total	10175	100,0

Science 1_25		
	Frequency	*Percent*
0	6578	64,6
1	2561	25,2
Missing	1036	10,2
Total	10175	100,0

Science 1_26		
	Frequency	*Percent*
0	3013	29,6
1	5999	59,0
Missing	1163	11,4
Total	10175	100,0

Missing Values of Items (continued)

Science 1_27		
	Frequency	*Percent*
0	5224	51,3
1	3255	32,0
Missing	1696	16,7
Total	10175	100,0

Science 1_28		
	Frequency	*Percent*
0	3933	38,7
1	5679	55,8
Missing	563	5,5
Total	10175	100,0

Science 1_29		
	Frequency	*Percent*
0	6582	64,7
1	831	8,2
Missing	2762	27,1
Total	10175	100,0

Science 1_30		
	Frequency	*Percent*
0	5233	51,4
1	3742	36,8
Missing	1200	11,8
Total	10175	100,0

Science 2_23		
	Frequency	*Percent*
0	3061	30,1
1	3000	29,5
Missing	4114	40,4
Total	10175	100,0

Science 2_24		
	Frequency	*Percent*
0	4783	47,0
1	2360	23,2
Missing	3032	29,8
Total	10175	100,0

Missing Values of Items (continued)

Science 2_25		
	Frequency	*Percent*
0	3967	39,0
1	2477	24,3
Missing	3731	36,7
Total	10175	100,0

Science 2_26		
	Frequency	*Percent*
0	4829	47,5
1	1846	18,1
Missing	3500	34,4
Total	10175	100,0

Science 2_27		
	Frequency	*Percent*
0	1303	12,8
1	2686	26,4
Missing	6186	60,8
Total	10175	100,0

Science 2_28		
	Frequency	*Percent*
0	5121	50,3
1	2429	23,9
Missing	2625	25,8
Total	10175	100,0

Science 2_29		
	Frequency	*Percent*
0	3930	38,6
1	2181	21,4
Missing	4064	39,9
Total	10175	100,0

Science 2_30		
	Frequency	*Percent*
0	3891	38,2
1	3542	34,8
Missing	2742	26,9
Total	10175	100,0

Frequencies of Items

	Skewness	*Kurtosis*
Turkish 1	-,517	-1,733
Turkish 2	-4,750	20,569
Turkish 3	-,704	-1,505
Turkish 4	-,732	-1,465
Turkish 5	-,961	-1,076
Turkish 6	,084	-1,993
Turkish 7	-,414	-1,829
Turkish 8	-,965	-1,069
Turkish 9	-,072	-1,995
Turkish 10	-,573	-1,672
Turkish 11	-1,213	-,529
Turkish 12	-,303	-1,909
Turkish 13	,204	-1,959
Turkish 14	-1,355	-,163
Turkish 15	-2,312	3,348
Turkish 16	-1,119	-,748
Turkish 17	-1,266	-,397
Turkish 18	-,360	-1,871
Turkish 19	-,836	-1,302
Turkish 20	-1,279	-,364
Turkish 21	-,574	-1,671
Turkish 22	-,625	-1,610
Turkish 23	-1,071	-,853
Turkish 24	-,825	-1,319
Mathematics1_1	-2,859	6,177
Mathematics1_2	-2,880	6,297
Mathematics1_3	-2,836	6,045
Mathematics1_4	-,065	-1,996
Mathematics1_5	-,641	-1,590
Mathematics1_6	-,376	-1,859
Mathematics1_7	-,340	-1,885
Mathematics1_8	-2,563	4,572
Mathematics1_9	-1,597	,550
Mathematics1_10	-1,067	-,862
Mathematics1_11	-,373	-1,862
Mathematics1_12	-1,612	,599
Mathematics1_13	-3,334	9,118
Mathematics1_14	-1,277	-,369
Mathematics1_15	-1,623	,634
Mathematics1_16	-,815	-1,336

Frequencies of Items (continued)

	Skewness	*Kurtosis*
Mathematics1_17	-1,446	,092
Mathematics1_18	-1,485	,204
Mathematics1_19	-1,117	-,752
Mathematics1_20	,056	-1,997
Mathematics1_21	-2,501	4,255
Mathematics1_22	-,744	-1,447
Mathematics1_23	-,778	-1,395
Mathematics1_24	-2,825	5,984
Mathematics1_25	-,945	-1,106
Mathematics1_26	-,752	-1,435
Mathematics1_27	,018	-2,000
Mathematics1_28	-1,413	-,005
Mathematics1_29	-1,047	-,904
Mathematics1_30	-,219	-1,952
Science1_1	-1,487	,212
Science1_2	-,937	-1,123
Science1_3	-,345	-1,881
Science1_4	3,258	8,615
Science1_5	-,165	-1,973
Science1_6	-,551	-1,697
Science1_7	1,324	-,247
Science1_8	,206	-1,958
Science1_9	-,650	-1,577
Science1_10	,898	-1,194
Science1_11	,378	-1,857
Science1_12	-,720	-1,482
Science1_13	-1,292	-,331
Science1_14	-,649	-1,580
Science1_15	,274	-1,925
Science1_16	-,388	-1,850
Science1_17	-,709	-1,497
Science1_18	-,474	-1,776
Science1_19	-,405	-1,836
Science1_20	,063	-1,997
Science1_21	,575	-1,670
Science1_22	-,060	-1,997
Science1_23	-1,043	-,912
Science1_24	-,216	-1,954

Frequencies of Items (continued)

	Skewness	*Kurtosis*
Science1_25	,979	-1,042
Science1_26	-,702	-1,507
Science1_27	,478	-1,772
Science1_28	-,369	-1,864
Science1_29	2,460	4,050
Science1_30	,337	-1,887
Mathematics2_1	-1,126	-,733
Mathematics2_2	-1,368	-,128
Mathematics2_3	-,445	-1,803
Mathematics2_4	-,548	-1,700
Mathematics2_5	2,555	4,532
Mathematics2_6	,080	-1,994
Mathematics2_7	-,151	-1,978
Mathematics2_8	-,508	-1,742
Mathematics2_9	-,309	-1,905
Mathematics2_10	-,598	-1,643
Mathematics2_11	-1,502	,255
Mathematics2_12	-,101	-1,990
Mathematics2_13	,945	-1,108
Mathematics2_14	,671	-1,550
Mathematics2_15	-,025	-2,000
Mathematics2_16	-,306	-1,907
Mathematics2_17	-,566	-1,681
Mathematics2_18	,735	-1,461
Mathematics2_19	-,550	-1,698
Mathematics2_20	,371	-1,863
Mathematics2_21	-,996	-1,009
Mathematics2_22	-,345	-1,882
Mathematics2_23	-,155	-1,977
Mathematics2_24	-,140	-1,981
Mathematics2_25	,740	-1,453
Mathematics2_26	-1,185	-,595
Mathematics2_27	,103	-1,990
Mathematics2_28	,612	-1,626
Mathematics2_29	-,262	-1,932
Mathematics2_30	-1,183	-,600
Science2_1	-,615	-1,622
Science2_2	1,929	1,721

Frequencies of Items (continued)

	Skewness	*Kurtosis*
Science2_3	-,124	-1,985
Science2_4	,241	-1,942
Science2_5	-,483	-1,767
Science2_6	1,061	-,874
Science2_7	,221	-1,952
Science2_8	,660	-1,564
Science2_9	,235	-1,945
Science2_10	-,500	-1,751
Science2_11	,410	-1,832
Science2_12	,413	-1,830
Science2_13	,574	-1,671
Science2_15	-,079	-1,994
Science2_16	-1,084	-,826
Science2_17	-,445	-1,803
Science2_18	-,300	-1,911
Science2_19	,059	-1,997
Science2_20	-,790	-1,376
Science2_21	-,133	-1,983
Science2_22	-,664	-1,559
Science2_23	,020	-2,000
Science2_24	,721	-1,480
Science2_25	,475	-1,775
Science2_26	,999	-1,002
Science2_27	-,740	-1,454
Science2_28	,763	-1,418
Science2_29	,598	-1,643
Science2_30	,094	-1,992

Item and Test Analysis Program (ITEMAN) Results

Item Statistics					Alternative Statistics				
Seq. No.	Scale -Item	Prop. Corr.	Biser.	Point Biser.	Alt .	Prop. Endor.	Biser.	Point Biser.	Key
S1_23	1-1	0.653	0.593	0.460	A	0.051	-0.151	-0.072	
					B	0.034	- 0.082	-0.034	
					C	0.653	0.593	0.460	*
					D	0.100	- 0.396	- 0.232	
					E	0.054	- 0.339	- 0.165	
					Ot.	0.107	- 0.488	- 0.291	
S1_24	1-2	0.457	0.676	0.538	A	0.089	-0.215	-0.121	
					B	0.095	-0.167	-0.096	
					C	0.103	-0.140	-0.083	
					D	0.457	0.676	0.538	*
					E	0.082	-0.309	-0.170	
					Ot.	0.174	-0.520	-0.352	
S1_25	1-3	0.252	0.703	0.516	A	0.051	-0.085	-0.041	
					B	0.252	0.703	0.516	*
					C	0.051	-0.148	-0.070	
					D	0.185	-0.187	-0.128	
					E	0.359	-0.255	-0.198	
					Ot.	0.102	-0.307	-0.180	
S1_26	1-4	0.590	0.671	0.530	A	0.029	-0.301	-0.118	
					B	0.041	-0.193	-0.086	
					C	0.178	-0.372	-0.253	
					D	0.048	-0.340	-0.159	
					E	0.590	0.671	0.530	*
					Ot.	0.114	-0.482	-0.292	
S1_27	1-5	0.320	0.774	0.593	A	0.277	-0.248	-0.185	
					B	0.028	-0.276	-0.108	
					C	0.320	0.774	0.593	*
					D	0.163	-0.183	-0.122	
					E	0.044	-0.223	-0.101	
					Ot.	0.167	-0.439	-0.294	
S1_28	1-6	0.558	0.415	0.330	A	0.558	0.415	0.330	*
					B	0.135	-0.214	-0.136	
					C	0.068	-0.266	-0.139	
					D	0.156	-0.198	-0.130	
					E	0.027	-0.161	-0.062	
					Ot.	0.055	-0.222	-0.108	

Item and Test Analysis Program (ITEMAN) Results

Item Statistics					Alternative Statistics				
Seq. No.	Scale -Item	Prop. Corr.	Biser.	Point Biser.	Alt.	Prop. Endor.	Biser.	Point Biser.	Key
S1_29	1-7	0.082	0.172	0.095	A	0.082	0.172	0.095	*
CHECK THE KEY A was specified, D works better					B	0.139	-0.069	-0.044	
					C	0.037	-0.235	-0.101	
					D	0.388	0.553	0.434	?
					E	0.082	-0.247	-0.136	
					Ot.	0.271	-0.500	-0.373	
S1_30	1-8	0.368	0.368	0.287	A	0.368	0.368	0.287	*
					B	0.044	-0.277	-0.126	
					C	0.176	0.188	0.128	
					D	0.182	-0.317	-0.217	
					E	0.113	-0.159	-0.096	
					Ot.	0.118	-0.239	-0.147	
S2_23	1-9	0.295	0.655	0.495	A	0.059	-0.149	-0.075	
					B	0.057	0.073	0.036	
					C	0.119	-0.049	-0.030	
					D	0.065	-0.111	-0.057	
					E	0.295	0.655	0.495	*
					Ot.	0.404	-0.497	-0.392	
S2_24	1-10	0.232	0.672	0.486	A	0.117	0.302	0.184	
					B	0.091	-0.190	-0.108	
					C	0.232	0.672	0.486	*
					D	0.110	-0.052	-0.031	
					E	0.152	-0.117	-0.077	
					Ot.	0.298	-0.565	-0.428	
S2_25	1-11	0.243	0.591	0.432	A	0.059	-0.054	-0.027	
					B	0.134	0.217	0.138	
					C	0.054	-0.113	-0.055	
					D	0.243	0.591	0.432	*
					E	0.144	0.042	0.027	
					Ot.	0.367	-0.592	-0.463	
S2_26	1-12	0.181	0.693	0.474	A	0.181	0.693	0.474	*
					B	0.181	-0.056	-0.038	
					C	0.065	-0.077	-0.040	
					D	0.127	0.162	0.101	
					E	0.101	-0.011	-0.007	
					Ot.	0.344	-0.516	-0.400	

