THE ACQUISITION OF SCIENCE PROCESS SKILLS THROUGH GUIDED (TEACHER-DIRECTED) INQUIRY

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

BY

ELA AYŞE KÖKSAL

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

JUNE 2008

Approval of the thesis:

THE ACQUISITION OF SCIENCE PROCESS SKILLS THROUGH GUIDED (TEACHER-DIRECTED) INQUIRY

submitted by **ELA AYŞE KÖKSAL** in partial fulfillment of the requirements for the degree of **Doctor of Philosopy in Secondary Science and Mathematics Education Department, Midde East Technical University** by,

Prof. Dr. Canan Özgen _____
Dean, Graduate School of **Natural and Applied Sciences**

Prof. Dr. Ömer Geban _____
Head of Department, **Secondary Science and Mathematics Education**

Prof. Dr. Giray Berberoğlu _____
Supervisor, **Secondary Science and Mathematics Education Dept., METU**

Examining Committee Members:

Prof. Dr. Ömer Geban _____
Secondary Science and Mathematics Education Dept., METU

Prof. Dr. Giray Berberoğlu _____
Secondary Science and Mathematics Education Dept., METU

Assoc. Prof. Dr. Özlem Yıldırım _____
Biology Dept., Ankara University

Assoc. Prof. Dr. Ceren Tekkaya _____
Elementary Education Dept., METU

Ins. Dr. Ömer Faruk Özdemir _____
Secondary Science and Mathematics Education Dept., METU

Date: _____

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name: Ela Ayşe Köksal

Signature :

ABSTRACT

THE ACQUISITION OF SCIENCE PROCESS SKILLS THROUGH GUIDED (TEACHER-DIRECTED) INQUIRY

Köksal, Ela Ayşe

PhD., Department of Secondary Science and Mathematics Education

Supervisor: Prof. Dr. Giray Berberoğlu

June 2008, 246 pages

The international and national assessment results indicated that Turkish students' conceptual understanding in science and basic inquiry skills are far behind the expected levels. The reason of low achievement could be attributed to many sources such as family background characteristics, students' attitudes, and teaching methodologies. The low socioeconomic environment in the school and crowded classrooms are important facts that should be somehow considered by the educational researchers. The way a teacher teaches in a crowded classroom is important to help students' understanding of concepts and development of inquiry skills.

The present study aimed to propose a methodology that helps teachers to enhance students' understanding of concepts and develop inquiry skills in many schools with various socio-economic-status environments and large classrooms. The method proposed could be called as guided (teacher-directed) inquiry to develop concepts, skills, and affective characteristics of the students such as attitudes.

This study was conducted with 168 sixth grade public elementary school students in Ankara in 2006-07 academic year. Repeated measures design was used in the study. Intact groups received either traditional or teacher-directed inquiry instructions. The students in both groups were measured with the unit achievement and science process skills tests, and attitudes toward science questionnaire before and after the instructions, and repeatedly after no treatment by a retention or delayed test.

It was found that while the guided (teacher-directed) inquiry instruction made a difference on student achievement in the first unit (Reproduction, Development and Growth in Living Things), it could not make a difference on student achievement in the second unit (Force and Motion). The instruction also made a difference on students' science process skills test performance and both the composite and individual attitude scores.

It is concluded that guided (teacher-directed) inquiry instruction generally helps students' understanding of science concepts and results with achievement in science. It helps students' development of scientific skills with authentic experiences. Guided (teacher-directed) inquiry instruction also has an effect on students' development of positive attitudes toward science and technology course, specifically on self-concept, anxiety, interest, career, enjoyment, and usefulness dimensions.

Keywords: Science Education, Guided Inquiry, Science Process Skills, Science Achievement, Attitudes toward Science and Technology Course.

ÖZ

ÖĞRETMEN REHBERLİĞİNDEKİ SORGULAYICI ARAŞTIRMA YÖNTEMİ İLE BİLİMSEL SÜREÇ BECERİLERİNİN KAZANDIRILMASI

Köksal, Ela Ayşe
Doktora, Ortaöğretim Fen ve Matematik Alanları Eğitimi Bölümü
Tez Yöneticisi: Prof. Dr. Giray Berberoğlu

Haziran 2008, 246 sayfa

Yapılan uluslararası ve ulusal değerlendirme sonuçları Türk öğrencilerinin fen bilimlerindeki kavramsal anlama ve temel sorgulayıcı araştırma becerilerinin beklenen düzeylerden geride olduğunu göstermiştir. Bu düşük başarının nedeni öğrencinin aile özelliklerine, tutumlarına ve öğretim yöntemlerine bağlanabilir. Okuldaki düşük sosyoekonomik çevre ve kalabalık sınıflar eğitim araştırmacılarının düşünmesi gereken önemli gerçeklerdir. Bir öğretmenin kalabalık bir sınıfta nasıl öğretim yaptığı, öğrencilerin kavramları anlamalarına ve sorgulayıcı araştırma becerilerini geliştirmelerine yardım etmede önem taşımaktadır.

Bu çalışma öğretmenlere farklı sosyoekonomik çevre ve büyük sınıflara sahip çoğu okulda öğrenim gören öğrencilerin kavramları anlamalarını ve sorgulayıcı araştırma becerilerini geliştirmelerine yardım eden bir yöntem önermeyi amaçlamıştır. Öğrencilerin kavramları, becerileri ve tutumlar gibi duyuşsal özelliklerini geliştirmek için önerilen bu yöntem, Öğretmen Rehberliğindeki Sorgulayıcı Araştırma Yöntemi olarak adlandırılabilir.

Bu çalışma Ankara'da 2006-07 eğitim ve öğretim yılında devlete ait ilköğretim okullarına giden 168 altıncı sınıf öğrencisiyle gerçekleştirilmiştir. Çalışmada Tekrarlı Ölçümler Deseni kullanılmıştır. Çalışmaya katılan mevcut sınıflar ya geleneksel ya da öğretmen rehberliğindeki sorgulayıcı araştırma yöntemine tabi tutulmuşlardır. Bu öğretim yöntemleri uygulamadan önce ve sonra ve ardından uygulama yokken kalıcılık testi ya da gecikmiş test olarak gruplardaki öğrencilere unite başarı ve bilimsel süreç becerileri testleri ile fen ve teknoloji dersine yönelik tutumlar anketi uygulanmıştır.

Bu çalışmanın bulgular şunlardır: Öğretmen rehberliğindeki sorgulayıcı araştırma yöntemi öğrencilerin ilk ünitedeki (Canlılarda Üreme Büyüme ve Gelişme) başarılarında bir farka neden olurken, ikinci ünitedeki (Kuvvet ve Hareket) başarılarında bir farka neden olamamıştır. Ayrıca bu yöntem öğrencilerin bilimsel süreç becerileri test performansları ile tutum düzeylerinin genelinde ve alt boyutlarında bir farka neden olmuştur.

Bu çalışmadan çıkan sonuçlar şunlardır: Öğretmen rehberliğindeki sorgulayıcı araştırma yöntemi genel olarak öğrencilerin fen kavramlarını anlamalarına yardım etmekte ve fen başarısına neden olmaktadır. Bu yöntem yeni deneyimler aracılığıyla öğrencilerin bilimsel becerileri geliştirmesine yardım eder. Öğretmen rehberliğindeki sorgulayıcı araştırma yöntemi öğrencilerin fen ve teknoloji dersine yönelik olumlu tutumlar geliştirmelerinde, özellikle akademik öz yeterlik, kaygı, ilgi, kariyer, zevk alma ve faydalılık boyutlarında etkilidir.

Anahtar Kelimeler: Fen Eğitimi, Öğretmen Rehberliğindeki Sorgulayıcı Araştırma Yöntemi, Bilimsel Süreç Becerileri, Fen Başarısı, Fen ve Teknoloji Dersine Yönelik Tutumlar

To Turkish children, Asena, Alper, and Gökay

ACKNOWLEDGEMENTS

I primarily wish to express my special gratitude to Prof. Dr. Giray BERBEROĞLU for his valuable suggestions, guidance, and criticism in the realization of this study.

I also wish to thank my jury members especially those in my Thesis Committee members, Assoc. Prof. Dr. Özlem YILDIRIM and Prof. Dr. Ömer GEBAN, and Assoc. Prof. Dr. Ceren TEKKAYA and Ins. Dr. Ömer Faruk ÖZDEMİR for their valuable remarks and advises. Thanks are also due to my parents and friends for their endless support and patience throughout my dissertation.

And thanks to the science teachers and their students participating to my study and the other personnel from their schools without whose assistance and encouragement; this study could not have been accomplished.

This study was supported by the Graduate School of Natural and Applied Sciences, Middle East Technical University, Grant No: BAP-2006-07-02-00-01.

TABLE OF CONTENTS

LIST OF TABLES

TABLES

LIST OF FIGURES

FIGURES

CHAPTER 1

INTRODUCTION

The aims of science education are to develop students' understanding of natural phenomena, and the reasons underlying them; have students to be aware of the methodology that involved in making sense of the natural phenomena; help students to appreciate that science is a collective process of all human beings. Science education also aims to get attention of students to the issues of science, technology, society, and environment and make them interested in science and science related occupations for future. In other words, by affecting students' career choices, science education may initiate national development. Therefore countries take some initiatives to support science education. For example, in Turkey, general educational objectives are determined with Five-Year Development Plans, and specific objectives are established with the science curricula developed by the Ministry of National Education, and the universities (Keser, 2005). The relationship between importance given to education and economic growth can be explained with the following example. A country, which literacy score 1% higher than the international average, attains levels of labour productivity and Gross Domestic Product (GDP) per capita that are 2.5% and 1.5% higher than others (Coulombe, Tremblay, & Marchand, as cited in McGaw, 2006). On the other hand, improved levels of education are also likely to lead to improved health and other social outcomes (OECD, as cited in McGaw, 2006).

Besides the importance given to education, the value given to the quality of its outcomes is also important for understanding educational productivity (McGaw, 2006). Although the previous discussions often focused on international comparisons of levels of investment, using the percentage of GDP spent on education as the indicator, currently the focus on outcomes is supported by both national and international measurements of the knowledge and skills of students (McGaw, 2006). There are national and international testing programs that are used to give information about Turkish students' performances on learning outcomes. They are the Student Assessment Program (SAP, Öğrenci Başarılarının

Belirlenmesi Sınavı, in Turkish), Third International Mathematics and Science Study (TIMSS), Programme for International Student Assessment (PISA), and Progress in International Reading Literacy Study (PIRLS).

In general, those studies report low student achievement in science (Berberoğlu, 2008; Kalender & Berberoğlu, 2008; Ceylan & Berberoğlu, 2007). The results of the international studies were evaluated in terms of student achievement, teaching methods and techniques, and teacher attitudes. Turkish students' achievement is lower than that in European Union countries; teachers' use of classroom evaluation results (Turkish teachers' preference to use evaluation for summative reasons, i.e. to give grade, rather than formative, i.e. to feed-back), their expectations from students (low rather than high), their motivation of students to use all their capacities are different than those in European Union countries (Berberoğlu, 2008). On TIMSS-R our 8th grade students were number 33rd among 38 countries, whereas on PIRLS our 4th graders became number 28th among 35 countries (Türkiye İktisat Kongresi, 2004). On the other hand, on PISA our 15-year-olds were 33rd out of 40 countries (EARGED, 2005).

The results of Turkish students' performances in all these studies, especially in international ones, showed the Ministry of National Education (MONE) to reform educational system, and elementary school curricula were renewed for grades 1-5 in 2005-2006 academic year after a pilot study a year ago (EARGED, 2005) especially for the courses of science, social science, mathematics, and Turkish (Talim Terbiye Kurulu, as cited in Akşit, 2007). The reform has also included elementary grades 6-8, which curricula were started to be renewed in 2006-2007 academic year, and secondary school curriculum for the new 4-year high school (Talim Terbiye Kurulu, as cited in Akşit, 2007). The following list shows some of the objectives aimed by the curriculum reform (Talim Terbiye Kurulu, as cited in Akşit, 2007):

1. To lessen the amount of content and number of concepts,
2. To organize the units thematically,
3. To move from a teacher-centred didactic model to a student-centred constructivist model,
4. To integrate information and communication technologies into instruction,
5. To monitor student progress through formative assessment, and
6. To shift from traditional assessment of recall, and launch authentic assessment.

The MONE also determined both core and subject area specific teacher competencies in order to guide teachers in new patterns of teaching. The core competencies are related to students' needs, interests and wants, the process of teaching and learning, observing progress, and interaction with parents and community (ÖYEGM, as cited in Akşit, 2007).

Although our elementary science curriculum was revised according to the lessons gained from the measurement studies, there are some factors that have an effect on Turkish students' achievement in science and should be considered first hand in order for the new curriculum to be effective. In other words, some steps should be taken to improve these conditions. These factors were determined by analysis of the national and international tests. Here two studies will be outlined in order to present these factors.

The analysis of 2002 SAP data by Kalender & Berberoğlu (2008) showed that there were positive relationships between students' socio-economic status and teacher-centred activities with science achievement, and student-centred activities did not contribute to explain achievement measures positively. The researchers suggested that the quality of student-centred activities should be examined in detail.

Ceylan & Berberoğlu (2007) investigated the factors related to Turkish students' science achievement in the TIMSS-R using Linear Structural Modelling, and found that there are negative relation between our students' perception of failure in science, student-centred activities, and their attitudes toward science with their science achievement; and there are positive relation between teacher-centred activities and science achievement. These studies generally suggest that Turkish students' performance in science is low due to teacher and instructional methods. The reason might be the inability to apply student-centred activities properly.

It should be noted that science teaching/learning effectiveness is likely a function of compatibility between instructional outcomes, nature of the subject area, teaching strategy, and the nature of students (Shymansky & Yore, as cited in Yore, 1984).

It is hard to cover all concepts in a science class when considering the limited time (Temiz & Tan, 2003) and deepness of these concepts and principles (Berberoğlu, 2004). In fact, science is a process to describe and explain nature (Lawson, Rissing, and Faeth, 1990). Since it is a process of learning (Lawson et al., 1990), science lessons should include and improve some science related skills, i.e. science process, critical thinking, and scientific judgment, rather than content coverage (Badders, Fu, Bethel, Peck, Sumners, Valentino, & Mullane, as cited in Dökme & Ozansoy, 2004).

The method that can be used to support both science understanding and science related skills is Inquiry. The following quotations present Inquiry's emphasis on both process and knowledge dimensions of science learning:

> *Inquiry is a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating results. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations."* (National Research Council, as cited in Llewllyn, 2005, p. 4-5)

> *"Inquiry abilities require students to mesh these processes with scientific knowledge as they use scientific reasoning and critical thinking to develop their understanding of science."* (National Research Council, 2000, p. 18)

Inquiry is a combination of inquiry teaching and learning, and scientific inquiry, in a way that:

> *"Teaching science as a process of inquiry requires teachers to set up learning environments in which students can engage in discovery. Finally, learning as a process of inquiry involves students in using science process skills to investigate and discover patterns in the world."* (Rakow, as cited in Davison, 2000, p.18)

National Science Education Standards explains scientific inquiry as

> "the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work, and the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world." (National Research Council, as cited in Chang & Mao, 1999)

As a summary, inquiry as a teaching method serves the aims of science education better due to its inclusion of scientific inquiry as a process to reach a sound understanding of science concepts.

When the research studies summarized above and inquiry approach used in the science classrooms are thought together in terms of enhancing the quality of educational practices in science classes, educators should reconsider the role of teachers within the inquiry method.

In the new curricula the inquiry approach is emphasized frequently in the objectives considered in different content dimensions. For example, new Turkish science curriculum was prepared according to student-centred approach, but as observed in the previous 1992 and 2000 curricula, which also took students in the centre of learning process, teacher-centred activities have been dominant (Akdeniz, Yiğit & Kurt, as cited in Dede & Yaman, 2006), and teachers probably are going to continue this behaviour (Dede & Yaman, 2006). Science teachers tend to use more teacher-centred activities when they perceive themselves as the main factor in learning (Hansen, as cited in Dede & Yaman, 2006), or see themselves as inadequate in teaching science (Çepni, Küçük, & Ayvacı, as cited in Dede & Yaman, 2006).

The preferences of teachers toward teaching and learning may reflect in their questioning style. A study of the classification of elementary teachers' questions with Bloom taxonomy showed that the teachers tend to ask knowledge level questions in their classes (Baysen, as cited in Afacan & Nuhoğlu, 2007). Students' understanding should be evaluated in all cognitive domains and the evaluation will be fairer when students are assessed in the learning process (Afacan & Nuhoğlu, 2007).

The strategies used by Turkish science teachers also affect students' achievement and learning preferences. As the analyses of the performances of our students with respect to their perceptions of science teaching strategies implemented in their science classes, teacher-centred vs. student-centred, on both national (Kalender & Berberoğlu, 2008) and international (Ceylan & Berberoğlu, 2007) studies, as explained previously, indicate there is a positive relationship between teacher-centred activities and achievement. This finding is also supported with another study by Dede & Yaman (2006) on science learning preferences of 679 students attending grade 6-8 in Sivas showed that teacher-centred learning and working with group was preferred more than individual learning. Students' preference to teacher-centred activities can be a consequence of their 5 year education with the same classroom teacher, and they probably see this teacher as the only information source (Dede & Yaman, 2006). Students, in transition from traditional to student-centred education, may

develop resistance to learn because they continue to be passive, can not take responsibility of their own learning, and do not know how to learn (Akgün, as cited in Dede & Yaman, 2006)

The previous paragraphs highlight the importance of teacher factor in determining the implementation of science curriculum and assessing its effectiveness in Turkey.

Another factor that should be considered as a limitation to the implementation of inquiry instruction is related to classroom management. The crowded classrooms, and physical conditions of schools and situations of students, i.e. being a rural village school and low socio-economic status, are the actual inadequacies stated by elementary science teachers (in implementing the new science and technology curriculum) (Demirci Güler & Laçin Şimşek, 2007).

When considering these situations, which are specific to Turkey, and the importance of teacher on student learning and achievement, the method that can be suggested for Turkish context is guided or teacher-directed inquiry. Guided (teacher-directed) inquiry will also provide teachers (and students) a transition from teacher-centred approach to student-centred approach.

In guided-inquiry (Germann, Haskins, & Auls, 1996), teacher guides students in developing problem, purpose, hypothesis, variables, procedures, conclusion, and other science processes. Teacher prepares student for a skill, students individually attempt the skill, and these attempts are evaluated so that they can see positive and negative examples of the skill, students and teacher construct a model response, and the model is applied to subsequent skills. Although teacher knows the outcomes, students construct their own knowledge of problem as the experiment goes on. Consequently, teacher helps students negotiate their way through the processes until they have the declarative and procedural knowledge to process inquiry (Germann, et al., 1996).

1.1 Purpose of the Study

The purpose of the present study is to integrate teacher-directed inquiry approach into Turkish science classes and assess its impact on various student outcomes. Thus this study aims at investigating how effective is the guided (teacher-directed) inquiry approach in

enhancing content knowledge achievement, attitudes toward science and technology course, and science process skill development of students at the elementary education level.

1.1.1 Statement of the Hypotheses

The following null hypotheses are the hypotheses of the statistical analysis that are tested at the .05 level of significance:

H_O: There is no statistically significant difference between teacher-guided inquiry and traditional instruction on the population means of the 6th grade students' "Reproduction, Growth and Development in Living Things" unit achievement test scores.

H_O: There is no statistically significant difference between teacher-guided inquiry and traditional instruction on the population means of the 6th grade students' "Force and Motion" unit achievement test scores.

H_O: There is no statistically significant difference between teacher-guided inquiry and traditional instruction on the population means of the 6th grade students' attitudes toward science and technology course questionnaire scores in total and specifically in academic self-concept, anxiety, interest, career, enjoyment, and usefulness dimensions.

H_O: There is no statistically significant difference between teacher-guided inquiry and traditional instruction on the population means of the of 6th grade students' science process skills tests scores

1.2 Definition of Terms

Inquiry: Engaging students into inquiry in which they investigate a natural phenomenon by using science process skills.

Guided (Teacher-Directed) Inquiry: Guided (teacher-directed) inquiry is engaging students in scientific inquiry by teacher-directed question. Teacher also provides students the materials that will be needed during the inquiry. The guided (teacher-directed) inquiry used in this study is a combination of the instructional models of guided discovery, learning cycle, and using scientists as an inquiry model.

Traditional Instruction: This type of instruction is widely used in science classrooms. It is also used as control treatment in studies investigating the effect of a teaching method (Myers, 2004). In traditional instruction, teachers follow "Teacher Guide Book for Elementary Grade 6 Science and Technology" prepared by Turkish Ministry of National Education. This book directs teachers on how to give the subject matter, how to deal with misconceptions, which student outcomes are desirable, etc. It also gives teachers the autonomy to select among the alternative activities so that the activities fit the students, and class and laboratory conditions.

Unit Achievement Test: This test is designed to assess students' knowledge about the topic and administered before and after the instruction on the unit. Since there were two units, the number of unit achievement tests was two: Reproduction, Growth and Development in Living Things, and Force and Motion. The tests were developed from the items from Secondary School Institutions Student Selection and Placement Test, TIMSS as well as the literature on the subject by considering the Grade 6 Science and Technology Lesson Program. The approximate number of test questions in each unit was 25.

Science Process Skills: The skills and abilities required in science and ranges from simple observation to interpreting data.

Science Process Skills Test: The test aimed to assess students' total progress in the science process skills list outlined by the Board of Education of the Ministry of National Education. There are 3 parallel forms of the science process skills test.

Attitudes toward Science and Technology Course: Students' affective orientation toward science and technology as a course matter.

Attitudes toward Science and Technology Course Questionnaire: The test aimed to assess students' attitudes toward science and technology course, and consisted of academic self-concept, anxiety, interest, career, enjoyment, and usefulness subtests.

CHAPTER 2

LITERATURE REVIEW

The previous chapter gave the rationale for evaluating the impact of teacher-guided inquiry on science process skills, unit achievement and attitudes toward science of students. This chapter will give both the theoretical and empirical site of the related studies. The literature review was based on the publications in science education as the search results of various databases and indexes by using “inquiry”, guided (teacher-directed) inquiry”, “science process skills”, “achievement”, and “attitudes toward science” as keywords. This chapter consists of the following titles:

1. Inquiry
2. Guided (Teacher Directed) Inquiry
3. Inquiry Instruction Models
4. Science Process Skills
5. Attitudes toward Science
6. Science Achievement

2.1 Inquiry

The National Science Education Standards use inquiry in three different senses, scientific inquiry, inquiry learning, and inquiry teaching.

Scientific inquiry is those what scientists investigate nature and explain their observations. It is related to how science proceeds and can be considered independent from educational processes.

Inquiry learning is the active processes in which students are engaged in order to develop their understanding of science. There is a relation between scientific inquiry and inquiry learning. Student learning in school environment should reflect the nature of scientific

inquiry in the scientific world. As how the meaning of constructivism changes from one person to another, so does the meaning of inquiry. In the National Science Education Standards (NSES) book, inquiry is used in different meanings. It is used in the same meaning with constructivism. Learning requires an active process. That is to say inquiry is the core of learning.

Inquiry teaching is the thing that develops inquiry learning. It is not used as simple as talking about teacher's daily activities (Anderson, 2005). There are five characteristics of inquiry teaching; students are engaged by scientifically oriented questions, give priority to evidence, formulate explanations from evidence to address the questions, evaluate their explanations in light of alternate explanations particularly those reflecting scientific understanding, and communicate and justify their proposed explanations (National Research Council, as cited Beerer & Bodzin, 2004). The explanations of what each feature mean are given next.

1. Learner Engages in Scientifically Oriented Questions: Scientifically oriented questions base on objects, organisms, and events in the natural world. These questions are investigated empirically and guide to gathering and using data to develop explanations for scientific phenomena. There are two kinds of questions: Existence, and causal and functional questions. Existence questions search origins and consist of many "why" questions: Why do objects fall toward Earth? Why do some rocks enclose crystals? Why do human beings have chambered hearths? Many "why" questions can not be answered by science. On the other hand, causal and functional questions, which investigate mechanisms and include most of the "how" questions: How do sunlight assist plants to grow? How are crystals formed? (Bybee, Carlson Powell, & Trowbridge, 2008)

Students tend to ask why questions. These questions can be transformed into how questions and are investigated with scientific inquiry. This change limits and sharpens inquiry and makes it more scientific (Bybee et al., 2008).

A question, which is robust and fruitful enough to drive an inquiry, creates a need to know in students, stimulating additional questions of how and why a phenomenon occurs. The initial question may be initiated by the students, teachers, instructional materials, internet, some other source, or some combination of these. The teacher plays a crucial role in guiding the identification of questions particularly those of students. Productive inquiries are developed from questions that are meaningful and relevant to students, but they also must be

answerable by students' observations and the scientific information they obtain from reliable sources. The knowledge and procedures that students use in order to answer the questions should be accessible and manageable besides being appropriate to the students' cognitive developmental level. Skilful teachers help students focus their questions so that they can experience both interesting and productive investigations (Bybee et al., 2008).

2. Learner Gives Priority to Evidence in Responding to Questions: Science differs from other knowledge through use of empirical evidence as the base for explanations about how the natural world works. Scientists try to get accurate data from observations of phenomena. They acquire evidence from observations and measurements taken in natural settings such as oceans, or in artificial settings such as laboratories. They use their senses, the instruments improving their senses, such as telescopes, or measuring what they can not sense, i.e. magnetic fields. Scientists sometime control variables in order to get evidence, sometime can not, or the control alters the phenomena. Therefore scientists collect data over a wide range of naturally occurring conditions and long enough period of time in order that they can deduce what the influence of different factors might be. The precision of the evidence collected is confirmed by checking measurements, repeating the observations, or drawing different data from the same phenomena (Bybee et al., 2008).

Conversely students use evidence in building explanations for scientific phenomena. They observe plants, animals, and rocks and cautiously express their characteristics. Students measure temperature, distance, and time and carefully record them. They observe chemical reactions and moon phases, and graph their progress. They obtain evidence to stimulate their inquiries from various resources, such as their teacher, instructional materials, and the internet (Bybee et al., 2008).

3 Learner Formulates Explanations from Evidence: Scientific explanations are centred on reason. They present causes for effects and ascertain relationships based on evidence and logical argument. Scientific explanations should be coherent with experimental and observational evidence about nature. They obey rules of evidence, and open to criticism, and necessitate the use of many cognitive processes, which are associated with science such as classification, analysis, inference, and prediction, along with general processes such as critical thinking and logic (Bybee et al., 2008).

Explanations are means to learn about what is unknown by relating what is observed to what is already known. Consequently, they go beyond present knowledge and propose new understanding. New ideas have been developed on existing knowledge base in science, whereas they stem from current understandings of students in science education. For example, students may use observational and other evidence to propose an explanation for the phases of the moon, why plants die under certain conditions but live in others, and relationship between diet and health (Bybee et al., 2008).

4 Learner Connects Explanations to Scientific Knowledge: To evaluate and eliminate or revise explanations in terms of the evidence, research question, reasoning connecting evidence and explanation, and other rational explanations is one feature that discerns scientific inquiry from other forms of inquiry and subsequent explanations. Alternative explanations may be re-evaluated as students engage in dialogues, compare results, or check their results with those proposed by teacher or instructional materials (Bybee et al., 2008).

5 Learner Communicates and Justifies Explanations: Scientists communicate their explanations in such a way that their results can be replicated. This needs clear representation of the question, procedures, evidence, and proposed explanation and a review of alternative explanations. It provides a foundation for further review and the opportunity for other scientists to use the explanation in work on new questions (Bybee et al., 2008).

Having students share their explanations offers them an occasion to ask questions, examine evidence, recognize faulty reasoning, reveal statements that go beyond the evidence, and advise alternative explanations for the same observations. Sharing explanations can lead to query or strengthen the connections students made among the evidence, existing scientific knowledge, and their proposed explanations. At the end, students can resolve contradictions and solidify an empirically based argument (Bybee et al., 2008).

2.1.1 Inquiry Continuum

The characteristics of inquiry teaching may be implemented in a science class either in a structured format, where teachers and/or materials direct students toward known outcomes, or an open-ended format, which is student-centred (Beerer & Bodzin, 2004).

Inquiry science teaching engages students in thinking skills and processes, i.e. formulating questions and hypotheses, predicting, interpreting data, synthesizing information, and making conclusions (Chin & Kayalvizhi, 2002). While these skills are known as higher order, the processes in which students are appointed are open-ended investigations. Open-ended means students both ask their own problems and find a way to answer these questions (Chin & Kayalvizhi, 2002). This investigation represents the holistic nature of scientific inquiry (Woolnough, as cited in Chin & Kayalvizhi, 2002). Open-ended investigation also develop scientific problem solving skills of students (Hodson; Woolnough; Woolnough & Allsop, as cited in Chin & Kayalvizhi, 2002). Open-ended investigation according to Lock (as cited in Chin & Kayalvizhi, 2002) is an experimental study which involves students actively and directs them toward providing evidence that answers the question and according to Duggan & Gott (as cited in Chin & Kayalvizhi, 2002) is a genuine problem solving method and allows student autonomy in problem solution. Open-endedness lies in one end of a continuum where close-endedness is found in the opposite end (Garrett; Lock, as cited in Chin & Kayalvizhi, 2002). In close ended investigation, teacher has control on any step in the investigation (Garrett; Lock, as cited in Chin & Kayalvizhi, 2002). The continuum of inquiry ranging from close-ended to open-ended is given in the Table 2.1.

As the Table 2.1 suggests, there are variations among inquiry instruction. According to Tafoya, Sunal, & Knecht (as cited in Staver & Bay, 1987), inquiry has four categories:

1. Confirmation: A concept, principle, etc. is presented before the activity. The student carry outs an exercise, which confirms it. The student knows the results in advance and follows a carefully designed procedure.

2. Structured inquiry: The student is presented with a problem, but does not know the results before the activity. Procedures are summarized and materials are selected for the students. The activity is structured so that the student can discover a relationship and generalize from the data collected.

3. Guided inquiry: The student is given only a problem to be investigated. The student plans the procedures and methods of data collection. The student finds out results and generalizations.

4. Open inquiry: The student formulates the problem as well as the procedures for solving it. The student collects and interprets data, and makes conclusions.

Table 2.1 Inquiry continuum

Feature	Direction from teacher or material ⟷ Self-direction			
Learner engages in scientifically oriented question	Learner engages in question presented by teacher, materials, or other sources	Learner sharpens or clarifies question presented by teacher, materials, or other sources	Learner chooses among questions, asks new questions	Learner asks a question
Learner gives priority to evidence in responding questions	Learner is provided data and told how to analyse	Learner is provided data and asked to analyse	Learner is guided to collect certain data	Learner decides what constitutes evidence and collects it
Learner formulates explanations from evidence	Learner is provided with evidence	Learner is provided possible ways to use evidence to formulate explanation	Learner is guided in the process of formulating explanations from evidence	Learner articulates explanations after summarizing evidence
Learner connects explanations to scientific knowledge	Learner is given all connections	Learner is given possible connections	Learner is directed toward areas and sources of scientific knowledge	Learner independently looks at other resources and forms the links to explanations
Learner communicates and justifies explanations	Learner is given steps and procedures for communication	Learner is provided broad guidelines to use to sharpen communication	Learner is coached in development of communication	Learner develops reasonable and logical argument to communicate explanations

Note: From Essential Features of Inquiry, National Research Council, as cited in Bybee et al., 2008, p. 63).

2.1.2 The Research on Inquiry

In this part, the studies on the effectiveness of inquiry on various academic outcomes are summarized.

Montgomery (1969) investigated the effect of the Biological Science Curriculum Study materials and inquiry teaching method on 9^{th} and 10^{th} grade students' achievement in biology and science process. He chose teachers based on who employed Biological Science Curriculum Study (BSCS) materials with inquiry, BSCS materials with traditional method, traditional materials with inquiry, and traditional materials with traditional method. He

randomly selected 12 students from each class and gave them the Nelson Biology Test and the Processes of Science Test as pre-, post- and retention-tests. He analyzed data using pre-test scores as covariate. He found that students of BSCS materials with inquiry class were more successful; students of all BSCS classes had greater retention; students of traditional materials with inquiry had greater retention on the Processes of Science Test than students of traditional materials with traditional method. Tenth grade students were successful than ninth graders.

Saunders & Shepardson compared two 6th grade classes, one receiving traditional and the other receiving inquiry instruction for nine months and found that students in inquiry class scored 2 standard deviations higher in both reasoning abilities and science achievement in the post-test (as cited in Davison, 2000, p. 28-29).

Hall & McCurdy (1990) compared a Biological Sciences Curriculum Study (BSCS) type inquiry laboratory with traditional instruction at two private liberal-arts colleges. While the BSCS instruction included basic and integrated science process skills, concept development through questioning, and student judgment; the traditional instruction comprised structured, prescriptive, teacher-oriented activities. The researchers used quasi-experimental research design in the study. They selected their sample from the students attending to the laboratory sections of introductory general biology course. Hall & McCurdy (1990) used pre-and post test to get data on three dependent variables (achievement, reasoning ability, and attitudes toward biology). The achievement was measured by the Test on Biology Laboratory Concepts, reasoning ability was measured by the Group Assessment of Logical Thinking (GALT), and attitude was measured by the Biology Students Behaviour Inventory. Analysis of covariance on students' tests scores showed that the experimental group (n=60) were significantly more successful than the control group (n=59) on achievement (F (1, 14) = 4.07, p <.05), but on the reasoning ability, and attitude. On the other hand, students' gain scores on the GALT showed that both groups made a 15% increase in the number of formal thinkers. Hall & McCurdy (1990) concluded that a BSCS type laboratory achieved the learner outcomes at higher education, and laboratory can be used to advance students' formal reasoning.

Chang & Mao (1998) investigated the effect of inquiry instruction on Taiwanese ninth grade students' achievement in earth science. They used a quasi-experimental non-equivalent control group design. Their sample was consisted of 232 students, who were 15 years-old

and attending six classes. While the experimental group was delivered inquiry-based instruction, the control group was given traditional-instruction. The students in both groups were given an achievement test both as pre-and post-tests. The test had 27 items and was constructed from Taiwan Indicators of Educational Progress in Science Skills and Taiwan Entrance Examinations for Senior High School. The cognitive processes of the test items according to Bloom's Taxonomy were factual (knowledge), comprehension, and integrated (application). The researchers by using students' pre-test scores as covariate conducted an analysis of covariance to assess the effect of treatment. After the analysis, they found that experimental group students were more successful on the post-test ($F=6.75$, $p<0.05$), especially on comprehension-level ($F=3.94$, $p<0.05$), and integrated-level ($F=6.47$, $p<0.05$) test items.

The following four meta-analyses also show the effectiveness of inquiry-based science programs on many outcomes:

1. Lott (as cited in Costenson & Lawson, 1986) made a metaanalysis of 39 studies published between 1957 and 1980. The researcher found that inquiry compared to traditional instruction led to significantly better performance on higher order thinking skills, but equal performance on lower order thinking skills.

2. Shymansky (as cited in Costenson & Lawson, 1986) did a metaanalysis of 302 studies comparing the effectiveness of inquiry curricula over traditional ones. He found that students' performance with inquiry curricula was higher than that with traditional, and among the inquiry curricula, Biological Sciences Curriculum Study (BSCS) was more successful, such that an average BSCS student outperformed 84% of traditional students on attitude, 81% of traditional students on process skills, 77% of traditional students on analytic skills, and 72% of traditional students on achievement.

3. Bredderman made a meta-analysis of 57 research reports published after 1965 and used 13,000 students from 900 elementary classes using Elementary Science System, Science – A Process Approach and Science Curriculum Improvement Study. He found that with a weighted mean effect size of .35, a 14 percentile improvement was measured for an average student who participated in these programs (as cited in Davison, 2000, p. 29).

4. In a meta-analysis of the impact of the National Science Foundation-reform inquiry-oriented science curricula on student performance; it was found that the science curricula improved students' science achievement and process skills as well as their attitudes toward science with larger effect sizes for biology (Shymansky, Kyle, & Alport, as cited in Chang & Mao, 1999). Moreover, the re-synthesis of this study due to recent developments in the meta-analysis indicated that the science programs of 1960's and 70's were effective in improving student performance both in cognitive and affective domains (Shymansky, Hedges, & Woodworth, as cited in Davison, 2000, p. 20-21).

The effectiveness of inquiry instruction was also studied by Turkish researchers. These studies will be given in the following paragraphs.

Tatar (2006) in her PhD study investigated the effect of inquiry instruction in "Let's Know and Conserve our Blue Planet, Our Common Home with All Living Things" unit on 7th grade students' science process skills, achievement, and attitudes toward science. She used a sample of 104 students attending two elementary schools in Çankaya, Ankara. In the study Tatar applied quasi-experimental research design with pre- and post-test control group. She administered the science process skills and achievement tests, and attitudes toward science questionnaire to the students in order to get data. After analysis of data with repeated two factors ANOVA, Tatar (2006) found that the inquiry instruction had more effect in developing science process skills, academic achievement, and attitudes when compared to the traditional instruction. According to this finding, she further suggested the need for both in- and pre-service training of teachers, and revision of science curricula on inquiry.

Gençtürk & Türkmen (2007) studied the effect of inquiry instruction on achievement of fourth grade students attending an elementary school in Afyonkarahisar. The researchers used quasi-experimental research design with two classes, one was experimental and the other was control group. Both groups were given an achievement test on "Living Things are diverse" unit before and after a seven-week-instruction by the same teacher. The analysis of pre-test data with ANOVA showed that the groups were similar and both female and male students performed similarly in the achievement test. On the other hand, the analysis of post-test scores showed that the groups performed differently in the achievement test, and both gender groups performed similarly. The comparison of pre- and post-test scores with paired t-test showed that both groups performed well after the instruction.

2.2 Guided (Teacher-Directed) Inquiry

In guided (teacher-directed) inquiry, teacher presents a problem to students. Students have to solve this problem by presenting different hypotheses and then by testing them (Aho, Huopio, & Huttunen, 1993).

There are some limitations to implement an effective science instruction intended to increase science literacy (Beck, Czerniak, & Lumpe, as cited in Black, 2003), which is aimed by inquiry (Black, as cited in Black, 2003). The reason is teachers' lack of experience in constructivist teaching and learning. The lack of experience with this kind of teaching make teacher feels discomfort and unfamiliarity, thus increases the time for a teacher to spend on the duties not related with teaching. Therefore there is a need to understand and be familiar with guided inquiry during pre-service (Beck et al., as cited in Black, 2003).

2.2.1 The Research on Guided (Teacher-Directed) Inquiry

The first study is of Germann, who investigated the effect of the directed-inquiry approach on science process skills and scientific problem solving. The sample was four sections of grade 9 and 10 general biology students. The students were grouped into experimental and control groups according to their academic abilities, average ability students were included in the experimental group, whereas above-average ability students were incorporated in the comparison group. It was found that directed-inquiry had no significant effect on the learning of science process skills or on cognitive development over traditional instruction (as cited in Myers, 2004).

In the second study, Aho, Huopio, & Huttunen (1993) examined the effect of teacher-guided inquiry on knowledge, enjoyment, and evaluation of learning of students attending to grade 2 and 4. There were 17 second grade and 31 fourth grade students participating to the study. The researchers organized two science lessons each based on a problem of water absorption in plants and floating of leaves of water plants. The students' own teacher implemented the treatment. The teacher presented the first problem of water absorption on tulip plant and instruments, and then she discussed with the class what and how to study, which instruments to use, and what the result would be. The second experiment was given in the written form by which the students were instructed to how to set up an experiment in order to study the problem of floating of leaves of water plants. During both experiments, the teacher helped

students by asking why they were doing the experiment and what they would discover. After the experiment she asked them what they learned. The students' knowledge of water absorption in plants and floating of leaves of water plants was assessed by two standard school tests (in fact the first test measured students' understanding of the concepts such as what plants need to grow, why they need water, and how they get water; but the second test assesses students' knowledge of water lily and why the leaves of water plants float or sink, and if the leaves of other plants will float or sink). Both tests administered two weeks prior to the experiment as a pre-test and two weeks after the experiments as a post-test. The second research question was studied according to the data from observations and videotapes of the lesson, and the analyses of interactions among the students and among the students and the teacher were done. The last research question was examined by asking the students about their views on the experiments. The analyses of students' performance on the pre-and post-tests by t-test revealed that the understanding of plants' water absorption did not improve among the second graders but in the fourth grade (N=27 t-value 4.32, p=.000). On the other hand, the students of each grade showed significant improvement in the second test regarding floating of the leaves of water plants (for second grade N=15 t-value 4.07, p=.001, and for fourth grade N=22 t-value 11.17, p=.000). Further analyses of students' responses to the first test items showed that students' understanding increased after the experiments. For example 29% of second grade students and 70% of fourth grade students gave the correct answer to the item asking how plant obtains water in the pre-test. After the experiment, these percentages raised to 46% for grade 2 students and to 78% for grade 4 students. On the other hand, it was found that students use correct concepts only at grade 4 (or at grade 2 after the experiment). For example the concept of "evaporation" was used by only 33% fourth graders in the pre-test, and by only 15% second graders (and 82% fourth graders) in the post-test. The analyses of classroom observations showed that at both grade, the students proposed similar methodology on how to study the problems. However the students' answers to the inference questions, i.e. "Why the plant after being cut into two and put into water with different colour has dyed these colours?" were showed second graders' inability to describe the phenomena. The analyses of students' views on the lessons showed that 75% second grade and 100% fourth grade students had positive attitudes towards the first experiment, while all of them had positive attitudes toward the second experiment (although the fourth graders found the second experiment simple). Aho et al. (1993) corroborated the previous idea that inquiry tasks should be in line with students' cognitive level, and concrete activities support the formation of abstract concepts and suggested that when there are many concepts to learn, students should be given the basic ones. The researchers stated that their result

confirmed the idea of students' need to get help from teacher during inquiry, which may result from students' inexperience with inquiry. The researchers also found that the discussions during the experiment helped students to test and change their own ideas. On the other hand, Aho et al. concluded that since the students' metacognition was low, they evaluated their own learning in knowledge terms rather than in process terms. The researchers also suggested teachers to use appropriate materials in science classes in order to avoid teacher-oriented instruction.

2.3 Inquiry Instruction Models

Instructional models suggest a particularly useful way for teachers to improve their utilization of inquiry (National Research Council, 2000). Inquiry teaching makes use of various models, such as learning cycle, guided discovery (Carin, Bass, & Contant, 2005, p. 105), and using scientists as an inquiry model. Although both learning cycle and guided discovery have many common elements, guided discovery is more open and more unstructured when compared to learning cycle (Carin et al., 2005, p. 111).

2.3.1 Learning Cycle

Learning Cycle assists students in understanding of science concepts and developing science process skills (Matyas, 2000). Generally learning cycle has 3 steps: exploration, term introduction, and concept application. The 5E (and 4E, 7E, and 9E) is an extension of the original three-phase learning cycle. For example the middle three phases of 5E Learning Cycle are similar to three-phases learning cycle (Carin et al., 2005, p. 111). Apart from these, engagement intends to give a focus about the subject and allows teacher to probe students' prior knowledge, and evaluation reveals contemporary ideas about ongoing assessment of student performance and learning (Carin et al., 2005, p. 111).

The explanations of the steps of the three-phase learning cycle are as follows (though they are formerly named as exploration, invention, and discovery by Karplus & Their, as cited in (Lawson, 1995, p. 136):

Exploration: In this step, students are given a new situation so that they start to ask questions about it and try to solve the problem with their experiences. When students see that their ideas are in conflict with the new situation or not adequate, they generate alternative ideas and discuss the applicability of these ideas to the problem. Students also make an analysis of

the regularity pattern in the phenomena, and form hypotheses, for example heart rate increases with temperature (Lawson, 1995, p. 136).

Term introduction: In this step, students are given the new concepts, which are used to refer to the patterns realized in exploration, for example metabolism coldblooded or poikilotherm by teacher, textbook, or other medium (Lawson, 1995, p. 136).

Concept application: In this step, students relate the new concept or pattern to additional examples. For example, after teacher introduces the term cold-bloodedness, she/he asks students to classify other invertebrates or vertebrates as coldblooded and warm-blooded (Lawson, 1995, p. 137).

4E Learning Cycle: It is consisted of the phases of Explore, Explain, Expand, and Evaluate (Yılmaz & Çavaş, as cited in Çavaş, 2004).

In exploration step, students interact with each other and material (Martin, Sexton & Gerlowich, as cited in Çavaş, 2004).

In explanation step, students interact with teacher in order to find the concept which comes out from the observations and data in exploration phase (Martin et al., as cited in Çavaş, 2004).

In expansion step, students are guided by teacher in applying the concept and expand their ideas and science usage (Martin et al., as cited in Çavaş, 2004).

In evaluation step, students are assessed formally or informally throughout the cycle (Martin et al., as cited in Çavaş, 2004).

5E Learning Cycle: It is consisted of the phases of Engage, Explore, Explain, Elaborate, and Evaluate.

In engagement step, students' interest is gained through a hands-on mini lab or demonstration or a pre-test like KWL or concept map (Matyas, 2000).

In exploration step, students get concrete experiences on subject through laboratory activities (by applying whole procedure or some steps of it such as collecting and analysing data) (Matyas, 2000).

In explanation step, student questions are answered through using related sources for example readings, web quests, lectures, discussions, and experts (Matyas, 2000).

In elaboration step, students utilize their subject knowledge and science process skills in order to make use of the subject through a guided or open inquiry activity (Matyas, 2000).

In evaluation step, students are asked to apply their understanding to new situations through use of some instruments such as the previous materials i.e., KWL, concept map, quiz, or new

materials i.e., reflection papers. Evaluation can be also made with use of students' performances on the previous instruments such as laboratory reports, presentations and posters, home works and web quests, reflection papers, self and peer evaluation forms on group work (Matyas, 2000).

7E Learning Cycle: It is consisted of the phases of Engage, Elicit, Explore, Explain, Elaborate, Evaluate, and Extend (Eisenkraft, as cited in Mecit, 2006).
In engagement step, students' interest is taken through a scenario or an experimental activity. This leads students to form questions. Students' prior knowledge is also measured by this way (Eisenkraft, as cited in Mecit, 2006).
In elicitation step, students' prior knowledge is learned (Eisenkraft, as cited in Mecit, 2006).
In exploration step, students are given materials, questions, and directions so that they start their discoveries as a group by using materials. Students also discuss with group members and teacher (Eisenkraft, as cited in Mecit, 2006).
In explanation step, students after organizing data, determining pattern, comparing, and stating problems with the guidance of teacher construct their own understandings and communicate these concepts. The concepts can be introduced in the form of scientific terminology by students and teacher (Eisenkraft, as cited in Mecit, 2006).
In elaboration step, students are asked to offer alternative solutions to the problem. They may repeat the whole or some parts of the activity by transferring their understanding into new areas, and form new questions and hypotheses, which means that they start to a new discovery, or learning cycle (Eisenkraft, as cited in Mecit, 2006).
In extension step, by offering students new experiences to transfer their understanding into new problem areas, students can relate what they have learned to daily life applications (Eisenkraft, as cited in Mecit, 2006).
In evaluation step, students are assessed on what they learned. Assessment is done by teacher or student (Eisenkraft, as cited in Mecit, 2006).

2.3.1.1 The Research on Learning Cycle

In this part, the studies on the effectiveness of learning cycle on various academic outcomes are summarized.

Küçükyılmaz (2003) explored the effect of three-stage learning cycle on 5th grade students' achievement in "Sound and Light" unit. She made use of pre test-post test control group

design in her study and took one of the classes in an elementary school as experimental and the other as control group in the same school. The school was located in Eskişehir, Turkey. The treatment took 6 weeks, during this time the experimental group received three-phase learning cycle instruction whereas the control group received traditional instruction. She measured the students' achievement in the unit before and after the treatment, and after the semester break as retention. She made the control and experimental group students equal by eliminating the data from the students with diverse socio-economic status, and a high or low score in the pre-achievement test and their previous science course grade point average. Thus the original sample size of 69 (34 versus 35) decreased to 44 (22 in each group). She used independent t-test for analyses and found that there was no significant difference between the groups with respect to the mean achievement score after the treatment, but there was a significant difference between the groups on the retention test, favouring the experimental group students. The researcher concluded that learning cycle is effective on increasing the level of remembrance of the students when compared to traditional instruction. She concluded that in order to keep students' retention of understanding, learning cycle should be used; teachers and teacher candidates should be given some courses on learning cycle; when applying learning cycle, class organization should be arranged in an order that permits students to work independently and in group; and same kind of arrangements should be done in school level so that students have rich experiences with interacting with materials.

Çavaş (2004) investigated the effect of 4E learning cycle on 6th grade elementary students' attitudes toward science and understanding of flowing electricity subject within the "Electricity Directing Our Life" unit. She made use of pre test-post test control group design in her study and took one of the classes in an elementary school as experimental and the other as control group in the same school. The school was located in İzmir, Turkey. There were a total of 79 students in the sample. The researcher herself applied the treatment to each group (4E learning cycle instruction to the experimental and traditional instruction to the control group). She measured the students' achievement in flowing electricity subject before and after the treatment. She used the percentages of correct responses in each item of the flowing electricity test, and both dependent and independent t-tests for analyses. The researcher found that although there was a significant difference between the mean pre test and post test scores in each group, when the percentages of correct responses given to each test item was considered, there was more gain in the experimental group from pre test to post test; there was a significant difference between the groups with respect to the mean post test score favouring the experimental group; there was a significant difference between the

groups with respect to the difference between the post- and pre-test mean scores, in other words the mean gain score, favouring the experimental group. On the other hand, when the researcher analysed the data on attitudes toward science with independent t-test, she found that although there was no significant difference between the mean pre- and post-attitudes toward science score in the control group, there was a significant difference between the mean pre- and post-attitudes toward science score in the experimental group; there was a significant difference between the groups with respect to the mean post-attitudes toward science test score favouring the experimental group. Moreover the researcher performed a correlation analysis to find a relation between the achievement test and attitudes toward science questionnaire scores and found that there was a significant correlation between both tests, although the relationship was medium. The researcher concluded that 4E learning cycle is effective in eliminating students' misunderstandings in flowing electricity subject; developing understanding and attitudes toward science due to its consideration of students' prior knowledge and experiences; and providing a learning environment for students to make discoveries on subject that result with increased interests and positive attitudes toward science through active involvement of students. The researcher concluded that teachers after getting acquaintance with constructivist teaching methods can prepare an effective learning environment for their students and in-service training can help teachers in learning and applying constructivist approaches.

Doğru Atay (2006) examined the effect of three-stage learning cycle on 8th grade students' achievement in genetics concepts, and the main predictors of achievement with a pre test-post test control group design. Her sample consisted of 213 students from eighth classes attending two elementary schools in Ankara. The experimental group students received learning cycle, whereas control group students received traditional instruction. She administered a genetics achievement test to the students before and after the treatment. She also used the Learning Approach Questionnaire to measure learning orientation, Test of Logical Thinking for level of reasoning ability, Motivational Strategies for Learning Questionnaire for determining self-efficacy, Locus of Control Scale for evaluating locus of control, and Attitude towards Science Scale. She analysed the data with one-way ANOVA and found that learning cycle instruction increased students' achievement in genetics more than traditional one. Moreover her analysis with stepwise multiple regression showed that while in the learning cycle classes students' meaningful learning orientation and attitudes toward science are the main predictors of achievement; in the traditional classes students' attitudes toward science and reasoning ability are the main predictors of achievement.

2.3.2 Guided Discovery

Students start guided discovery learning with interesting question and concrete materials, by working as individual or as a group they explore materials, make observations, and discover answers to their questions, when teacher works as a facilitator and guide (Carin et al., 2005, p. 105). Discovery activities motivate students during their search and discovery (Sears & Kessen, as cited in Carin et al., 2005, p. 105). Discovery activities also help students to find their own meanings and systematize their own ideas (Wiggins & McTighe, as cited in Carin et al., 2005, p. 105).

2.3.2.1 The Research on Guided Discovery

Aktamış, Ergin, & Akpınar (2002) explored the effect of discovery on 8th grade students' achievement, understanding, and attitudes in "Magnetism Affecting Our Life" unit. The researchers made use of pre test-post test control group design in their study. Their sample was consisted of 60 students at two classes (30 in each class) attending an elementary school. Both groups were given a magnetism achievement test, a set of essay questions to determine their understanding of magnetism concepts, and attitudes toward magnetism questionnaire both before and after the treatment. The researchers also interviewed with the experimental and control group students after the treatment in order to understand how the students constructed their understanding during the instruction. Both discovery and traditional instruction were given by the same science teacher to the groups for four weeks. After the analyses of student data on the measures with independent and dependent t-test, the researchers found that that there was a significant difference between the groups on the post achievement mean score, post essay mean score, and post attitudes toward magnetism mean score favouring the experimental group. The researchers concluded that since the students in the experimental group actively involved and learned how to learn, they constructed their own knowledge easily. The interviews with the students showed that the students could easily comprehend the subject and relate it with daily life. The researchers also concluded that since various teaching materials were used and the students actively involved into the lessons, discovery treatment improved students' attitudes toward magnetism. Therefore, the researchers suggested using teaching materials developed from simple and low-cost materials rather than complex and expensive ones.

Ünal & Ergin (2006) studied the effect of discovery on 7th grade students' achievement, learning approach and attitudes for "Pressures of Liquids and Gases" unit. The sample of this study was consisted of 59 students from two classes (30 in the experimental class and 29 in the control class) of an elementary school in Buca, İzmir. The school was purposively selected for best representing the other schools in the same region. Moreover the classes were selected for having the students with similar GPA scores. Both groups were given an achievement test and attitudes toward science questionnaire, and a science learning approach scale before and after the treatment. Both the discovery and traditional treatments were given by the same science teacher to the groups for five weeks. The discovery treatment was consisted of three stages: study with concrete material, concept introduction, and generalize. The teacher started each activity with discussion questions and assigned the students groups of 3-4 for studying with the concrete materials. The teacher then handed out the concrete materials and worksheets to the groups and asked the students to answer the questions on the sheet while they work with the concrete material. After the groups finished their work with the materials, the teacher asked them to explain their observations and the reasons of these observation results. The teacher guided the students on reaching the concepts underlying the phenomena. The teacher again asked the students to revise their answers to the worksheet questions. Then the teacher started asking the evaluation questions of the sheet, which were related to the daily life applications, transferring and generalizations. After the analyses of student data on the measures with independent and dependent t-test, the researchers found that that there was a significant difference between the groups on the mean post achievement scores favouring the experimental group, there was no significant difference between the groups on the mean post learning approach score, and post attitudes toward science scores, and there was a significant relationship between students' scores in achievement and learning approach, between students' scores in achievement and attitudes toward science, and between students' scores in attitudes toward science and learning approach, though these relationships are medium. The researchers concluded that the worksheets provided an opportunity for working with concrete materials and increased students' motivation, and the concepts introduction and generalization parts of the activity (worksheet) improved students' understanding and made relating the subject with daily life easy. Regarding no attitude and learning approach change for both groups, the researchers concluded that the instruction was short to make a difference in attitudes and learning approach, and they suggested that their research should be replicated for a longer instruction time.

2.3.3 Using Scientists as an Inquiry Model

Through working directly with students, a scientist can be a role model for students and encourage them in science (Board of Agriculture, 1998, p. 25). Moreover scientists can encourage teachers to learn science as a process and help them improve their science content understanding (Board of Agriculture, 1998, p. 12; Morrison & Estes, 2007), whereas teachers can help scientists understand learning processes and diversity of students (Board of Agriculture, 1998, p. 12-13). Besides modelling science as inquiry, scientists can also serve up a resource for science subject and help teacher in classroom demonstration (Board of Agriculture, 1998, p. 13). Science teachers can integrate content with daily life and provide students both an educational and vocational orientation (Kesercioğlu, Türkoğuz, & İşçier, 2005) toward science by using scientists in their classrooms. The use of scientists as models improves elementary students' scientific attitudes (Demirbaş & Yağbasan, as cited in Demirbaş & Yağbasan, 2005), which are consisted of attitudes toward thinking and knowledge, i.e. curiosity, open mindedness; attitudes toward evaluation of thinking and knowledge, i.e. critical thinking, objectivity, and testing hypotheses; and accepting special scientific beliefs, i.e. commitment to reality (Byrne & Johnstone, as cited in Demirbaş & Yağbasan, 2005).

2.3.3.1 The Research on Using Scientists as an Inquiry Model

Marx, Honeycutt, Rahmati Clayton, & Moreno (2006) developed a set of inquiry lessons on human anatomy called "The Elizabeth Towns Incident" with a partnership between a biology teacher from the Houston Independent School District (HISD) and two graduate students serving as content advisors from Baylor College of Medicine. This unit was a combination of case-based teaching and laboratory, where the students could play a physican role. The unit was implemented in Biology I classes of the HISD. The experiences gained during the application of the unit showed that the collaboration increased students' understanding of human anatomy as assessed by the raise in the number of students passing the state mandated Biology I test, helped to determine critical areas in collaboration, and assisted students' change of their streotypes toward scientists, i.e., what scientists does, what to do to be a scientist, etc.

2.4 Science Process Skills

Terminology of science process skills are those used by scientists in solving problems. The name "skills" are given to the steps involved in scientific method after the development of "Science-A Process Approach" or "SAPA" in the US. Scientists were studied to determine what they do (McComas, 1989).

Science process skills are classified into two groups as basic and integrated. Basic skills provide a foundation for learning the more complex integrated ones (Padilla, as cited in Myers, Washburn, Dyer, 2004). The following tables (Table 2.2 and 2.3) outline both basic and integrated skills.

Table 2.2 Basic science process skills

Basic Skills
Observation: It is the process of gathering information by using sense organs and instruments that extend the senses, and the various instruments used in medical diagnosis (Minnesota Mathematics and Science Teaching Project, as cited in Carin et al, 2005, p. 38).
Using Numbers: It is the process of using quantitative relationships (Chiappetta & Koballa, as cited in Myers, Washburn, Dyer, 2004).
Measurement: It is the process of quantifying observations through measurement (Carin et al, 2005, p. 41).
Classification: It is the process of organizing information, i.e., sorting objects according to their properties. There are two kinds of classification, binary and multistage. Binary classification is organization of objects into two groups on the base of common characteristics. On the other hand, multistage classification is organization of objects over and over again (Carin et al, 2005, p. 41-42).
Using Space-Time Relationship: It is the process of describing changes in a parameter with time. The parameter can be location, direction, shape, size, volume, weight and mass (Ministry of Education Malaysia, 2003).
Inference: It is the process of interpreting observations based on prior knowledge and experiences (Carin et al, 2005, p. 42).
Prediction: It is the process of forecasting a possible outcome based on knowledge of patterns in data. The difference between inference and prediction is backward looking feature of inference (what happened), whereas forward looking feature of prediction (what will happen) (Carin et al, 2005, p. 44).
Communication: It is the process of presenting and sharing the results of observation, investigation through oral, written, and visual materials (TTKB, 2005)

Note: The table shows all the skills found in the literature.

Table 2.3 Integrated science process skills

Integrated Skills
Defining and Controlling Variables: It is the process of identifying the independent, dependent and control variables for investigation. A variable is a property of objects or events that can change and have various amounts, i.e., the time passed during a candle burn, amount of fertiliser given to a plant. Independent variable is the manipulated or changed variable, dependent variable is the responding variable as a result of change in independent variable, and control variable is the one kept constant or unchanged during investigation so that not confounded the results (Carin et al, 2005, p. 45).
Planning Experiment: It is the process of suggesting an experiment in order to test the hypothesis (TTKB, 2005).
Knowing and Using Laboratory Materials: It is the process of selecting and using materials safely and effectively (TTKB, 2005).
Experimenting: It is the process of changing one variable at a time and observing the effect on another variable while holding all other variables constant (Carin et al, 2005, p. 44).
Hypothesizing: It is the process of forming hypotheses, which are the statements of possible relationships between the independent and dependent variables that might be identified through investigation (Carin et al, 2005, p. 44).
Collecting Information and Data: It is the process of gathering information from various sources via observation and experiment, and using books, maps or information and communication technologies (TTKB, 2005).
Recording Data: It is the process of recording data in the form of writing, picture, table, and figure (TTKB, 2005).
Interpreting Data: It is the process of seeing the relationships and trend among data (Arthur as cited in Temiz & Tan, 2003).
Processing Data and Formulating Models: It is the process of presenting data in the forms of frequency distribution, histogram, table, physical models, etc. (TTKB, 2005). There are many ways to form a model even for the same event. For example, the melting of an ice cube can be shown with a graph, picture, three-dimensional object, video recording, table, or photograph (Turgut, Baker, Cunningham, & Piburn, 1997).
Defining Operationally: It is the process of describing variables exactly with a measurement criterion (TTKB, 2005).

Note: The table shows all the skills found in the literature.

The following literature review is dealt with the studies on the effectiveness of instruction and curriculum on science process skills; science process skills of students, and teachers, and content analysis of textbooks with respect to these skills.

2.4.1 The Research on Effectiveness of Instruction on Science Process Skills

The first study is an investigation of science process skills development of university students through computer-assisted instruction by Burchfield and Gifford (as cited in Myers, 2004). The sample was 92 students enrolled in General Biology I for Science Majors at a small, rural community college in the south-eastern United States. The study found no significant difference in the mean science process skill gain scores between students in the traditional class and those in computer-assisted instruction class. It was also found no significant effect of student academic aptitude, as measured by score on the Enhanced

American College Testing Assessment, and gender on science process skill development (Burchfield & Gifford, as cited in Myers, 2004).

The following studies were done in Turkey at elementary school level when our current science curriculum is in action.

Karahan (2006) studied the effect of looked into the effect of science process skills based learning on achievement, attitude, science process, and logical and creative thinking of fourth grade students in Ereğli, Zonguldak. She used quasi-experimental design with pre- and post-test control group. There were a total of 76 students attending the same elementary school in her study, 39 in the experimental, whereas 37 in the control groups. Karahan (2006) used an achievement and attitude tests, a problem solving attitude inventory, the Turkish version of Torrance's Creative Thinking test and Tobin & Capie's Test of Logical Thinking and Science Process Skills tests, in her study. After the analysis of data with t-test, Karahan (2006) found that the difference between both experimental and control groups students' post-test mean scores on logical and creative thinking skills tests were significantly different than 0, on behalf of the experimental group, but the differences on problem-solving attitude, science process skills, attitudes, and achievement. The researcher concluded that because the new curriculum already based on science process skills, she could not observe the change in most of the learning outcomes.

Başdaş (2007) investigated the effect of hands-on science learning in "Matter and Heat" unit on sixth grade students' science process skills, achievement, and motivation in his master's thesis. He used experimental research design with a treatment group and control group in one elementary school, and one control group in another elementary school in Manisa Demirci. The study was done when our current science curricula was in action. Therefore, while the treatment group was receiving hands-on instruction, the control group was being instructed with the new curriculum. There were 63 students in total (20 in experimental, 43 in control groups). Başdaş (2007) used a science process skills test, an academic achievement test, and a motivation scale towards science learning in his study. He found that experimental group students got significantly higher scores in all measures than those in control. His interviews with experimental group teacher also showed that treatment was effective and sufficient in developing students' scientific attitude and behaviour. Başdaş (2007) suggested that science lesson should include hands-on activities which will develop science process skills, because as asked in the international examinations such as PISA and TIMSS, the aim of science is to

develop those skills, and inclusion of science process skills in science curriculum will bring our science education to the international standards. Başdaş (2007) stated that this also will result with higher motivation and active involvement of students in science courses which will turn out to be an increase in their career choices. Başdaş (2007) also suggested same revisions in both pre- and in-service training.

2.4.2 The Research on Science Process Skills of Teachers

The first study was the investigation of the relation between science process skills and attitudes toward science of pre-service elementary teachers. The sample was 46 pre-service elementary teachers enrolled in a mathematics and science methods course before student teaching. The study found that there is a moderately positive correlation (r = .39) between the pre-service teachers' competency levels of science process skill and attitudes toward science (Downing, Filer, & Chamberlain, as cited in Myers, 2004).

In the second study Padilla, Okey, & Garrard studied how science teachers integrate process skills to their sixth and eighth grade classrooms (as cited in Narode, Heiman, Lochead, & Slomianko, 1987). These researchers used the following steps in their process skills based instruction (it includes also what the previous research by both the first author (Padilla) and Tobin and Capie utilized (as cited in Narode et al., 1987):

1. Teacher asks a researchable question, for example: "Are some body parts more sensitive to touch than others?"
2. Students form hypotheses with the help of teacher, for example: "Fingertips are more sensitive to touch than the palms".
3. Students identify variables.
4. Students select independent and dependent variables and control others, for example: operational definition for dependent variable is the ability to recognize the touch of a pencil, and the tool and force used to touch fingertips and palms are controlled.
5. Students design the experiment and draw a proper table.
6. Students perform the experiment.
7. Students organize data onto a class chart and make generalizations in the form of conclusion or new hypothesis.