Item and Test Analysis Program (ITEMAN) Results

Item Statistics					Alternative Statistics				
Seq. No.	Scale -Item	Prop. Corr.	Biser.	Point Biser.	Alt .	Prop. Endor.	Biser.	Point Biser.	Key
S2_27	1-13	0.264	0.769	0.570	A	0.046	0.003	0.001	
					B	0.034	-0.135	-0.056	
					C	0.028	-0.128	-0.050	
					D	0.264	0.769	0.570	*
					E	0.020	-0.149	-0.052	
					Ot.	0.608	-0.588	-0.462	
S2_28	1-4	0.239	0.733	0.533	A	0.110	-0.001	-0.000	
					B	0.239	0.733	0.533	*
					C	0.043	-0.141	-0.064	
					D	0.202	-0.057	-0.040	
					E	0.148	-0.038	-0.024	
					Ot.	0.258	-0.587	-0.433	
S2_29	1-5	0.214	0.669	0.476	A	0.214	0.214	0.476	*
					B	0.057	-0.057	-0.018	
					C	0.064	-0.064	-0.017	
					D	0.157	0.157	0.036	
					E	0.108	0.108	0.044	
					Ot.	0.399	-0.399	-0.436	
S2_30	1-6	0.348	0.560	0.435	A	0.163	0.058	0.039	
					B	0.074	-0.026	-0.014	
					C	0.066	-0.059	-0.030	
					D	0.348	0.560	0.435	*
					E	0.079	-0.049	-0.027	
					Ot.	0.269	-0.614	-0.457	

Scale Statistics

Scale	*1*
N of Items	16
N of Examinees	10175
Mean	5.296
Variance	10.606
Std. Dev.	3.257
Skew	0.566
Kurtosis	-0.539
Minimum	0.000
Maximum	16.000
Median	5.000
Alpha	0.748
SEM	1.634
Mean P	0.331
Mean Item-Tot.	0.453
Mean Biserial	0.607

Factor Analysis

Descriptive Statistics

	Mean	*Std. Deviation*	*N*
Science1_23	,7312	,44337	9084
Science1_24	,5537	,49713	8401
Science1_25	,2802	,44913	9139
Science1_26	,6657	,47178	9012
Science1_27	,3839	,48636	8479
Science1_28	,5908	,49171	9612
Science1_29	,1121	,31551	7413
Science1_30	,4169	,49308	8975
Science2_23	,4950	,50002	6061
Science2_24	,3304	,47039	7143
Science2_25	,3844	,48649	6444
Science2_26	,2766	,44733	6675
Science2_27	,6734	,46905	3989
Science2_28	,3217	,46717	7550
Science2_29	,3569	,47912	6111
Science2_30	,4765	,49948	7433

KMO and Bartlett's Test	
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	,874
Bartlett's Test of Sphericity	
Approx. Chi-Square	3992,619
df	120
Sig.	,000

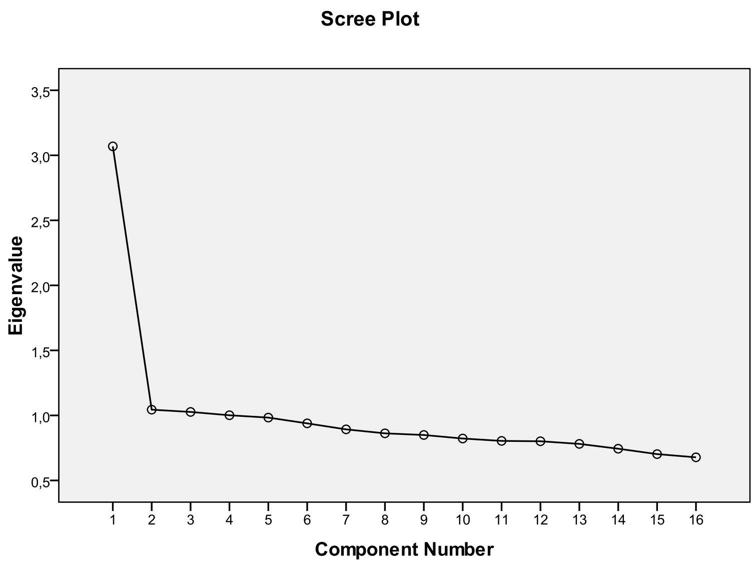
Communalities

	Initial	*Extraction*
Science1_23	1,000	,252
Science1_24	1,000	,284
Science1_25	1,000	,334
Science1_26	1,000	,331
Science1_27	1,000	,381
Science1_28	1,000	,101
Science1_29	1,000	,782
Science1_30	1,000	,530
Science2_23	1,000	,273
Science2_24	1,000	,234
Science2_25	1,000	,309
Science2_26	1,000	,225
Science2_27	1,000	,397
Science2_28	1,000	,281
Science2_29	1,000	,342
Science2_30	1,000	,084

Total Variance Explained

Total Variance Explained									
Component	*Initial Eigenvalues*			*Extraction Sums of Squared Loadings*			*Rotation Sums of Squared Loadings*		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*
1	3,069	19,181	19,181	3,069	19,181	19,181	2,463	15,393	15,393
2	1,044	6,526	25,707	1,044	6,526	25,707	1,642	10,264	25,657
3	1,027	6,417	32,124	1,027	6,417	32,124	1,035	6,466	32,124
4	1,001	6,258	38,382						
5	,983	6,144	44,526						
6	,939	5,868	50,394						
7	,893	5,579	55,973						
8	,862	5,388	61,361						
9	,849	5,309	66,670						
10	,822	5,140	71,810						
11	,804	5,025	76,835						
12	,801	5,008	81,843						
13	,781	4,881	86,724						
14	,744	4,649	91,373						
15	,702	4,390	95,764						
16	,678	4,236	100,000						

Scree Plot



Component Matrix

	Component		
	1	*2*	*3*
Science1_27	,609	-	,104
Science2_27	,606	,165	-
Science1_25	,550	-,168	-
Science1_26	,529	,224	-
Science2_28	,514	-,118	-
Science1_24	,497	-	,186
Science2_23	,466	,235	-
Science2_26	,457	-	,119
Science1_23	,439	,243	-
Science2_24	,427	-,219	-
Science1_28	,289	-	-,102
Science2_30	,256	-,134	-
Science2_25	,259	-,491	-
Science2_29	,404	-,413	-
Science1_29	-,113	,283	,830
Science1_30	,212	,491	-,494

Rotated Component Matrix

	Component		
	1	*2*	*3*
Science2_27	,596	,189	-
Science1_26	,566	,103	-
Science2_23	,517	-	-
Science1_27	,514	,336	-
Science1_23	,499	-	-
Science1_24	,448	,242	,156
Science2_26	,411	,219	-
Science1_28	,285	-	-,117
Science2_29	,109	,560	-,130
Science2_25	-	,551	-
Science1_25	,370	,443	-
Science2_24	,240	,419	-
Science2_28	,368	,382	-
Science2_30	,142	,252	-
Science1_29	-	-,248	,844
Science1_30	,428	-,326	-,491

Component Transformation Matrix

Component	*1*	*2*	*3*
1	,837	,544	-,062
2	,546	-,837	,031
3	,035	,060	,998

The Simplis Syntax For Biology Subtest of 2006 SST

```
Observed Variables
S1_23 S1_24 S1_25 S1_26 S1_27 S1_28 S1_29 S1_30 S2_23 S2_24 S2_25
S2_26 S2_27 S2_28 S2_29 S2_30
Covariance Matrix from File: CFA2006.COV
Sample Size = 10175
Latent Variables
DISCR NDISCR

Relationships
S1_23 S1_24 S1_25 S1_26 S1_27 S2_23 S2_24 S2_25 S2_26 S2_27 S2_28
S2_29 S2_30 = DISCR
S1_28 S1_29 S1_30 = NDISCR

Path Diagram
End of Problem
```

Goodness-Of-Fit Criteria For Biology Cluster Of 2006 SST

Goodness-of-Fit Criteria	2006SST
Chi-Square ($\chi 2$), df	1855.75; 103
Normed Chi-Square (NC)	
Goodness-of-Fit Index (GFI)	0.96
Adjusted Goodness-of-Fit Index (AGFI)	0.95
Root-Mean-Square Residual (RMR)	0.034
Root-Mean-Squared Error of Approximation (RMSEA)	0.047
Normed Fit Index (NFI)	0.97
Non-Normed Fit Index (NNFI)	0.97
Comparative Fit Index (CFI)	0.97
Incremental Fit Index (IFI)	0.97
Relative Fit Index (RFI)	0.97
Expected Cross Validation Index (ECVI)	0.31
Parsimonious Normed Fit Index (PNFI)	0.83
Parsimonious Goodness-of-Fit Index (PGFI)	0.73

Regression Analysis

Model Summary

R	*R Square*	*Adjusted R Square*	*Std. Error of the Estimate*
,784[a]	,615	,615	2,02447

ANOVA

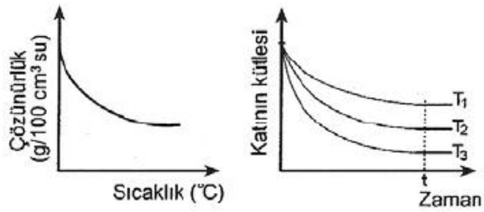
	Sum of Squares	*df*	*Mean Square*	*F*	*Sig.*
Regression	65047,417	7	9292,488	2267,310	,000[a]
Residual	40734,633	9939	4,098		
Total	105782,050	9946			

Coefficients

	Unstandardized Coefficients		*Standardized Coefficients*		
	B	*Std. Error*	*Beta*	*t*	*Sig.*
(Constant)	,047	,089		,527	,598
math	,007	,003	,032	2,279	,023
phy	,181	,008	,307	24,136	,000
che	,266	,009	,398	30,730	,000
selected	,350	,064	,051	5,487	,000
private	,073	,087	,006	,843	,399
gender	,464	,043	,070	10,751	,000
Turkish	,046	,005	,077	9,469	,000

A

22. Aşağıdaki I. grafik, bir X katısının sudaki çözünürlüğünün sıcaklıkla değişimini, II. grafik de T_1, T_2, T_3 sıcaklıklarında çözünme süresince bu katının kütlesinin zamanla değişimini göstermektedir.



I. grafik II. grafik

Bu grafiklere göre, aşağıdaki yargılardan hangisi yanlıştır?

A) X in çözünürlüğü ekzotermiktir.

B) X in doygun çözeltisi ısıtılırsa çökelme olur.

C) Sıcaklıklar arasında $T_3 < T_2 < T_1$ ilişkisi vardır.

D) T_1, T_2, T_3 sıcaklıklarındaki çözeltiler t anında doygun haldedir.

E) X in T_1 sıcaklığındaki çözünürlüğü T_2 ve T_3 tekinden fazladır.

23. **Hücrede gerçekleşen biyokimyasal olaylarla ilgili,**

I. Hücre içi enerji üreten reaksiyonların başlaması için enerji gerekir.

II. Metabolik bir yolda yer alan enzimler birbirini izleyerek işlev görür.

III. Reaksiyonun başlaması için enzimin bulunması her zaman yeterlidir.

açıklamalarından hangileri doğrudur?

A) Yalnız I B) Yalnız II C) I ve II

D) I ve III E) II ve III

24. **Aşağıdakilerden hangisi turgor basıncı yüksek olan bir bitki hücresinin turgor basıncının azalmasını sağlar?**

A) Hücrenin izotonik bir ortama konması

B) Hücrenin, sitoplazmasındaki çözünmüş maddeleri dış ortama atması

C) Hücrenin hipotonik bir ortama konması

D) Hücrenin, ozmotik basıncı yüksek bir ortama konması

E) Hücrenin ATP kullanarak suyu içine alması

25. **Nükleik asitlerin,**

I. organel yapısında yer alma,

II. protein sentezinde rol oynama,

III. aminoasitleri tanıma

özelliklerinden hangileri RNA çeşitlerinin tümünde bulunur?