The researchers found that this method was more effective after a two-week-introduction of process skills (the total duration for the instruction took a semester). The study showed that science process skills can be taught to middle school students and integrated into subject, and

continued instruction on science process skills in various content areas are more effective than short term instruction in process skills alone (as cited in Narode et al., 1987).

In another study, Demir (2007) tried to find the relationship between pre-service classroom teachers' science process skills and some variables (gender, parent education level, income, university entrance test score, average of the science and quantitative course scores, GPA, attitudes toward science, self-efficacy, and cognitive development). He sampled 277 senior students who were attending primary education department at Gazi University. In order to collect data, he made use of the Test of Integrated Process Skills II, Science Teaching Attitude Scale II, Science Teaching Self-efficacy Beliefs of Classroom Teachers, Test of Logical Thinking, and a demographic form. He employed path analysis with AMOS 5.0. He found that:

1. The model explains 36% of the variance observed in pre-service teachers' science process skills scores. Among the variables, cognitive development level has the most effect (.58), followed by income (.10), and attitudes (.9) in explaining variance in the science process skills scores.

3. The variables in the model (gender, mother education level, university entrance exam score, average score of science and quantitative courses, GPA, and science self efficacy), do not have a direct but an indirect effect on science process skills scores. From these variables university entrance exam score has the highest indirect effect on science process skills (.178).

He suggested that pre-service programs should consider and develop students' cognitive development levels, and in pre-service science courses should include activities by which students have a chance to improve their attitudes toward science, which will result with development of science process skills.

2.4.3 The Research on Content Analysis of Textbooks with respect to Science Process Skills

Content analysis is a technique to study human behaviour indirectly through analysis of their communications, i.e., textbooks, newspapers, articles, speeches, advertisements, films, pictures, musical compositions (Fraenkel & Wallen, 2005, p. 483).

Content analysis is a powerful and efficient approach to curriculum evaluation (Tamir & Lunetta, 1981). Although analysis of the content of curriculum materials does not give direct

data on student growth, it allows the researcher to find out the link between the actual materials and the stated goals of the curriculum developers and others (Tamir & Lunetta, 1981).

Science process skills, along with critical thinking and scientific reasoning skills, take part systematically in the textbooks of developed countries, and in both teacher, and student books, this structure complete each other (Badders, Fu, Bethel, Peck, Sumners, Valentino, & Mullane, as cited in Dökme, 2004b).

The first study by Tamir & Lunetta (1981) was a content analysis of laboratory handbooks of selected high school curricula. Tamir & Lunetta (1981) content analysed the exercises of some physics, chemistry, and biology laboratory handbooks with the Laboratory Structure and Task Analysis Inventory (LAI). The LAI has two dimensions. Laboratory Organization, and Laboratory Tasks. Laboratory organization part has 14 categories and consists of Structure, Relation to Text, Cooperation Mode, and Simulations subparts. On the other hand, laboratory tasks part has 24 categories and consists of Planning and Design, Performance, Analysis, and Application subparts. The researchers coded every laboratory investigations in the books with the LAI. When coding the Laboratory Organization categories, they checked categories according to the classification of activities in each investigation. When coding the Laboratory Task categories, the researchers checked the appropriate behavioural category according to each statement of a laboratory investigation (if the statement called more than one activity they put more checks). Tamir and Lunetta (1981) then counted the number of the checks, and divided by the total number of investigations and represented this value in percentages. After the analysis, the researchers found that investigations are highly structured; while students are often asked to perform a variety of manipulative and observational procedures and interpret the results of their investigations; they are rarely asked to formulate a question and hypothesis, predict results, work according to their own design, and both formulate new questions and apply an experimental technique after the investigation. Tamir and Lunetta (1981) suggested that the LAI can be used to assess laboratory curriculum; inquiry skills development of students; and selecting laboratory activities and developing them by teachers. The researchers also mentioned that laboratory experiences differentiate according to subject matter, for example inquiry skills in biology are not same with those in chemistry, even in the same subject area variances occur.

The following two studies were on the analysis of activities in our previous elementary science textbooks for grades 4 and 7. Both of the studies were done by Dökme (2004a, 2004 b).

In the first study, Dökme (2004a) analysed the fourth grade science textbook of the previous curriculum according to the definitions of the six basic science process skills stated in an American textbook, Discovery Work by Badders et al. These six basic skills were observation, classification, measuring and using numbers, communication, inference, and prediction. She classified all 50 textbook activities from all 4 units into each of the six science process skills, and made comparisons between the activities and science process skills, and between the units and science process skills according to the frequencies of science process skills acquired by the activity. According to her findings, inference is the most stated skill with 94%, observation is the second with a percent of 82, and classification is the third with a percent of 14 abundant skills. These skills are followed by communication (12%), and prediction (11%).

In the second study, Dökme (2004b) evaluated the seventh grade science textbook of our previous curriculum according to the definitions of the 12 science process skills stated in an American textbook, Discovery Work by Badders et al. These six basic skills were observation; classification; measuring and using numbers; communication; inference; prediction; collecting, recording and analysing data; determining and controlling variables; defining operationally; hypothesizing; experimenting; and making and using model. She classified all 61 textbook activities from all 4 units into each of the 12 science process skills, and made comparisons between the activities and science process skills, and between the units and science process skills according to the frequencies of science process skills acquired by the activity. According to her findings, half of the basic science process skills are highly mentioned in the book: Inference (69%), measuring and using numbers (56%), experimentation (54%), and observation (51%). The remaining three basic skills come second in this order: Classification (8%), communication (23%) and prediction (14%). On the other hand, determining and controlling variables (33%), collecting, recording and analysing data (30%), defining operationally (26%), and communicating (23%) are also highly mentioned in the book. Dökme emphasized that other skills such as formulating hypothesis (2%), making and using model (8), controlling variables (33%), collecting data (30%), and evaluating hypothesis are advanced and should be mentioned in the activities at

the end of the units. And the textbook sections called “Düşün ve Araştır” are regarded as appropriate for her to include these skills.

Dökme (2004a; 2004b) in both of her studies suggested that:
1. Dökme suggested that communication, and prediction (and classification) skills should be included more in the available activities or mentioned in the additional activities.
2. The activities should highlight the skills overtly, i.e., by emphasizing which skill to be used through bold characters as “please **observe** the parts of the plant”.
3. In order to develop communication skills, students should prepare reports of their studies; present their studies to their group members, class, teacher, or other listeners; and if needed organize their studies in the format of graphic, table, and diagram; therefore the activities should guide students to these actions with statements and these statement, as in the mentioning the specific skills, should be obvious (and written bold).
3. The textbook activities should be revised for the purpose of improving science process skills, and the review will support science teaching when integrated with teacher guide books, student workbooks, and computer aided instruction.

2.4.4 The Research on Effectiveness of Curriculum with respect to Science Process Skills

This part is dealt with the studies on the effectiveness of previous and current Turkish science curricula with respect to science process skills. Three studies will be outlined here. Although the third study explains clearly that the students were being instructed by both, the second one does not say anything about when the students were tested, but the year of the study implies that it deals with our previous science curriculum.

Aydoğdu (2006) investigated the factors affecting science process skills at seventh grade level in Buca, İzmir. These factors were academic achievement, attitudes toward science, parent’s relevance, instructional methods, teachers’ usage level of science process skills, and demographic characteristics. Aydoğdu (2006) used a science process skills test for students and science process skills test teachers, the attitudes toward science questionnaire and perception toward parent attitude scale. He also made use of the course scores, which is the mean of the students’ all science grades in the tests for the first semester and those in the “Energy: The Meeting of Force and Motion” unit achievement test, and a teacher observation form, by which he evaluated teacher use of science process skills as good,

mediocre, and poor. Aydoğdu administered these instruments to a sample of 176 students and their teachers in 5 elementary schools. He found that there is a positive but medium relationship between science process skills, academic achievement, attitudes towards science and parent's relevance; and there is a statistical difference between students' acquisition of science process skills and teachers' usage level of science process skills, the education level of parents, and having a computer.

Aydınlı (2007) studied Turkish 6-8 grade students' basic and integrated science process skills. She administered the Test of Integrated Process Skills test to the students attending an elementary school in Ankara, and four elementary schools in Muş. Her sample consisted of a total of 670 students. Aydınlı (2007) also analysed her data with one-way ANOVA and found that there is a significant difference among students' performance in both basic and integrated skills subtest scores according to following variables:

1. Grade: Seventh graders are more successful than eighth and sixth graders respectively, and differences between the grades are significant except grade 7 and 8.
2. Gender: Females are significantly more successful than males.
3. Family income: The students with high socio-economic status are more successful than those with medium and low socio-economic status and the differences between the socio-economic levels are significant.
4. Father job: For the basic skills subtest, the students whose fathers are white-collar are more successful than those whose fathers are self-employed, blue-collar, or farmer, and the differences in the student performances with respect to father occupation are significant except white-collar and self-employed group.

On the other hand, for the integrated skills subtest, the students whose fathers are white-collar are more successful than those whose fathers are self-employed, blue-collar, or farmer and the differences in the student performances with respect to father occupation are significant except blue-collar and self-employed group.

5. Mother job: For the basic skills subtest, the students whose mothers are self-employed are more successful than those whose mothers are white-collar, farmer, blue-collar, or house-wife, and the differences in the student performances with respect to mother occupation are significant between housewife and white-collar, housewife and self-employed, and blue-collar and self-employed groups.

On the other hand, for the integrated skills subtest, the students whose mothers are self-employed are more successful than those whose mothers are white-collar, farmer, house-wife, or blue-collar, and the differences in the student performances with respect to mother

occupation are significant between housewife and white-collar, housewife and self-employed, blue-collar and white-collar, blue-collar and farmer, blue-collar and self-employed groups.

6. Father Education: The students whose father are university graduate are more successful than those whose father are graduated from high and elementary school, or not educated, and the differences in the student performances with respect to father education level are significant.

7. Mother Education: The students whose mothers are university graduate are more successful than those whose mothers are graduated from high and elementary school, or not educated, and the differences in the student performances with respect to mother education level are significant except high school and university groups.

8. Family size: For the basic skills subtest, the students whose family consists of 2-3 persons are more successful than those whose family consists of 4-7, 8-11, and more than 12 persons, and the differences in the student performances with respect to family size are significant except between 4-7 and more than 12, and 8-11 and more than 12 groups.

On the other hand, for the integrated skills subtest, the students whose family consisted of 2-3 persons are more successful than those whose family consists of 4-7, more than 12, and 8-11 persons, and the differences in the student performances with respect to family size are significant except between 2-3 and 4-7, and 8-11 and more than 12. After analysis of data with respect to number of correct responses in each grade level, Aydınlı (2007) also found that seventh graders are proficient in both basic and integrated skill subtests because 67.8% of them answered correctly 6-10 items of basic skill subtest, and 56.9% of them answered correctly 7-12 items of integrated skills subtest. Eighth graders are proficient in basic skills subtest but not in integrated skills subtest, because 52.7% of them answered correctly 6-10 items of basic skill subtest and 39.8% of them answered correctly 7-12 items of integrated skills subtest. Sixth graders are not proficient in both subtests, because 35.2% of sixth graders correctly answered 6-10 items of the basic skills subtest, and 21.3% of sixth graders correctly answered 7-12 items of the integrated skills subtest. Aydınlı (2006) suggested that teachers should do their best to achieve the requirements of new science curriculum and motivate their students in importance of education, and further research is needed to study the effect of instructional materials on student science process skill performance.

Our previous and current science curriculum with respect to science process skills were compared by Başdağ (2006) in her MSc thesis. Başdağ (2006) investigated whether the previous (2000 science curriculum) or current (2004 science curriculum) was more

successful on the students' attainment of science process skills. She administered a science process evaluation test to two groups of students, the ones being instructed by the 2000 curriculum and the others being instructed by the 2004 curriculum. The first group consisted of the students in three elementary schools. On the other hand, the second included the students in two elementary schools where the new curriculum was being piloted. Both schools were located in Ankara. There were a total of 457 students. The researcher analysed data with independent t-test, and found that the students of the 2004 science curriculum were significantly performed well than those in the 2000 science curriculum on the whole and on the items dealing with the following science process skills: observation, inference, prediction, measuring, recording data, defining operationally, hypothesizing. However there was a difference between the both curricula students on the mean scores of the following science process skills; classification, number and space relation, experimenting, defining variables, interpreting data, and model formation. Başdağ (2006) also found that among the students who were being instructed with the 2000 curriculum, the female students performed well on the items measuring classification skill when compared to males, and the students from the higher socio-economic status had higher scores on the test in total and on the following skills: Classification, prediction, measuring, hypothesizing, interpreting data. On the other hand, among the students who were being instructed with the 2004 curriculum, the female students performed well on the items measuring classification skill when compared to males, and students from the higher socio-economic status had higher scores from the test on the following skills: recording variables, and interpreting data. The researcher concluded that the 2004 curriculum are more successful than the 2000 curriculum; gender has no effect in development of science process skills, the 2004 science curricula is more effective in developing scientific skills of the students' regardless of their socio-economic status than the 2000 curriculum. Moreover she suggested that tests can be developed for elementary and secondary students; since teachers are important in developing science process skills, they should be given in-service courses; studies on science process skills are needed, and these can be used in curriculum development; and studies can be done with the students of 2004 curriculum.

2.5 Attitudes toward Science

Attitude is a phenomenon, which is acquired by learning, directs individual's behaviours and causes subjectivity in decision making process (Ülgen, as cited in Durmaz & Özyıldırım, 2005). It includes the behaviours of showing positive attitude toward a course or subject,

being satisfied with answer, giving in positive part or value (Özçelik, as cited in Durmaz & Özyıldırım, 2005).

Science is the all information that is formed from the process that helps students to understand the world by studying the nature and natural events and directed to examine the nature, and its product, the systematic knowledge (Çilenti, as cited in Durmaz & Özyıldırım, 2005). In order for today's human being to feel and interpret technological developments she/he should be given a basic science culture. And for this instruction to have an effect the factors that influence student learning should be determined and those that give rise to negative attitudes toward science and should be keep minimal (Durmaz & Özyıldırım, 2005).

A study by Yager & Yager (as cited in Hall & McCurdy, 1990) showed that students' interest to science begin to decline at 4th grade to university. And another study by Lucas & Dooley (as cited in Hall & McCurdy, 1990) found that negative attitudes toward science among pre-service elementary teachers may be drawn back to their school experiences.

To study students' attitudes toward science is important for the following reasons:
1. Attitudes affect some behaviour, i.e. to select courses, visit museum, and support scientific inquiry (Kaballa & Crowley, as cited in Weinburgh, 2000).
2. Attitudes are related to achievement. Attitudes influence achievement (Schibeci & Riley, as cited in Weinburgh, 2000). In other words, attitudes both influence personal and social decision-making (Millar, as cited in Johnston 1997) and performance in science courses (National Curriculum Council; Johnston; Harlen, as cited in Johnston, 1997) and taking of science in the future grade levels (Sears; Havard, as cited in Johnston, 1997).

Both the educational practices and research studies showed that attitudes toward science should be developed not only in students, but also teachers, teacher candidates (Johnston, Ahtee, & Hayes; Watters & Ginns, as cited in Johnston, 1997), and parents (the Association for Science Education; Johnston, as cited in Johnston, 1997). It can be said that attitudes are developed through earlier contacts with family, teachers, and peers, which are influenced by unconscious prejudices, interests, and thoughts (Johnston, 1997).

The first contributor to the literature on attitudes toward science was Klopfer who in 1971 classified some affective behaviour in science education as:
-the demonstration of positive attitudes towards science and scientists;

-the approval of scientific inquiry as a way of thought;
-the acceptance of scientific attitudes;
-the enjoyment of science learning experiences
-the growth of interest in science and related activities; and
-the growth of an interest in choosing a career in science and related jobs (as cited in Osborne, Simon, and Collins, 2003).

The distinction between attitudes towards science and scientific attitudes was made by Gardner (as cited in Osborne, Simon, and Collins, 2003). Scientific attitudes are a composite of the wish to know and understand, a questioning approach to all statements, a search for data and their meaning, a demand for verification, a respect for logic, a consideration of premises and a consideration of results (Education Policies Commission, as cited in Osborne, Simon, and Collins, 2003). Scientific attitudes characterize scientific thinking and relate to cognitive domain Therefore scientific attitudes differ from attitudes towards science. Attitudes toward science include the feelings, beliefs and values held about the enterprise of science, school science, and the impact of science on society or scientists themselves (Osborne, Simon, and Collins, 2003).

There are some factors that correlate with attitudes towards science. Some studies showed that there is a positive correlation between attitudes toward science and achievement in it (German; Hough & Piper, as cited in Durmaz & Özyıldırım, 2005), but some demonstrated that in the elementary level, there is no relation with gender and attitude (Boylan; Dieck, as cited in Durmaz & Özyıldırım, 2005). The studies on attitudes toward science will be summarized in the following part.

Durmaz & Özyıldırım (2005) studied fourth and fifth grade students' attitudes toward science and its relation with school type (in terms of socio-economic status), gender, and education level of both mother and father. They used a 16-item attitude questionnaire that developed by themselves. There were 162 students in Edirne city participated to the study. The researchers used both independent t-test (for comparing female and male students' attitudes) and one way analysis of variance (for comparing students with different school type, mother and father education level, and Scheffe Test in order to determine the group that makes difference in the data analyses. They found that students' attitudes toward science differs with school type ($p=.023$, the higher socio-economic status the school has, the more positive attitudes its students have) and father education level ($p=.008$ the higher education

level the father has, the more positive attitudes his student has), but not with gender (p=.365) and mother education level (p=295). The researchers concluded that the school's socio-economic status influence students' attitudes toward science. Therefore, both school's and parents' support should be increased in order to develop students' positive attitudes toward science. The study showed that gender has not an effect on science attitude due to young age of students. The reason is the characteristics of this stage (students share their interests and cooperate with each other and they learn by doing and experiencing) (Aral et al., as cited in Durmaz & Özyıldırım, 2005), and the curriculum that values this learning style (Durmaz & Özyıldırım, 2005). Another thing that the study showed is the effect of father's education level on attitude. The reason is again related to socio-economic level, as it increases with the education level, so does student' attitudes.

Inquiry teaching and curriculum materials develop students' attitudes toward science (Gabel, Rubba, & Franz, Kyle, Bonnstetter, & Gadsden, as cited in Chang & Mao, 1999). As stated "In an inquiry classroom there is a time for doing ... a time for reflection ... a time for feeling ... and a time for assessment" (Welch, Klopfer, Aikenhead, & Robinson, 1981, p. 35), inquiry teaching may help students to appreciate that they are doing and feeling real science. And this directs them to more positive attitudes toward science.

2.6 Science Achievement

> *"Learning achievement is the grasp of subject matter, in which the student constructs her/his own meaning as she/he places the learning in the broader context of an accumulated base of knowledge for retrieval when the students needs that learning for unanticipated problem solving arising in the context of schools, work, or life"* (Palincsar & Winn, as cited in Izard, 1991, p. 3).

Achievement consists of two dimensions, content achievement, and lifelong achievement (Nitko & Brookhart, 2007, p. 507).

1. Content achievement is a continuum which includes the specific declarative and procedural learning targets (Marzano, Pickering, & McTighe, as cited in Nitko & Brookhart, 2007, p. 510). Declarative knowledge can be considered as information and can be categorised somewhat hierarchically according to its generality. The facts about people, things, and events are in the bottom, whereas the concepts and generalizations are in the top

of this hierarchy. On the other hand, procedural knowledge can be considered as strategies or skills. Similar to declarative knowledge, procedural knowledge can be classified hierarchically according to its generality. Algorithms are in the bottom, whereas strategies are in the top of this hierarchy. Algorithms are skills, and the procedures with steps that must be executed in s set order. On the other hand, strategies apply to a variety of situations such as the general strategy of analysing a novel problem, relating it to the familiar problems, and identifying important differences (Marzano et al., 1993, p. 16-17).

2. Lifelong achievement is a category of achievement learning targets that cross curricula or may be helpful out of school, such as complex thinking, information processing, effective communication, cooperation/collaboration, and habit of mind (Marzano et al., 1993, p. 18-19), which has in there categories: self-regulation, critical thinking, and creative thinking (Ennis; Paul; Costa; Perkins; Flavell, Zimmerman; Amabile, as cited in Marzano et al., 1993, p. 23-34).

Achievement is not measured directly. The measurement of achievement tries to identify indications of the learning as it occurs or the outcomes at the end of a stage of learning. The result of this measurement serves as the evidence to be considered when deciding whether or not a change has occurred (Izard, 1991, p. 3).

Since inquiry curriculum has a positive effect on achievement, perception of science, and some skills, i.e. science process skills, of students; students develop both science process skills and interest in science in elementary school and these skills progress in secondary school; and teachers who are trained in inquiry are more effective than traditional teachers on achievement of their students (Shymansky, Hedges, & Woodworth, as cited in Davison, 2000, p. 31), it is worthwhile to explore the comparative efficiency between inquiry and traditional teaching method in terms of the development of students' science process skills in typical elementary science classrooms.

CHAPTER 3

METHODOLOGY

3.1 Research Design

The purpose of this study was to find the effect of teacher directed inquiry on students' science process skills. Therefore the design of the study was Experimental Design. Since the random assignment of the subjects to the experimental and control groups was not possible due to the rigid course schedule of the participating schools, "non-equivalent control group quasi experimental design" (Campbell & Stanley, as cited in Chang & Mao, 1999) was used to at least randomize classes and schools.

Table 3.1 indicates the design used in this research:

1. Both experimental and control group students took the Pre Achievement Test in Reproduction, Development, and Growth in Living Things (PreRDGLT), Attitudes toward Science & Technology Course Questionnaire (Att), and Science Process Skills Test First Form (SPC 1) as a pre-test before the instruction on the Reproduction, Development, and Growth in Living Things unit.
2. The experimental group students were taught using the Treatment in Reproduction, Development, and Growth in Living Things (TreRDGLT), where the guided (teacher-directed) inquiry instruction was implemented along with the elementary grade 6 science and technology curriculum. On the other hand, the control group students were taught only the elementary grade 6 science and technology curriculum.
3. After the instruction on the Reproduction, Development, and Growth in Living Things unit, both experimental and control group students took the Post Achievement Test in Reproduction, Development, and Growth in Living Things (PostRDGLT), Attitudes toward Science & Technology Course Questionnaire (Att), and Science Process Skills Test Second Form (SPC 2) as a post-test; and the Pre Achievement Test in Force and Motion (PreFM) as a pre-test before the instruction on the Force and Motion unit.

4. The experimental group students were taught using the Treatment in Force and Motion (TreFM), where the guided (teacher-directed) inquiry instruction was implemented along with the elementary grade 6 science and technology curriculum. On the other hand, the control group students were taught only the elementary grade 6 science and technology curriculum.

5. After the instruction on the Force and Motion unit, both experimental and control group students took the Post Achievement Test in Force and Motion (PostFM), Attitudes toward Science & Technology Course Questionnaire (Att), and Science Process Skills Test Third Form (SPC 3) as a post-test.

6. Both experimental and control group students were taught by the elementary grade 6 science and technology curriculum.

7. After the instruction on the Particulate Nature of Matter unit, both experimental and control group students took the Delayed Achievement Test in Reproduction, Development, and Growth in Living Things (DelRDGLT), Attitudes toward Science & Technology Course Questionnaire (Att), and Science Process Skills Test Fourth Form (SPC 4), and Delayed Achievement Test in Force and Motion (DelFM), as a retention test.

Table 3.1 Research design of the study

Groups	Tests	Types of Treatment	Tests	Types of Treatment	Tests	Types of Treatment	Tests
Exp	PreRDGLT Att SPS 1	TreRDGLT	PostRDGLT Att SPS 2 PreFM	TreFM	Att SPS 3 PostFM	No Tre	DelRDGLT Att SPS 4 DelFM
Con	PreRDGLT Att SPS 1		PostRDGLT Att SPS 2 PreFM		Att SPS 3 PostFM		DelRDGLT Att SPS 4 DelFM

Note: The abbreviations mean the following (according to time and alphabetic order):
Exp: Experimental Group
Con: Control Group
PreRDGLT: Pre Achievement Test in Reproduction, Development, and Growth in Living Things
PostRDGLT: Post Achievement Test in Reproduction, Development, and Growth in Living Things
DelRDGLT: Delayed Achievement Test in Reproduction, Development, and Growth in Living Things
PreFM: Pre Achievement Test in Force and Motion
PostFM: Post Achievement Test in Force and Motion
DelFM: Delayed Achievement Test in Force and Motion
Att: Attitudes toward Science & Technology Course Questionnaire
SPC 1: Science Process Skills Test First Form
SPC 2: Science Process Skills Test Second Form
SPC 3: Science Process Skills Test Third Form
SPC 4: Science Process Skills Test Fourth Form
Tre: Treatment
No Tre: No Treatment
TreRDGLT: Treatment in Reproduction, Development, and Growth in Living Things
TreFM: Treatment in Force and Motion

3.2 Population and Sample

Since the guided (teacher-directed) inquiry units were developed for the elementary science and technology students and curriculum, the population of the study was determined as the 6th grade students attending to the public elementary schools in Ankara city. This was the target population.

The accessible population of the study was those students attending to the public elementary schools in the Etimesgut and Çankaya districts of the Ankara city.

The sample of the study consisted of the students attending a public elementary school at Etimesgut district, and six public elementary schools at Çankaya district. The reasons to select these schools were their low socio-economic status, and the researcher's access to these schools both for transportation and permission. Therefore sampling method was both purposive and convenient.

The students involved in the population were and hence the sample was approximately 11 years old. They were graduated from the 1st level of their elementary schooling which was formerly known as "Primary School" or "İlkokul" in Turkish. Primary Schooling was previously compulsory and was taking 5 years. In 1997-98 academic year (Gündem, 2007), duration of the compulsory education became 8 years as a union of both 5 year primary and 3 year middle schooling. This means a student attending an elementary school has the same classroom teacher for 5 years which corresponds to what is called "1st Level" or "1. Kademe" in Turkish informally, and then has many subject teachers for 3 years which corresponds to the middle school and hence called "2nd Level" or "2. Kademe" in Turkish informally.

The students can be said to be in pre- or concrete operational stage (Gega; Simpson & Anderson, as cited in Llyod & Contreras, 1985), which comes before formal operational period characterized by abstract thinking, and controlling of variables, proportional, hypothetico-deductive, and combinatorial reasoning (Staver, 1986).

When the district statistics (Çankaya MEM, 2007; Etimesgut MEM) were considered, the number of the schools forming the population and sample were as follows:

Table 3.2 Number of the schools in population and sample

District	Population	Sample
Etimesgut	38	1
Çankaya	103	6
Total	141	7

As seen from the Table 3.2, the sample consisted of 7 schools and formed 5% of the schools, of which 3% from the schools in Etimesgut, and 7% from the schools in Çankaya districts. On the other hand, the number of students in the sample was as follows:

Table 3.3 Number of classes, and students in the sample

District	Schools	Number of Class in the School	Number of Class in the Sample	Number of Students in the Sample
Etimesgut	1	5	5	38 + 42 + 36 + 40 + 40 = 196
Çankaya	1	1	1	10
	2	1	1	23
	3	2	2	29 + 27 = 56
	4	2	2	21 + 21 = 42
	5	1	1	31
	6	8	2	37 + 32 = 69
Total	7	20	14	427

As seen from the Table 3.3, the sample consisted of 14 classes corresponding to 70% of the total class number. This value corresponded to 100% of the classes in the school located in Etimesgut district, and 60% of the classes in the six schools located in Çankaya district. On the other hand, the total number of students in the sample was 427.

As stated in the research design, there were two treatments, and the aim was to repeatedly test each student with pre, post, and delayed tests. However some conditions, such as a student' absence from the school , resulted from their illness, or class, due to her/his responsibility in the school, during the administration of tests limited the participation of this student to at least one of the tests. Therefore the number of the students who took each one of the tests was lower than 427. This number is given in the following table (Table 3.4).

Table 3.4 Number of students in the sample who took all of the tests

District	Schools	Number of Students in the Sample	Number of Students in the Sample Who Took All of the Tests
Etimesgut	1	38 + 42 + 36 + 40 + 40 = 196	22 + 16 + 3 + 27 + 18 = 86
Çankaya	1	10	5
	2	23	8
	3	29 + 27 = 56	9+ 18 = 27
	4	21 + 21 = 42	0
	5	31	14
	6	37 + 32 = 69	15 + 13 = 28
Total	7	427	168

As seen from the Table 3.4, the number of the students taking all the tests was 168, which is 39% of the sample participating to the study. It means that 61% of the students from the original sample were missing. The missing value was in experimental group 64%, and in the control group 65%. From the control group schools the missing values were as follows: the first school 50%, the second school 65%, the third school 48%, the fifth school 100%, the sixth school 65%, and the seventh school 59%.

The characteristics of the sample are given from Table 3.5 to Table 3.8.

As seen from the Table 3.5, the numbers of both female and male students were equal. Furthermore, in the experimental group 48% of the students were female, 52% were male. On the contrary, the females constituted 52%, males constituted 48% of the control group.

Table 3.5 Group and gender cross tabulation

	Gender		
Group	Female	Male	Total
Experimental	41	45	86
Control	43	39	82
Total	84	84	168

The Table 3.6 shows that the majority of the students (116 out of 168, or 69%) were born in 1995. The students who were born in 1994 came second with 21% (35 out of 168). The students who were born in 1993 were 2% (3 out of 168) and those who were born in 1996 were 1% (2 out of 168). There was no information about the year of birth for 7% (12 out of

168) of the students. Moreover, in the experimental group the students who were born in 1995 were 68% (59 out of 86), students who were born in 1994 came second with 20% (17 out of 86). There was no student born in 1993 and 1996. There was no information about 12% (10 out of 86) of the students in the experimental group. On the other hand, in the control group, the students who were born in 1995 were 70% (57 out of 82), those born in 1994 were 22% (18 out of 82). The students who were born in 1993 were 4% (3 out of 82), and those who were born in 1996 were 2% (2 out of 82). There was no information about the year of birth for 2% (2 out of 82) of the students in the control group.

Table 3.6 Group and birth year cross tabulation

	Year of Birth					
Group	1993	1994	1995	1996	unknown	Total
Experimental	0	17	59	0	10	86
Control	3	18	57	2	2	82
Total	3	35	116	2	12	168

As seen from the Table 3.7, the majority of the students' mother (91%, 152 out of 168) was house-wife, followed by white-collar (6%, 8 out of 168). The frequencies for blue-collar, self-employed, and other job categories were equal (1%, 2 out of 168). There was no information about the mother occupation for 1% (2 out of 168). In the experimental group the majority of the students' mother (97%, 83 out of 86) was house-wife, 1% (1 out of 86) was in blue-collar, and 2% (2 out of 86) of the mothers were working in the other jobs. In the control group the majority of the students' mother (85%, 69 out of 82) was house-wife, followed by white-collar (10%, 8 out of 82). 1% (1 out of 82) was blue-collar, 2% (2 out of 82) was self-employed. There was no information about the mother occupation for 2% (2 out of 82).

On the other hand, the Table 3.8 demonstrates that the majority of the students' father (35%, 59 out of 168) was self-employed, followed by blue-collar (34%, 57 out of 168), white-collar (22%, 36 out of 168), and other (5%, 8 out of 168). The frequencies for unemployed and not reported job categories were equal (2%, 4 out of 168). In the experimental group the majority of the students' father was blue-collar (47%, 40 out of 86), followed by self-employed (24%, 21 out of 68), white-collar (23%, 20 out of 86), and other (4%, 3 out of 68). The frequencies

for unemployed and not reported job categories were equal (1%, 1 out of 168). In the control group the majority of the students' father was self-employed (46%, 38 out of 82), followed by blue-collar (21%, 17 out of 82) and white-collar (19%, 16 out of 82), and other (6%, 5 out of 82). The frequencies for unemployed and not reported job categories were equal (4%, 3 out of 82).