A) Yalnız I B) Yalnız II C) Yalnız III

D) I ve II E) II ve III

26. Normal çevre koşullarında, bitkilerin kloroplastlarında aşağıdaki olaylardan hangisi <u>gerçekleşmez</u>?

A) Enzimlerin kullanılması

B) ATP üretimi

C) DNA nın eşlenmesi

D) Organik madde üretimi

E) Yağ depolanması

27. Kapalı bir deney ortamında, deneyin başlangıcından 24 saat sonra, karbondioksit ve serbest azot miktarının azaldığı, oksijen miktarının arttığı gözleniyor.

Bu değişikliğe, aşağıdakilerin hangisinde verilen iki canlı grubunun birlikte yaşaması neden olur?

A) Yeşil bitki – Mantar

B) Parazit bitki – Mantar

C) Baklagiller – Nitrifikasyon bakterileri

D) Yeşil bitki – Parazit bitki

E) Mantar – Çürükçül bakteriler

28. Sıcak ve kuru bir ortamda bulunan ve yeterli miktarda su alamayan normal bir insanın vücudunda,

I. vücut iç sıcaklığında artma,

II. terleme,

III. doku sıvısındaki tuz miktarında azalma

olayları, aşağıdakilerin hangisinde verilen sıraya göre gerçekleşir?

A) I – II – III

B) I – III – II

C) II – I – III

D) III – I – II

E) III – II – I

29. Aynı türden kırmızı çiçekli iki bitki arasında yapılan birinci çaprazlama sonucunda $\frac{3}{4}$ ü kırmızı çiçekli, $\frac{1}{4}$ ü beyaz çiçekli olan F_1 dölü elde edilmiştir. F_1 dölünden alınan kırmızı çiçekli iki bitkiyle yapılan ikinci çaprazlamadan elde edilen F_2 dölündeki tüm bitkiler kırmızı çiçekli olmuştur.

Buna göre,

I. Birinci çaprazlamaya alınan bireylerin ikisi de heterozigottur.

II. F_1 dölündeki bireylerin bir kısmı homozigot bir kısmı heterozigottur.

III. İkinci çaprazlamaya alınan bireylerin ikisi de heterozigottur.

ifadelerinden hangileri <u>kesinlikle</u> doğrudur?

A) Yalnız I

B) Yalnız II

C) Yalnız III

D) I ve II

E) II ve III

30.

I. Adaptasyon

II. Mutasyon

III. Kalıtsal varyasyon

Bir populasyondaki bireyler, yukarıdakilerden hangilerini "doğal seçilim"le kazanır?

A) Yalnız I

B) Yalnız II

C) Yalnız III

D) I ve II

E) II ve III

FEN BİLİMLERİ–1 TESTİ BİTTİ.

23. Fotosentezde aynı klorofil molekülünün tekrar tekrar kullanılabilmesini aşağıdakilerden hangisi sağlar?

A) Ortamda ADP moleküllerinin bulunması

B) Oksijenin sudan ayrılması

C) Yüksek enerjili elektron enerjilerinin ATP lerde tutulması

D) P ~ 5C ~ P bileşiğinin serbest karbondioksiti tutması

E) Elektron taşıma sistemine elektron aktarılması

24. Stomaların gece kapanmasını, kilit hücrelerinde,

I. glukozun nişastaya çevrilmesi,

II. ozmotik basıncın düşmesi,

III. hücre içinde karbondioksit birikmesi,

IV. suyun komşu epidermis hücrelerine geçmesi

olaylarının hangi sırayla gerçekleşmesi sağlar?

A) I – II – IV – III
B) II – III – I – IV
C) III – I – II – IV
D) IV – I – II – III
E) IV – II – III – I

25. Kapalı tohumlu diploit bir bitkide,

I. mikrospordan tüp çekirdeğinin oluşması,

II. triploit endosperm çekirdeğinin oluşması,

III. zigottan embriyo oluşması,

IV. üretken (generatif) çekirdekten sperm çekirdeklerinin oluşması

olaylarından hangileri mitozla gerçekleşir?

A) I ve II
B) II ve III
C) II ve IV
D) I, III ve IV
E) II, III ve IV

26. İnsanda, kan plazmasının ozmotik basıncının artması, aşağıdakilerden hangisine neden olur?

A) Atılan idrar miktarının azalmasına

B) Kanda glukoz miktarının artmasına

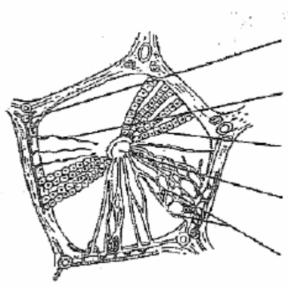
C) İdrarda glukoz miktarının azalmasına

D) İdrarla atılan tuz miktarının artmasına

E) İdrarla atılan üre miktarının artmasına

Diğer sayfaya geçiniz.

27.



Yukarıdaki şemada, insan karaciğerini oluşturan lopçuklardan biri, numaralanmış bazı damarları, kanalları ve bir kısım hücreleriyle gösterilmiştir. Karaciğerin lopçuklarında gerçekleşen olaylar arasında,

I. üretilen safra sıvısının uzaklaştırılması,

II. depolanmış öncül A vitamininden oluşturulan A vitamininin kan dolaşımına gönderilmesi

olayları da vardır.

Lopçuklarda I. ve II. olaylarla ilgili madde akışının gerçekleştiği yapılar ve bu yapıların madde akışına göre sıralanışı aşağıdakilerin hangisinde doğru olarak verilmiştir?

	I. olay	II. olay
A)	1 → 2 → 3	3 → 2 → 4
B)	2 → 4 → 5	1 → 4 → 3
C)	3 → 5 → 4	2 → 3 → 1
D)	3 → 2 → 1	3 → 5 → 4
E)	4 → 3 → 1	5 → 2 → 4

28. Botoks, insanda uygulandığı bölgede sadece motor sinirlerdeki iletimi engellemek için kullanılan bir maddedir.

Buna göre, botoks, uygulandığı bölgede,

I. uyarıların alınarak merkezi sinir sistemine iletilmesi,

II. tepki organında cevap oluşması,

III. uyarıların merkezi sinir sisteminde algılanması

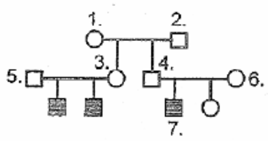
işlevlerinden hangilerini engeller?

A) Yalnız I B) Yalnız II C) Yalnız III

D) I ve II E) II ve III

Diğer sayfaya geçiniz.

29.



□: Fenotipinde, izlenen özellik görülmeyen erkek birey

○: Fenotipinde, izlenen özellik görülmeyen dişi birey

■: Fenotipinde, izlenen özellik görülen erkek birey

Yukarıdaki soyağacı, eşeye bağlı olarak kalıtılan bir özelliği göstermektedir.

İzlenen özellik bakımından, bu soyağacındaki bireylerle ilgili aşağıdaki ifadelerden hangisi doğrudur?

A) 1. ve 6. bireylerin izlenen özellikle ilgili genotipleri aynıdır.

B) 2. ve 4. bireylerin izlenen özellikle ilgili genotipleri farklıdır.

C) 3. bireyde izlenen özellikle ilgili allel bulunmaz.

D) 5. birey taşıyıcıdır.

E) 7. birey homozigottur.

30. Himalaya tavşanlarında kuyruk, kulak ve ayak uçları siyah, vücudun diğer kısımları beyaz renklidir. Bir deneyde, bir Himalaya tavşanının sırt bölgesindeki bir alan tıraş edilip bu kısma buz yastığı konmuştur. Bu bölgede yeni çıkan kılların siyah olduğu görülmüştür.

Deneyin bundan sonraki aşamalarında:

I. Yukarıda sözü edilen tavşan, sırt bölgesinde çıkan siyah kıllar tıraş edildikten sonra, doğal ortama bırakıldığında bu bölgede tekrar beyaz kılların çıkması

II. Başka bir tavşanın sırt kılları tıraş edilip bu bölgeye sıcak yastık uygulanması sonucunda bölgede beyaz kılların çıkması

III. Sırtında siyah bölge oluşturulan başka bir tavşanın doğal üreme ortamında üremesiyle oluşan yavruların kıl renklerinin Himalaya tavşanlarının normal kıl renklerinde olması

durumunda, bunlardan hangileri modifikasyon kanıtı olarak kullanılabilir?

A) Yalnız I B) Yalnız II C) Yalnız III

D) I ve III E) II ve III

FEN BİLİMLERİ–2 TESTİ BİTTİ.

APPENDIX B

ANALYSIS OF 2007 STUDENT SELECTION TEST

Missing Values of Items

Science 1_23		
	Frequency	*Percent*
0	4293	36,7
1	6792	58,1
Missing	601	5,1
Total	11686	100,0

Science 1_24		
	Frequency	*Percent*
0	3027	25,9
1	6016	51,5
Missing	2643	22,6
Total	11686	100,0

Science 1_25		
	Frequency	*Percent*
0	5072	43,4
1	5308	45,4
Missing	1306	11,2
Total	11686	100,0

Missing Values of Items (continued)

Science 1_26		
	Frequency	*Percent*
0	3777	32,3
1	6046	51,7
Missing	1863	15,9
Total	11686	100,0

Science 1_27		
	Frequency	*Percent*
0	4466	38,2
1	3703	31,7
Missing	3517	30,1
Total	11686	100,0

Science 1_28		
	Frequency	*Percent*
0	2332	20,0
1	8624	73,8
Missing	730	6,2
Total	11686	100,0

Science 1_29		
	Frequency	*Percent*
0	1719	14,7
1	9387	80,3
Missing	580	5,0
Total	11686	100,0

Science 1_30		
	Frequency	*Percent*
0	1872	16,0
1	6991	59,8
Missing	2823	24,2
Total	11686	100,0

Missing Values of Items (continued)

Science 2_23		
	Frequency	*Percent*
0	7063	60,4
1	1952	16,7
Missing	2671	22,9
Total	11686	100,0

Science 2_24		
	Frequency	*Percent*
0	2976	25,5
1	3480	29,8
Missing	5230	44,8
Total	11686	100,0

Science 2_25		
	Frequency	*Percent*
0	4221	36,1
1	5038	43,1
Missing	2427	20,8
Total	11686	100,0

Science 2_26		
	Frequency	*Percent*
0	3085	26,4
1	5012	42,9
Missing	3589	30,7
Total	11686	100,0

Science 2_27		
	Frequency	*Percent*
0	4474	38,3
1	3955	33,8
Missing	3257	27,9
Total	11686	100,0

Missing Values of Items (continued)

Science 2_28		
	Frequency	*Percent*
0	2554	21,9
1	6515	55,8
Missing	2617	22,4
Total	11686	100,0

Science 2_29		
	Frequency	*Percent*
0	3300	28,2
1	3008	25,7
Missing	5378	46,0
Total	11686	100,0

Science 2_30		
	Frequency	*Percent*
0	3867	33,1
1	3947	33,8
Missing	3872	33,1
Total	11686	100,0

Frequencies of Items

	Skewness	*Kurtosis*
Turkish1_1	-1,833	1,362
Turkish1_2	-,502	-1,748
Turkish1_3	-5,018	23,183
Turkish1_4	-1,851	1,428
Turkish1_5	-1,486	,209
Turkish1_6	,347	-1,880
Turkish1_7	-3,829	12,661
Turkish1_8	-3,327	9,069
Turkish1_15	,828	-1,315
Turkish1_16	-,068	-1,996
Turkish1_19	-,552	-1,696
Turkish1_20	-,534	-1,716
Turkish1_21	-3,656	11,368
Turkish1_22	-,726	-1,473
Turkish1_23	-2,886	6,328
Turkish1_24	-2,730	5,456
Turkish1_25	-1,813	1,288
Turkish1_26	-1,666	,775
Turkish1_27	-1,139	-,702
Turkish1_28	-,677	-1,543
Turkish1_29	-,476	-1,774
Turkish1_30	-1,215	-,523
Mathematics1_1	-2,589	4,702
Mathematics1_2	-5,071	23,721
Mathematics1_3	-2,480	4,152
Mathematics1_4	-3,982	13,862
Mathematics1_5	-2,348	3,514
Mathematics1_6	-2,113	2,466
Mathematics1_7	-1,093	-,806
Mathematics1_8	-1,084	-,825
Mathematics1_9	-1,489	,216
Mathematics1_10	-1,488	,214
Mathematics1_11	-1,900	1,612