Table 3.7 Group and mother occupation cross tabulation

	Mother Occupation						
Group	Housewife	Blue-collar	White-collar	Self-employed	Other	unknown	Total
Experimental	83	1	0	0	2	0	86
Control	69	1	8	2	0	2	82
Total	152	2	8	2	2	2	168

Table 3.8 Group and father occupation cross tabulation

	Father Occupation						
Group	Unemployed	Blue-collar	White-collar	Self-employed	Other	unknown	Total
Experimental	1	40	20	21	3	1	86
Control	3	17	16	38	5	3	82
Total	4	57	36	59	8	4	168

3.3 Instruments

There were five instruments used in the study; the first was student demographic form; the second was science process skills test; the third instrument was attitudes toward science questionnaire. The fourth and last instruments were "Reproduction, Development and Growth in Living Things" and "Force and Motion" units achievement tests. The second and third instruments were developed through a pilot testing.

3.3.1 Demographic Form

This first instrument was a kind of checklist asking students some of their demographic such as age; socio-economic status such as parents' education. This instrument was administered to the students at the beginning of 2006-07 academic year before the treatment began. Each

student individually gave their responses to this form by checking each item's alternatives. When these alternatives did not apply to the students' status, they could write down their situation into the "others" part (See Appendix C for the demographic form).

3.3.2 Science Process Skills Test

There are some measurements to assess students' science process skills. For example Padilla, Okey, & Garrard studied how science teachers integrate process skills to their sixth and eighth grade classrooms and used the Test of Integrated Process Skills (as cited in Narode et al., 1987). The Test of Integrated Process Skills (TIPS) assesses students' hypothesizing, identifying variables, constructing operational definitions, designing experiments, and interpreting data abilities (Padilla, Okey, & Garrard, as cited in Narode, et al., 1987). Padilla, Okey, & Garrard stated that the Test of Integrated Process Skills (TIPS) are reliable and valid instrument for measuring science reasoning abilities of middle and high school students (as cited in Narode, et al., 1987). The sample items from TIPS are as following (Padilla, Okey, & Garrard, as cited in Narode, et al., 1987):

a. Hypothesize

John cuts grass for seven different neighbours. Each week he makes the rounds with his lawn mover. The grass is usually different in the lawns-in some it is tall not in others. He begins to make hypotheses about the height of grass. Which of the following is a suitable hypothesis he could test?

A) Lawn moving is more difficult when weather is warm.

B) The amount of fertilizer a lawn receives is important.

C) Lawns that receive more water have longer grass.

D) The more hills there are in a lawn the harder it is to cut.

b. Define Operationally

Students in a science class did an experiment; in it they pointed a flashlight at a screen. They put the flashlight at different distances from the screen. They then measured the size of the lighted spot.

Which of the following would be an appropriate measure of the size of the lighted spot?

A) The diameter of the flashlight.

B) The size of the batteries in the flashlight.

C) The size of the screen.

D) The radium of the spot on the screen.

On the other hand, the Processes of Science Test (POST), which was developed by the Biological Science Curriculum Study, assesses students' ability to use inquiry in biology Montgomery (1969).

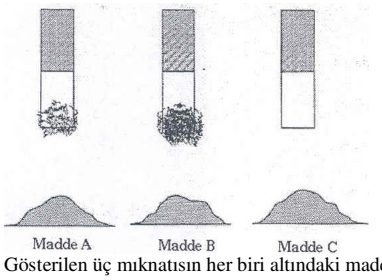
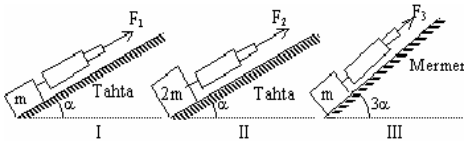
As these studies suggested, students' science process skills can be measured by instruments, and science process skills are consisted of many skills, such as hypothesize, and define operationally.

The instrument, which was used to measure the science process skills of the sixth graders students that participated to the study, was constructed by the researcher, due to abundance of instruments employed to assess students' science process skills, and being uncertain about the appropriateness of them both for the sixth grade students, and our science curricula. Although the information on how this instrument was developed is explained in the following (Procedure) part, an overview is given here.

The Science Process Skills Test is consisted of three equal forms. Each form was administered to the students as the first, second, and third science process skills test. A combination of these three tests was administered as the fourth test during the study. The test forms are all in Turkish. The first three science process skills tests have equal number of items, each of which correspond to and intend to measure a science process skill outlined in the 2005 Science and Technology Curriculum by the Board of Education for grades 6-8 in Turkey except for the last 18^{th} skill, which is communicating (presentation). On the other hand, the last science process skills test has a total of 40 items since it consisted of the items from the previous test forms (See Appendix A for the list of the science process skills for grades 6-8, Appendix B for the science process skills test forms and their cognitive processes). The science process skills are the cognitive processes of the science process skills tests (and items). On the other hand, the subject matters of the tests (and items) are not limited to a specific science subject area.

The items of the science process skills tests are in the multiple-choice with 3 to 5 alternatives, open-ended, matching, and hot-spot formats. The students gave their answers to the multiple-choice items by selecting the alternative, which they thought the right answer, and by writing the answer to the open-ended items right below the question. In other words this test is a paper-and-pencil test. Table 3.9 shows the item characteristics of the test, along with the dimensions.

Table 3.9 Item types, scale and sample items from the science process skills test

Type	Scale	Sample Items
Multiple-choice with 3 alternatives	Inference	 Gösterilen üç mıknatısın her biri altındaki maddenin içine batırılıyor. Hangi madde kahve olabilir?
Multiple-choice with 4 alternatives	Observation	Yandaki mum resmine bakınız. Hangi açıklama doğrudan göz ile yapılan bir gözlemdir? A) Mum, balmumundan yapılmıştır. B) Mum ağırdır. C) Mum yanıyor. D) Alev sıcaktır 
Multiple-choice with 5 alternatives	Prediction	**Gezegen** **Güneşten Ortalama Uzaklık (kilometre)** Dünya 150 milyon Jübiter 778 milyon Mars 228 milyon Merkür 58 milyon Venüs 108 milyon Tabloya göre, hangi gezegen en yüksek sıcaklığa sahip olur?
Open-ended	Controlling Variables	 Bir öğrenci eğik düzlemde sabit hızla çekilen bir cisme uygulanan kuvvet ile eğim açısı arasındaki ilişkiyi göstermek istiyor. Bunun için öğrenci yukarıdaki deney düzeneklerini kuruyor, ancak amacına ulaşamıyor. Bu amaca ulaşabilmek için düzeneklerde hangi değişiklikleri yapıp deneyi nasıl gerçekleştirmelidir, neden?
Matching	Classification	Yanda resmedilen kuşlar aynı bölgede yaşamaktadır. Kuşlardan birinin ana besin kaynağı uzun boru şekilli çiçeklerdeki nektardır. Diğer kuş kemiricilerle beslenir. Üçüncü kuş ise ağaçların kabuklarını, içerdeki böcekleri yakalamak için gagalar. Bu bilgiye dayanarak resimdeki kuşları ve besinlerini eşleştiriniz.  sinek kuşu atmaca ağaçkakan
Hot-spot	Knowing Laboratory Instruments, and Using Them	A. Büyüteç B. Pil   Güvenlik amacıyla kullanılan laboratuar malzemeleri hangileridir?

The scoring of the science process skills tests is done by assigning 1 point to each correct answer simply. In order to eliminate misinterpretations, the grading procedure is outlined in Table 3.10.

Table 3.10 Scoring system of the science process skills test

Item type	Marking Procedure
Multiple-choice with 3-5 alternatives	1 point for correct response 0 point for incorrect or no response
Open-ended	2 points for correct response 1 point for partially correct response 0 point for incorrect or no response
Matching	1 point for each correct matching 0 point for incorrect or no response
Hot-spot	Each condition is regarded as separate item 1 point for each correct selection 0 point for incorrect or no response

After this item level scoring, the total test score can be calculated by counting the scores of each items and dividing this value with the number of items in the test.

The Cronbach alpha reliability coefficients were found .744, .781, .739, and .870 after the analyses of each science process skills test data with Reliability Analysis on SPSS.

3.3.3 Attitudes toward Science Lesson

In education, to assess affective characteristics of students besides their cognitive features is wanted. One of the affective variables that are subject to measurement in education is attitudes. Since attitudes are not observable directly, some actions which are thought to be related to attitudes are measured by observation (Tezbaşaran & Kelecioğlu, 2004).

There are many attitude scales to assess students' attitudes, such as Likert scales, two-point scales, and semantics differentials (Kubiszyn & Borich, 2007, p. 452).

There are also some measurements to assess students' attitude toward science. These can be called as attitude toward science inventory. For example, Weinburgh (2000) made use of the Attitude toward Science Inventory: Version A in order to examine grades 6 to 8 students' attitudes toward science. The researcher employed The Attitude toward Science Inventory:

Version A (ATSI) because of its construct related validity evidence reported by Goglin & Swartz, and Weinburgh as well as content related validity evidence of its mathematic version stated by Sandman (as cited in Weinburgh, 2000). The other reason to select ATSI was its multidimensionality, having six factors: perception of the science teacher, anxiety toward science, value of science in society, self-concept in science, enjoyment of science, and motivation in science (Weinburgh, 2000). The ATSI is four-point-Likert scale (strongly agree, agree, disagree, and strongly agree), and has 48 items. Weinburgh (2000) reported that the alpha reliability coefficients range from .56 to .84 according to the gender, ethnicity, and grade level of the students who took ATSI and were acceptable (Nunnelly, as cited in Weinburgh, 2000).

In other study, Dhindsa & Chung (2003) employed an attitude towards science instrument in order to assess Bruneian 14-years-olders' attitudes toward science. Although this test was originally developed by Aiken to assess Iranian secondary students' mathematics attitudes, by changing the term, mathematics, with "science", the researchers made use of it. The test had six scales; enjoyment, anxiety, importance, interest, confidence, and motivation, and in five-point Likert type. After some validity (consulting scholars whether the name change would not be biased), and reliability (piloting the test twice and comparing Cronbach-alpha values of each scale, and looking at test-retest reliability coefficient) studies, the researchers developed it.

As these studies suggested, students' attitudes toward science can be measured by instruments, and attitudes toward science are consisted of many attitudes, such as anxiety, enjoyment, and motivation; and it is possible to develop an attitudes toward science instrument.

The instrument, which was used to measure the attitudes toward science and technology course of the sixth graders students that participated to the study, was constructed by the researcher, due to abundance of instruments employed to assess students' attitudes toward science, and being uncertain about the appropriateness of them both for the sixth grade students, and our science courses. Although the information on how the instrument was developed is explained in the following (Procedure) part, an overview is given here.

The Attitudes toward Science and Technology Course Questionnaire is in Turkish, and has 6 factors and a total of 30 items. The students gave their answers to the item statements by

using the five-point Likert type response format ranging from (1) Strongly Agree to (5) Strongly Disagree next to the item. In other words this test is a paper-and-pencil test. The following table (Table 3.11) shows its dimensions with their sample item statements.

Table 3.11 Scale, description and sample test items from "the attitudes toward science and technology course" instrument

Scale	Description	Sample Items
Anxiety	The extent to which student is anxious about science course.	Fen Bilgisi dersinde yapılan sınavlardan korkarım.
Career	The extent to which student uses science now and want to use it in the future.	Fen Bilgisi dersinde öğrendiklerimi ileride kullanmayı düşünüyorum.
Enjoyment	The extent to which student enjoys science course.	Fen Bilgisi dersinden zevk alırım.
Interest	The extent to which student develops interest in science and its related activities.	Fen Bilgisi dersi ile ilgili televizyon programı ve CD izlemekten hoşlanırım.
Academic Self-Concept	The extent to which student believe that her/his personal efforts influence her/his learning and achievement, hence is confident and successful doing science. (The second explanation may be termed as "Confidence")	Fen Bilgisi dersinde başarılı olmak için gerekli yeteneğe sahibim.
Usefulness	The extent to which student perceives that science is useful in life. (It may be termed as "Importance")	Fen Bilgisi dersi doğa olaylarını daha iyi anlamama yarar.

Note: The table was constructed by using the following references: Harrington Lindberg, 1990; Dhindsa & Chung, 2003

The scoring of each item of the attitudes toward science and technology course questionnaire is done by assigning 5 points to each positive response or to the selection of "Strongly Agree, and 1 point to each negative response or to the selection of "Strongly Disagree". In this way, the "Neutral' choice gets 3, "Agree" choice gets 4, and "Disagree" choice gets 2 points. This scoring is for positive statements of the questionnaire. For negative statements the contrary is done. If there is no answer it should be coded as "Missing". This grading is outlined in the following table (Table 3.12).

After this item level scoring, total scale scoring and test scoring can be calculated. Total scale score is found by counting the scores of each scale items and dividing this value with the number of items in the scale. On the other hand, total test score can be found by either adding up each scale score and dividing the addition by the number of scales or counting each item score and dividing this total to the number of items.

Table 3.12 Scoring system of the attitudes toward science and technology course questionnaire

Item type	Marking Procedure
Positive Statements Example: Fen Bilgisi dersinde öğrendiklerimi ailemle paylaşırım.	Strongly Agree: 5 points Agree: 4 points Neutral: 3 points Disagree: 2 points Strongly Disagree: 1 point
Negative Statements Example: Fen Bilgisi dersinde yapılan sınavlardan korkarım.	Strongly Agree: 1 point Agree: 2 points Neutral: 3 points Disagree: 4 points Strongly Disagree: 5 points

The Cronbach alpha reliability coefficients were found .894, .884, .893, and .905 after the analyses of each attitudes toward science and technology course questionnaire test data with Reliability Analysis on SPSS.

3.3.4 Achievement Tests

There were two achievement tests: Reproduction, Growth and Development in Living Things, and Force and Motion. The researcher assumed that these tests measure students' achievement for Reproduction, Growth and Development in Living Things, and Force and Motion units.

Achievement test are the instruments chosen to assess students' achievement. For example, Montgomery (1969) employed the Nelson Biology Test for his study with ninth and tenth grade students since is widely used and has the content of Biology courses.

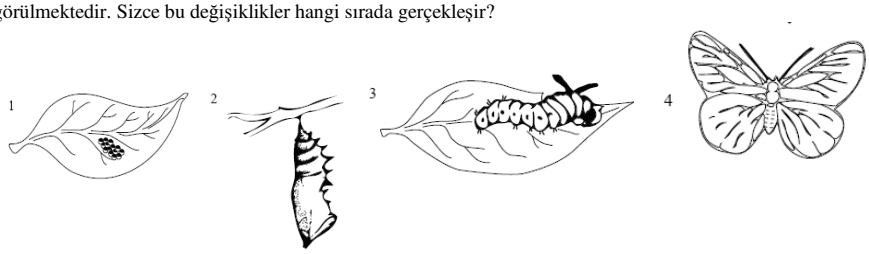
As this study suggested, students' achievement in science should be measured by any instrument, which content is in line with the curriculum.

The instruments, which were used to measure the achievement in both "Reproduction, Development, and Growth in Living Things", and "Force and Motion" unit were constructed by the researcher since there is no available test form. The researcher utilized the related items from the national and international exams, such as Secondary School Institutions Student Selection and Placement Tests, and TIMSS, and studies in science education literature. The current science curriculum, and its objectives and subjects were taken as a

base to select the items from these resources. Although the information on how the instrument was developed is explained in the following (Procedure) part, an overview is given here (See Appendix F for the form and blueprints (subject matters and cognitive processes) of "The Reproduction, Development, and Growth in Living Things Unit Achievement Test" and "The Force and Motion Unit Achievement Test").

The first "Reproduction, Development, and Growth in Living Things Unit Achievement Test" is in Turkish and a total of 25 items: 23 of them are in multiple-choice format with 4 alternatives, one is in fill-in-the-blank format, and one is in open-ended format. The students gave their answers to the multiple-choice items by selecting the alternative, which they thought the right answer, by filling the blanks with the given words, and by writing the answer to the open-ended items right below the question. In other words this test is a paper-and-pencil test. Table 3.13 shows the item characteristics of the test.

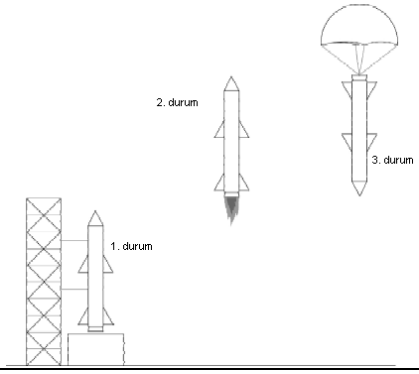
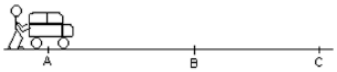
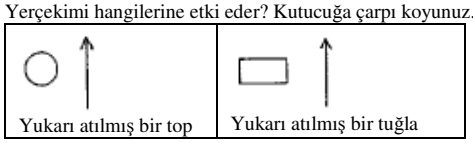
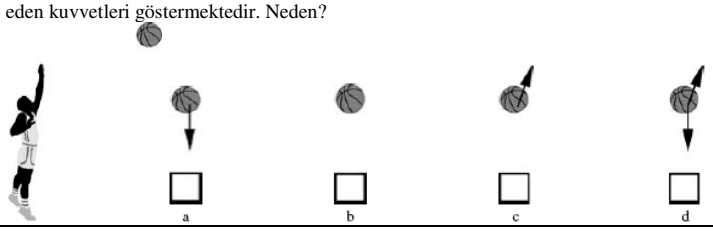
Table 3.13 Item types and sample items of the Reproduction, Development, and Growth in Living Things Unit Achievement Test

Type	Sample Items
Multiple-choice	Bir yaprağa konan kelebek, oraya yumurtalarını bıraktı. Aşağıda yumurtaların geçirdiği değişim görülmektedir. Sizce bu değişiklikler hangi sırada gerçekleşir?  A) 1, 2, 3, 4 B) 1, 3, 2, 4 C) 1, 4, 3, 2 D) 1, 4, 2, 3
Fill-in-the-blank	Molekül, atom ve bileşik kelimelerini kullanarak aşağıdaki cümleyi oluşturabiliriz: Şekerler, atomların oluşturduğu moleküllerden meydana gelen bileşiklerdir. Organ, doku ve hücre kelimelerini kullanarak aşağıdaki cümleyi tamamlayınız: Akciğerler, …… oluşturduğu ……... meydana gelen ……..
Open-ended	Siz büyüdükçe vücudunuzda hangi değişiklikler meydana gelir? Gözlemlediklerinizi ve bildiklerinizi yazınız.

The second "Force and Motion Unit Achievement Test" is also in Turkish. It has a total of 23 items, 17 of which are in multiple-choice format with 4 alternatives, 4 of which are in

open-ended format (one of these questions has two parts), 1 is hot-spot, and the remaining item has three parts, each of which is consisted of both multiple choice and open-ended formats. The students gave their answers to the multiple-choice items by selecting the alternative, which they thought the right answer by writing the answer to the open-ended items right below the question, and by putting a mark, "X", to the hot spot item. In other words this test is a paper-and-pencil test. Table 3.14 shows the item characteristics of the test.

Table 3.14 Item types and sample items of the force and motion unit achievement test

Type	Sample Items
Multiple-choice	**11.** 30 m/s sabit süratle hareket eden bir otomobil 10 dakikada kaç km yol alır? A) 18 B) 20 C) 25 D) 30
Open-ended	 Şekiller Dünya'dan fırlatılan ve sonra geri dönen bir roketi göstermektedir. Yerçekimi roket üzerine etki eder mi? Hangi durumlarda? Neden?
Open-ended with two parts	Buzlu bir yolda A noktasında duran araba (motoru çalışmayan ve fireni tutmayan), şoför tarafından sabit bir kuvvetle itilerek B'ye getiriliyor. a. Sizce araba nasıl hareket etmiştir? b. Sizce araba B'den C'ye gelir mi? Nasıl? 
Hot-spot	Yerçekimi hangilerine etki eder? Kutucuğa çarpı koyunuz. 
Multiple-choice and Open-ended	Dünyadaki yerçekimini düşünerek ve rüzgârın direncini hesaba katmayarak aşağıdakileri cevaplayınız. 1. Bir basketbol oyuncusu topu potaya fırlatır. Aşağıdakilerden hangisi top en yukardayken topa etki eden kuvvetleri göstermektedir. Neden? 

The scoring of the achievement tests is done by assigning 1 point to each correct answer simply. In order to eliminate misinterpretations, the grading procedure is outlined in Table 3.15.

Table 3.15 Scoring system of the achievement tests

Item type	Marking Procedure
Multiple-choice	1 point for correct response 0 point for incorrect or no response
Open-ended	2 points for correct response 1 point for partially correct response 0 point for incorrect or no response
Open-ended with two parts	Each part is regarded as separate items 2 points for correct response 1 point for partially correct response 0 point for incorrect or no response
Fill-in-the-blank	1 point for all correct fillings 0 point for any incorrect filling or no response
Hot-spot	Each condition is regarded as separate items 1 point for each correct selection 0 point for incorrect or no response
Multiple-choice and Open-ended	2 points when both multiple-choice and open-ended parts are answered correctly 1 point when either multiple-choice or open-ended part is answered correctly 0 point for all incorrect or no response

After this item level scoring, total test scoring can be calculated by counting the scores of each item.

The Cronbach alpha reliability coefficients were found 770, .898, and .876 for the Reproduction, Development, and Growth in Living Things Unit Achievement Test and .779, .832, and .840 for the Force and Motion Unit Achievement Test after the analyses of each test data with Reliability Analysis on SPSS.

3.4 Procedures

This part is consisted of two parts: Procedures on Instrument development and instructional design.

3.4.1. Instrument Development

All of the instruments that were used in the study were developed by the researcher. There were two steps in developing instruments:

1. Developing both the Science Process Skills Tests and Attitudes toward Science and Technology Course Questionnaire, and
2. Developing Student Demographic Form, and two of the Unit Achievement tests, one of which is on "Reproduction, Development, and Growth in Living Things", and the other is on "Force and Motion".

The information on both the first step, where two pilot studies were conducted, and the second step will be explained in the following titles.

3.4.1.1 Developing the Science Process Skills Tests, and Attitudes toward Science and Technology Course Questionnaire

3.4.1.1.1 Constructing the Science Process Skills Pilot Tests

The science process skills pilot test items were gathered from various resources, such as Secondary School Institutions Student Selection and Placement Test (years 1998-2001, 2004, 2005), Private Schools Test (years 2001, 2005), State Tests (Devlet Parasız Yatılı ve Bursluluk Sınavları) (year 2001), TIMSS 1999, TIMSS-R, and Virginia State Science Standards. The items were collected from these sources during the first semester of 2005-06 academic year (See Appendix B for the lists of reference for the items of "The Science Process Skills Test").

The reason to make use of Secondary School Institutions Student Selection and Placement Test, and Private Schools Tests was their inclusion of items which consisted of both knowledge and skills, and their aim to measure academic ability (Kutlu & Karakaya, 2004), and their base on the elementary curricula (MEB, as cited in (Kutlu & Karakaya, 2004). These tests, regardless of their subject matter, aim to assess students' higher order thinking skills i.e., whether to use, interpret, generalize, predict, discriminating among elements, make relationships between elements, and evaluate information (EARGED, 1995). These skills can be examined further as the cognitive processes of the achievement tests, which is also a blue-print for the cognitive processes assessed through these tests by the Ministry of

National Education (See Appendix F). To know which cognitive process the test tries to measure is important for the validity of the test (Kutlu & Karakaya, 2004). The studies on the factor structure (cognitive processes) of the Secondary School Institutions Student Selection and Placement Tests supported the aim of this test (Aslan, as cited in Kutlu & Karakaya, 2004; Kutlu & Karakaya, as cited in Kutlu & Karakaya, 2004; Köksal, 2002).

The items from these sources were selected in terms of science process skills explained in the MONE's list of science process skills in the Elementary Science and Technology Curriculum for Grades 6-8 (See Appendix A for the list of "The Science Process Skills").

Since there were more than 200 test items found in the resources, theSE items were grouped according to the process skill acquired. Thus, 5 equal forms of science process skills test forms were prepared.

3.4.1.1.2 Constructing the Attitudes toward Science and Technology Course Pilot Questionnaire Forms

The researcher prepared Attitudes toward Science and Technology Course Pilot Questionnaire, the second pilot test, by the use of related literature on attitudes and science. Since the number of items found from this literature review was more than 60, the items were grouped by the researcher according to the factor measured. The names of the factors were also found from the literature. The grouping was based on the opinions of a group of scholar (mostly research assistants from the Secondary Science and Elementary Education departments, and one biology teacher at a science and arts centre). The researcher asked the opinions of the group individually by presenting them the items and factor sheet by which they could classify the items to a specific factor. Finally, she prepared two equal forms of Attitudes toward Science Lesson Questionnaire forms.

3.4.1.1.3 The Pilot Testing of the Science Process Skills Test and Attitudes toward Science and Technology Course Pilot Questionnaire Forms

The pilot study in developing the science process skills tests and attitudes toward science and technology questionnaire was conducted with the grade 6-8 students attending three elementary schools, one of which was located in the Etimesgut district, whereas the latter two were located in the Çankaya District, at the end of the first semester and at the beginning

of the second semester of 2005-06 academic year. The number of students in the sample was as follows:

Table 3.16 Number of the schools in population and sample for the pilot study of science process skills tests, and attitudes toward science and technology course questionnaire forms

District	Population	Sample
Etimesgut	38	1
Çankaya	103	2
Total	141	3

As seen from the Table 3.16, the sample, where both science process skills test forms, and the attitudes toward science and technology questionnaire forms were piloted, consisted of 3 schools and formed 2% of the schools, 3% of which from the schools in Etimesgut, and 2% from the schools in Çankaya districts. On the other hand, the distributions of students to the grade levels were as follows:

Table 3.17 Grade levels of the students in the pilot study of the science process skills test forms and attitudes toward science and technology questionnaire forms

Grades			Total
6	7	8	
356	264	147	767

As seen from the Table 3.17, the sample, where both science process skills test forms, and the attitudes toward science and technology questionnaire forms were piloted, consisted of 767 students, 47% of whom were attending sixth grade, 34% were attending seventh grade, and 19% were attending eighth grade.

3.4.1.1.3.1 The Pilot Testing of Science Process Skills Test Forms

Each test form was administered to grades 6-8 students in the three elementary schools, one of which was located in the Etimesgut district whereas the latter two were located in the Çankaya District. This pilot study was done at the end of the first semester and at the

beginning of the second semester of 2005-06 academic year. On the other hand, the number of students in the sample was as follows:

Table 3.18 School and grade cross tabulation for the pilot study of the science process skills test forms

School	Grades			Total
	6	7	8	
Etimesgut 1	167	52	32	251
Çankaya 1	74	42	36	152
Çankaya 2	39	70	29	138
Total	280	164	97	541

As seen from the Table 3.18, the sample, where the science process skills test forms were piloted, consisted of 541 students, 46% of whom were attending the school located in Etimesgut district, and the remaining 54% were attending to the two schools (as 28%, and 26%) located in Çankaya district. The grade levels of the students were as follows: 52% at grade 6, 30% at grade 7, and 18% at grade 8. At the sixth grade level, students' distributions to the districts were 60% to Etimesgut, 40% to Çankaya (26% to the first school, and 14% to the second school). At the seventh grade level, students' distributions to the districts were 32% to Etimesgut, 68% to Çankaya (26% to the first school, and 42% to the second school). At the eighth grade level, students' distributions to the districts were 33% to Etimesgut, 67% to Çankaya (37% to the first school, and 30% to the second school).

The following tables (from Table 3.19 to Table 3.23) show the sample along with the science process skills test forms.

Table 3.19 School and grade cross tabulation for the pilot study of the first science process skills test form

School	Grades			Total
	6	7	8	
Etimesgut 1	35	0	0	35
Çankaya 1	0	0	36	36
Çankaya 2	0	34	9	43
Total	35	34	45	114

As seen from the Table 3.19, the sample, where the first science process skills test form was piloted, consisted of 114 students, 31% of whom were attending the school located in Etimesgut district, and the remaining 69% of whom were attending to the two schools (as 31%, and 38%) located in Çankaya district. The grade levels of the students were as follows: 31% at grade 6, 30% at grade 7, and 39% at grade 8. At the sixth grade level, all students were from the school in Etimesgut. At the seventh grade level, all students were from the second school in Çankaya. At the eighth grade level, all students were from Çankaya, 80% from the first school, and 20% from the second school.

Table 3.20 School and grade cross tabulation for the pilot study of the second science process skills test form

School	Grades			Total
	6	7	8	
Etimesgut 1	37	18	0	55
Çankaya 1	38	0	0	38
Çankaya 2	0	6	15	21
Total	75	24	15	114

As seen from the Table 3.20, the sample, where the second science process skills test form was piloted, consisted of 114 students, 48% of whom were attending the school located in Etimesgut district, and the remaining 52% of whom were attending to the two schools (as 33%, and 19%) located in Çankaya district. The grade levels of the students were as follows: 66% at grade 6, 21% at grade 7, and 13% at grade 8. At the sixth grade level, 49% of the students were from Etimesgut district, 51% were from the first school in Çankaya. At the seventh grade level, 75% of the students were from Etimesgut district, 25% were from the second school in Çankaya. At the eighth grade level, all students were from the second school of Çankaya.

As seen from the Table 3.21, the sample, where the third science process skills test form was piloted, consisted of 89 students, 66% of whom were attending the school located in Etimesgut district, and the remaining 34% of whom were from the second school in Çankaya. The students in Etimesgut formed the sixth grade sample with a percent of 66, whereas those in the second school of Çankaya formed the seventh grade sample with a percentage of 34. There were no students at grade 8.

Table 3.21 School and grade cross tabulation for the pilot study of the third science process skills test form

School	Grades			Total
	6	7	8	
Etimesgut 1	59	0	0	59
Çankaya 1	0	0	0	0
Çankaya 2	0	30	0	30
Total	59	30	0	89

Table 3.22 School and grade cross tabulation for the pilot study of the fourth science process skills test form

School	Grades			Total
	6	7	8	
Etimesgut 1	0	0	32	32
Çankaya 1	36	0	0	36
Çankaya 2	39	0	4	43
Total	75	0	36	111

As seen from the Table 3.22, the sample, where the fourth science process skills test form was piloted, consisted of 111 students, 29% of whom were attending the school located in Etimesgut district, and the remaining 71% of whom were attending to the two schools (as 32%, and 39%) located in Çankaya district. The grade levels of the students were as follows: 68% at grade 6, and 32% at grade 8. There were no students at grade 7. At the sixth grade level, all students were from Çankaya, 48% of who were in the first, 52% of who were in the second school. At the eighth grade level, 89% of the students were from Etimesgut, and 11% of them were from Çankaya.

Table 3.23 School and grade cross tabulation for the pilot study of the fifth science process skills test form

School	Grades			Total
	6	7	8	
Etimesgut 1	36	34	0	70
Çankaya 1	0	42	0	42
Çankaya 2	0	0	1	1
Total	36	76	1	113

As seen from the Table 3.23, the sample, where the fifth science process skills test form was piloted, consisted of 113 students, 62% of whom were attending the school located in Etimesgut district, and the remaining 38% of whom were attending to the two schools (as 37%, and 1%) located in Çankaya district. The grade levels of the students were as follows: 32% at grade 6, 67% at grade 7, and 1% at grade 8. At the sixth grade level all students were from Etimesgut. At the seventh grade level, 45% of the students were from Etimesgut, while 55% were from the second school in Çankaya. At the eighth grade level, all students were from the second school in Çankaya.

3.4.1.1.3.2 The Pilot Testing of Attitudes toward Science and Technology Course Pilot Questionnaire Forms

There were two forms of Attitudes toward Science Lesson Questionnaire for pilot. Each test form was administered by the researcher to 226 grades 6-8 students in the three elementary schools one of which was located in the Etimesgut district, whereas the latter two were located in the Çankaya District. This pilot study was done at the end of the first semester and at the beginning of the second semester of 2005-06 academic year.

The Table 3.24 shows the sample along with the attitudes toward science and technology questionnaire forms.

Table 3.24 Grade and test form cross tabulation for the pilot study of the attitudes toward science and technology course questionnaire forms

Grades	1st Form	2nd Form	Total
6	21	55	76
7	44	56	100
8	50	0	50
Total	115	111	226

As seen from the Table 3.24, the sample, where the attitudes toward science and technology course questionnaire forms were piloted, consisted of 226 students, 34% of whom were going to grade six, 44% were attending to grade seven, and the remaining 22% were at grade eight. On the other hand, the sample, where the first attitudes toward science and technology

course questionnaire form was piloted, consisted of 115 students, 18% of whom were at grade six, 38% were going to grade seven, and the remaining 44% were attending to grade eight. In addition, the sample where the second attitudes toward science and technology course questionnaire form was piloted, consisted of 111 students, 50% of whom were attending to grade six, and 50% were going to grade seven. There were no eighth grade students.