Frequencies of Items (Continues)

	Skewness	*Kurtosis*
Mathematics1_12	-1,616	,611
Mathematics1_13	-1,849	1,418
Mathematics1_14	-3,892	13,154
Mathematics1_15	-,997	-1,006
Mathematics1_16	-1,715	,942
Mathematics1_17	-2,325	3,408
Mathematics1_18	-,998	-1,004
Mathematics1_19	-,113	-1,988
Mathematics1_20	-1,973	1,894
Mathematics1_21	-1,382	-,091
Mathematics1_22	-,540	-1,709
Mathematics1_23	-,839	-1,297
Mathematics1_24	-1,820	1,311
Mathematics1_25	-,654	-1,573
Mathematics1_26	-2,395	3,736
Mathematics1_27	-1,594	,541
Mathematics1_28	-,489	-1,762
Mathematics1_29	-,961	-1,077
Mathematics1_30	-,865	-1,252
Science1_1	,331	-1,891
Science1_2	-,628	-1,605
Science1_3	-,421	-1,823
Science1_4	,176	-1,970
Science1_5	-,716	-1,487
Science1_6	-2,006	2,025
Science1_7	-,487	-1,763
Science1_8	-1,272	-,382
Science1_9	-1,092	-,808
Science1_10	-1,906	1,632
Science1_11	-1,414	-,002
Science1_12	-1,503	,258
Science1_13	-,298	-1,912
Science1_14	-1,126	-,732

Frequencies of Items (Continues)

	Skewness	*Kurtosis*
Science1_15	-1,262	-,408
Science1_16	-1,013	-,974
Science1_17	-1,406	-,024
Science1_18	-3,541	10,540
Science1_19	-,912	-1,168
Science1_20	-,117	-1,987
Science1_21	-1,465	,146
Science1_22	-1,445	,087
Science1_23	-,463	-1,786
Science1_24	-,701	-1,510
Science1_25	-,045	-1,998
Science1_26	-,475	-1,775
Science1_27	,188	-1,965
Science1_28	-1,403	-,031
Science1_29	-1,909	1,645
Science1_30	-1,415	,003
Mathematics2_1	-,858	-1,264
Mathematics2_2	-1,621	,628
Mathematics2_4	-1,599	,555
Mathematics2_3	-1,348	-,182
Mathematics2_5	-1,101	-,789
Mathematics2_6	-,833	-1,307
Mathematics2_7	-2,759	5,615
Mathematics2_8	-,991	-1,018
Mathematics2_9	-,509	-1,741
Mathematics2_10	-,788	-1,380
Mathematics2_11	-,764	-1,417
Mathematics2_12	-1,739	1,024
Mathematics2_13	,493	-1,757
Mathematics2_14	1,140	-,700
Mathematics2_15	1,478	,185
Mathematics2_16	-,335	-1,888
Mathematics2_17	-,557	-1,691

Frequencies of Items (Continues)

	Skewness	*Kurtosis*
Mathematics2_18	-,608	-1,631
Mathematics2_19	-,125	-1,985
Mathematics2_20	-,625	-1,611
Mathematics2_21	-1,385	-,082
Mathematics2_22	-2,485	4,176
Mathematics2_23	-,146	-1,979
Mathematics2_24	-1,047	-,903
Mathematics2_25	-,951	-1,096
Mathematics2_26	-1,063	-,871
Mathematics2_27	-1,467	,153
Mathematics2_28	,951	-1,096
Mathematics2_29	-2,202	2,848
Mathematics2_30	-2,631	4,921
Science2_1	-,012	-2,000
Science2_2	-,525	-1,724
Science2_3	1,780	1,169
Science2_4	-,169	-1,972
Science2_5	,620	-1,615
Science2_6	,103	-1,991
Science2_7	1,025	-,949
Science2_8	,462	-1,787
Science2_9	,606	-1,634
Science2_10	-,023	-2,000
Science2_11	-,055	-1,997
Science2_12	,538	-1,711
Science2_13	,989	-1,021
Science2_14	-,544	-1,705
Science2_15	-,589	-1,653
Science2_16	-1,130	-,723
Science2_17	,005	-2,001
Science2_18	-1,189	-,586
Science2_19	-1,125	-,735
Science2_20	-,174	-1,970

Frequencies of Items (Continues)

	Skewness	*Kurtosis*
Science2_21	,048	-1,998
Science2_22	-,583	-1,660
Science2_23	1,377	-,105
Science2_24	-,157	-1,976
Science2_25	-,177	-1,969
Science2_26	-,490	-1,760
Science2_27	,123	-1,985
Science2_28	-,971	-1,057
Science2_29	,093	-1,992
Science2_30	-,020	-2,000

Item and Test Analysis Program (ITEMAN) Results

Item Statistics					*Alternative Statistics*				
Seq. No.	*Scale -Item*	*Prop. Corr.*	*Biser.*	*Point Biser.*	*Alt.*	*Prop. Endor.*	*Biser.*	*Point Biser.*	*Key*
S1_23	1-1	0.581	0.667	0.528	A	0.581	0.667	0.528	*
					B	0.126	-0.325	-0.203	
					C	0.117	-0.437	-0.267	
					D	0.031	-0.320	-0.129	
					E	0.093	-0.260	-0.149	
					Ot.	0.051	-0.398	-0.190	
S1_24	1-2	0.515	0.751	0.599	A	0.038	-0.327	-0.141	
					B	0.133	-0.301	-0.191	
					C	0.034	-0.293	-0.122	
					D	0.055	-0.312	-0.152	
					E	0.515	0.751	0.599	*
					Ot.	0.226	-0.503	-0.362	
S1_25	1-3	0.454	0.720	0.573	A	0.074	-0.431	-0.231	
					B	0.454	0.720	0.573	*
					C	0.090	-0.225	-0.128	
					D	0.215	-0.244	-0.173	
					E	0.056	-0.302	-0.148	
					Ot.	0.112	-0.438	-0.265	
S1_26	1-4	0.517	0.671	0.536	A	0.517	0.671	0.536	*
					B	0.068	-0.235	-0.123	
					C	0.067	-0.276	-0.143	
					D	0.111	-0.182	-0.110	
					E	0.076	-0.316	-0.171	
					Ot.	0.159	-0.498	-0.330	
S1_27	1-5	0.317	0.813	0.622	A	0.015	-0.164	-0.052	
					B	0.242	-0.078	-0.057	
					C	0.317	0.813	0.622	*
					D	0.045	-0.089	-0.041	
					E	0.080	-0.200	-0.110	
					Ot.	0.301	-0.634	-0.481	
S1_28	1-6	0.738	0.730	0.540	A	0.030	-0.324	-0.128	
					B	0.027	-0.390	-0.150	
					C	0.065	-0.468	-0.241	
					D	0.738	0.730	0.540	*
					E	0.078	-0.410	-0.223	
					Ot.	0.062	-0.590	-0.300	

Item and Test Analysis Program (ITEMAN) Results

Item Statistics					*Alternative Statistics*				
Seq. No.	*Scale -Item*	*Prop. Corr.*	*Biser.*	*Point Biser.*	*Alt.*	*Prop. Endor.*	*Biser.*	*Point Biser.*	*Key*
S1_29	1-7	0.803	0.519	0.362	A	0.029	-0.375	-0.148	
					B	0.008	-0.334	-0.083	
					C	0.094	-0.352	-0.203	
					D	0.015	-0.202	-0.064	
					E	0.803	0.519	0.362	*
					Ot.	0.050	-0.431	-0.204	
S1_30	1-8	0.598	0.692	0.546	A	0.013	-0.269	-0.079	
					B	0.049	-0.230	-0.108	
					C	0.598	0.692	0.546	*
					D	0.028	-0.336	-0.130	
					E	0.071	-0.260	-0.137	
					Ot.	0.242	-0.574	-0.418	
S2_23	1-9	0.167	0.397	0.266	A	0.018	-0.186	-0.062	
					B	0.092	-0.057	-0.032	
					C	0.147	0.010	0.006	
					D	0.347	0.156	0.121	
					E	0.167	0.397	0.266	*
					Ot.	0.229	-0.467	-0.336	
S2_24	1-10	0.298	0.720	0.546	A	0.032	-0.195	-0.080	
					B	0.087	-0.074	-0.042	
					C	0.298	0.720	0.546	*
					D	0.069	0.150	0.079	
					E	0.067	0.086	0.045	
					Ot.	0.448	-0.645	-0.513	
S2_25	1-11	0.431	0.772	0.613	A	0.085	-0.255	-0.143	
					B	0.431	0.772	0.613	*
					C	0.008	-0.283	-0.068	
					D	0.076	-0.223	-0.120	
					E	0.192	-0.194	-0.134	
					Ot.	0.208	-0.604	-0.426	
S2_26	1-12	0.429	0.850	0.674	A	0.062	-0.124	-0.063	
					B	0.069	-0.274	-0.143	
					C	0.066	-0.129	-0.067	
					D	0.429	0.850	0.674	*
					E	0.067	-0.204	-0.105	
					Ot.	0.307	-0.681	-0.519	

Item and Test Analysis Program (ITEMAN) Results

Item Statistics					*Alternative Statistics*				
Seq. No.	*Scale -Item*	*Prop. Corr.*	*Biser.*	*Point Biser.*	*Alt.*	*Prop. Endor.*	*Biser.*	*Point Biser.*	*Key*
S2_27	1-13	0.338	0.674	0.521	A	0.054	-0.295	-0.143	
					B	0.142	-0.070	-0.045	
					C	0.338	0.674	0.521	*
					D	0.032	-0.254	-0.103	
					E	0.155	0.105	0.069	
					Ot.	0.279	-0.611	-0.458	
S2_28	1-4	0.558	0.862	0.685	A	0.558	0.862	0.685	*
					B	0.066	-0.368	-0.190	
					C	0.076	-0.328	-0.176	
					D	0.023	-0.304	-0.110	
					E	0.055	-0.311	-0.151	
					Ot.	0.224	-0.654	-0.469	
S2_29	1-5	0.257	0.704	0.520	A	0.076	0.015	0.008	
					B	0.073	-0.038	-0.021	
					C	0.066	-0.124	-0.064	
					D	0.257	0.704	0.520	*
					E	0.066	0.018	0.009	
					Ot.	0.460	-0.530	-0.422	
S2_30	1-6	0.338	0.670	0.518	A	0.338	0.670	0.518	*
					B	0.052	-0.081	-0.039	
					C	0.189	0.176	0.122	
					D	0.041	-0.193	-0.085	
					E	0.049	-0.108	-0.051	
					Ot.	0.331	-0.706	-0.544	

Scale Statistics

Scale	*1*
N of Items	16
N of Examinees	11686
Mean	7.340
Variance	16.781
Std. Dev.	4.096
Skew	0.258
Kurtosis	-1.048
Minimum	0.000
Maximum	16.000
Median	7.000
Alpha	0.843
SEM	1.624
Mean P	0.459
Mean Item-Tot.	0.541
Mean Biserial	0.701

Factor Analysis
Descriptive Statistics

	Mean	*Std. Deviation*	*N*
Science1_23	,6127	,48715	11085
Science1_24	,6653	,47192	9043
Science1_25	,5114	,49989	10380
Science1_26	,6155	,48650	9823
Science1_27	,4533	,49784	8169
Science1_28	,7871	,40934	10956
Science1_29	,8452	,36171	11106
Science1_30	,7888	,40819	8863
Science2_23	,2165	,41190	9015
Science2_24	,5390	,49851	6456
Science2_25	,5441	,49808	9259
Science2_26	,6190	,48566	8097
Science2_27	,4692	,49908	8429
Science2_28	,7184	,44981	9069
Science2_29	,4769	,49950	6308
Science2_30	,5051	,50001	7814

KMO and Bartlett's Test	
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	,925
Bartlett's Test of Sphericity	
Approx. Chi-Square	10442,939
df	120
Sig.	,000