3.4.1.1.4 The Analysis of the Pilot Testing of the Science Process Skills Test and Attitudes toward Science and Technology Course Pilot Questionnaire Forms

The data from both the science process skills pilot tests and attitudes toward science and technology course pilot questionnaires were analysed with the Statistical Package for Social Sciences for WINDOWS (SPSS) program by both the Reliability Analysis, and Factor Analysis, since reliability analysis gives information about each items in terms of the p (item difficulty index) and r (corrected item-total correlation coefficient) values; and factor analysis gives information about the factorial structure of test.

The *p* and *r* values stated above are important for test construction. When considering *p*, which is the proportion of students who answered the item correctly, an item should not be easy so that it is answered correctly or should not be hard so that it can not be answered correctly by students. The ideal *p* should be between .20 and .80 (Kubiszyn & Borich, 2007, p. 205, 207). On the other hand, *r* shows the extent to which an item separates students who are successful on the overall test and those who are not. The ideal *r* should be positive, which means that students who are successful on the overall test are also responded correctly to the item (Kubiszyn & Borich, 2007, p. 205). When an achievement test is being developed both *p* and *r* values are important. On the other hand, since there is no right answer in attitude tests, only *r* should be looked at.

The reason to use factor analysis was the dimensionality of science process skills and attitudes. Science process skills consist of various skills such as observation, prediction, hypothesizing, etc. Attitudes toward science have also many features such as anxiety, interest, enjoyment, etc.

For the pilot data, principal component analysis was selected as the extraction or factor analysis method (Tinsley and Tinsley, as cited in Ashton, 2001). In this analysis, Kaiser's

Criterion, which is extracting only the factors with an eigenvalue over one is met (Kaiser, as cited in Ashton, 2001). Moreover "Varimax" was used as the rotation method. Factor analysis gives KMO and Bartlett's Test, Total Variance Explained Table, Scree Plot, and Rotated (Varimax Factor Rotation) Component Matrix.

KMO is a measure of whether the distribution of values is adequate for conducting factor analysis (George & Malllery, 2003, p. 256). The classification used to interpret KMO values is below (George & Malllery, 2003, p. 256):
KMO > .9 marvellous,
KMO > .8 meritorious,
KMO > .7 middling,
KMO > .6 mediocre,
KMO > .5 miserable,
KMO < .5 unacceptable.

On the other hand, Bartlett Test of Sphericity should be significant, < .05. According to George & Malllery (2003, p. 256) this means that the test data do not produce an identity matrix and approximately normal, and acceptable for factor analysis.

The total variance explained table shows how many factors with eigenvalues over 1 are there and how much these factors are responsible for the variance in the total test scores.

Scree Plot is a representation of factors according to eigenvalues. This criterion asks to look at this graph and determine the breaks in the slope of the line (Tinsley & Tinsley as cited in Ashton, 2001).

Rotated Component Matrix shows the items loaded to the factors when the data were reanalyzed with varimax rotation. This rotation hypothesizes that if there are underlying factors they will be highly correlated (Tinsley & Tinsley as cited in Ashton, 2001).

For the science process skills pilot tests, item selection was done by the researcher and supervisor according to both *p* and *r*; and scale selection was done according to factor analysis results in terms of KMO and Bartlett's Test, Total Variance Explained Table, Scree Plot, and Rotated (Varimax Factor Rotation) Component Matrix.

For the attitudes toward science and technology pilot questionnaires, item selection was done by the researcher and supervisor according according to only *r* (item-total correlation coefficient), and scale selection was done according to factor analysis results in terms of KMO and Bartlett's Test, Total Variance Explained Table, Scree Plot, and Rotated (Varimax Factor Rotation) Component Matrix.

3.4.1.1.5 The Results of the Pilot Testing of the Science Process Skills Test and Attitudes toward Science and Technology Course Pilot Questionnaire Forms

The results of the science process skills pilot tests showed that many items worked well (were in moderate difficulty and could differentiate between higher achievers and lower achievers) and there were dimensions corresponding to each science process skills.

At the end the final forms were prepared by considering the p (or the mean) and r (item-total correlation) values of the items (please see Appendix B); and factor structure.

3.4.1.2 Developing Student Demographic Form, "Reproduction, Development, and Growth in Living Things" and "Force and Motion" Unit Achievement Tests

In the construction of "The Student Demographic Form", the researcher made use of many theses, and TIMSS-R student questionnaire (See Appendix C for the student demographic form).

On the other hand, when developing the unit achievement tests (Reproduction, Development, and Growth in Living Things, and Force and Motion), the researcher selected the related items from many tests, such as Secondary School Institutions Student Selection and Placement Tests (Ortaöğretim Kurumları Öğrenci Seçme ve Yerleştirme Sınavları), Private Schools Tests (Özel Okullar Sınavları), State Tests (Devlet Parasız Yatılı ve Bursluluk Sınavları), TIMSS 1999, TIMSS-R. The researcher also employed the related literature (See Appendix F for the forms and references of the Reproduction, Development, and Growth in Living Things and Force and Motion unit achievement tests).

The state tests, as stated earlier in the development of science process skills test, measure higher order thinking skills and are consistent with the science curriculum, and therefore these considered suitable for the achievement test by the researcher. On the other hand, the

TIMSS include the items from the life science, physical science, chemistry, and the nature of science content category (TIMSS, 1999a; TIMSS, 1999b), or subject matter, which are coherent with the objectives and subject matters of the 6th grade curriculum. For example, TIMSS life science subject which contains the items on living-nonliving, sprouting of seeds, stages of plant growth, stages of caterpillar, butterfly and frog, pollination, animal-plant, changes in children's' bodies (TIMSS, 1999a) and chemistry subject, which contains the item on compounds, molecules, and atoms (TIMSS, 1999b), measure students' understanding on those subject areas, which are also found in our elementary school science curriculum. Moreover the cognitive processes or performance objectives are on understanding simple and complex information; theorizing, analyzing, and solving problems; using tools; routine procedures, and science processes; and investigating the natural world (TIMSS, 1999a; TIMSS, 1999b).

The researcher selected the items from these sources in terms of the objectives, and subject matter given in our new science and technology curriculum for grade 6 and Reproduction, Development, and Growth in Living Things, and Force and Motion units (See Appendix F for the blue-prints of the Reproduction, Development, and Growth in Living Things and Force and Motion unit achievement tests).

Both the science process skills tests and attitudes toward science and technology course questionnaire data were analysed with the Statistical Package for Social Sciences for WINDOWS (SPSS) program. Item selection was done by the researcher and supervisor according according to both *p* (item difficulty index) and *r* (item-total correlation coefficient). On the other hand, scale selection was done according to factor analysis results in terms of KMO and Bartlett's Test, Scree Plot, and Rotated (Varimax Factor Rotation) Component Matrix.

The results of the analyses (KMO and Bartlett's Test, Factor analysis, Scree Plot, item discriminations and difficulty), which were summarized in the previous methodology part, are given in the appendices.

At the end the final forms were prepared by considering the p (or the mean) and r (item-total correlation) values of the items (please see Appendix B)

3.4.2 Instructional Design

When the researcher was preparing the guided (teacher-directed) inquiry instruction, she considered the following points:

1. Inquiry when used with cooperative learning improves student achievement in science classroom (Haukoos and Penick, as cited in Chang & Mao, 1999). Inquiry-oriented classes tend to be more cooperative and should include a variety of cooperative activities (Johnson, as cited in Chang & Mao, 1999).

2. Inquiry imposes an overload on the short term memory of students who simultaneously have to attend to new subject, unfamiliar materials and problem-solving task (Case; Linn; Pascual Leone, as cited in Rubin & Tamir, 1988). On the other hand, advance organizers bridges students' existing cognitive structure and the new content (Ausubel, as cited in Rubin & Tamir, 1988). Therefore, as an invitation for students to inquiry (Scwab, as cited in Rubin & Tamir, 1988), advance organizer tasks were found effective especially for average and low achieving students (Rubin & Tamir, 1988). The following constitutes an example to the advance organizer task (Rubin & Tamir, 1988):

The length of a kite's tail

Students test the hypothesis that "the longer the tail in relation to the kite's frame, the higher the kite will rise." They plan an adequate experiment and answer questions such as:

What is the problem?

What is the hypothesis?

What are the treatments?

How many replications are intended?

What is the dependent variable?

What is the independent variable?

Is it important that the size and shape of the kites used in different treatments be identical?

That weather conditions be identical?

That the kites are built of identical materials?

3. On the other hand, the environment of the school selected as experimental was taken into account. This can be outlined as the physical class environment, laboratory facilities, science and technology teachers' choice to use laboratory for a classroom or instrumental source.

There was no available space for the students' cooperative work in the classrooms. Although the school laboratory offered a variety of instruments, they had limited in number.

4. The age level of the students, and their experience with inquiry were also important for the design.

In order to meet the criteria outlined in the related literature especially those by Carin et al. (2005), a pilot study on teacher-guided inquiry was performed with the experimental school students when they were at grade 5. The pilot was on Electricity Unit and a worksheet was used as both an advance organizer and report form. This material is given in the Appendix J. The form was revised then for the actual treatment.

The teacher-guided inquiry materials were also evaluated by using performance tasks and coding categories of Solano-Flores & Shavelson (1997), and Lee & Butler Songer (2003). An example to this analysis can be seen in the Appendix J.

3.5 Implementation of Instructional Design

The treatment, guided (teacher-directed) inquiry instruction was implemented on the experimental group students during their lessons on "Reproduction, Development, and Growth in Living Things" and "Force and Motion" units. These units were the first two units of the elementary grade 6 science and technology curriculum in Turkey. The experimental group students were from the same school in Etimesgut District of Ankara. There were 5 classes at this grade level in the school. There were two teachers responsible for teaching elementary grade 6 science and technology course; one of them was instructing two of the classes (A, and B), the other one was instructing the last three classes (C, D, and E).

The researcher explained the teachers about the aim of the present research study and guided (teacher-directed) inquiry treatment at the beginning of the academic year and before the lessons. Moreover, the researcher instructed both teachers on how they would implement the guided (teacher-guided) inquiry treatment by giving the related lesson plans and activity sheets to them before the class. Sometimes the researcher only gave verbal instruction to the teachers on what they would do in the class. The researcher also helped the teachers during their implementation of the method by serving as a model to the teachers for the future implementation of the treatment to the other class(es) and other guided (teacher-directed)

inquiry activities. Sometimes the researcher worked as co-teacher in the class and assisted to the teacher and students. The teachers gave the guided (teacher-directed) inquiry instruction to the students in the classroom or school laboratory according to the preferences of the teachers to use either class or laboratory. The following paragraph gives an overview on how guided (teacher-directed) inquiry treatment was implemented with a sample activity, which was used in the experimental group in the Reproduction, Development, and Growth in Living Things unit.

After revising the previous lesson on reproduction on flowering plants with the students, the teacher inform the students that the present lesson is an inquiry activity based on what they already know about this topic.

The teacher asks the research question “Is there a relationship between fruit size and number of seed?” either verbally and by writing it to the white-board. The students give their responses.

The teacher informs the students that they as a group will be using the activity sheets for their inquires. The teacher hands out the activity sheets to the student groups and wants them to follow the steps outlined in the paper. The teacher wants the students give answers to her questions verbally and then write their responses to the related fields after the whole class replied the question she asks. She further clarifies that one group member or all of the members of the group can write the answer to the worksheet.

The teacher helps the students to form hypotheses on this relationship, and writes the hypothesis statements on the board. She then determines the independent, dependent and controlled variables with the students. The teacher asks over the students how they can study to understand the relationship between the size of a fruit and the number of its seeds. After listening the students’ answers, the teacher writes the summaries of the students’ proposed methodology on the board. She then requests the names of the instruments to be used for the study from the students. The teacher then asks the students which data they should collect and record. Furthermore she asks how the students will control bias in the measurements which may result from the instrument used, and the data collector and recorder. The teacher writes the required information on these steps on the board too.

The teacher gives the materials the students will use during their inquiries. She gives enough time to the students for data collection, recording, and analysis. She helps the student groups during this process, for example on their determination of the variable to be measured, writing of measurement units correctly, and recording and analysing data in the correct form.

After giving enough time to the students for their inquiries, the teacher asks the student groups what they find, whether their hypotheses are failed to reject or rejected. The teacher wants the groups to make conclusions by using their previous knowledge and the books, especially their own textbooks. Furthermore she asks the students to explain the terminology they used during this activity.

The teacher poses the students that what they would like to study further and the things they should consider for their future studies. She then asks the students to relate what they learned from this activity with the ones they learned from other subject areas.

3.6 Analysis of Data

General Linear Model Repeated Measures (repeated analysis of variance) design was used in analyzing the experimental data to answer if guided (teacher-directed) inquiry affected students' acquisition of science process skills, achievement in unit tests, and attitudes toward science and technology course subtests, and if guided (teacher-directed) inquiry interacts with time. This analysis was performed after checking it for the assumptions such as equal variances (Højsgaard & Jørgensen, 2001).

The independent variable is the method of instruction; the dependent variables are students' science process skills, achievement, and attitudes toward science and technology course. Students' science process skills were measured by the science process skills test. Students' achievement was measured by two unit achievement tests. Students' attitudes were measured by the attitudes toward science and technology course questionnaire.

Separate repeated analyses of variances (ANOVAs) were conducted to find any significant difference between the experimental and control classes with respect to achievement and science process skills. On the other hand, a repeated multivariate analysis of variance (MANOVA) on the subtests of attitudes toward science and technology course was performed in order to detect any significant differences between the experimental and

control groups. Then separate repeated analyses of variances (ANOVAs) were conducted to find any significant difference between the experimental and control classes with respect to academic self-concept, anxiety, interest, career, enjoyment, and usefulness dimensions. The level of confidence was set at .05. The analyses were conducted by using the Statistical Package for the Social Sciences (SPSS) Version 15.0 for Windows computer program.

CHAPTER 4

RESULTS

The results of the data analysis will be given in this part. First the descriptive statistics regarding both experimental and control group students' scores in achievement tests, science process skills tests, and attitudes toward science and technology course questionnaire and its subtests will be given in terms of means, and standard deviations. Then the inferential statistics will be presented to determine the effect of instruction on these outcomes.

4.1 Descriptive Statistics

This part is devoted to give information about the descriptive statistics of the student performances on the unit achievement tests, science process skills tests, and attitudes toward science and technology course questionnaire.

Table 4.1 shows the means and standard deviations of students' performances on Reproduction, Development and Growth in Living Things (RDGLT) and Force and Motion (FM) Unit Achievement Tests. As the table suggests, the mean of the students' scores on the Reproduction, Development, and Growth in Living Things Unit Achievement Tests were medium when considering its total number of questions and correspondingly the maximum score that can be taken from the test, which is 25. Both experimental and control group students' mean scores in the pre test were similar (10.72 versus 10.55). After the instruction on the unit, the mean scores of both groups were increased in the post test (12.83 for the experimental whereas 11.34 for the control group), especially that of the experimental group. Then on the retention test, both groups' mean scores on the Reproduction, Development, and Growth in Living Things Unit Achievement Test were decreased (11.47 for the experimental whereas 9.72 for the control group), especially that of the control group. On the other hand, the mean of the students' scores on the Force and Motion Unit Achievement Tests were low when considering its total number of questions and correspondingly the maximum score that

can be taken from the test, which are 34. Both experimental and control group students' mean scores in the pre test were similar (11.00 versus 11.22). After the instruction on the unit, the mean scores of both groups were decreased in the post test (10.22 for the experimental whereas 8.07 for the control group), especially that of the control group. Then on the retention test, both groups' mean scores on the Force and Motion Unit Achievement Test were increased (13.23 for the experimental whereas 11.87 for the control group), especially that of the experimental group.

Table 4.1 Means and standard deviations of the students' scores on the achievement tests

Variable	Group	Mean	Std. Deviation	N
RDGLT 1	1	10.72	3.886	86
	2	10.55	3.349	82
	Total	10.64	3.624	168
RDGLT 2	1	12.83	4.380	86
	2	11.34	4.522	82
	Total	12.10	4.498	168
RDGLT 3	1	11.47	4.972	86
	2	9.72	4.717	82
	Total	10.61	4.914	168
FM 1	1	11.00	5.062	86
	2	11.22	4.792	82
	Total	11.11	4.919	168
FM 2	1	10.22	5.639	86
	2	8.07	4.648	82
	Total	9.17	5.274	168
FM 3	1	13.23	5.873	86
	2	11.87	5.447	82
	Total	12.57	5.693	168

Note: The abbreviations mean the following (according to time and alphabetic order):
RDGLT: Reproduction, Development and Growth in Living Things Unit Achievement Test
RDGLT 1: Pre RDGLT
RDGLT 2: Post RDGLT
RDGLT 3: Delayed RDGLT
FM: Force and Motion Unit Achievement Test
FM 1: Pre FM
FM 2: Post FM
FM 3: Delayed FM
Group 1: Experimental Group
Group 2: Control Group

Table 4.2 shows the means and standard deviations of students' performances on Science and Process Skills Tests. As the table suggests, the mean of the students' scores on the Science Process Skills Tests were low when considering the percentage value of each item and correspondingly the maximum score that can be taken from the test, which is 1 (the only exception was the mean scores of the experimental group students on the second science process skills test, which can be regarded as medium). Both experimental and control group

students' mean scores in the pre test were similar (.319 versus .338). After the instruction on the Reproduction, Development, and Growth in Living Things unit, the mean scores of both groups were increased in the second test (.467 for the experimental whereas 1.352 for the control group), especially that of the experimental group. After the instruction on the Force and Motion unit, the mean scores of the experimental group students were decreased to .392, whereas the mean scores of the control group students were increased to .355 in the third test. Then on the retention test, both groups' mean scores on the science process skills test were decreased (.385 for the experimental whereas .354 for the control group).

Table 4.2 Means and standard deviations of the students' scores on the science process skills tests

Variable	Group	Mean	Std. Deviation	N
SPS 1	1	.319	.157	86
	2	.338	.155	82
	Total	.328	.156	168
SPS 2	1	.467	.157	86
	2	.352	.145	82
	Total	.411	.162	168
SPS 3	1	.392	.154	86
	2	.355	.124	82
	Total	.374	.141	168
SPS 4	1	.385	.147	86
	2	.354	.130	82
	Total	.370	.139	168

Note: The abbreviations mean the following (according to time and alphabetic order):
SPS: Science Process Skills Test
SPS 1: The First SPS
SPS 2: The Second SPS
SPS 3: The Third SPS
SPS 4: The Fourth SPS
Group 1: Experimental Group
Group 2: Control Group

Table 4.3 shows the means and standard deviations of students' performances on the self-concept, anxiety, interest, career, enjoyment, and usefulness attitudes toward science and technology course subtests. Table 4.3 suggests the following:

1. The mean of the students' scores on the Self-Concept subtest were high when considering the number of response alternatives in the attitude scale and correspondingly the maximum score that can be taken from the subtest, which is 5. Both experimental and control group students' mean scores in the first self-concept subtest were similar (4.13 versus 4.21). After

the instruction on the Reproduction, Development, and Growth in Living Things unit, the mean self-concept subtest scores of both groups were increased in the second test (4.29 for the experimental whereas 4.34 for the control group). After the instruction on the Force and Motion unit, the mean self-concept subtest scores of the experimental group students were increased to 4.57, and the mean scores of the control group students were increased to 4.39. Then on the retention self-concept subtest, both groups' mean scores on the self-concept subtest were decreased (4.45 for the experimental whereas 4.38 for the control group).

2. The mean of the students' scores on the anxiety subtest were medium when considering the number of response alternatives in the attitude scale and correspondingly the maximum score that can be taken from the subtest, which are 5. Both experimental and control group students' mean scores in the first anxiety subtest were similar (3.64 versus 3.78). After the instruction on the Reproduction, Development, and Growth in Living Things unit, the mean anxiety subtest scores of the experimental group students were increased when the mean anxiety subtest scores of the control group students were decreased (3.65 for the experimental whereas 3.47 for the control group). After the instruction on the Force and Motion unit, the mean anxiety subtest scores of both groups decreased (3.37 versus 2.84). Then on the retention anxiety subtest, both groups' mean scores on the anxiety subtest were decreased (3.59 for the experimental whereas 3.32 for the control group).

3. The mean of the students' scores on the interest subtest were high when considering the number of response alternatives in the attitude scale and correspondingly the maximum score that can be taken from the subtest, which are 5. Both experimental and control group students' mean scores in the first anxiety subtest were similar (3.98 versus 4.20). After the instruction on the Reproduction, Development, and Growth in Living Things unit, the mean interest subtest scores of both group students were increased (4.09 for the experimental whereas 4.27 for the control group). After the instruction on the Force and Motion unit, while the mean interest subtest scores of the experimental group increased, those of the control group decreased to 4.41, and 4.14 respectively. Then on the retention interest subtest, both groups' mean scores on the interest subtest were increased (4.42 for the experimental whereas 4.20 for the control group).

4. The mean of the students' scores on the career subtest were high when considering the number of response alternatives in the attitude scale and correspondingly the maximum score that can be taken from the subtest, which is 5. Both experimental and control group students'

mean scores in the first career subtest were similar (4.09 versus 4.24). After the instruction on the Reproduction, Development, and Growth in Living Things unit, the mean career subtest scores of both groups were increased in the second test (4.31 for the experimental whereas 4.27 for the control group). After the instruction on the Force and Motion unit, the mean career subtest scores of the experimental group students were increased to 4.42, whereas the mean scores of the control group students were decreased to 4.16. Then on the retention career subtest, while the mean scores of the experimental group decreased, the mean scores of the control group increased (4.37 for the experimental whereas 4.28 for the control group).

5. The mean of the students' scores on the enjoyment subtest were high when considering the number of response alternatives in the attitude scale and correspondingly the maximum score that can be taken from the subtest, which are 5. Both experimental and control group students' mean scores in the first enjoyment subtest were similar (4.23 versus 4.34). After the instruction on the Reproduction, Development, and Growth in Living Things unit, the mean enjoyment subtest scores of the experimental group students were increased when the mean enjoyment subtest scores of the control group students were decreased (4.38 for the experimental whereas 4.30 for the control group). After the instruction on the Force and Motion unit, the mean enjoyment subtest scores of the experimental group students were increased when the mean enjoyment subtest scores of the control group students were decreased (4.53 versus 4.17). Then on the retention enjoyment subtest, both groups' mean scores on the enjoyment subtest were increased (4.55 for the experimental whereas 4.43 for the control group).

6. The mean of the students' scores on the usefulness subtest were high when considering the number of response alternatives in the attitude scale and correspondingly the maximum score that can be taken from the subtest, which are 5. Both experimental and control group students' mean scores in the first usefulness subtest were similar (4.25 versus 4.46). After the instruction on the Reproduction, Development, and Growth in Living Things unit, the mean usefulness subtest scores of the experimental group students were increased but the mean usefulness subtest scores of the control group students were remained same (4.48 for the experimental whereas 4.46 for the control group). After the instruction on the Force and Motion unit, while the mean usefulness subtest scores of the experimental group increased, those of the control group decreased to 4.64, and 4.29 respectively. Then on the retention usefulness subtest, while the mean scores of the experimental group students were decreased,

the mean usefulness subtest scores of the control group students were increased (4.53 for the experimental whereas 4.35 for the control group).

Table 4.3 Means and standard deviations of the students' scores on the attitudes subtests

Variable	Group	Mean	Std. Deviation	N
Self-Concept 1	1	4.1308	.56974	86
	2	4.2104	.58197	82
	Total	4.1696	.57539	168
Self-Concept 2	1	4.2907	.62292	86
	2	4.3415	.58599	82
	Total	4.3155	.60390	168
Self-Concept 3	1	4.5698	.56315	86
	2	4.3872	.61508	82
	Total	4.4807	.59438	168
Self-Concept 4	1	4.4507	.62292	86
	2	4.3841	.65522	82
	Total	4.4643	.64179	168
Anxiety 1	1	3.6421	.90979	86
	2	3.7764	.80209	82
	Total	3.7077	.85899	168
Anxiety 2	1	3.6460	.95695	86
	2	3.4743	1.01746	82
	Total	3.5622	.98774	168
Anxiety 3	1	3.3708	1.18876	86
	2	2.8388	1.06017	82
	Total	3.1111	1.15182	168
Anxiety 4	1	3.5917	1.16876	86
	2	3.3238	1.04293	82
	Total	3.4610	1.11394	168
Interest 1	1	3.9826	.73743	86
	2	4.2043	.79943	82
	Total	4.0908	.77403	168
Interest 2	1	4.2791	.59337	86
	2	4.1921	.64226	82
	Total	4.2366	.61740	168
Interest 3	1	4.4128	.69321	86
	2	4.1402	.87409	82
	Total	4.2798	.79614	168
Interest 4	1	4.4186	.73007	86
	2	4.2043	.66797	82
	Total	4.3140	.70658	168
Career 1	1	4.0901	.67618	86
	2	4.2378	.58122	82
	Total	4.1622	.63407	168
Career 2	1	4.3140	.64190	86
	2	4.2744	.60935	82
	Total	4.2846	.62467	168
Career 3	1	4.4215	.63739	86
	2	4.1646	.83723	82
	Total	4.2961	.75057	168
Career 4	1	4.3663	.62860	86
	2	4.2835	.69806	82
	Total	4.3259	.66271	168

Table 4.3 (Cont'd)

Variable	Group	Mean	Std. Deviation	N
Enjoyment 1	1	4.2267	.68560	86
	2	4.3445	.63785	82
	Total	4.2842	.66337	168
Enjoyment 2	1	4.3857	.67812	86
	2	4.2988	.57794	82
	Total	4.3423	.63077	168
Enjoyment 3	1	4.5320	.60609	86
	2	4.1677	.83523	82
	Total	4.3542	.74746	168
Enjoyment 4	1	4.5465	.65250	86
	2	4.4329	.68273	82
Usefulness 1	1	4.2488	.55471	86
	2	4.4561	.53173	82
	Total	4.3500	.55186	168
Usefulness 2	1	4.4837	.51924	86
	2	4.4610	.51801	82
	Total	4.4726	.51721	168
Usefulness 3	1	4.6442	.53261	86
	2	4.2878	.76018	82
	Total	4.4702	.67572	168
Usefulness 4	1	4.5326	.71397	86
	2	4.3537	.76871	82
	Total	4.4452	.74438	168

Note: The abbreviations mean the following (according to time and alphabetic order):
1: The First Subtest
2: The Second Subtest
3: The Third Subtest
4: The Fourth Subtest
Group 1: Experimental Group
Group 2: Control Group

4.2 Inferential Statistics

This part is intended to give information on the results of inferential statistics. For the first hand, the result of groups' equivalency in socio-economic status (ses) variables will be given. The following parts are devoted to the results of the testing null hypothesis via GLM Repeated Measures analysis. In this part, first the results on achievement will take place. Then the findings will be presented along with the tests for science process skills. This part will end with the findings on the overall attitude test and then results will be given for each sub test.

4.2.1 The Results of the Analysis on the Differences between Experimental and Control Group Students' Socio-Economic Status Variables

Socio-economic status is an important confounding variable that should be considered in interpreting the results of experimental studies. In order to give evidence to the experimental and control groups' equivalency in terms of socio-economic status, students' responses to related socio-economic status items in the demographic form were analysed with exploratory factor analysis. Two factors were found with this analyses, Wealth, and Impact of Mother. After saving the regression factor scores of these two variables, the index values for wealth and impact of mother variables were found. And these values were used in the analysis comparing if there was difference among the groups when considering the means (The results of these analyses can be found in the Appendix G).

Independent Samples t-test was done to compare experimental and control groups with respect to the index values of the first two socio-economic status (ses) variables (The results of the analyses on the assumptions can be found in the Appendix H). Table 4.5 shows the results of independent t-test which was applied to find if there is a difference between the experimental and control group students with respect to the mean socio-economic status index.

Table 4.4 Result of independent t-test showing the differences between the experimental and control groups mean scores on wealth and impact of mother indices

	Group	N	Mean	SD	t	df	p
REGR factor score 1 for analysis 1	1	64	-,0202214	,95172343	-.225	129	.822
	2	67	,0193160	1,05086436			
REGR factor score 2 for analysis 1	1	64	-,1449165	,95444092	-1.631	129	.105
	2	67	,1384277	1,02972311			

Note: The data show the values for equal variances assumed

As the Table 4.4 suggests, independent t-test failed to reveal a statistically significant difference between (1) the means of the experimental (X = -.02, s = .95) and control (X = -.14, s = .95) groups on the wealth index, t (129) = -.225, p = .822, α = .05, and (2) the means of the experimental (X = -.14, s = .95) and control (X = -.14, s = .95) groups on the impact of

mother index, t (129) = -1.63, p = .105, α = .05. These results mean that their corresponding population distributions also do not differ.

4.2.2 The Results of the Effect of Teacher-Guided Inquiry vs. Traditional Instruction on Students' Achievement, Science Process, and Attitudes toward Science and Technology Lesson

This part shows the results of the GLM Repeated Measures analyses that were used in testing the null hypotheses regarding the effect of teacher-directed inquiry on some academic outcomes (in order to save space, the analyses used in checking the assumptions of GLM repeated measures analyses are given in Appendix H) .

In order to find the effect of instruction on students' achievement, science process and attitudes toward science and technology course, first the students who took all the tests repeatedly were determined. The number of these students was 168. Missing data analysis was done only for attitude questionnaire, because some students did not rated all the questionnaire items. The analysis result showed that missing ratio (coded as 0) ranged from .6 to 4.8 in percentage. The missings were replaced with the mode value in general, in one case when there were two modes (bimodal distribution) the missing was replaced with the one that close to 3 (see Appendix E for missings).

4.2.2.1 The Results of the Effect of Teacher-Guided Inquiry vs. Traditional Instruction on Students' Achievement

This part shows the GLM Repeated Measures ANOVA results for two hypotheses to be tested: one for achievement in "Reproduction, Development and Growth in Living Things" unit and the other is for "Force and Motion" unit.

4.2.2.1.1 The Results of the Effect of Teacher-Guided Inquiry vs. Traditional Instruction on Students' Achievement in Reproduction, Development and Growth in Living Things Unit

H_0: There is no statistically significant effect between teacher-guided inquiry and traditional instruction on the population means of the 6^{th} grade students' "Reproduction, Growth, and Development in Living Things" unit achievement test scores.

In order to test this null hypothesis, within-subjects effect test results are used. The interaction between the within subject variable (achievement in "Reproduction, Growth, and Development in Living Things" unit) and between subjects variable (group) is considered.

Table 4.5 Result of glm repeated anova for the students' scores on the reproduction, development and growth in living things unit achievement tests

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Between-subjects	2228,92	167						
group	53.975	1	53.975	4.120	.044	0.24	4.120	.523
Error	2174.945	166	13.102					
Within-subjects	3159,238	336						
rdglt	242.015	2	121.007	14.059	.000	0.78	28.118	.999
rdglt* group	**59.682**	**2**	**29.841**	**3.467**	**.032**	**0.20**	**6.934**	**.647**
Error (rdglt)	2857.541	332	8.607					
Total	5388,158	503						

a. Computed using alpha= .05
Note: The data show the values for sphericity assumed

As the Table 4.5 suggests, there was a significant interaction effect between Reproduction, Development and Growth in Living Things achievement tests and instruction on students' scores, F (2, 332) = 3.47. In other words, Reproduction, Development and Growth in Living Things achievement test scores of both experimental and control group students showed a significant difference from the beginning of instruction to the end and retention. While the experimental group increased their scores by 2.11 from pre-test (X = 10.72) to post-test (X = 12.83) and decreased their scores by 1.36 to retention test (X = 11.47), control group increased their scores by .79 from pre-test (X = 10.55) to post-test (X = 11.34) and decreased their scores by 1.62 to retention test (X = 9.72). Also, the treatment accounted for 20% of the variance in the Development and Growth in Living Things Achievement Test change scores.