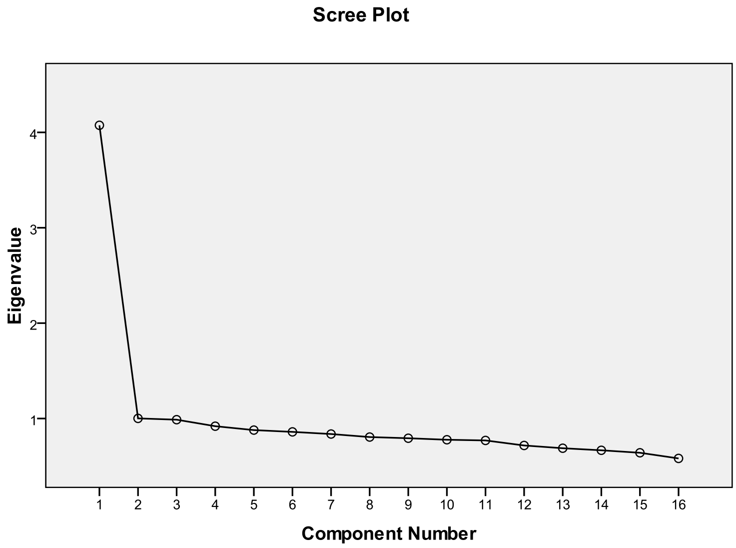
Communalities

	Initial	*Extraction*
Science1_23	1,000	,278
Science1_24	1,000	,368
Science1_25	1,000	,328
Science1_26	1,000	,253
Science1_27	1,000	,357
Science1_28	1,000	,337
Science1_29	1,000	,136
Science1_30	1,000	,250
Science2_23	1,000	,858
Science2_24	1,000	,188
Science2_25	1,000	,327
Science2_26	1,000	,387
Science2_27	1,000	,182
Science2_28	1,000	,464
Science2_29	1,000	,244
Science2_30	1,000	,120

Total Variance Explained

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4,074	25,463	25,463	4,074	25,463	25,463	3,896	24,350	24,350
2	1,001	6,258	31,721	1,001	6,258	31,721	1,179	7,371	31,721
3	,988	6,173	37,894						
4	,920	5,747	43,641						
5	,879	5,491	49,133						
6	,860	5,374	54,506						
7	,837	5,233	59,740						
8	,806	5,035	64,775						
9	,793	4,958	69,733						
10	,777	4,859	74,591						
11	,770	4,814	79,405						
12	,717	4,484	83,888						
13	,689	4,304	88,192						
14	,667	4,168	92,360						
15	,641	4,005	96,365						
16	,582	3,635	100,000						

Scree Plot



Component Matrix

	Component	
	1	*2*
Science2_28	,676	-
Science2_26	,620	-
Science1_24	,600	-
Science1_27	,573	,167
Science1_25	,571	-
Science2_25	,567	-
Science1_28	,552	-,179
Science1_23	,522	-
Science1_26	,501	-
Science2_29	,493	-
Science1_30	,472	-,163
Science2_27	,425	-
Science2_24	,407	,148
Science1_29	,341	-,140
Science2_30	,338	-
Science2_23	,158	,913

Rotated Component Matrix

	Component	
	1	*2*
Science2_28	,677	
Science2_26	,614	,101
Science1_24	,604	
Science1_27	,579	
Science1_25	,544	,178
Science2_25	,533	,209
Science1_28	,525	
Science1_23	,516	,301
Science1_26	,498	
Science2_29	,488	
Science1_30	,475	,164
Science2_27	,407	,128
Science2_24	,365	
Science1_29	,360	,242
Science2_30	,311	,151
Science2_23		,924

Component Transformation Matrix

Component	*1*	*2*
1	,971	,241
2	-,241	,971

The Simplis Syntax For Biology Items of 2007 SST

```
CFA BIO 2007
Observed Variables
S1_23 S1_24 S1_25 S1_26 S1_27 S1_28 S1_29 S1_30 S2_23 S2_24 S2_25 S2_26
S2_27 S2_28 S2_29 S2_30
Covariance Matrix from File: CFA2007.COV
Sample Size = 11686
Latent Variables
Normal Difficult

Relationships
S1_23 S1_24 S1_25 S1_26 S1_28 S1_29 S1_30 S2_25 S2_26 S2_27 S2_28 S2_29
S2_30 = Normal
S1_27 S2_23 S2_24 = Difficult

Path Diagram
End of Problem
```

Goodness-Of-Fit Criteria For Biology Items of 2007 SST

Goodness-of-Fit Criteria	2007 SST
Chi-Square ($\chi 2$), df	4519.57; 103
Normed Chi-Square (NC)	
Goodness-of-Fit Index (GFI)	0.96
Adjusted Goodness-of-Fit Index (AGFI)	0.95
Root-Mean-Square Residual (RMR)	0.028
Root-Mean-Squared Error of Approximation (RMSEA)	0.059
Normed Fit Index (NFI)	0.98
Non-Normed Fit Index (NNFI)	0.98
Comparative Fit Index (CFI)	0.98
Incremental Fit Index (IFI)	0.98
Relative Fit Index (RFI)	0.98
Expected Cross Validation Index (ECVI)	0.37
Parsimonious Normed Fit Index (PNFI)	0.84
Parsimonious Goodness-of-Fit Index (PGFI)	0.72

Regression Analysis

Model Summary

R	*R Square*	*Adjusted R Square*	*Std. Error of the Estimate*
,840[a]	,706	,706	2,22006

ANOVA

	Sum of Squares	*df*	*Mean Square*	*F*	*Sig.*
Regression	135850,889	8	16981,361	3445,438	,000[a]
Residual	56511,910	11466	4,929		
Total	192362,799	11474			

Coefficients

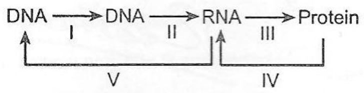
	Unstandardized Coefficients		*Standardized Coefficients*		
	B	*Std. Error*	*Beta*	*t*	*Sig.*
(Constant)	-,532	,134		-3,970	,000
age	,032	,037	,005	,865	,387
gender	,434	,045	,053	9,625	,000
selected	,882	,072	,104	12,281	,000
private	,581	,089	,037	6,544	,000
Turkish	,020	,006	,108	15,562	,000
math	,022	,003	,083	7,337	,000
phy	,196	,007	,270	26,451	,000
che	,293	,008	,380	35,255	,000

23. Aralarındaki ortak özellikler en fazla olan canlılar, aşağıdaki filogenetik sınıflandırma basamaklarından hangisinde bulunur?

A) Tür B) Cins C) Familya

D) Takım E) Sınıf

24.



Normal bir insan hücresinde biyokimyasal olaylar, şemada I, II, III, IV ve V numaralı okların hangileriyle gösterilen yönlerde gerçekleşmez?

A) I ve II B) I ve V C) II ve III

D) III ve IV E) IV ve V

25. Çimlenmekte olan bir tohumda, fotosentez yapana kadar geçen süreçte, aşağıdakilerden hangisi gerçekleşmez?

A) Mitoz bölünme B) Besin depolama

C) Hücresel farklılaşma D) Enerji üretimi

E) Enzim faaliyeti

26. Canlılarda, yeni ırkların elde edilmesinde, kural olarak, yarar sağlamayan özellik aşağıdakilerden hangisidir?

A) Eşeysiz üreme

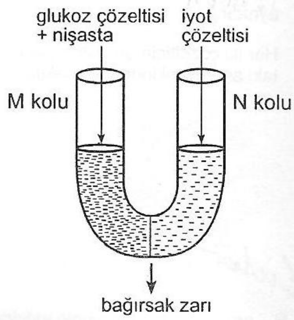
B) Alt türlere sahip olma

C) Tür içi kalıtsal çeşitliliğe sahip olma

D) Kısa zamanda tamamlanan bir yaşam döngüsüne sahip olma

E) Kolay yetiştirilebilme

27.



U şeklindeki bir borunun M ve N kolları bir bağırsak zarıyla şekildeki gibi ayrılmıştır. M koluna glukoz çözeltisiyle nişasta, N koluna ise iyot çözeltisi konmuştur. (İyot nişasta ayıracıdır ve nişasta taneciklerini maviye boyar.)

Bu deneyin sonunda aşağıdakilerden hangisi beklenmez?

A) M kolunda çözelti yoğunluğunun değişmesi

B) M kolunda nişasta miktarının aynı kalması

C) N kolunda sıvı renginin maviye dönüşmesi

D) N kolunda iyot yoğunluğunun azalması

E) Kollardaki glukoz yoğunluğunun eşitlenmesi

Diğer sayfaya geçiniz.

28. Aşağıdaki tabloda bazı canlı türlerinin kromozom sayıları verilmiştir.

Canlı Türü	Kromozom Sayısı (2n)
Arı	32
Ayı	76
Tavuk	78
Köpek	78
Eğrelti otu bitkisi	500

Bu tablodaki bilgilere göre,

I. İki canlı türünün kromozom sayılarına bakılarak akrabalıkları hakkında karar verilemez.

II. Bir canlı türünün kromozom sayısı, onun hangi sınıfa (classise) ait olduğunu belirler.

III. Bir canlı türünün kromozom sayısının az olması ya da çok olması gelişmişlik düzeyini belirlemez.

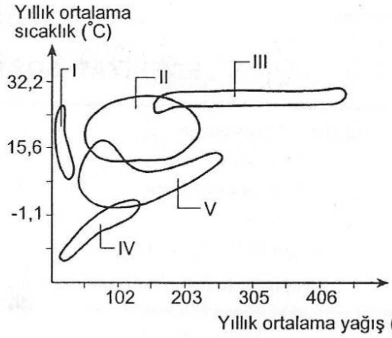
yargılarından hangileri doğrudur?

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

29. Omurgalılarda aşağıdaki sistemlerden hangisi dış ortama açılmaz?

A) Üreme B) Boşaltım C) Sindirim D) Solunum E) Dolaşım

30.



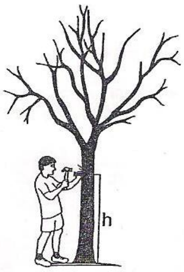
Yıllık ortalama yağış ve sıcaklık değerlerine göre hazırlanan yukarıdaki grafikte, tundra, çöl, yağmur ormanı, yaprak döken ağaç ormanı ve iğne yapraklı ağaç ormanı biyomları I, II, III, IV ve V olarak numaralanmıştır.

Buna göre, yağmur ormanı biyomu grafikte hangi numarayla gösterilmiştir?

A) I B) II C) III D) IV E) V

FEN BİLİMLERİ–1 TESTİ BİTTİ.

23. Yaprak döken bir ağacın gövdesinin yerden h yüksekliğindeki bir noktasına uzun bir çivi, $\frac{2}{3}$ ü dışarıda kalacak şekilde, öz bölgesine kadar çakılıyor.



Bu bitki 10 yıl sonra incelendiğinde,

I. ağacın gövdesi dışında kalan çivi uzunluğunun aynı kaldığı,

II. ağacın gövdesi dışında kalan çivi uzunluğunun azaldığı,

III. uzayan ağaçta çivinin, h yüksekliğinden daha yukarıda olduğu,

IV. ağacın uzamasına karşın çivinin, h yüksekliğinde kaldığı

durumlarından hangileri gözlenir?

A) Yalnız I B) Yalnız III C) I ve IV

D) II ve III E) II ve IV

24. Şeker hastalarında kullanılan insülin hormonu, rekombinant DNA teknolojisiyle *E. coli* bakterilerinde üretilmektedir. Bu işlemin bazı aşamaları aşağıda verilmiştir:

I. İnsülin geni içeren insan DNA parçasının taşıyıcı DNA (plazmit) ile birleşmesi

II. *E. coli* plazmit DNA sının ve insan DNA sının tümünün saf olarak elde edilmesi

III. *E. coli* plazmit DNA sının ve insan DNA sının insülin genini kodlayan kısmının restriksiyon enzimiyle kesilmesi

IV. Gen aktarılmış *E. coli* bakterilerinin besiyerinde çoğaltılması

V. Plazmitin *E. coli* hücresine aktarılması

Bu aşamaların doğru sıralanışı aşağıdakilerin hangisinde verilmiştir?

A) I – III – II – IV – V B) II – I – III – IV – V

C) II – III – I – V – IV D) III – II – V – I – IV

E) V – I – IV – III – II

Diğer sayfaya geçiniz.

25. Normal bir insanda yoğun bir egzersiz sonucunda aşağıdakilerden hangisi gerçekleşmez?

A) Kandaki karbondioksit miktarının artması

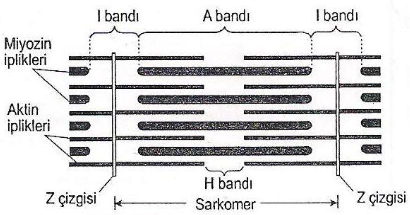
B) Kan pH sının yükselmesi (Kanın bazikleşmesi)

C) Soluk alıp – verme hızının artması

D) Dokulardaki oksijen miktarının azalması

E) Hücrelerdeki ADP miktarının artması

26. Aşağıdaki şema, insanda bir sarkomerin yapısını göstermektedir.



Kayan iplikler hipotezine göre, kasılmış bir çizgili kasın gevşemesi sırasında,

I. H bandının kısalması,

II. A bandının aynı kalması,

III. I bandının kısalması,

IV. Z çizgilerinin birbirinden uzaklaşması

olaylarından hangileri görülür?

A) I ve II B) I ve III C) II ve III

D) II ve IV E) III ve IV

27. Bir refleks yayını oluşturan nöronlarla ilgili olarak, fiziksel ya da kimyasal etkinin şiddeti değişse bile aşağıdakilerden hangisi değişmez?

A) Kullanılan ATP miktarı

B) İmpuls sayısı

C) İmpuls şiddeti

D) Harcanan oksijen miktarı

E) Uyarılan nöron sayısı

28. Annenin AB, babanın O kan grubundan olduğu bir ailede 3 çocuk vardır.

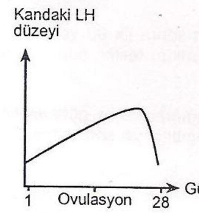
Bu çocukların kan gruplarının fenotipleri aşağıdakilerin hangisinde verilenler gibiyse üçünün de öz kardeş olduğu söylenebilir?

	1. çocuğun kan grubu fenotipi	2. çocuğun kan grubu fenotipi	3. çocuğun kan grubu fenotipi
A)	B	A	A
B)	AB	O	AB
C)	A	O	B
D)	B	AB	B
E)	B	A	AB

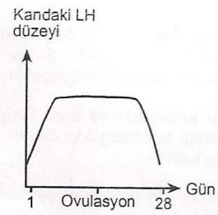
Diğer sayfaya geçiniz.

29. İnsanda dişi bireyde, normal bir menstrual döngü sırasında, kandaki LH hormonunun miktarındaki değişimi, aşağıdaki grafiklerden hangisi gösterir?

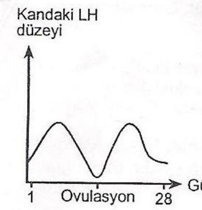
A)



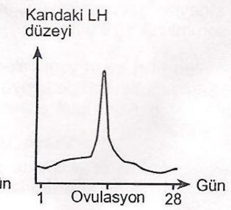
B)



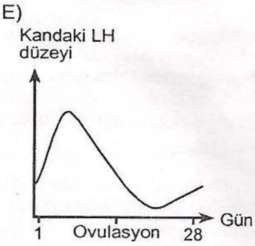
C)



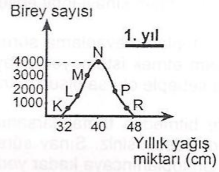
D)

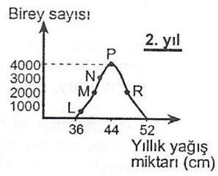


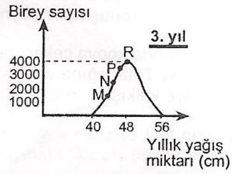
E)



30. Aşağıdaki grafikler, yıllık yağış ortalamalarında farklılıklar saptanan bir ekosistemde, bir bitki populasyonunun K, L, M, N, P ve R varyasyonlarının 1., 2. ve 3. yıllardaki dağılımını göstermektedir.







Buna göre, aşağıdaki yargılardan hangisi yanlıştır?

A) Populasyonun devamlılığı, varyasyonların birey sayılarının aynı kalmasıyla sağlanmıştır.

B) Populasyondaki her bir varyasyonun birey sayısı yağış miktarına göre değişmiştir.

C) Yağış miktarındaki değişme populasyon büyüklüğünü etkilememiştir.

D) Farklı varyasyonlar farklı uyum göstermiştir.

E) Yağış miktarındaki değişme bazı varyasyonların elenmesine neden olmuştur.

FEN BİLİMLERİ–2 TESTİ BİTTİ.

APPENDIX C

ANALYSIS OF 2008 STUDENT SELECTION TEST

Missing Values of Items

Science 1_23		
	Frequency	*Percent*
0	7470	71,4
1	2596	24,8
Missing	393	3,8
Total	10459	100,0

Science 1_24		
	Frequency	*Percent*
0	8296	79,3
1	1562	14,9
Missing	601	5,7
Total	10459	100,0

Science 1_25		
	Frequency	*Percent*
0	5071	48,5
1	4914	47,0
Missing	474	4,5
Total	10459	100,0

Science 1_26		
	Frequency	*Percent*
0	5966	57,0
1	4045	38,7
Missing	448	4,3
Total	10459	100,0

Missing Values of Items (continued)

Science 1_27		
	Frequency	*Percent*
0	9001	86,1
1	1024	9,8
Missing	434	4,1
Total	10459	100,0

Science 1_28		
	Frequency	*Percent*
0	8280	79,2
1	1483	14,2
Missing	696	6,7
Total	10459	100,0

Science 1_29		
	Frequency	*Percent*
0	8303	79,4
1	1539	14,7
Missing	617	5,9
Total	10459	100,0

Science 1_30		
	Frequency	*Percent*
0	7565	72,3
1	2363	22,6
Missing	531	5,1
Total	10459	100,0

Science 2_23		
	Frequency	*Percent*
0	6195	59,2
1	2343	22,4
Missing	1921	18,4
Total	10459	100,0

Science 2_24		
	Frequency	*Percent*
0	7603	72,7
1	811	7,8
Missing	2045	19,6
Total	10459	100,0

Missing Values of Items (continued)

Science 2_25		
	Frequency	*Percent*
0	6347	60,7
1	1966	18,8
Missing	2146	20,5
Total	10459	100,0

Science 2_26		
	Frequency	*Percent*
0	7316	69,9
1	1136	10,9
Missing	2007	19,2
Total	10459	100,0

Science 2_27		
	Frequency	*Percent*
0	6163	58,9
1	2323	22,2
Missing	1973	18,9
Total	10459	100,0

Science 2_28		
	Frequency	*Percent*
0	6278	60,0
1	1929	18,4
Missing	2252	21,5
Total	10459	100,0

Science 2_29		
	Frequency	*Percent*
0	7495	71,7
1	974	9,3
Missing	1990	19,0
Total	10459	100,0

Science 2_30		
	Frequency	*Percent*
0	6623	63,3
1	1886	18,0
Missing	1950	18,6
Total	10459	100,0

Frequencies of Items

	Skewness	*Kurtosis*
Turkish 1	,579	-1,666
Turkish 2	1,236	-,473
Turkish 3	,561	-1,686
Turkish 4	1,866	1,481
Turkish 5	1,643	,700
Turkish 6	2,104	2,427
Turkish 7	2,733	5,473
Turkish 8	,519	-1,731
Turkish 9	1,337	-,213
Turkish 10	,524	-1,726
Turkish 11	,460	-1,789
Turkish 12	1,014	-,971
Turkish 13	,338	-1,886
Turkish 14	1,444	,086
Turkish 15	2,571	4,609
Turkish 16	,940	-1,117
Turkish 17	,016	-2,000
Turkish 18	2,383	3,679
Turkish 19	1,587	,520
Turkish 20	,923	-1,148
Turkish 21	,782	-1,389
Turkish 22	,523	-1,727
Turkish 23	,184	-1,967
Turkish 24	,866	-1,250
Mathematics1_1	,964	-1,071
Mathematics1_2	,054	-1,997
Mathematics1_3	,960	-1,079
Mathematics1_4	,051	-1,998
Mathematics1_5	2,205	2,863
Mathematics1_6	2,455	4,027
Mathematics1_7	2,664	5,099
Mathematics1_8	,844	-1,287
Mathematics1_9	2,191	2,803
Mathematics1_10	,965	-1,068
Mathematics1_11	1,358	-,156
Mathematics1_12	,944	-1,109
Mathematics1_13	1,033	-,933
Mathematics1_14	1,342	-,198
Mathematics1_15	2,416	3,837
Mathematics1_16	1,003	-,994

Frequencies of Items (Continues)

	Skewness	*Kurtosis*
Mathematics1_17	1,260	-,413
Mathematics1_18	1,734	1,006
Mathematics1_19	1,203	-,552
Mathematics1_20	1,636	,677
Mathematics1_21	1,581	,498
Mathematics1_22	1,548	,396
Mathematics1_23	,527	-1,722
Mathematics1_24	,666	-1,557
Mathematics1_25	1,169	-,635
Mathematics1_26	,531	-1,718
Mathematics1_27	,239	-1,943
Mathematics1_28	,982	-1,036
Mathematics1_29	,937	-1,123
Mathematics1_30	,547	-1,702
Science1_1	1,112	-,763
Science1_2	-,431	-1,814
Science1_3	,018	-2,000
Science1_4	1,529	,338
Science1_5	1,518	,304
Science1_6	,730	-1,468
Science1_7	,715	-1,490
Science1_8	2,432	3,917
Science1_9	1,415	,002
Science1_10	2,578	4,647
Science1_11	1,065	-,865
Science1_12	,947	-1,103
Science1_13	1,102	-,786
Science1_14	,678	-1,541
Science1_15	1,085	-,823
Science1_16	1,789	1,199
Science1_17	,520	-1,730
Science1_18	,422	-1,823
Science1_19	1,151	-,675
Science1_20	1,306	-,295
Science1_21	1,397	-,048
Science1_22	1,403	-,030
Science1_23	1,106	-,777
Science1_24	1,871	1,502

Frequencies of Items (Continues)

	Skewness	*Kurtosis*
Science1_25	,025	-2,000
Science1_26	,394	-1,845
Science1_27	2,627	4,904
Science1_28	1,940	1,765
Science1_29	1,898	1,601
Science1_30	1,229	-,488
Mathematics2_1	,909	-1,175
Mathematics2_2	-,216	-1,954
Mathematics2_3	,087	-1,993
Mathematics2_4	1,122	-,741
Mathematics2_5	2,127	2,525
Mathematics2_6	1,887	1,559
Mathematics2_7	,860	-1,261
Mathematics2_8	2,159	2,664
Mathematics2_9	1,929	1,723
Mathematics2_10	1,645	,706
Mathematics2_11	,915	-1,163
Mathematics2_12	1,139	-,703
Mathematics2_13	,905	-1,182
Mathematics2_14	,844	-1,288
Mathematics2_15	,601	-1,639
Mathematics2_16	,949	-1,099
Mathematics2_17	,852	-1,274
Mathematics2_18	,332	-1,890
Mathematics2_19	,863	-1,256
Mathematics2_20	,934	-1,128
Mathematics2_21	,764	-1,417
Mathematics2_22	,126	-1,985
Mathematics2_23	2,671	5,134
Mathematics2_24	2,142	2,588
Mathematics2_25	,393	-1,846
Mathematics2_26	,633	-1,599
Mathematics2_27	,964	-1,072
Mathematics2_28	,355	-1,874
Mathematics2_29	1,050	-,898
Mathematics2_30	,178	-1,969
Science2_1	1,765	1,114
Science2_2	-,070	-1,996

Frequencies of Items (Continues)

	Skewness	*Kurtosis*
Science2_3	1,226	-,497
Science2_4	1,059	-,878
Science2_5	1,244	-,452
Science2_6	1,508	,274
Science2_7	1,720	,957
Science2_8	,565	-1,681
Science2_9	,025	-2,000
Science2_10	,057	-1,997
Science2_11	,212	-1,955
Science2_12	1,333	-,222
Science2_13	1,589	,525
Science2_15	1,381	-,092
Science2_16	,785	-1,384
Science2_17	2,479	4,145
Science2_18	,220	-1,952
Science2_19	1,477	,181
Science2_20	1,212	-,531
Science2_21	,965	-1,069
Science2_22	,802	-1,357
Science2_23	,837	-1,299
Science2_24	1,011	-,978
Science2_25	2,738	5,498
Science2_26	1,243	-,455
Science2_27	2,150	2,622
Science2_28	1,251	-,436
Science2_29	1,018	-,965
Science2_30	2,411	3,816