Table 4.6 Result of tests of within-subjects contrasts for the students' scores on the reproduction, development and growth in living things unit achievement tests

Source RDGLT	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
rdglt								
Level 1 vs. Level 2	352.371	1	352.371	23.977	.000	.126	23.977	.998
Level 2 vs. Level 3	373.370	1	373.370	20.721	.000	.111	20.721	.995
rdglt*group								
Level 1 vs. Level 2	72.252	1	72.252	4.916	.028	.029	4.916	.597
Level 2 vs. Level 3	2.870	1	2.870	.159	.690	.001	.159	.068
Error(rdglt)								
Level 1 vs. Level 2	2439.534	166	14.696					
Level 2 vs. Level 3	2991.106	166	18.019					

a. Computed using alpha = .05

The Table 4.6 revealed that students' scores on the post-Reproduction, Development and Growth in Living Things achievement test were significantly higher than the pre-test in the experimental group (F (1, 166) = 4.92, r =.17). On the other hand students' scores on the delayed-Reproduction, Development and Growth in Living Things achievement test were not significant than those on post-test in the experimental group (F (1, 166) = .16, r =.03).

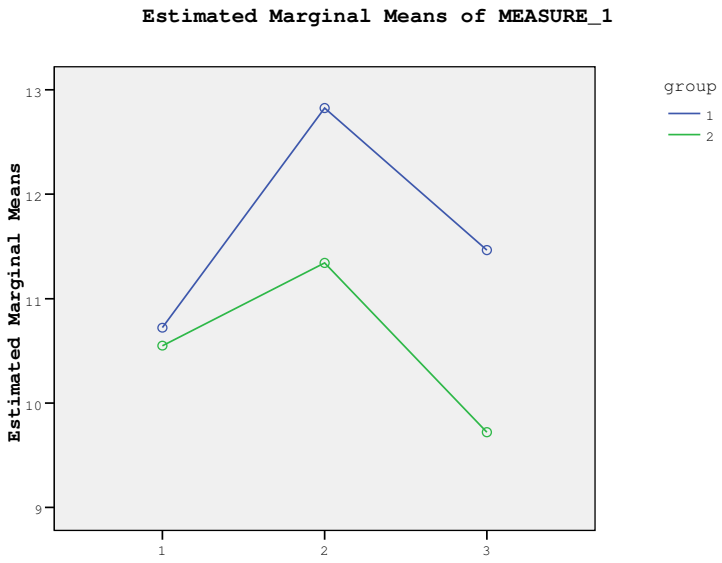


Figure 4.1 Profile plot for the students' scores on the reproduction, development and growth in living things unit achievement tests

Looking at the interaction graph, this effect reflects that instruction (treatment) increased post- Reproduction, Development and Growth in Living Things achievement test scores significantly more in the experimental group than it did for the control group. All of the groups' scores decreased in the retention test.

4.2.2.1.2 The Results of the Effect of Teacher-Guided Inquiry vs. Traditional Instruction on Students' Achievement in Force and Motion Unit

H_0: There is no statistically significant effect between teacher-guided inquiry and traditional instruction on the population means of the 6th grade students' "Force and Motion" unit achievement test scores.

In order to test this null hypothesis, within-subjects effect test results are used. The interaction between within subject variable (achievement in "Force and Motion" unit) and between subjects variable (group) is considered.

Table 4.7 Result of glm repeated anova for the students' scores on the force and motion unit achievement tests

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Between-subjects	2228,92	167						
group	50.636	1	50.636	3.066	.082	0.18	3.066	.413
Error	2741.584	166	16.516					
Within-subjects	3159,238	336						
fm	979.382	2	489.691	29.029	.000	.149	58.058	1.000
fm*group	**122.152**	**2**	**61.076**	**3.621**	**.028**	**0.21**	**7.241**	**.667**
Error (fm)	5600.534	332	16.869					
Total	5388,158	499						

a. Computed using alpha= .05

Note: The data show the values for sphericity assumed

There was a significant interaction effect between Force and Motion achievement tests and instruction on students' scores, F (2, 332) = 3.621. In other words, Force and Motion achievement test scores of both experimental and control group students showed a significant difference from the beginning of instruction to the end and retention. While the experimental group decreased their scores by 0.78 from pre-test (X = 11.00) to post-test (X = 10.22) and increased their scores by 3.01 to retention test (X = 13.23), control group

increased their scores by 3.15 from pre-test (X = 11.22) to post-test (X = 8.07) and increased their scores by 3.8 to retention test (X = 11.87). Also, the treatment accounted for 21% of the variance in the Force and Motion Achievement Test change scores.

Table 4.8 Result of tests of within-subjects contrasts for the students' scores on the force and motion unit achievement tests

Source fm	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
fm								
Level 1 vs. Level 2	646.805	1	646.805	18.006	.000	.098	18.006	.988
Level 2 vs. Level 3	1943.441	1	1943.441	55.561	.000	.251	55.561	1.000
fm*group								
Level 1 vs. Level 2	235.234	1	235.234	6.548	.011	.038	6.548	.720
Level 2 vs. Level 3	25.607	1	25.607	.732	.393	.004	.732	.136
Error(fm)								
Level 1 vs. Level 2	5963.046	166	35.922					
Level 2 vs. Level 3	5806.464	166	34.979					

a. Computed using alpha = .05

The Table 4.8 revealed that students' scores on the post-Force and Motion achievement test were significantly higher than the pre-test in the experimental group (F (1, 166) = 6.548, r =.19). On the other hand students' scores on the delayed- Force and Motion achievement test were not significant than those on post-test in the experimental group (F (1, 166) = .732, r =.07).

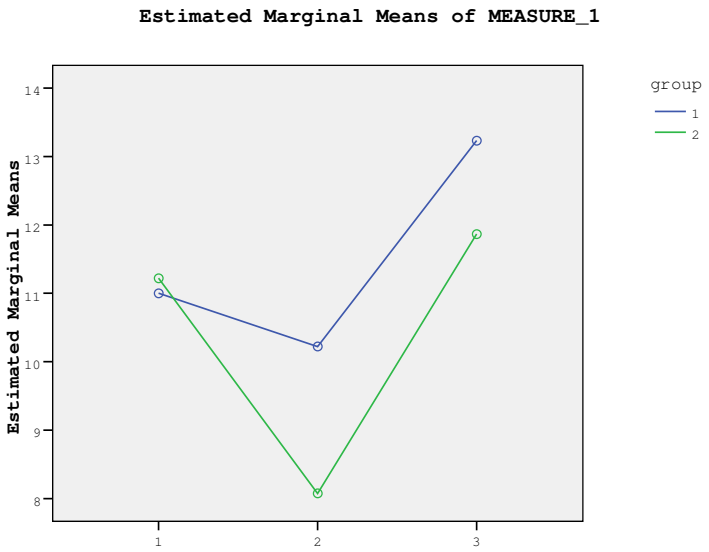


Figure 4.2 Profile plot for the students' scores on the force and motion unit achievement tests

Looking at the interaction graph, this effect reflects that instruction (treatment) decreased post-Force and Motion achievement test scores significantly less in the experimental group than it did for the control group. All of the groups' scores increased in the retention test.

4.2.2.2 The Results of the Effect of Teacher-Guided Inquiry vs. Traditional Instruction on Students' Science Process Skills

H_0: There is no statistically significant effect between teacher-guided inquiry and traditional instruction on the population means of the 6th grade students' "Science Process Skills Test" scores.

In order to test this null hypothesis, within-subjects effect test results are used. The interaction between within subject variable (achievement in the "Science and Process Skills" test) and between subjects variable (group) is considered.

Table 4.9 Result of glm repeated anova for the students' scores on the science process skills tests

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Between-subjects	2.080	167						
group	.070	1	.070	5.822	.017	0.34	5.822	.670
Error	2.010	166	.012					
Within-subjects	7,243	491,77						
sps	.557	2.927	.190	14.667	.000	.081	42.934	1.000
sps* group	**.388**	**2.927**	**.133**	**10.229**	**.000**	**.058**	**29.941**	**.998**
Error (sps)	6.298	485.916	.013					
Total	9,323	658,77						

a. Computed using alpha= .05
Note: Data show the values for Huynh-Feldt estimate of sphericity

There was a significant interaction effect between Science Process Skills tests and instruction on students' scores, F (2.93, 485.92) = 10.23. In other words, Science Process Skills test scores of both experimental and control group students showed a significant difference from the beginning of instruction to the end and retention. The experimental group increased their scores by 0.148 from the first test (X = .319) to the second test (X = .467), and decreased their scores by 0.075 to the third test (X = .392), and by 0.007 to the fourth test (X = .385). On the other hand, the control group increased their scores by 0.014 from the first test (X = .338) to the second test (X = .352), and by 0.003 to the third test (X = .355), and decreased by 0.001 to the fourth test (X = .354). Also, the treatment accounted for 5.8% of the variance in the Science Process Skills Test change scores.

Table 4.10 Result of tests of within-subjects contrasts for the students' scores on the science process skills tests

Source sps	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
sps								
Level 1 vs. Level 2	1.109	1	1.109	40.700	.000	.197	40.700	1.000
Level 2 vs. Level 3	.222	1	.222	7.872	.006	.045	7.872	.797
Level 3 vs. Level 4	.003	1	.003	.110	.740	.001	.110	.063
sps*group								
Level 1 vs. Level 2	.758	1	.758	27.835	.000	.144	27.835	.999
Level 2 vs. Level 3	.260	1	.260	9.220	.003	.053	9.220	.855
Level 3 vs. Level 4	.001	1	.001	.048	.828	.000	.048	.055
Error(sps)								
Level 1 vs. Level 2	4.522	166	.027					
Level 2 vs. Level 3	4.688	166	.028					
Level 3 vs. Level 4	3.944	166	.024					

a. Computed using alpha = .05

The Table 4.10 revealed that students' scores on the second Science Process Skills test were significantly higher than the first test in the experimental group (F (1, 166) = 27.83, r =.38). Additionally students' scores on the third Science Process Skills test were significantly lower than the second test in the experimental group (F (1, 166) = 9.22, r =.22). On the other hand students' scores on the fourth Science Process Skills test were not significant than those on third test in the experimental group (F (1, 166) = .048, r =.02).

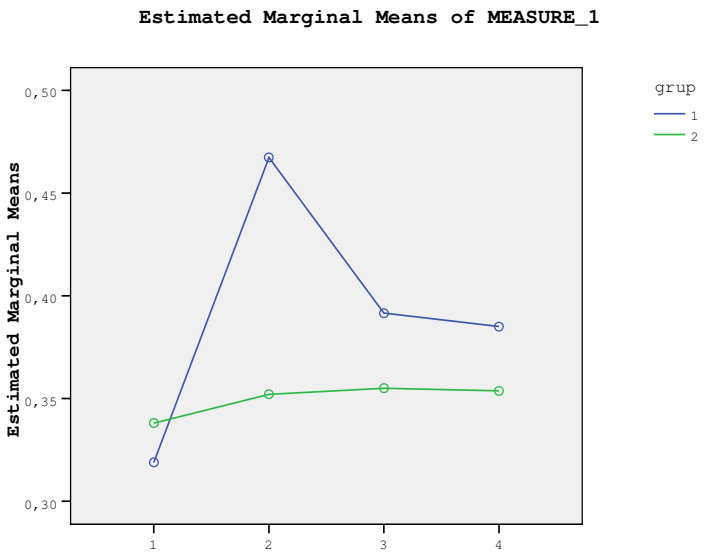


Figure 4.3 Profile plot for the students' scores on the science process skills tests

Looking at the interaction graph, this effect reflects that instruction (treatment) first increased, and then decreased the second and third Science Process Skills test scores significantly more in the experimental group than it did for the control group. All of the groups' scores decreased in the retention test.

4.2.2.3 The Results of the Effect of Teacher-Guided Inquiry vs. Traditional Instruction on Students' Attitudes toward Science and Technology Lesson

H_0: There is no statistically significant effect between teacher-guided inquiry and traditional instruction on the population means of the 6th grade students' "Attitudes toward Science & Technology Course Questionnaire" scores.

In order to test this null hypothesis, within-subjects effect test results are used. The interaction between within subject variables (time and attitudes) and between subjects variable (group) is considered.

Table 4.11 Result of glm repeated anova for the students' scores on the attitudes toward science and technology questionnaires

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Between-subjects	164.602	167						
group	2.573	1	2.573	2.636	.106	.016	2.636	.365
error	162.029	166	.976					
Within-subjects	1324.941	825.681						
att	444.497	2.261	196.563	148.206	.000	.472	335.146	1.000
att*group	**2.759**	**2.261**	**1.220**	**.920**	**.409**	**.006**	**2.080**	**.221**
error(att)	497.864	375.384	1.326					
time	8.056	2.814	2.863	3.919	.010	.023	11.029	.810
time*group	**30.562**	**2.814**	**10.860**	**14.869**	**.000**	**.082**	**41.843**	**1.000**
error(time)	341.203	467.147	.730					
Total	1489.543	1019.681						

a. Computed using alpha= .05
Note: Data show the values of Greenhouse-Geisser estimate of sphericity for att, and Huynh-Feldt estimate of sphericity for time.

There was a significant interaction effect between time and instruction on students' scores, F (2.81, 467.15) = 14.87. In other words, attitude subtests scores of both experimental and control group students showed a significant difference from the beginning of instruction to

the end and retention. The experimental group increased their scores by 0.18 from the first test (X = 4.05) to the second test (X = 4.23), by 0.09 to the third test (X = 4.32), and by 0.01 to the fourth test (X = 4.16). On the other hand, the control group decreased their scores by 0.03 from the first test (X = 4.20) to the second test (X = 4.17), and by 0.18 to the third test (X = 4.00), and increased by 0.17 to the fourth test (X = 4.38). Also, the treatment accounted for 8.2% of the variance in the attitudes change scores.

Table 4.12 Result of tests of within-subjects contrasts the students' scores on the attitudes toward science and technology questionnaires

Source self	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
time								
Level 1 vs. Level 2	5.522	1	5.522	4.413	.037	.026	4.413	.551
Level 2 vs. Level 3	1.761	1	1.761	1.618	.205	.010	1.618	.244
Level 3 vs. Level 4	7.588	1	7.588	6.376	.013	.037	6.376	.709
time*group								
Level 1 vs. Level 2	11.169	1	11.169	8.925	.003	.051	8.925	.844
Level 2 vs. Level 3	18.123	1	18.123	16.650	.000	.091	16.650	.982
Level 3 vs. Level 4	6.324	1	6.324	5.314	.022	.031	5.314	.630
Error(time)								
Level 1 vs. Level 2	207.733	166	1.251					
Level 2 vs. Level 3	180.683	166	1.088					
Level 3 vs. Level 4	197.532	166	1.190					

a. Computed using alpha = .05

The Table 4.12 revealed that the students' scores on the second subtests were significantly higher than the first subtests in the experimental group (F (1, 166) = 8.92, r =.22). Moreover, the students' scores on the third subtests were significantly higher than the second subtests in the experimental group (F (1, 166) = 16.65, r =.30). On the other hand the students' scores on the fourth attitude subtests were significantly higher than those on the third attitude subtests in the control group (F (1, 166) = 5.314, r =.18).

4.2.2.3.1 The Results of the Effect of Teacher-Guided Inquiry vs. Traditional Instruction on Students' Self-Concept Attitudes toward Science and Technology Lesson

H_0: There is no statistically significant effect between teacher-guided inquiry and traditional instruction on the population means of the 6th grade students' "Self-Concept Attitudes toward Science & Technology Course Questionnaire" scores.

In order to test this null hypothesis, within-subjects effect test results are used. The interaction between within subject variables (self-concept scores) and between subjects variable (group) is considered.

Table 4.13 Result of glm repeated anova for the students' scores on the self-concept subtests

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Between-subjects	31,937	167						
group	.114	1	.114	.597	.441	.004	.597	.120
error	31.823	166	.192					
Within-subjects	126,692	504						
self	10.460	2.920	3.582	15.246	.000	.084	44.517	1.000
self*group	**2.344**	**2.920**	**.803**	**3.417**	**.018**	**.020**	**9.977**	**.760**
Error	113.888	484.723	.235					
Total	158,629	671						

a. Computed using alpha= .05
Note: Data show the values for Huynh-Feldt estimate of sphericity

There was a significant interaction effects between self-concept subtest scores and instruction on students' scores, F (2.920, 484.723) = 3.417. In other words, self-concept subtests scores of both experimental and control group students showed a significant difference from the beginning of instruction to the end and retention. The experimental group increased their scores by 0.16 from the first test (X = 4.13) to the second test (X = 4.29), and by 0.27 to the third test (X = 4.57), and decreased their scores by 0.03 to the fourth test (X = 4.54). On the other hand, the control group increased their scores by 0.13 from the first test (X = 4.21) to the second test (X = 4.34), and by 0.05 to the third test (X = 4.39), and decreased by 0.01 to the fourth test (X = 4.38). Also, the treatment accounted for 2% of the variance in the Self-Concept change scores.

Table 4.14 Result of tests of within-subjects contrasts the students' scores on the self-concept subtests

Source self	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
self								
Level 1 vs. Level 2	3.554	1	3.554	7.878	.006	.045	7.878	.797
Level 2 vs. Level 3	4.428	1	4.428	12.687	.000	.071	12.687	.943
Level 3 vs. Level 4	.043	1	.043	.104	.747	.001	.104	.062
self*group								
Level 1 vs. Level 2	.035	1	.035	.077	.782	.000	.077	.059
Level 2 vs. Level 3	2.285	1	2.285	6.548	.011	.038	6.548	.720
Level 3 vs. Level 4	.028	1	.028	.068	.794	.000	.068	.058
Error(self)								
Level 1 vs. Level 2	74.892	166	.451					
Level 2 vs. Level 3	57.943	166	.349					
Level 3 vs. Level 4	68.989	166	.416					

a. Computed using alpha = .05

The Table 4.14 revealed that students' scores on the third Self-Concept Subtest were significantly higher than the second test in the experimental group (F (1, 166) = 6.548, r =.93). On the other hand students' scores on the second Self-Concept Subtest were not significant than those on first test in the experimental group (F (1, 166) = .077, r =.26), and students' scores on the fourth Self-Concept Subtest were not significant than those on third test in the experimental group (F (1, 166) = .068, r =.25). However, these contrasts did yield medium effect sizes.

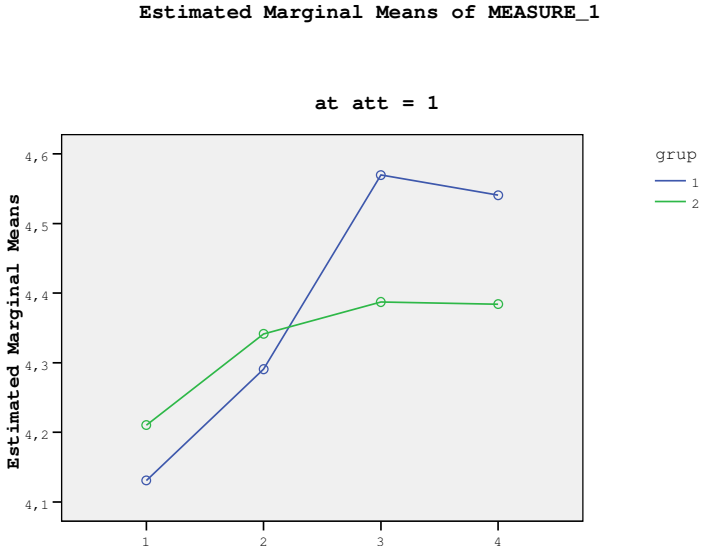


Figure 4.4 Profile plot for the students' scores on the self-concept subtests

Looking at the interaction graph, this effect reflects that instruction (treatment) increased the third Self-Concept Subtest scores significantly more in the experimental group than it did for the control group. All of the groups' scores decreased in the retention test.

4.2.2.3.2 The Effect of Instruction on Students' Anxiety Attitudes toward Science and Technology Course

H_0: There is no statistically significant effect between teacher-guided inquiry and traditional instruction on the population means of the 6th grade students' "Anxiety Attitudes toward Science & Technology Course Questionnaire" scores.

In order to test this null hypothesis, within-subjects effect test results are used. The interaction between within subject variables (anxiety scores) and between subjects variable (group) is considered.

Table 4.15 Result of glm repeated anova for the students' scores on the anxiety subtests

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Between-subjects	104,063	167						
group	1.840	1	1.840	2.987	.086	.018	2.987	.405
error	102.223	166	.616					
Within-subjects	104,063	473,06						
anx	33.301	2.816	11.826	19.118	.000	.103	53.832	1.000
anx*group	**9.532**	**2.816**	**3.385**	**5.472**	**.001**	**.032**	**15.408**	**.927**
Error (anx)	289.154	467.428	.619					
Total	208,126	640,06						

a. Computed using alpha= .05

Note: Data show the values for Huynh-Feldt estimate of sphericity

There was a significant interaction effect between anxiety and group on students' scores, F (2.816, 467.428) = 5.472. In other words, anxiety subtests scores of both experimental and control group students showed a significant difference from the beginning of instruction to the end and retention. The experimental group increased their scores by 0.01 from the first test (X = 3.64) to the second test (X = 3.65), and decreased by 0.27 to the third test (X = 3.37), and increased their scores by 0.22 to the fourth test (X = 3.59). On the other hand, the control group decreased their scores by 0.31 from the first test (X = 3.78) to the second test

(X = 3.47), and by 0.63 to the third test (X = 2.84); and decreased by 0.48 to the fourth test (X = 3.32). Also, the treatment accounted for 3% of the variance in the Anxiety change scores.

Table 4.16 Result of tests of within-subjects contrasts for the students' scores on the anxiety subtests

Source anx	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
anx								
Level 1 vs. Level 2	3.735	1	3.735	3.735	.055	.022	3.735	.485
Level 2 vs. Level 3	34.814	1	34.814	30.869	.000	.157	30.869	1.000
Level 3 vs. Level 4	20.924	1	20.924	22.554	.000	.120	22.554	.997
anx*group								
Level 1 vs. Level 2	3.932	1	3.932	3.932	.049	.023	3.932	.505
Level 2 vs. Level 3	5.449	1	5.449	4.832	.029	.028	4.832	.589
Level 3 vs. Level 4	2.929	1	2.929	3.157	.077	.019	3.157	.423
Error(anx)								
Level 1 vs. Level 2	165.993	166	1.000					
Level 2 vs. Level 3	187.210	166	1.128					
Level 3 vs. Level 4	154.000	166	.928					

a. Computed using alpha = .05

The Table 4.16 revealed that students' scores on the second Anxiety Subtest were significantly lower than the first test in both the experimental group, and control group (F (1, 166) = 3.932, r =.89). Moreover, students' scores on the third Anxiety Subtest were significantly lower than the second test in both the experimental group, and control group (F (1, 166) = 4.832, r =.91). On the other hand students' scores on the fourth Anxiety Subtest were not significant than those on the third test in both the experimental group, and control group (F (1, 166) = 3.157, r =.87). However, these contrasts yielded large effect size.

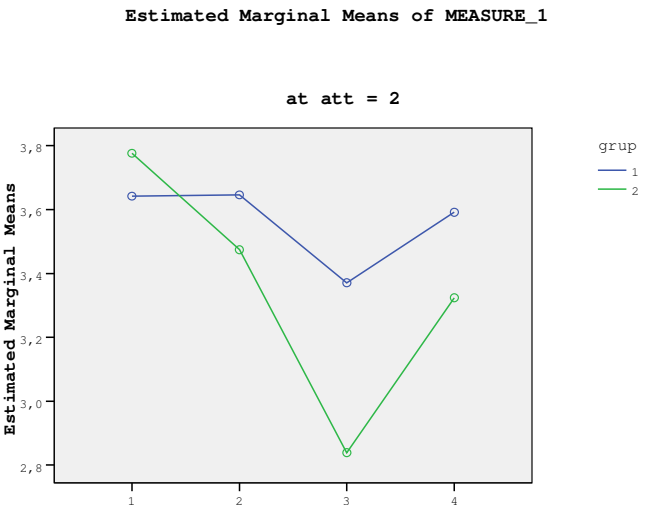


Figure 4.5 Profile plot for the students' scores on the anxiety subtests

Looking at the interaction graph, this effect reflects that instruction significantly decreased both experimental and control group students' scores in the anxiety subtests, however this decline was fewer in the experimental group when compared to the control group. Both groups' increased in the retention test.

4.2.2.3.3 The Effect of Instruction on Students' Interest Attitudes toward Science and Technology Course

H_0: There is no statistically significant effect between teacher-guided inquiry and traditional instruction on the population means of the 6^{th} grade students' "Interest Attitudes toward Science & Technology Course Questionnaire" scores.

In order to test this null hypothesis, within-subjects effect test results are used. The interaction between within subject variables (interest scores) and between subjects variable (group) is considered.

Table 4.17 Result of glm repeated anova for the students' scores on the interest subtests

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Between-subjects	46,188	167						
group	.325	1	.325	1.178	.279	.007	1.178	.190
error	45.863	166	.276					
Within-subjects	172,796	171,274						
int	4.614	2.637	1.750	4.726	.004	.028	12.462	.866
int*group	**6.126**	**2.637**	**2.323**	**6.275**	**.001**	**.036**	**16.545**	**.948**
Error (int)	162.056	437.691	.370					
Total	218,984	338,274						

a. Computed using alpha= .05
Note: Data show the values for Huynh-Feldt estimate of sphericity for interest

There was a significant interaction effect between interest and group on students' interest scores, F (2.637, 437.691) = 6.275. In other words, interest subtests scores of both experimental and control group students showed a significant difference from the beginning of instruction to the end and retention. The experimental group increased their scores by 0.30 from the first test (X = 3.98) to the second test (X = 4.28), by 0.13 to the third test (X = 4.41), by 0.01 to the fourth test (X = 4.42). On the other hand, the control group decreased their scores by 0.01 from the first test (X = 4.20) to the second test (X = 4.19), and by 0.05 to the third test (X = 4.14), and increased by 0.0 to the fourth test (X = 4.20). Also, the treatment accounted for 4% of the variance in the Interest change scores.

Table 4.18 Result of tests of within-subjects contrasts for the students' scores on the interest subtests

Source int	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
int								
Level 1 vs. Level 2	3.393	1	3.393	4.460	.036	.026	4.460	.556
Level 2 vs. Level 3	.282	1	.282	.643	.424	.004	.643	.125
Level 3 vs. Level 4	.205	1	.205	.383	.537	.002	.383	.094
int*group								
Level 1 vs. Level 2	4.000	1	4.000	5.258	.023	.031	5.258	.625
Level 2 vs. Level 3	1.445	1	1.445	3.301	.071	.019	3.301	.439
Level 3 vs. Level 4	.142	1	.142	.266	.607	.002	.266	.081
Error(int)								
Level 1 vs. Level 2	126.302	166	.761					
Level 2 vs. Level 3	72.679	166	.438					
Level 3 vs. Level 4	88.723	166	.534					

a. Computed using alpha = .05

The Table 4.18 revealed that students' scores on the second Interest Subtest were significantly higher than the first test in the experimental group (F (1, 166) = 5.258, r = .84) On the other hand students' scores on the third (F (1, 166) = 3.301, r =.76), and fourth (F (1, 166) = .266, r =.21) Interest Subtests were not significant than those on previous ones in the experimental group. However, these contrasts did yield very large and small effect sizes.

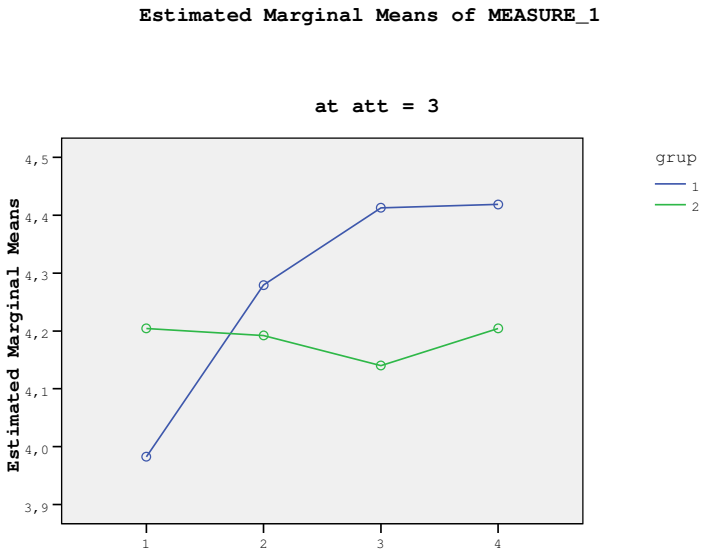


Figure 4.6 Profile plot for the students' scores on the interest subtests

Looking at the interaction graph, this effect reflects that the instruction increased significantly the second Interest subtest scores in the experimental group than it did for the control group. Although this rise continued till the third and fourth implementations of the Interest test, it was not significant. On the other hand, control group students' scores declined till the third test after that it raised.

4.2.2.3.4 The Effect of Instruction on Students' Career Attitudes toward Science and Technology Course

H_0: There is no statistically significant effect between teacher-guided inquiry and traditional instruction on the population means of the 6th grade students' "Career Attitudes toward Science & Technology Course Questionnaire" scores.

In order to test this null hypothesis, within-subjects effect test results are used. The interaction between within subject variables (career scores) and between subjects variable (group) is considered.

Table 4.19 Result of glm repeated anova for the students' scores on the career subtests

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Between-subjects	38,619	167						
group	.141	1	.141	.607	.437	.004	.607	.121
Error	38.478	166	.232					
Within-subjects	147,84	470,246						
career	2.581	2.799	.922	3.022	.033	.018	8.459	.689
career* group	**3.476**	**2.799**	**1.242**	**4.070**	**.009**	**.024**	**11.392**	**.824**
Error (career)	141.783	464.648	.305					
Total	186,459	637,246						

a. Computed using alpha= .05
Note: Data show the values for Huynh-Feldt estimate of sphericity for career

There was a significant interaction effect between career and group on students' scores, F (2.799, 464.648) = 4.070. In other words, career subtests scores of both experimental and control group students showed a significant difference from the beginning of instruction to the end and retention. The experimental group increased their scores by 0.22 from the first test (X = 4.09) to the second test (X = 4.31), and by 0.11 to the third test (X = 4.42), and decreased their scores by 0.06 to the fourth test (X = 4.36). On the other hand, the control group increased their scores by 0.03 from the first test (X = 4.24) to the second test (X = 4.27); and decreased by 0.11 to the third test (X = 4.16); and increased by 0.12 to the fourth test (X = 4.28). Also, the treatment accounted for 2% of the variance in the Interest change scores.

Table 4.20 Result of tests of within-subjects contrasts for the students' scores on the career subtests

Source career	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
career								
Level 1 vs. Level 2	2.847	1	2.847	4.954	.027	.029	4.954	.600
Level 2 vs. Level 3	.000	1	.000	.000	.985	.000	.000	.050
Level 3 vs. Level 4	.170	1	.170	.442	.507	.003	.442	.101
career*group								
Level 1 vs. Level 2	1.472	1	1.472	2.561	.111	.015	2.561	.356
Level 2 vs. Level 3	1.982	1	1.982	3.466	.064	.020	3.466	.457
Level 3 vs. Level 4	1.273	1	1.273	3.304	.071	.020	3.304	.439
Error(career)								
Level 1 vs. Level 2	95.394	166	.575					
Level 2 vs. Level 3	94.955	166	.572					
Level 3 vs. Level 4	63.953	166	.385					

a. Computed using alpha = .05

The Table 4.20 revealed that students' scores on the second (F (1, 166) = 2.561, r =.71), third (F (1, 166) = 3.466, r =.77), and fourth (F (1, 166) = 3.304, r =.76) Career Subtests were not significant in the experimental group. However, these contrasts did yield very large effect sizes.

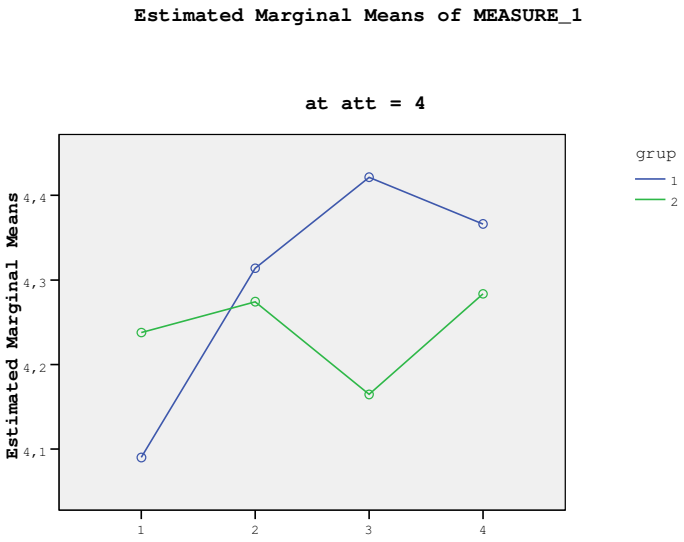


Figure 4.7 Profile plot for the students' scores on the career subtests

Looking at the interaction graph, this effect reflects that instruction increased both group of students' Career scores in the second test, and then while it continued to increase scores in the experimental group, decreased the scores of the control group students in the third test. Finally by the fourth test, experimental group students' scores decreased, while the control group scores increased.