Item and Test Analysis Program (ITEMAN) Results

Item Statistics					*Alternative Statistics*				
Seq. No.	*Scale -Item*	*Prop. Corr.*	*Biser.*	*Point Biser.*	*Alt.*	*Prop. Endor.*	*Biser.*	*Point Biser.*	*Key*
S1_23	1-1	0.248	0.681	0.499	A	0.030	-0.058	-0.023	
					B	0.248	0.681	0.499	*
					C	0.185	-0.248	-0.171	
					D	0.394	-0.306	-0.241	
					E	0.105	-0.094	-0.056	
					Ot.	0.037	-0.128	-0.055	
S1_24	1-2	0.149	0.723	0.472	A	0.191	-0.109	-0.075	
					B	0.130	0.100	0.063	
					C	0.188	-0.177	-0.122	
					D	0.284	-0.315	-0.237	
					E	0.149	0.723	0.472	*
					Ot.	0.057	-0.045	-0.022	
S1_25	1-3	0.471	0.251	0.200	A	0.312	-0.037	-0.029	
					B	0.039	-0.108	-0.047	
					C	0.111	-0.250	-0.151	
					D	0.471	0.251	0.200	*
					E	0.021	-0.208	-0.073	
					Ot.	0.045	-0.207	-0.095	
S1_26	1-4	0.386	0.639	0.502	A	0.216	-0.381	-0.272	
					B	0.232	-0.219	-0.159	
					C	0.093	-0.224	-0.129	
					D	0.386	0.639	0.502	*
					E	0.030	-0.116	-0.047	
					Ot.	0.043	-0.226	-0.102	
S1_27	1-5	0.098	1.000	0.706	A	0.098	1.000	0.706	*
					B	0.313	-0.334	-0.255	
					C	0.224	-0.038	-0.027	
					D	0.227	-0.203	-0.146	
					E	0.097	-0.071	-0.041	
					Ot.	0.041	-0.079	-0.035	
S1_28	1-6	0.142	0.804	0.518	A	0.447	-0.357	-0.284	
					B	0.142	0.804	0.518	*
					C	0.040	0.146	0.064	
					D	0.116	-0.097	-0.059	
					E	0.189	-0.066	-0.046	
					Ot.	0.066	-0.116	-0.060	

Item and Test Analysis Program (ITEMAN) Results

Item Statistics					*Alternative Statistics*				
Seq. No.	*Scale -Item*	*Prop. Corr.*	*Biser.*	*Point Biser.*	*Alt.*	*Prop. Endor.*	*Biser.*	*Point Biser.*	*Key*
S1_29	1-7	0.147	0.937	0.609	A	0.255	-0.266	-0.196	
					B	0.278	-0.239	-0.179	
					C	0.147	0.937	0.609	*
					D	0.117	0.052	0.032	
					E	0.145	-0.172	-0.111	
					Ot.	0.059	-0.177	-0.088	
S1_30	1-8	0.226	0.733	0.527	A	0.226	0.733	0.527	*
					B	0.443	-0.287	-0.228	
					C	0.057	-0.160	-0.079	
					D	0.050	0.043	0.020	
					E	0.173	-0.299	-0.202	
					Ot.	0.051	-0.158	-0.075	
S2_23	1-9	0.224	0.759	0.545	A	0.224	0.759	0.545	*
					B	0.115	-0.064	-0.039	
					C	0.137	-0.281	-0.179	
					D	0.154	-0.193	-0.127	
					E	0.187	-0.206	-0.142	
					Ot.	0.182	-0.196	-0.134	
S2_24	1-10	0.078	0.450	0.245	A	0.125	0.241	0.150	
					B	0.258	-0.304	-0.225	
					C	0.078	0.450	0.245	*
					D	0.173	-0.113	-0.076	
					E	0.172	0.211	0.143	
					Ot.	0.195	-0.151	-0.105	
S2_25	1-11	0.188	0.595	0.411	A	0.147	-0.085	-0.055	
					B	0.188	0.595	0.411	*
					C	0.130	-0.119	-0.075	
					D	0.193	-0.157	-0.109	
					E	0.138	-0.146	-0.093	
					Ot.	0.204	-0.142	-0.100	
S2_26	1-12	0.108	0.909	0.544	A	0.093	-0.052	-0.030	
					B	0.305	-0.332	-0.252	
					C	0.180	-0.071	-0.048	
					D	0.108	0.909	0.544	*
					E	0.123	0.137	0.085	
					Ot.	0.191	-0.197	-0.136	

Item and Test Analysis Program (ITEMAN) Results

Item Statistics					*Alternative Statistics*				
Seq. No.	*Scale -Item*	*Prop. Corr.*	*Biser.*	*Point Biser.*	*Alt.*	*Prop. Endor.*	*Biser.*	*Point Biser.*	*Key*
S2_27	1-13	0.222	0.495	0.355	A	0.054	-0.083	-0.040	
					B	0.196	-0.082	-0.057	
					C	0.137	-0.166	-0.106	
					D	0.222	0.495	0.355	*
					E	0.204	-0.099	-0.070	
					Ot.	0.188	-0.190	-0.131	
S2_28	1-4	0.185	0.397	0.273	A	0.110	-0.260	-0.157	
					B	0.130	0.041	0.026	
					C	0.155	-0.081	-0.053	
					D	0.206	0.059	0.042	
					E	0.185	0.397	0.273	*
					Ot.	0.214	-0.217	-0.154	
S2_29	1-5	0.093	1.000	0.692	A	0.353	-0.313	-0.243	
					B	0.093	1.000	0.692	*
					C	0.161	-0.119	-0.079	
					D	0.109	-0.059	-0.035	
					E	0.095	0.036	0.021	
					Ot.	0.189	-0.190	-0.131	
S2_30	1-6	0.180	0.771	0.527	A	0.211	-0.034	-0.024	
					B	0.066	-0.051	-0.026	
					C	0.180	0.771	0.527	*
					D	0.237	-0.349	-0.253	
					E	0.121	-0.135	-0.083	
					Ot.	0.185	-0.193	-0.133	

Scale Statistics

Scale	*1*
N of Items	16
N of Examinees	10359
Mean	3.146
Variance	8.030
Std. Dev.	2.834
Skew	2.228
Kurtosis	5.228
Minimum	0.000
Maximum	16.000
Median	2.000
Alpha	0. 753
SEM	1. 408
Mean P	0. 197
Mean Item-Tot.	0. 476
Mean Biserial	0. 697

Factor Analysis

Descriptive Statistics

	N	*Mean*	*Std. Deviation*
Science1_23	9971	,2580	,43758
Science1_24	9765	,1584	,36516
Science1_25	9891	,4937	,49999
Science1_26	9916	,4033	,49058
Science1_27	9934	,1022	,30289
Science1_28	9672	,1519	,35892
Science1_29	9751	,1559	,36276
Science1_30	9833	,2382	,42599
Science2_23	8469	,2744	,44624
Science2_24	8341	,0963	,29498
Science2_25	8242	,2361	,42471
Science2_26	8383	,1340	,34063
Science2_27	8147	,2349	,42398
Science2_28	8416	,2733	,44567
Science2_29	8405	,1152	,31925
Science2_30	8440	,2212	,41509

KMO and Bartlett's Test	
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	,848
Bartlett's Test of Sphericity	
Approx. Chi-Square	28264,157
df	120
Sig.	,000

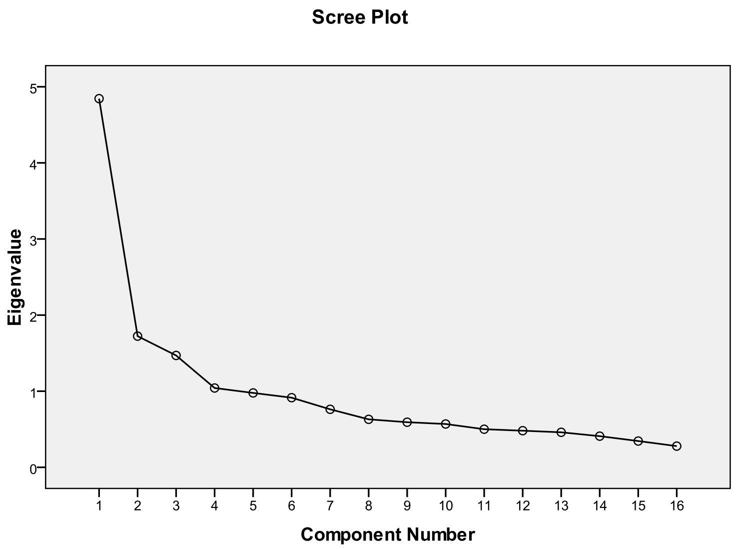
Communalities

	Initial	*Extraction*
Science1_23	1,000	,407
Science1_24	1,000	,384
Science1_25	1,000	,732
Science1_26	1,000	,748
Science1_27	1,000	,606
Science1_28	1,000	,356
Science1_29	1,000	,470
Science1_30	1,000	,566
Science2_23	1,000	,495
Science2_24	1,000	,132
Science2_25	1,000	,602
Science2_26	1,000	,403
Science2_27	1,000	,093
Science2_28	1,000	,413
Science2_29	1,000	,639
Science2_30	1,000	,483

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*
1	4,406	27,536	27,536	4,406	27,536	27,536	3,113	19,457	19,457
2	1,672	10,447	37,983	1,672	10,447	37,983	2,392	14,949	34,406
3	1,450	9,065	47,048	1,450	9,065	47,048	2,023	12,642	47,048
4	1,013	6,334	53,381						
5	,994	6,216	59,597						
6	,918	5,739	65,336						
7	,791	4,945	70,281						
8	,716	4,478	74,758						
9	,647	4,045	78,804						
10	,607	3,797	82,601						
11	,571	3,569	86,170						
12	,540	3,375	89,545						
13	,498	3,112	92,657						
14	,444	2,773	95,430						
15	,396	2,475	97,905						
16	,335	2,095	100,000						
Extraction Method: Principal Component Analysis.									

Scree Plot



Component Matrix

	Component		
	1	2	3
Science1_27	,771	,105	-
Science2_29	,769	,207	-
Science1_29	,647	,209	-
Science2_23	,599	-,355	-
Science2_26	,594	-	,209
Science2_30	,580	-,380	-
Science1_28	,555	,209	-
Science1_30	,539	,419	-,317
Science1_24	,502	-,329	,155
Science1_23	,496	-,116	,384
Science1_26	,557	-,648	-,137
Science2_27	,289	,416	-,395
Science2_28	,166	,254	-
Science1_25	-	,535	,664
Science2_25	,425	-	-,642
Science2_24	,227	-	-,278

Rotated Component Matrix

	Component		
	1	*2*	*3*
Science1_26	,818	-,218	,179
Science2_23	,688	,121	-
Science2_30	,683	-	,105
Science1_24	,609	,116	-
Science1_23	,496	,372	-,147
Science1_25	-,207	,732	-,391
Science2_29	,431	,586	,331
Science1_29	,344	,529	,267
Science1_27	,494	,497	,338
Science2_26	,410	,474	,101
Science1_28	,274	,472	,240
Science2_28	-	,281	,110
Science2_25	,151	-	,761
Science1_30	-	,420	,621
Science2_27	-,128	,247	,579
Science2_24	-	-	,352

Component Transformation Matrix

Component	*1*	*2*	*3*
1	,727	,532	,433
2	-,669	,689	,277
3	,151	,492	-,858

The Simplis Syntax For Biology Subtest of 2008 SST

CFA BIO 2008

Observed Variables
S1_23 S1_24 S1_25 S1_26 S1_27 S1_28 S1_29 S1_30 S2_23 S2_24 S2_25 S2_26 S2_27 S2_28 S2_29 S2_30
Covariance Matrix from File: CFA2008.COR
Sample Size = 10359
Latent Variables
Remembering Other

Relationships
S1_23 S1_24 S1_26 S1_28 S1_30 S2_23 S2_24 S2_25 S2_27 S2_30 = Other
S1_25 S1_27 S1_29 S2_26 S2_28 S2_29 = Remembering