4.2.2.3..5 The Effect of Instruction on Students' Enjoyment Attitudes toward Science and Technology Course

H_0: There is no statistically significant effect between teacher-guided inquiry and traditional instruction on the population means of the 6th grade students' "Enjoyment Attitudes toward Science & Technology Course Questionnaire" scores.

In order to test this null hypothesis, within-subjects effect test results are used. The interaction between within subject variables (enjoyment scores) and between subjects variable (group) is considered.

Table 4.21 Result of glm repeated for the students' scores on the enjoyment subtests

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Between-subjects								
group	.520	1	.520	2.397	.123	.014	2.397	.337
Error	35.991	166	.217					
Within-subjects								
enjoyment	3.801	3	1.267	4.025	.008	.024	12.075	.840
enjoyment* group	**4.919**	**3**	**1.640**	**5.209**	**.002**	**.030**	**15.626**	**.926**
Error (enjoyment)	156.761	498	.315					
Total								

a. Computed using alpha= .05
Note: Data show the values for sphericity assumed

There was a significant interaction effect between enjoyment and group on students' scores F (3, 498) = 5.209. In other words, enjoyment subtests scores of both experimental and control group students showed a significant difference from the beginning of instruction to

the end and retention. The experimental group increased their scores by 0.15 from the first test (X = 4.23) to the second test (X = 4.38), by 0.15 to the third test (X = 4.53), and by 0.02 to the fourth test (X = 4.55). On the other hand, the control group decreased their scores by 0.04 from the first test (X = 4.34) to the second test (X = 4.30), and by 0.13 to the third test (X = 4.17); and increased by 0.26 to the fourth test (X = 4.43). Also, the treatment accounted for 3% of the variance in the Enjoyment change scores.

Table 4.22 Result of tests of within-subjects contrasts for the students' scores on the enjoyment subtests

Source enjoyment	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
enjoyment								
Level 1 vs. Level 2	.519	1	.519	.910	.342	.005	.910	.158
Level 2 vs. Level 3	.012	1	.012	.019	.890	.000	.019	.052
Level 3 vs. Level 4	3.286	1	3.286	5.209	.024	.030	5.209	.621
enjoyment *group								
Level 1 vs. Level 2	1.725	1	1.725	3.021	.084	.018	3.021	.408
Level 2 vs. Level 3	3.276	1	3.276	5.102	.025	.030	5.102	.612
Level 3 vs. Level 4	2.638	1	2.638	4.183	.042	.025	4.183	.529
Error(enjoyment)								
Level 1 vs. Level 2	94.772	166	.571					
Level 2 vs. Level 3	106.575	166	.642					
Level 3 vs. Level 4	104.713	166	.631					

a. Computed using alpha = .05

The Table 4.22 revealed that students' scores on the third (F (1, 166) = 5.102, r =.83), and fourth (F (1, 166) = 4.183, r =.89) Enjoyment Subtests were significantly different in the experimental and control group students. On the other hand students' scores on the second Enjoyment Subtest were not significant than those on first test (F (1, 166) = 3.021, r =.86). However, this contrast yielded very large effect sizes.

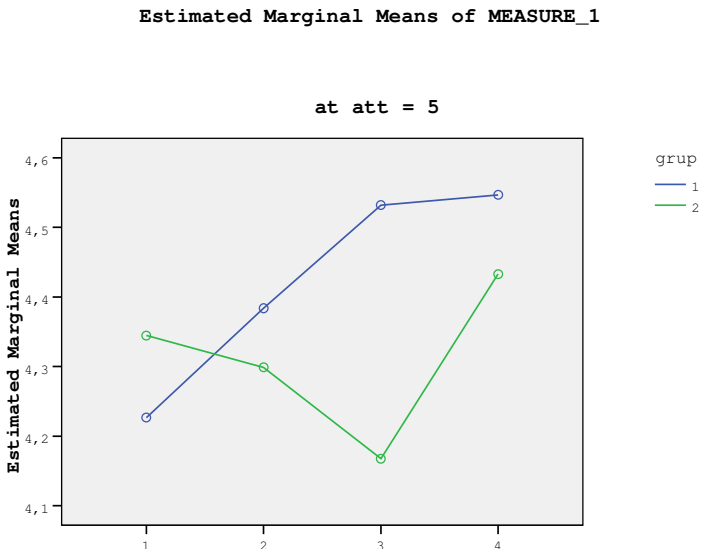


Figure 4.8 Profile plot for the students' scores on the enjoyment subtests

Looking at the interaction graph, this effect reflects that:

1. While the experimental group increased its score in the second Enjoyment test, the control group decreased its score in the second Enjoyment test; both of the groups did not differ in their scores in the second Enjoyment test.
2. While the experimental group significantly increased its third Enjoyment score, the control group significantly decreased its third Enjoyment score.
3. Although both of the groups significantly increased their scores in the fourth Enjoyment test, the control group increased its score more than the experimental group.

4.2.2.3..6 The Effect of Instruction on Students' Usefulness Attitudes toward Science and Technology Course

H_0: There is no statistically significant effect between teacher-guided inquiry and traditional instruction on the population means of the 6^{th} grade students' "Usefulness Attitudes toward Science & Technology Course Questionnaire" scores.

In order to test this null hypothesis, within-subjects effect test results are used. The interaction between within subject variables (usefulness scores) and between subjects variable (group) is considered.

Table 4.23 Result of glm repeated anova for the students' scores on the usefulness subtests

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Between-subjects	32,44	167						
group	.323	1	.323	1.668	.198	.010	1.668	.250
Error	32.117	166	.193					
Within-subjects	136,111	504						
usefulness	1.549	3	.516	2.019	.110	.012	6.056	.519
usefulness* group	**7.208**	**3**	**2.403**	**9.396**	**.000**	**.054**	**28.188**	**.997**
Error (usefulness)	127.354	498	.256					
Total	168,551	671						

a. Computed using alpha= .05
Note: Data show the values for sphericity assumed

There was a significant interaction effects between usefulness and group, F (3, 498) = 9.396, on students' scores. In other words, usefulness subtest scores of both experimental and control group students showed a significant difference from the beginning of instruction to the end and retention. The experimental group increased their score by 0.59 from the first test (X = 4.25) to the second test (X = 4.48), and by 0.16 to the third test (X = 4.64), and decreased their score by 0.11 to the fourth test (X = 4.53). On the other hand, the control group remained same from the first test (X = 4.46) to the second test (X = 4.46); then decreased their score by 0.17 to the third test (X = 4.29); and increased by 0.06 to the fourth test (X = 4.35). Also, the treatment accounted for 5% of the variance in the Usefulness change scores.

Table 4.24 Result of tests of within-subjects contrasts for the students' scores on the usefulness subtests

Source usefulness	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
usefulness								
Level 1 vs. Level 2	2.413	1	2.413	6.090	.015	.035	6.090	.689
Level 2 vs. Level 3	.007	1	.007	.015	.903	.000	.015	.052
Level 3 vs. Level 4	.088	1	.088	.156	.693	.001	.156	.068
usefulness *group								
Level 1 vs. Level 2	2.221	1	2.221	5.605	.019	.033	5.605	.653
Level 2 vs. Level 3	4.672	1	4.672	10.286	.002	.058	10.286	.890
Level 3 vs. Level 4	1.322	1	1.322	2.350	.127	.014	2.350	.332
Error(usefulness)								
Level 1 vs. Level 2	65.773	166	.396					
Level 2 vs. Level 3	75.407	166	.454					
Level 3 vs. Level 4	93.413	166	.563					

a. Computed using alpha = .05

The Table 4.24 revealed that students' scores on the second (F (1, 166) = 5.605, r =.92), and third (F (1, 166) = 10.286, r =.95) Usefulness Subtests were significantly different in the experimental and control group. On the other hand students' scores on the fourth Usefulness Subtest were not significant than those on third test (F (1, 166) = 2.350, r =.83). However, this contrast yielded very large effect size.

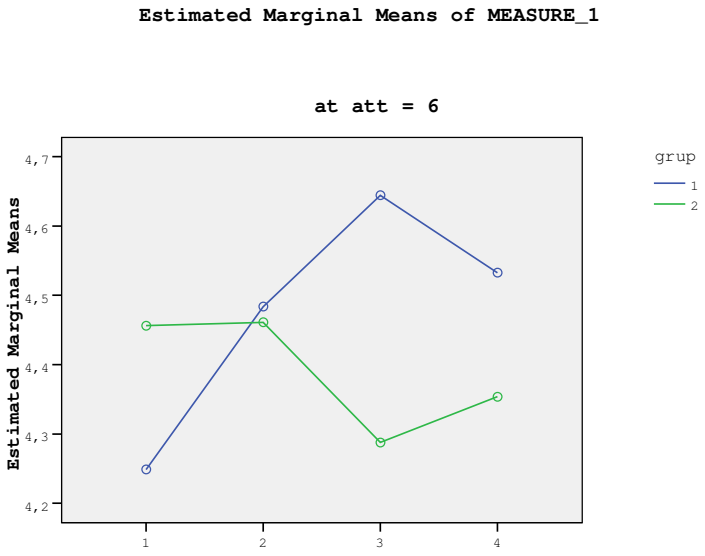


Figure 4.9 Profile plot for the students' scores on the usefulness subtests

Looking at the interaction graph, this effect reflects that:

1. Students' usefulness scores significantly increased in the experimental group when compared to the control group in the second test.
2. While the experimental group significantly increased its score, the control group significantly decreased its score in the third usefulness test.
3. While the experimental group decreased its score, the control group increased its score in the fourth usefulness test.

CHAPTER 5

DISCUSSION

The aim of the present study was to evaluate the effect of a teacher-guided inquiry instruction on 6th grade students' achievement, science process skills, and attitudes toward science and technology course. To accomplish this aim the following steps were followed:

1) Two achievement tests, which were on "Reproduction, Development and Growth in Living Things" (RDGLT) and "Force and Motion" (FM) units, were developed and validated.

2) Three science process skills tests (SPS 1, SPS 2, and SPS 3) were developed and validated.

3) An attitudes toward science and technology course questionnaire (ATT) was developed and validated.

4) Teacher-guided activities on "Reproduction, Development and Growth in Living Things" and "Force and Motion" units were developed and implemented in the experimental group.

5) RDGLT and FM achievement tests, SPS 1-3, and ATT were administered in order to collect data.

6) Data were analysed by using GLM Repeated Measures ANOVA and MANOVA statistical analyses.

5.1 Summary of the Experiment

424 grade 6 students participated to the study. The students were attending 7 elementary schools, 1 in Etimesgut and 6 in Çankaya districts of Ankara city during the 2006-2007 academic year. From these schools, the one in Etimesgut was the experimental group, whereas the others in Çankaya served as the control group of the study. There were 196 students in the experimental group, and 231 students in the control group.

The treatment was consisted of two instructions corresponding to the first two units of the grade 6 elementary science and technology curriculum:

1. The instruction in Reproduction, Development, and Growth in Living Things unit, and
2. The instruction in Force and Motion unit.

Both experimental and control group students received the pre-tests (RDGLT, ATT, and SPS) before the instruction in Reproduction, Development, and Growth in Living Things unit. The experimental group was instructed with teacher-guided inquiry besides the new science and technology curriculum, whereas the control group was instructed with the new science and technology curriculum only. At the end of this unit, both experimental and control group students were given the post-tests (RDGLT, ATT, and SPS) plus FM as a pre-test.

The second instruction was on Force and Motion. Similar to the first treatment, the experimental group experimental group was instructed with teacher-guided inquiry besides the new science and technology curriculum, whereas the control group was instructed with the new science and technology curriculum only. At the end of this unit, both experimental and control group students were given the post-tests (FM, ATT, and SPS).

After the instruction in the third unit on Particulate Nature of Matter with new science and technology curriculum, both groups were given delayed tests (RDGLT, FM, ATT, and SPS 4).

5.2 Limitations

5.2.1 Internal Validity

The degree to which the observed differences on the dependent variable are directly related to the independent variable but the other variables is called internal validity. When a study lacks internal validity, its' results are explained by an alternative hypothesis or some hypotheses. These alternative hypotheses are called threats to internal validity (Fraenkel & Wallen, 2006, p. 169). The possible treats to the internal validity were tried to be minimized by the researcher via some techniques as the followings (the names of the treats is in accord with the classification of Fraenkel & Wallen, 2006, p. 170-185):

1. The research design of the study was a pre-test post-test quasi experimental research design. Since the subjects were not assigned randomly to the both groups there might be differences in terms of the characteristics between experimental and control group students. As the information obtained from students' demography variables such as age, gender, and parents' occupation showed, both groups have similar distribution. In addition to these, the independent t-test result showed that the groups have no difference in socio-economic status. Therefore subject characteristics can not be threat to the present study.

2. The research design of the study was also repeated measurements design, which requires measuring the subjects several times. Due to their absence from the class, many students were unable to take all the tests. The students could not attend the class because of illness, business and relocation of family, requirement to work as an officer of the guard, and to participate as a member to many club activities at the school. Thus, although the sample consisted of 424 students, the analyses were made with only 168 of them, who participated to all test administrations. In other words 61% of the students were lost from the study. The comparison of the experimental and control groups with respect to this missing student percentages showed that while 65% of the students from the experimental group were missing from any one of the tests, 64% of the students from the control group were missing from any one of the tests. These values show that both groups have nearly similar missing ratio. This implies that the missings were random. Therefore mortality or loss of subjects can not be threat to the present study.

3. Almost all the data were collected from the students when there were in their own classes. The classes, where both the experimental and control group students were being instructed, had similar physical structure consisting of a teacher table and many student desks; some closets for books; some bulletin boards on the walls, on which student products could be presented; a wide window from one wall to another, where a radiator took place right below; and fluorescent lamps on the ceiling for lighting.

On the other hand, some tests were collected from the experimental group students while they were in the laboratory. This was the case for just one class or two classes. The teachers of the experimental group sometimes preferred to instruct their students in the laboratory, and this made the researcher to give the tests when the students were already in the laboratory. However the laboratory was not a new location for the students since they were accustomed to being there for some of the science and technology lessons, and its' physical

structure is similar to their classes. All materials of the laboratory were found in the inner room and therefore not accessible by the students, and the only new material there was a TV. For these reasons, location can not be threat to the present study.

4. There were several instruments used in this study to gather data. From these instruments the attitudes toward science and technology course questionnaire was a Likert-scale requiring students to select among choices. The multiple-choice questions of the achievement tests, and science process skills tests had the same response type. And the researcher could score these questions by using the answer key. On the other hand, for the matching, open-ended, fill-in-the-blank, and hot-spot type questions of the achievement and science process skills tests, the researcher did the scoring by using the evaluation criteria and answer keys given in the related appendices. These scoring techniques provided the standardization of the scoring process.

As stated earlier the data were collected mainly by the researcher. Besides collecting data, the researcher tried to attend all science and technology course lessons of both experimental and control group classes in order to get acquainted by the students. Very few data were collected by the students' own science and technology teacher due to the large number of classes participated to the study and due to the researcher's study schedule which did not permit her to be more than one place at the same time.

When collecting data, the researcher did not behave differently to the students regarding being in the experimental or control groups. The data were collected from the students when they were in the science and technology course, and mainly when the science and technology teacher of the class was present. On the other hand, for some of the times, the data were collected when the students in the other lessons. The reason was the schedule of the science and technology teachers, which required them to teach a specific lesson in order to be in line with the time schedule outlined in the 6^{th} grade science and technology curriculum as suggested time line for the units. When this was the case, the teacher tried to get help from this course teacher to be with her during data collection in order to standardize the data collection procedure, and to minimize the disruptive student behaviours.

As the above procedures suggest, instrumentation can not be threat to the present study.

5. In this study, the students were tested before and after the instruction in order to assess the effect of the instruction on some outcomes, and tested one more time in order to assess the durability of these gains. Since both groups were following the elementary science and technology curriculum (although in addition to this the experimental group included teacher-guided activities), the time periods between the administrations of the tests were already outlined by the curriculum. This means that for the first treatment there was at least one and a half month time period, for the second treatment there was at least one month duration, and finally for no treatment there was at least 2 months period. In other words, the time periods between the tests were long enough to eliminate the students' remembrance of the test items. The use of the parallel forms for the science and technology test was also a technique to overcome the testing threat.

6. The researcher tried to administer all the tests to each class where the students attend at least in the same week in order to minimize the history threat. On the other hand, sometimes the teachers of both groups could not come to the class due to illness, seminar attendance, etc., but this happened randomly. As was the case for all teachers, when they came to the class they made the necessary changes in order to catch up with the curriculum. In this case, the researcher applied the post-tests after the unit was completely finished, or applied the pre-tests before the unit was started or just started. Moreover, one of the teachers from the control group was transferred to another school a new teacher started to teach the class, but this occurred during the third unit when there was no treatment.

7. This study was conducted for one and a half semester, and the subjects of the study were grade 6 students who were in the period of puberty. Because of the length and subjects' characteristics, maturation could be thought to be in effect. But the inclusion of the control group as a comparison, maturation threat was tried to be controlled.

8. The students, who participated to the study, were from diverse schools. The students in the experimental group were attending the same school, whereas the students in the control group were attending to 6 different schools. Therefore there was no interaction between the groups to cause "attitude of subjects" threat or Hawthorne effect.

9. This study was conducted with the 6^{th} grade students, who were attending to the public elementary schools in Ankara city, Turkey. In Turkey all school children are instructed with the same curriculum regardless of their academic ability, and there is no track. Therefore, the

students, who participated to this study, had similar educational background. Although tracking is not a case for Turkish schools, some of the schools may have already constructed a special class for their high achieving students. For none of the schools in the study, it is known that there was such a grouping. On the other hand, the use of intact classes and presence of a control group lessen regression threat.

10. This study aimed to investigate the effect of teacher-guided inquiry on some academic outcomes, such as achievement; therefore required implementation of a treatment, in this case two. The treatments were administered to the experimental group by two science and technology teachers, and the researcher. There were 5 intact classes in the experimental group. The first teacher was instructing two classes, whereas the second had three classes to instruct. In order to minimize implementation threat, which would have resulted from the characteristics of these teachers, the researcher instructed both teachers on teacher-guided inquiry by first explaining the research aim, and guided (teacher directed) inquiry, and then giving the lesson plans and activity sheets to them before the class. The researcher also helped the teachers during their implementation of the method by serving as a model or co-teacher. Sometimes the researcher just set and observed the class. On the other hand, the teachers in the control group were 6, each with different background. The researcher also tried to minimize implementation threat, which would have resulted from the characteristics of these teachers, by observing their lessons. As stated earlier, although all these teachers differed in their ability to teach, the requirement to use the same curriculum materials minimized this effect, and also helped the researcher to be sure that implementation threat was not a problem.

5.2.2 External Validity

The degree to which the results obtained from a study are generalizable to the population where the sample was drawn, population generalizability; and other settings different from the one the study was conducted, ecological generalizability, is called external validity (Fraenkel & Wallen, 2006, p. 104, 106).

5.2.2.1 Population Generalizability

The target population of the study was all 6th grade students attending to the public elementary schools in Ankara city. The accessible population was those in both Etimesgut

and Çankaya districts of Ankara. On the other hand, since the study aimed to propose a teacher-guided inquiry instruction for our average classes, both purposive and convenient samplings were used to select the sample as the 6th grade students with middle class socio-economic status. Therefore the results of the study can be generalizable to the other 6th grade students having similar characteristics.

5.2.2 Ecological Generalizability

The present study was conducted in 6th grade elementary science and technology classes of city schools. The student population of the classes was ranging from 10 to 42, with an average of 31. Moreover each science and technology class was being instructed by a science and technology teacher with the same science and technology curriculum. The teachers made use of Teacher Guide Book generally, whereas the students used both the textbook and workbook. The teachers also used laboratory facilities of their school or made use of their own materials. The teachers sometimes instructed their students in the school laboratory, or sometimes borrowed some materials from the laboratory and brought to the classroom. The results of this study can be generalizable to the other science and technology classes having the similar settings.

5.3 Conclusions

1. The instruction made a difference on student achievement in Reproduction, Development and Growth in Living Things unit test ($F=3.467$; $p<.05$).
2. The instruction could not make a difference on student achievement in Force and Motion unit test ($F=3.621$; $p<.05$).
3. The instruction made a difference on student performance in science process skills test ($F=10.229$; $p<.05$).
4. The instruction made a difference on students' attitude scores in self-concept subtest ($F=3.417$; $p<.05$).
5. The instruction made a difference on students' attitude scores in anxiety subtest ($F=5.472$; $p<.05$).
6. The instruction made a difference on students' attitude scores in interest subtest ($F=6.275$; $p<.05$).
7. The instruction made a difference on students' attitude scores in career subtest ($F=4.070$; $p<.05$).

8. The instruction made a difference on students' attitude scores in enjoyment subtest (F=5.209; p<.05).
9. The instruction made a difference on students' attitude scores in usefulness subtest (F=9.396; p<.05).

5.4 Discussions

The present study showed that guided (teacher-directed) inquiry instruction in general is successful when developing students' achievement in content knowledge and science process skills (though there were differences between the experimental and control groups with respect to their mean pre-, post- and retention- force and motion achievement test scores, and among them the one between the pre- and post-test was significant, they are not in the intended directions). These findings are similar to the results of the other studies on inquiry. In the previous studies, which compared inquiry with traditional instruction, it was found that the students in the inquiry group developed their science achievement and reasoning abilities from the pre test to post test more than that the traditional group (Saunders & Shepardson, as cited in Davison, 2000, p. 28-29). When pre-test scores were controlled as a covariate, students in inquiry were still more successful on achievement (Chang & Mao, 1998), especially on higher order thinking skills (Chang & Mao, 1998; Lott, as cited in Costenson & Lawson, 1986). Moreover, inquiry had a positive effect on science process skills (Tatar, 2006). Therefore it can be concluded that like inquiry, guided (teacher-directed) inquiry helps students to understand science concepts and develop this understanding, which will result with an increase in science achievement (Edelson, Gordin, & Pea, 1999; Bredderman, as cited in Weinburgh, 2000; Shymansky, Hedges, & Woodworth, as cited in Weinburgh, 2000). Through including students into authentic experiences, guided (teacher-directed) inquiry also grows students' scientific skills (Edelson et al, 1999). Therefore guided (teacher-directed) inquiry instruction improves both understanding and inquiry skills of students.

On the other hand, this study showed that guided (teacher-directed) inquiry instruction is effective when developing students' science process skills. These finding is contrary to the previous finding that teacher-directed inquiry had no effect on science process skills and cognitive development of the students at grade 9 and 10 (Germann, as cited in Myers, 2004). This success can be attributable to the appropriateness of the guided (teacher-directed) inquiry instruction to the cognitive level of the 6^{th} grade students in this study. When the

instruction fits the cognitive level of the students, they can understand the inquiry task and improve their science process skills. As Aho et al. (1993) found in their studies with grade 2 and 4 students, guided inquiry instruction although increased both grade students' understanding of science concepts from pre test to post test, this increase was significant at grade 4. In other words, students' understanding of concepts is affected by their cognitive level. Moreover both grade students proposed similar methodology to how to study the problems. However students' answers to the inference questions, i.e. "Why the plant, which cut into two and each part has put into water with different colour, has dyed these colours?" were showed second graders' inability to describe the phenomena.

When the results of the presents study is evaluated in terms of the instructional models used in the guided inquiry treatment applied, the use of learning cycle helped the students in the experimental group to develop their understanding of science concepts and science process skills as suggested by Matyas (2000). The improvement in the science understanding can be attributable to the emergence of students' prior knowledge about the phenomenon, which might created a cognitive conflict for the student who holds that framework, and they could generate alternative ideas and apply these ideas into the problem during engagement and exploration steps (Lawson, 1995, p. 136). Moreover, since the naming and introducing the concept took place after the students explored the patterns in the data (Lawson, 1995, p. 136), the students constructed their own understandings of the concept and made a link between what they explored and what the term given to them meaned. After this stage, the students were asked to relate the new concepts to new situations (Lawson, 1995, p. 137), which provided both the transfer of learning and evaluating their own knowledge, thus better refinement of students' own understanding. The studies by Çavaş (2004) and Doğru Atay (2006) showed that learning cycle is effective in developing students' understanding of various subjects (flowing electricity and genetics). Contrary to the results of Küçükyılmaz (2003) regarding the effect of three-stage learning cycle on durability (retention) of some science concepts, the guided (teacher-directed) inquiry instruction in the present study failed to give evidence to the durability of the concepts. On the other hand, guided discovery instruction required active involvement of students into learning process, and as a result the students improved their understanding and transfered it to new situations (Aktamış et al, 2002). The use of worksheets during discovery activites provided a guide for the students in their explorations with concrete materials to understand concepts better and make generalizations (Aktamış et al., 2002).

This study also showed that guided (teacher-directed) inquiry instruction is successful when developing students' attitudes toward science and technology course. This finding is similar to the results of the other studies on inquiry (Shymansky, Kyle, & Alport, as cited in Chang & Mao, 1999; Tatar, 2006). When the results of the presents study is evaluated from the instructional models point of view, similar to the studies of Çavaş (2004) and Doğru Atay (2006) learning cycle has an effect on developing attitudes toward science. It can be said that the significant improvement on the attitudes can be attributable to the ability of the activities to consider students' prior knowledge and experiences, and provide a positive environment to them, get students' interest and develop positive attitudes toward science and technology course (Çavaş, 2004). On the other hand, although the previous studies with guided discovery failed to show a difference from pre test to post treatment due to the short duration of the treatment (Ünal & Ergin, 2006), this stuıdy could show the effect of guided discovery instruction on students' attitudes toward science and technology course. The length of the present study could make a difference in finding a transformation in the attitudes.

One of the best things in this study was the use of subtests of attitudes toward science and technology course. The previous studies took attitudes toward science as a whole measure. The present "Attitudes toward Science and Technology Course Questionnaire" was developed by the researcher and supervisor for this study specifically. The assessment of students' performances on these subtests could help the researcher to explain the effect of the instruction on these attitudes separately. When the attitudes are considered individually, it can be said that:

1. Though the guided (teacher-directed) inquiry had a positive effect on the experimental group students' self-concept scores, the one on force and motion unit was significant on developing students' self-concept. It should be kept in mind that instruction could not make an effect on students' achievement in force and motion.

2. Although the guided (teacher-directed) inquiry had a negative effect on the experimental group students' anxiety scores and caused a decrease on them, this decrease was not much as did the traditional instruction on the control group students.

3. The guided (teacher-directed) inquiry positively affected students' interest scores for two units.

4. The guided (teacher-directed) inquiry had a positive effect on the experimental group students' career scores.

5. Though the guided (teacher-directed) inquiry increased students' enjoyment scores, the significant differences between the scores were found during the implementation of force and motion unit and during the retention.

6. The guided (teacher-directed) inquiry positively affected students' usefulness scores during the units it was implemented.

As the above studies suggest, there is a relation between science process skills and instruction, science achievement, and attitudes. The existence of this relationship was also supported by Aydoğdu (2006) for Turkish context. Moreover Doğru Atay's study (2006) also showed the predictability of students' achievement in science with their attitudes toward science. The stepwise multiple regression analyses in her study showed that attitudes toward science are the main predictor of achievement in genetics regardless of the treatment used. If we take a science curriculum as the base instruction, we can evaluate the effectiveness of that curriculum. In a study by Başdağ (2006), who compared our new curriculum with the old one, found that 2004 science curriculum were significantly more successful than the 2000 science curriculum on total and the following science process skills: observation, inference, prediction, measuring, recording data, defining operationally, and hypothesizing.

5.5 Implications

It is suggested that since students' cognitive level is important for their understanding of science concepts, therefore there should be concrete activities so that students understand abstract concepts; students' should get help from teacher during inquiry when they are inexperienced in inquiry; and teachers should use appropriate materials in science classes in order to avoid teacher-oriented instruction. The use of familiar materials and equipment from the environment also provide an opportunity for science courses when considering the scarcity of laboratory equipments. The employment of these materials works well and motivates students to plan different ways to complete experiments (Aho et al., 1993).

Teachers attend both the processes of science and the reorganization of content based on the curriculum. Therefore teacher training and in-service training should be given importance (Aho et al., 1993).

It is expected that this research has a high "research utilisation", the extent to be applicable in the classes (Kempa, 2002), especially elementary science and technology classes in Turkey.

5.6 Recommendations for Future Research

There are several suggestions for future studies in the same topic. Firstly this study should be replicated by other researchers in other settings, for example in a village school; other grade levels; other subjects within the same discipline for example Systems in Our Body unit of biology, or Light and Sound unit of physics or in the other disciplines, for example chemistry or earth science; and schools with low or high socio-economic status.

REFERENCES

Afacan, Ö., & Nuhoğlu, H. (2007, April). *TIMSS-R projesi: Canlı bilimi ile ilgili soruların fen öğretimi açısından değerlendirilmesi*. Paper presented in VI. Ulusal Sınıf Öğretmenliği Eğitimi Sempozyumu [The 6th National Classroom Education Symposium], Anadolu University, Eskişehir. http://w3.gazi.edu.tr/web/okocabas/yayinlar/anadoluposter.doc, last accessed date: 11 June, 2008.

Aho, L., Huopio, J., & Huttunen, S. (1993). Learning science by practical work in Finnish primary schools using materials familiar from the environment: a pilot study. *International Journal of Science Education, 15*(5), 497-507.

Akşit, N. (2007). Educational reform in Turkey. *International Journal of Educational Development, 27*, 129-137.

Aktamış, H., Ergin, Ö., & Akpınar, E. (2002, September). *Yapısalcı kurama örnek bir uygulama*. Paper presented in V. Ulusal Fen ve Matematik Eğitimi Kongresi [The 5th National Science and Mathematics Education Congress], Middle East Technical University, Ankara. http://www.fedu.metu.edu.tr/UFBMEK-5/b_kitabi/PDF/Fen/Bildiri/t58d.pdf, last accessed date: 19 June, 2008.

Ashton, K. R. (2001). The public image of psychologists: Development and validation of an attitudes toward psychologists scale (Doctoral Dissertation, Ohio State University, 2001). (UMI No. 3059195)

Aydınlı, E. (2007). *İlköğretim 6, 7 ve 8. sınıf öğrencilerinin bilimsel süreç becerilerine ilişkin performanslarının değerlendirilmesi* [*Evaluation of science process skill study on the 6, 7 and 8. grade students*]. Unpublished master's thesis, Gazi University, Ankara. http://www.acikarsiv.gazi.edu.tr/dosya/emek_aydinli__tez.pdf, last accessed date: 19 June, 2008.

Aydoğdu, B. (2006). İlköğretim fen ve teknoloji dersinde bilimsel süreç becerilerini etkileyen değişkenlerin belirlenmesi [Identification of variables effecting science process skills in primary science and technology course]. Unpublished master's thesis, Dokuz Eylül University, İzmir.

Başdağ, G. (2006). *2000 yılı fen bilgisi dersi ve 2004 yılı fen ve teknoloji dersi öğretim programlarının bilimsel süreç becerileri yönünden karşılaştırılması* [*The comparison of the 2004 science and technology curriculum with the 2000 science curriculum in their effects on developing the students' scientific process skills*]. Unpublished master's thesis, Gazi University, Ankara.

Başdaş, E. (2007). *İlkögretim fen eğitiminde, basit malzemelerle yapılan fen aktivitelerinin bilimsel süreç becerilerine, akademik başarıya ve motivasyona etkisi* [*The effect of hands-on science learning method in the education of science in primary school on the science process skills, academic achievement and motivation*]. Unpublished master's thesis Celal Bayar University, Manisa.

Berberoğlu, G. (2004). Personal Communication. December 17, 2004

Berberoğlu, G. (2008). Uluslararası Durum Belirleme Çalışmaları Kapsamında Türkiye'nin Dikkate Alması Gereken Sonuçlar. http://siteresources.worldbank.org/INTTURKEY/Resources/361616-1142415001082/Giray_Berberoglu_TR.pdf, last accessed date: 27 May, 2008.