Path Diagram
End of Problem

Goodness-Of-Fit Criteria For Biology Items of 2008 SST

Goodness-of-Fit Criteria	2008 SST
Chi-Square ($\chi 2$), df	6765.82; 89
Normed Chi-Square (NC)	
Goodness-of-Fit Index (GFI)	0.95
Adjusted Goodness-of-Fit Index (AGFI)	0.097
Root-Mean-Square Residual (RMR)	0.028
Root-Mean-Squared Error of Approximation (RMSEA)	0.087
Normed Fit Index (NFI)	0.86
Non-Normed Fit Index (NNFI)	0.84
Comparative Fit Index (CFI)	0.86
Incremental Fit Index (IFI)	0.86
Relative Fit Index (RFI)	0.83
Expected Cross Validation Index (ECVI)	0.70
Parsimonious Normed Fit Index (PNFI)	0.73
Parsimonious Goodness-of-Fit Index (PGFI)	0.68

Regression Analysis

Model Summary

R	*R Square*	*Adjusted R Square*	*Std. Error of the Estimate*
,842[a]	,709	,709	1,52957

ANOVA

	Sum of Squares	*df*	*Mean Square*	*F*	*Sig.*
Regression	58835,281	5	11767,056	5029,563	,000[a]
Residual	24170,183	10331	2,340		
Total	83005,463	10336			

Coefficients

	Unstandardized Coefficients		*Standardized Coefficients*		
	B	Std. Error	Beta	*t*	*Sig.*
(Constant)	-,118	,056		-2,108	,035
Math	,077	,004	,288	21,199	,000
Phy	,046	,006	,076	8,080	,000
Che	,241	,008	,292	28,616	,000
Turkish	,137	,006	,253	24,611	,000

21. Tabloda arı su, yemek tuzu ve çay şekerinin sulu çözeltileriyle ilgili bilgiler ve bulundukları ortamın dış basınçları verilmiştir.

Madde	Hacim (L)	Dış basınç (cm Hg)
I. Arı su	3	62
II. 1 mol yemek tuzu içeren tuzlu su	1	76
III. 1 mol çay şekeri içeren şekerli su	3	62

Buna göre, I, II, III maddeleriyle ilgili aşağıdaki ifadelerden hangisi doğrudur?

A) I. nin kaynama sıcaklığı en yüksektir.

B) II. nin kaynama sıcaklığı en düşüktür.

C) III. nün kaynama sıcaklığı I. ninkinden yüksektir.

D) II. ve III. nün kaynama sıcaklıkları aynıdır.

E) Kaynama sıcaklıklarının küçükten büyüğe doğru sıralanışı II < I < III tür.

22. 100 mL sinde 10 g X bulunan bir sulu çözelti ile 100 mL sinde 20 g X bulunan diğer bir sulu çözelti karıştırılıyor ve üzerine 50 mL arı su ilave ediliyor.

Sonuçta oluşan 250 mL çözeltiden alınan 100 mL çözeltideki X in ağırlığı kaç g dir?

A) 10 B) 12 C) 15 D) 20 E) 30

23. Bir insana,

I. kızamık aşısı yapıldıktan bir süre sonra kızamık etkeninin verilmesi,

II. suçiçeği hastalığı geçirmeden suçiçeği etkeninin verilmesi,

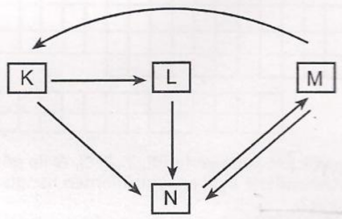
III. kabakulak hastalığı geçirdikten sonra kabakulak etkeninin verilmesi

uygulamalarından hangilerinin sonucunda o insanın hastalanması beklenir?

A) Yalnız I B) Yalnız II C) Yalnız III

D) I ve II E) II ve III

24. Bir ekosistemde besin zinciri aşağıdaki şemada gösterildiği gibidir.



Şemada oklar, besin kaynağı olan gruptan besin alan gruba doğru çizilmiştir.

Buna göre, üretici, birincil tüketici, ikincil tüketici ve ayrıştırıcı canlı grupları, aşağıdakilerin hangisinde doğru olarak verilmiştir?

	Üretici	Birincil Tüketici	İkincil Tüketici	Ayrıştırıcı
A)	K	L	M	N
B)	K	N	L	M
C)	N	M	K	L
D)	M	L	N	K
E)	M	K	L	N

Diğer sayfaya geçiniz.

25. Canlılarda gerçekleşen,

I. kromozomların kutuplara düzenli olarak çekilmesi,

II. mayozda homolog kromozomlar arasında parça değişiminin olması,

III. interfazda DNA nın kendini eşlemesi,

IV. mayozda homolog kromozomların ekvator düzleminde rastgele dizilmesi

olaylarından kural olarak genetik çeşitliliği artıranlar, aşağıdakilerin hangisinde birlikte verilmiştir?

A) I ve II B) I ve III C) II ve III

D) II ve IV E) III ve IV

26. Bir tür bakteri, uygun besiyeri içeren beş petri kabına ekilmiştir. Bu türün farklı antibiyotiklere karşı direncini araştırmak amacıyla petri kaplarına K, L, M, N ve P antibiyotiklerinin farklı kombinasyonları eklenmiş ve kaplarda üreme olup olmadığı gözlenmiştir.

Kullanılan antibiyotik kombinasyonları ve bunların eklendiği kaplardaki bakterilerin üreme durumu aşağıdaki tabloda gösterilmiştir. (Antibiyotiklerin birbirleriyle etkileşime girmediği kabul edilecektir.)

Petri kabı numarası	Eklenen antibiyotik kombinasyonu	Petri kaplarındaki üreme
1	K + L	Var
2	M + N	Yok
3	L + P	Var
4	K + N	Yok
5	M + P	Var

Buna göre, bu bakteri türü hangi antibiyotiğe karşı dirençli <u>değildir</u>?

A) K B) L C) M D) N E) P

27. Ökaryot canlıların oksijenli solunumunda,

I. glukozun sitoplazmada belirli moleküllere kadar yıkılması,

II. enerji elde etmede kullanılacak moleküllerin mitokondrilere geçmesi,

III. moleküllerin enzimlerle CO_2 ve H_2O ya kadar parçalanması

olaylarının gerçekleşme sırası aşağıdakilerin hangisinde doğru olarak verilmiştir?

A) I – II – III B) II – I – III C) II – III – I

D) III – I – II E) III – II – I

28. Küresel ısınmada aşağıdakilerden hangisinin en son gözlenmesi beklenir?

A) Buzullarda erime

B) Kıyı ekosistemlerinde değişme

C) Deniz suyu seviyesinde yükselme

D) Hava sıcaklığı ortalamalarında artma

E) Atmosferdeki karbondioksit miktarında artma

Diğer sayfaya geçiniz.

29. Hücre zarından madde alışverişiyle ilgili olarak

I. moleküllerin, derişimlerinin az olduğu ortamdan çok olduğu ortama taşınması,

II. hücredeki büyük moleküllü atık maddelerin dışarı atılması,

III. difüzyonla alınamayacak kadar büyük moleküllerin hücre içine alınması,

IV. suyun hipotonik ortamdan hücre içine geçmesi,

V. moleküllerin kolaylaştırılmış difüzyonla hücre içine alınması

olaylarından hangilerinin gerçekleştirilmesi için ATP enerjisi kullanılır?

A) I ve V B) II ve IV C) I, II ve III

D) I, III ve IV E) II, III ve V

30. Aşağıdaki tabloda, bir ekosistemde bulunan K, L, M, N, P ve R harfleriyle belirtilen altı tür kurbağanın yaşam alanları, çiftleşme mevsimleri ve besin çeşitleriyle ilgili bilgiler verilmiştir.

Kurbağa türü	Yaşam alanı	Çiftleşme mevsimi	Besin çeşidi
K	Ağaç üzeri	Nisan	Y türü böcek
L	Orman altı ortamı	Nisan	X türü böcek
M	Ağaç üzeri	Haziran	Y türü böcek
N	Göl ortamı	Mayıs	X türü böcek
P	Göl ortamı	Mayıs	Z türü böcek
R	Orman altı ortamı	Nisan	Z türü böcek

Tablodaki bilgilere göre, aşağıdakilerin hangisinde verilen iki kurbağa türü arasında rekabetin <u>en fazla</u> olması beklenir?

A) K ve M B) L ve N C) L ve R

D) N ve P E) P ve R

FEN BİLİMLERİ–1 TESTİ BİTTİ.

23. Aşağıdaki canlı gruplarından hangisine ait populasyonda, doğal seçilimle, gen frekansının en hızlı değişmesi beklenir?

A) Bakteri B) Böcek C) Kedi

D) Kuş E) Balık

24. Endosimbiyotik Hipotez, ökaryotlardaki mitokondri ve kloroplast organellerinin, prokaryotlardan köken aldığını savunur.

Buna göre, aşağıdakilerden hangisi "Endosimbiyotik Hipotez"**i desteklemek amacıyla kullanılamaz?**

A) Mitokondri ve kloroplastların halkasal DNA ya sahip olmaları

B) Mitokondri ve kloroplastların çoğalma şeklinin bakterilerinkine benzerlik göstermesi

C) Prokaryotlarla ökaryotların protein sentezinde aynı aminoasitleri kullanmaları

D) Mitokondri ve kloroplast ribozomlarının, prokaryotların ribozomlarına benzerlik göstermesi

E) Günümüzde bir hücreli ökaryot canlılarda simbiyotik olarak yaşayan prokaryot canlıların bulunabilmesi

25. Dengeli beslenen normal bir insan, bir öğünde protein içeren besinlerden fazla miktarda tükettiğinde, vücudunda aşağıdakilerden hangisinin olması beklenir?

A) Kan pH sında artma (bazikleşme)

B) İdrarda üre miktarında artma

C) Kanın ozmotik basıncında azalma

D) Kanda glukoz miktarında artma

E) İdrarda glukoz miktarında artma

26. Aşağıdakilerden hangisi, bitkisel ve hayvansal hormonların ortak özelliği değildir?

A) Az miktarlarının bile etkili olması

B) Hedef hücrelerde etkili olmaları

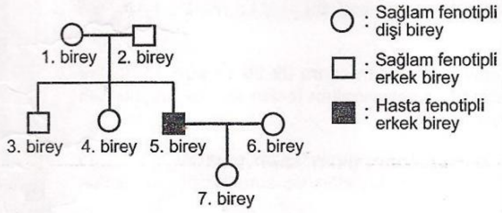
C) Özgün kimyasal yapıya sahip olmaları

D) Özelleşmiş bezler tarafından salgılanmaları

E) Sentezlendiği bölgeden farklı bölgeye taşınabilmeleri

Diğer sayfaya geçiniz.

27. Aşağıdaki soy ağacında X e bağlı çekinik bir özelliğin kalıtımı gösterilmiştir.



Buna göre, soy ağacındaki bireylerden hangilerinin bu özellik bakımından genotipi kesin olarak söylenemez?

A) 1. ve 3. B) 2. ve 4. C) 3. ve 4.

D) 4. ve 6. E) 6. ve 7.

28. **Fotosentezde aşağıdaki olaylardan hangisi ilk olarak gerçekleşir?**

A) Oksijen üretilmesi

B) ATP sentezlenmesi

C) Suyun ayrıştırılıp elektronlarının klorofile iletilmesi

D) Elektronun ferrodoksin tarafından tutulması

E) Klorofildeki elektronun enerji düzeyinin yükseltilmesi

29. **Bir canlı, aşağıdakilerden hangisiyle bir glukoz molekülünden en fazla ATP elde eder?**

A) Glikoliz

B) Elektron taşıma sistemi (ETS)

C) Laktik asit fermantasyonu

D) Etil alkol fermantasyonu

E) Pirüvattan Asetil CoA elde edilmesi

30. **İnsanda,**

I. karaciğer,

II. mide,

III. pankreas,

IV. ince bağırsak

organlarından hangilerinin salgıları (hormonlar hariç), üretildikleri yerden başka bir yerde işlev görür?

A) Yalnız III B) I ve II C) I ve III

D) II ve IV E) III ve IV

FEN BİLİMLERİ–2 TESTİ BİTTİ.