Berry, A., Gunstone, R., & Loughran, J. (2007). *Using laboratory work to teach about the practice of science*. http://www.ipn.uni-kiel.de/projekte/esera/book/007-ber.pdf, last accessed date: 11 June, 2007.

Black, K. (2003). *Science in the trenches: An exploration of four pre-service teacher's first attempts at teaching science in the classroom*. Paper presented at the Annual Meeting of the Association for the Education of Teachers of Science (St. Louis, MO, January 30-February, 2003). (ERIC Document Reproduction Service No. ED472953) http://eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/1a/c1/8a.pdf, last accessed date: 11 June, 2007.

Board of Agriculture (1998). *Agriculture's role in K-12 education: Proceedings from a forum on the national science education standards*. National Academy of Sciences – National Research Council, Washington, DC. (ERIC Document Reproduction Service No. ED425933)
http://eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/17/27/02.pdf, last accessed date: 11 June, 2007.

Bybee, R. W. (2007). Science teaching and international assessments. *Science Teacher, 74*(8), 41-48.

Bybee, R. W., Carlson Powell, J., & Trowbridge, L. W. (2008). *Teaching Secondary School Science: Strategies for Developing Scientific Literacy* (9th ed.). Colombus, Ohio: Pearson Education, Inc., Upper Saddle Pearson Prentice Hall.

Carin, .A. A., Bass, J. E., & Contant, T. L. (2005). *Methods for teaching science as inquiry* (9th ed.). New Jersey: Pearson/Merrill Prentice Hall, Upper Saddle River.

Cavalcante, P. C., Newton, L. D., & Newton, D. P. (1993). *Primary science teaching-facts or procedures? Do different teaching approaches influence children's learning?* http://www.leeds.ac.uk/educol/documents/000000056.doc, last accessed date: 27 May, 2008.

Ceylan, E., & Berberoğlu, G. (2007). Öğrencilerin fen başarısını açıklayan etmenler: Bir modelleme çalışması [Factors related with students' science achievement: A modelling study]. *Eğitim ve Bilim, 32*(144), 36-48.

Chang, C-Y., & Mao, S-L. (1998, April). *The effects of an inquiry-based instructional method on earth science students' achievement*. Paper presented at the annual meeting of the National Association for Research in Science Teaching, San Diego, CA. (ERIC Document Reproduction Service No. ED418858)

Chin, C., & Kayalvizhi, G. (2002). Posing problems for open investigations: What questions do pupils ask? *Research in Science & Technological Education, 20*(2), 269-287.

Costenson, K., & Lawson A. E. Why isn't inquiry used in more classrooms? *The American Biology Teacher, 48*(3), 150-158.

Çankaya MEM (2007). http://cankaya.meb.gov.tr/index.asp?frame=&part=0&page=okullar/resmi.htm, last accessed date: 7 January, 2007.

Çavaş, P. H. (2004). *İlköğretim fen bilgisi dersinde yer alan yaşamımızı yönlendiren elektrik ünitesinin öğrenme döngüsüne göre işlenmesi* [*Teaching the unit "electricity which directs our life" in the scence lessons of primary school within the approach of learning cycle*]. Unpublished master's thesis, Ege University, İzmir.

Dede, Y., & Yaman, S. (2006). İlköğretim öğrencilerinin fen ve teknoloji ile matematik dersini öğrenme tercihleri [Science and mathematics learning preferences primary school students]. *International Journal of Environmental and Science Education,1*(2), 172-180. http://www.ijese.com/Dede.pdf, last accessed date: 4 June, 2008.

Demir, M. (2007). *Sınıf öğretmeni adaylarının bilimsel süreç becerileriyle ilgili yeterliklerini etkileyen faktörlerin belirlenmesi* [*The factors affecting the pre-service primary teachers' adequacies on science process skills*]. Unpublished doctoral dissertation, Gazi University, Ankara. http://www.acikarsiv.gazi.edu.tr/dosya/metin_demir_tez.pdf, last accessed date: 19 June, 2008.

Demirbaş, M., & Yağbasan, R. (2005, September). *İlköğretim öğrencilerinin fen bilgisi dersindeki bilimsel tutumlarının belirlenmesi ve geliştirilmesine yönelik öneriler.* Paper presented in XIV. Ulusal Eğitim Bilimleri Kongresi [The 14th National Educational Sciences Congress], Pamukkale University, Denizli.

Demirci Güler, M. P., & Laçin Şimşek, C. (2007, April). 2005 *Fen ve Teknoloji Öğretim Programına Yönelik Öğretmen Görüşleri*. Paper presented in VI. Ulusal Sınıf Öğretmenliği Eğitimi Sempozyumu [The 6th National Classroom Education Symposium], Anadolu University, Eskişehir.

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

Doğru Atay, P. (2006). *Relative influence of cognitive and motivational variables on genetic concepts in traditional and learning cycle classrooms*. Unpublished doctoral dissertation, Middle East Technical University, Ankara.

Dökme, İ. (2004a, September). *Milli Eğitim Bakanlığı (MEB) ilköğretim 4. sınıf fen bilgisi ders kitabının temel bilimsel süreç becerileri yönünden değerlendirilmesi*. Paper presented in VI. Ulusal Fen ve Matematik Eğitimi Kongresi [The 6th National Science and Mathematics Education Congress], Marmara University, İstanbul.

Dökme, İ. (2004b, September). *Milli Eğitim Bakanlığı (MEB) ilköğretim 7. sınıf fen bilgisi ders kitabının bilimsel süreç becerileri yönünden değerlendirilmesi*. Paper presented in XIII. Ulusal Eğitim Bilimleri Kurultayı [The 13th National Educational Sciences Congress], İnönü University, Malatya.

Dökme, İ., & Ozansoy, Ü. (2004, September). *Fen öğretiminde bilimsel iletişim kurabilme becerisi* [*Communicating in science education*]. Paper presented in XIII. Ulusal Eğitim Bilimleri Kurultayı [The 13th National Educational Sciences Congress], İnönü University, Malatya.

Durmaz, H., & Özyıldırım, H. (2005). İlköğretim birinci kademe öğrencilerinin fen bilgisi ders ve fen bilimlerine ilişkin tutumlarının incelenmesi [An investigation on the elementary school students' attitudes toward science course and science]. *Çağdaş Eğitim, 30*(323), 25-31.

EARGED (1995). *Eğitimi Araştırma ve Geliştirme Dairesinin Durum Tesbiti Faaliyetleri ve Fen Bilgisi Durum Tesbiti Sonuçları*.

EARGED (2003). *PIRLS 2001 Uluslar Arası Okuma Becerilerinde Gelişim Projesi ulusal rapor* [*PIRLS Progress in International Reading Literacy Study*] T. C. Milli Eğitim Bakanlığı, Eğitimi Araştırma ve Geliştirme Dairesi Başkanlığı [Republic of Turkey, Ministry of National Education, Directorate of Educational Research and Development]. http://earged.meb.gov.tr/htmlsayfalar/birimlerimiz/olcmedeg/dokuman/PIRLSulusrap.rar, last accessed date: 28 May, 2008.

EARGED (2005). *OECD PISA-2003 araştırmasının Türkiye ile ilgili sonuçları PISA 2003 projesi ulusal nihai rapor* [*The results of OECD PISA-2003 study related to Turkey PISA 2003 project national Final Report*]. T. C. Milli Eğitim Bakanlığı, Eğitimi Araştırma ve Geliştirme Dairesi Başkanlığı [Republic of Turkey, Ministry of National Education, Directorate of Educational Research and Development]. http://earged.meb.gov.tr/pisa/dokuman/2003/rapor/PISA_RAPOR_2003.pdf, last accessed date: 28 May, 2008.

Edelson, D. C., Gordin, D. N., & Pea, R. D. (1999). Addressing the challenges of inquiry-based learning though technology and curriculum design. *The Journal of the Learning Sciences, 8*(2-3), 391-450.

Etimesgut MEM. (2007). http://etimesgut.meb.gov.tr/egitim_kurumlari.html, last accessed date: 7 January, 2007.

Field, A. (2005). *Discovering statistics using SPSS* (2nd ed.). London: SAGE.

Field, A. (2008). A bluffer's guide to ... sphericity. *BPS-MSC Newsletter, 6*(1), 13–24. Retrieved June 10, 2008 from http://www.statisticshell.com/sphericity.pdf

Fraenkel, J. R., & Wallen, N. E. (2005). *How to Design and Evaluate Research in Education* (6th ed.). Milan: McGraw-Hill.

Gençtürk, H. A., & Türkmen, L. (2007). *İlköğretim 4. sınıf fen bilgisi dersinde sorgulama yöntemi ve etkinliği üzerine bir çalışma* [*A study of effectiveness and application of inquiry method in a 4th grade science course*]. *GÜ, Gazi Eğitim Fakültesi Dergisi, 27*(1), 277-292. http://www.gefad.gazi.edu.tr//window/dosyapdf/2007/1/2007-1-277-292-17-haticeahugenctcrkvelctfullahtcrkmen.pdf, last accessed date: 10 June, 2008.

George, D., & Malllery, P. (2003). *SPSS for windows step by step: A simple guide and reference 11.0 update* (4th ed.). Munich: Allyn & Bacon.

Germann, P. J., Haskins, S., & Auls, S. (1996). Analysis of nine high school biology laboratory manuals: Promoting scientific inquiry. *Journal of Research in Science Teaching, 33*(5), 475-499.

Gündem. (2007). *A'dan Z'ye 8 yıl*. Kamuran Zeren Ankara. 24 Temmuz 1997. http://webarsiv.hurriyet.com.tr/1997/07/24/2307.asp, last accessed date: 7 January, 2007.

Hale, R. (2008). *Two sample tests*. http://espse.educ.psu.edu/edpsych/faculty/rhale/statistics/Chapters/Chapter10/Chap10.html, last accessed date: 10 June, 2008

Hall, D. A., & McCurdy, D. W. (1990). A comparison of a Biological Sciences Curriculum Study (BSCS) laboratory and a traditional laboratory on student achievement at two private liberal arts colleges. *Journal of Research in Science Teaching, 27*(7), 625-636.

Hargreaves, J., & Hargreaves, T. (1983). Some models of school science in British curriculum projects, and their implications for STS teaching at the secondary school level. *Social Studies of Science, 13*(4), 569-604. http://links.jstor.org/sici?sici=0306-3127%28198311%2913%3A4%3C569%3ASMOSSI%3E2.0.CO%3B2-B, last accessed date: 5 March, 2005.

Harrington Lindberg, D. (1990). What goes 'round comes 'round *doing* science. *Childhood Education, 67*(2), 79-81.

Harris, S. (1997, September). *The Third International Mathematics and Science Study (TIMSS) summary of national results*. Paper presented at the British Educational Research Association Annual Conference, University of York. http://www.leeds.ac.uk/educol/documents/000000464.doc, last accessed date: 27 May, 2008.

Henson, K. T. (1986). Inquiry learning: A new look. *Contemporary Education. 57*(4), 181-183.

Højsgaard, S., & Jørgensen, E. (2001). *Repeated measurements*. http://www.cc.jyu.fi/~aphalo/YMP235/failsYMP235_8a.pdf, last accessed date: 5 March, 2005.

Izard, J. F. (1991). *Assessment of learning in the classroom*. Geelong, Victoria: Deakin University Press.

Johnston, J. (1997). *Measuring attitudes in science: What exactly are we measuring and why?* Paper presented at the annual conference of the British Educational Research Association (BERA) Department of Primary Education, the Nottingham Trent University. http://www.leeds.ac.uk/educol/documents/000000318.htm, last accessed date: 28 May, 2008.

Kalender, İ., & Berberoğlu, G. (2008). An assessment of factors related to science achievement of Turkish students. *International Journal of Science Education*, 1–16.

Karahan, Z. (2006). *Fen ve teknoloji dersinde bilimsel süreç becerilerine dayalı öğrenme yaklaşımının öğrenme ürünlerine etkisi* [*Within the science and technology lesson, the effects of scientific process skills based learning on learning products*]. Unpublished master's thesis, Celal Bayar University, Manisa.

Keser, Ö. F. (2005). Recommendations towards developing educational standards to improve science education in Turkey. *The Turkish Online Journal of Educational Technology, 4*(1), 46-53. http://www.tojet.net/volumes/v4i1.pdf, last accessed date: 27 May, 2008.

Kesercioğlu, T., Türkoğuz, S., & İşçier, E. (2005, September). *Fen bilgisi eğitiminin ilköğretimin 8. sınıflarının eğitsel ve mesleki yönlendirilmelerine olan etkisi*. Paper presented in XIV. Ulusal Eğitim Bilimleri Kongresi [The 14th National Educational Sciences Congress], Pamukkale University, Denizli.

Köksal, E. A. (2002). *The assessment of the biology items in the 1998-2001 secondary school institutions student selection and placement tests.* Unpublished master's thesis, Middle East Technical University, Ankara.

Kubiszyn, T., & Borich, G. (2007). *Educational testing and measurement: Classroom application and practice* (8th ed.). Hoboken, New Jersey: John Wiley & Sons, Inc.

Kutlu, Ö., & Karakaya, İ. (2004, September). *Orta öğretim kurumları öğrenci seçme ve yerleştirme sınavının (OKÖSYS) faktör yapılarına ilişkin bir araştırma*. Paper presented in XIII. Ulusal Eğitim Bilimleri Kurultayı [The 13th National Educational Sciences Congress], İnönü University, Malatya.

Küçükyılmaz, E. A. (2003). *Fen bilgisi dersinde öğrenme halkası yaklaşımının öğrencilerin akademik başarılarına ve hatırlama düzeylerine etkisi* [*The effect of learning cycle approach on students' academic achievement and recall level in science classes*]. Unpublished doctoral dissertation, Anadolu University, Eskişehir.

Lawson, A. E. (1995). *Science teaching and the development of thinking*. Belmont, California: Wadsworth Publishing Company.

Lawson, A. E., Rissing, S. W., and Faeth, S. H. (1990). An inquiry approach to nonmajors biology. *Journal of College Science Teaching, 19*(6), 340-346.

Lee, H-S. & Butler, Songer, N. (2003). Making authentic science accessible to students. *International Journal of Science Education 25*(8), 923–948.

Llewllyn, D. (2005). *Teaching high school science through inquiry: A case study approach*. Thousand Oaks, California: Corwin Press & National Science Teachers Press (A Joint Publication).

Llyod, C. V., & Contreras, N. J. (1985, December). *The role of experience in learning science vocabulary*. Paper presented at the annual meeting of the National Reading Conference, San Diego, CA. (ERIC Document Reproduction Service No. ED281189)

Marx, J. G., Honeycutt, K. A., Rahmati Clayton, S., & Moreno, N. P. (2006). The Elizabeth Towns incident: An inquiry-based approach to learning anatomy developed through high school-university collaboration. *The American Bıology Teacher, 68*(3), 140-147.

Marzano, R. J., Pickering, D., & McTighe, J. (1993). *Assessing student outcomes. performance assessment using the dimensions of learning model*. Alexandria, Virginia: Association for Supervision and Curriculum Development.

Matyas, M. L. (2000). *Teaching and learning by inquiry*. The American Physiological Society. http://www.the-aps.org/education/2005rts_Archive/doc/Inquiry%20Article.doc, last accessed date: 26 May, 2008.

McGaw, B. (2006). Improving the effectiveness, efficiency and equity of education. In C. Hughes (Ed.), *Secondary education at the crossroads*. http://www.springerlink.com/content/v127588633568028/fulltext.pdf, last accessed date: 28 May, 2008.

MEB (2005). *İktisadi İşbirliği ve Gelişme Teşkilatı (OECD) Türkiye temel eğitim politikası incelemesi ön rapor* [*The Organisation for Economic Co-operation and Development (OECD) Turkey primary education policy evaluation pre report*]. T. C. Milli Eğitim Bakanlığı [Republic of Turkey Ministry of National Education]. http://digm.meb.gov.tr/uaorgutler/OECD/OECD_onrapor_TRMart06.pdf, last accessed date: 28 May, 2008.

MEB (2008). T. C. Milli Eğitim Bakanlığı, Eğitimi Araştırma ve Geliştirme Dairesi Başkanlığı [Republic of Turkey, Ministry of National Education, Directorate of Educational Research and Development]. http://www.designtrain-ldv.com/activitie1/presentationofministryofnationaleducation.ppt, last accessed date: 28 May, 2008.

Mecit, Ö. (2006). *The effect of 7e learning cycle model on the improvement of fifth grade students' critical thinking skills*. Unpublished doctoral dissertation, Middle East Technical University, Ankara.

Ministry of Education Malaysia. (2003). *Integrated curriculum for secondary schools. curriculum specifications science form 3*. Curriculum Development Centre. http://myschoolnet.ppk.kpm.my/sp_hsp/sains/kbsm/hsp_sn_f3a.pdf, last accessed date: 18 June, 2008.

Monaghan, C. (1995). *Science teaching methods in relationship to student knowledge and attitude*. (Unpublished master's thesis, the Texas Woman's University, 1995). (UMI No. 1375859)

Montgomery, J. I. (1969). *A comparison of BSCS versus traditional teaching methods by testing student achievement and retention of biology concepts*. (ERIC Document Reproduction Service No. ED033866)

Moore, J. M. (2001). *The effects of inquiry-based summer enrichment activities on rising eight graders' knowledge of science processes, attitude toward science, and perceptions of scientists*. (Unpublished doctoral dissertation, University of Mississippi, Oxford, 2001). (UMI No. 3011938)

Morrison, J. A., & Estes, J. C. (2007). Using scientists and real-world scenarios in professional development for middle school science teachers. *Journal of Science Teacher Education, 18*(2), 165–184.

Myers, B. E. (2004). Effects of investigative laboratory integration on student content knowledge and science process skill achievement across learning styles. *Dissertation Abstracts International, 65*(06), 2061A. (UMI No. 3128779)

Myers, B. E., Washburn, S. G., & Dyer, J. E. (2004). Assessing agriculture teachers' capacity for teaching science integrated process skills. *Journal of Southern Agricultural Education Research 54*(1), 74–85. http://pubs.aged.tamu.edu/jsaer/pdf/Vol54/54-01-074.pdf, last accessed date: 19 June, 2008.

Narode, R., Heiman, M., Lochead, J., & Slomianko, J. (1987). *Teaching thinking skills: science*. (ERIC Document Reproduction Service No. ED320755)

National Research Council (2000). *Inquiry and national science education standards: A guide for teaching and learning*. Centre for Science, Mathematics, and Engineering Education, National Research Council. Washington, D.C.: National Academy Press.

Nitko, A. J., & Brookhart, S. M. (2007). *Educational assessment of students* (5th ed.). Upper Saddle River, New Jersey: Pearson/Merrill Prentice Hall.

Osborne, J., Simon, S., and Collins, S. (2003). Attitudes towards science: a review of the literature and its implications. *International Journal of Science Education, 25*(9), 1049 – 1079. http://dx.doi.org/10.1080/0950069032000032199, last accessed date: 5 January, 2008.

Shepardson, D. P. (2002). Bugs, butterflies, and spiders: children's understandings about insects. *International Journal of Science Education, 24*(6), 627-643. http://dx.doi.org/10.1080/09500690110074765, last accessed date: 5 January, 2008.

Shan, G. B. (2008). *Assignment expectations*. http://people.uleth.ca/~g.shan/Format%20of%20Lab%20Reports.htm, last accessed date: 5 May, 2008.

Solano-Flores, G., & Shavelson, R. J. (1997). Development of performance assessments in science: conceptual, practical, and logistical issues. *Educational Measurement: Issues and Practice, Fall 1997*, 16-25.

Staver, J. R. (1986, September). *The constructivist epistemology of Jean Piaget: Its philosophical roots and relevance to science teaching and learning*. Paper presented at the United States-Japan Seminar on Science Education, Honolulu, HI. (ERIC Document Reproduction Service No. ED278563)

Staver, J. R., & Bay, M. (1986). Analysis of the project synthesis goal cluster orientation and inquiry emphasis of elementary science textbooks. *Journal of Research in Science Teaching, 24*(7), 629 – 643.

Stevens, J. (2002). *Applied multivariate statistics for the social sciences* (4th ed.). London: Lawrence Erlbaum Associates, Inc.

Tatar, N. (2006). *İlköğretim fen eğitiminde araştırmaya dayalı öğrenme yaklaşımının bilimsel süreç becerilerine, akademik başarıya ve tutuma etkisi* [*The effect of inquiry-based learning approaches in the education of science in primary school on the science process skills, academic achievement and attitude*]. Unpublished doctoral dissertation, Gazi University, Ankara.

Tezbaşaran, A., & Kelecioğlu, H. (2004, September). *Madde-ölçek korelasyonlarına, alt-üst grup ortalamalarına ve aşamalı tepki modeline göre geliştirilen sigaraya ilişkin tutum ölçeğinin madde ve ölçek özelliklerinin incelenmesi*. Paper presented in XIII. Ulusal Eğitim Bilimleri Kurultayı [The 13th National Educational Sciences Congress], İnönü University, Malatya.

TIMSS (1999a). *TIMSS IEA's Third International Mathematics and Science Study TIMSS science items: Released set for population 1 (third and fourth grades).* http://timss.bc.edu/timss1995i/TIMSSPDF/ASitems.pdf, last accessed date: 28 May, 2008.

TIMSS (1999b). *TIMSS 1999 science items released set for eighth grade*. http://timss.bc.edu/timss1999i/pdf/t99science_items.pdf, last accessed date: 28 May, 2008.

TTKB (2005). *İlköğretim fen ve teknoloji dersi öğretim programı ve kılavuzu: 6-7-8. sınıflar taslak basım*. T.C. Milli Eğitim Bakanlığı Talim ve Terbiye Kurulu Başkanlığı. Ankara: Ders Kitapları Müdürlüğü.

Turgut, M. F., Baker, D., Cunningham, R., & Piburn, M. (1997). *İlköğretim fen öğretimi.* Öğretmen Eğitimi Dizisi. Ankara: YÖK/Dünya Bankası Milli Eğitimi Geliştirme Projesi Hizmet Öncesi Öğretmen Eğitimi.

Turpin, T. J. (2000). *A study of the effects of and ıntegrated, activity-based science curriculum on student achievement, science process skills, and science attitudes*. (Unpublished doctoral dissertation, University of Louisiana at Monroe, 2000). (UMI No. 9993727)

Türkiye İktisat Kongresi (2004). *Eğitim ve insangücü çalışma grubu raporları: Çalışma grubu raporları-IV*. http://ekutup.dpt.gov.tr/ekonomi/tik2004/cilt14.pdf, last accessed date: 28 May, 2008.

Ünal, G., & Ergin, Ö. (2006). Buluş yoluyla fen öğretiminin öğrencilerin akademik başarılarına, öğrenme yaklaşımlarına ve tutumlarına etkisi. *Türk Fen Eğitimi Dergisi [Journal of Turkish Science Education], 3*(1), 36–52. http://www.tused.org/internet/tufed/arsiv/v3/i1/metin/tufedv3i1s3.pdf, last accessed date: 19 July, 2008.

Weinburgh, M. H. (2000). *Gender, ethnicity, and grade level as predictors of middle school students' attitudes toward science*. (ERIC Document Reproduction Service No. ED442662)

Wilder, M., & Shuttleworth, P. (2005). Cell inquiry: A 5E learning cycle lesson. *Science Activities, 41*(4), 37-43.

APPENDIX A

SCIENCE PROCESS SKILLS FOR GRADES 6-8

Table A.1 Science process skills for grades 6-8

Beceriler	Beceriye Yönelik Kazanım
Gözlem	Nesneleri (cisim, varlık) ve olayları duyu organlarını veya gözlem araç gereçlerini kullanarak gözlemler. Bir cismin şekil, renk, büyüklük ve yüzey özellikleri gibi duyusal özelliklerini belirler. Gözlem için uygun ve gerekli araç,gereci seçip bunları beceriyle kullanır.
Karşılaştırma-Sınıflama	Nesneleri sınıflandırmada kullanılacak nitel ve nicel özellikleri belirler. Nesneler veya olaylar arasındaki belirgin benzerlikleri ve farklılıkları saptar. Gözlemlere dayanarak bir veya birden fazla özelliğe göre karşılaştırmalar yapar. Benzerlik ve farklılıklara göre grup ve alt-gruplara ayırma şeklinde sınıflamalar yapar.
Çıkarım Yapma	Olmuş olayların sebepleri hakkında gözlemlere dayanarak açıklamalar yapar.
Tahmin	Gözlem, çıkarım veya deneylere dayanarak geleceğe yönelik olası sonuçlar hakkında fikir öne sürer.
Kestirme	Olay ve nesnelere yönelik kütle, uzunluk, zaman, sıcaklık ve adet gibi nicelikler için uygun birimleri de belirterek yaklaşık değerler hakkında fikirler öne sürer.
Değişkenleri Belirleme	Verilen bir olay veya ilişkide en belirgin bir veya birkaç değişkeni belirler. Verilen bir olaydaki bağımlı değişkeni belirler. Verilen bir olaydaki bağımsız değişkeni belirler. Verilen bir olaydaki kontrol edilen değişkenleri belirler.
Hipotez Kurma	Verilen bir olaydaki bağımsız değişkenin bağımlı değişken üzerindeki etkisini denenebilir bir önerme şeklinde ifade eder.
Deney Tasarlama	Kurduğu hipotezi sınamaya yönelik bir deney önerir.
Deney Malzemelerini, Araç ve Gereçlerini Tanıma ve Kullanma	Basit araştırmalarda gerekli malzeme, araç ve gereçleri seçerek emniyetli ve etkin bir şekilde kullanır.
Deney Düzeneği Kurma	Verilen malzemeleri kullanarak kurduğu hipotezi sınamaya yönelik tasarladığı deneyi gerçekleştireceği bir düzenek kurar.
Değişkenleri Kontrol Etme ve Değiştirme	Hipotezle ilgili olan değişkenlerin dışındaki değişkenleri sabit tutar. Bağımsız değişkeni değiştirerek bağımlı değişken üzerindeki etkisini belirler.
İşlevsel Tanımlama	Değişkenlerin birden fazla anlama gelebileceği, sınırları tam çizilmemiş durumlarda araştırmanın amacına (hipotez) uygun değişkenleri kesin olarak ve ölçme kriteri ile birlikte tanımlar.
Ölçme	Cetvel, termometre, tartı aleti ve zaman ölçer gibi ölçme araçlarını tanır. Büyüklükleri,uygun ölçme araçları kullanarak belirler. Büyüklükleri, birimleri ile ifade eder.
Bilgi ve Veri Toplama	Değişik kaynaklardan yararlanarak bilgi (çevrede, sınıfta gözlem ve deney yaparak, fotoğraf, kitap, harita veya bilgi ve iletişim teknolojilerini kullanarak) toplar. Kurduğu hipotezi sınamaya yönelik nitel veya nicel veriler toplar.
Verileri Kaydetme	Gözlem ve ölçüm sonucunda elde edilen araştırmanın amacına uygun verileri yazılı ifade, resim, tablo ve çizim gibi çeşitli yöntemlerle kaydeder.
Veri İşleme ve Model Oluşturma	Deney ve gözlemlerden elde edilen verileri derleyip işleyerek gözlem sıklığı dağılımı, çubuk grafik, tablo ve fiziksel modeller gibi farklı formlarda gösterir. Grafik çizmeyle ilgili kuralları uygular.
Yorumlama ve Sonuç Çıkarma	İşlenen verileri ve oluşturulan modeli yorumlar. Elde edilen bulgulardan desen ve ilişkilere ulaşır.
Sunma	Gözlem ve araştırmaları ve elde ettikleri sonuçları sözlü, yazılı ve/veya görsel malzeme kullanarak uygun şekillerde sunar ve paylaşır.

Note: From Tablo-2.2 6, 7 ve 8. Sınıf Düzeyleri İçin "Bilimsel Süreç Beceri" Kazanımları (TTKB, 2005).

APPENDIX B

THE SCIENCE PROCESS SKILLS TEST FORMS AND ATTITUDES TOWARD SCIENCE AND TECHNOLOGY COURSE QUESTIONNAIRE DEVELOPED FROM THE PILOT STUDY

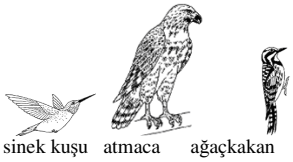
B.1 The Science Process Skills Tests Developed From the Pilot Study

B.1.1 The Science Process Skills Test Forms Developed From the Pilot Study

B.1.1.1 First Science Process Skills Test Form

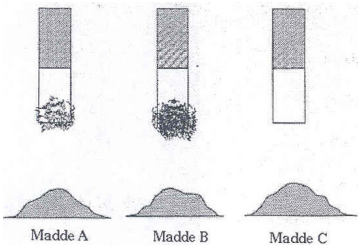
1. Yandaki mum resmine bakınız. Hangi açıklama doğrudan göz ile yapılan bir gözlemdir?
A) Mum, balmumundan yapılmıştır. B) Mum ağırdır. C) Mum yanıyor. D) Alev sıcaktır.

2. Yanda resmedilen kuşlar aynı bölgede yaşamaktadır. Kuşlardan birinin ana besin kaynağı uzun boru şekilli çiçeklerdeki nektardır. Diğer kuş kemiricilerle beslenir. Üçüncü kuş ise ağaçların kabuklarını, içerdeki böcekleri yakalamak için gagalar. Bu bilgiye dayanarak resimdeki kuşları ve besinlerini eşleştiriniz.

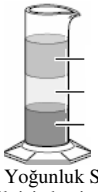


sinek kuşu atmaca ağaçkakan

3. Gösterilen üç mıknatısın her biri altındaki maddenin içine batırılıyor. Hangi madde kahve olabilir?



4.



sıvı yağ (yoğunluk 0.85 mL)

su (yoğunluk 1.00 g/mL)

mısır şurubu (yoğunluk 1.02 g/mL)

Yoğunluk Sütunu

Bilinmeyen Sıvıların Yoğunlukları

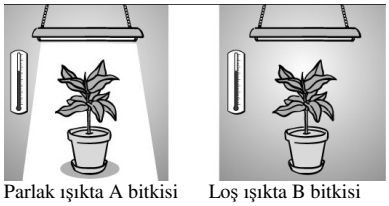
Sıvılar	Yoğunluk (g/mL)
A Örneği	1.02
B Örneği	0.96
C Örneği	1.15
D Örneği	0.82

Fen Bilgisi dersinde öğrenciler 4 sıvı örneğinin yoğunluğunu ölçüp kayıt ettiler. Yukarıdaki yoğunluk sütununu ve verileri kullanarak hangi sıvı örneğinin sıvı yağ üstünde yüzeceğini tahmin ediniz.

5. Yetişkin bir insanın ayak uzunluğu 20 ___ 'ye yakındır. Boşluğa aşağıdakilerden hangisi gelmelidir?
A) milimetre B) santimetre C) metre D) dekametre

6. Can ve Emel sofra tuzunun bitki gelişmesine etkisini bir deneyle araştırmaktadır. Deneylerinde her gün aynı miktar tuzlu su ile bitkileri sularlar. Can ve Emel deneylerini geliştirmek için aşağıdaki yollardan hangisini izlemelidir?
A) Suya eklenen tuz miktarını her gün artırarak.
B) Bitkilerin yarısını saf su, yarısını tuzlu su ile sulayarak.
C) Tuzun ne kadar hızlı bitkilere geçeceğini görmek için gıda boyası ekleyerek.
D) Bitkileri sulamadan önce tuzlu suyu soğutarak.

7. Yandaki resimler Draceana bitkisiyle yapılan bir deney düzeneğini göstermektedir.
Deneyin test ettiği hipotez aşağıdakilerden hangisidir?
A) Sıcaklık artarsa bitki daha fazla büyür.
B) Işık parlaksa bitki daha fazla büyür.
C) Saksı genişse bitki daha fazla yaprak oluşturur.
D) Bitkilerin hepsi yeşil yapraklara sahiptir.



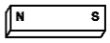
Parlak ışıkta A bitkisi Loş ışıkta B bitkisi

8. **Bilinen Laboratuar Malzemeleri**

A. Büyüteç

B. Pil

C. Eldiven



D. Mıknatıs

E. Gözlük

F. Cetvel

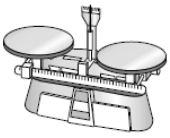
G. Mikroskop

H. Damlalık

J. Termometre

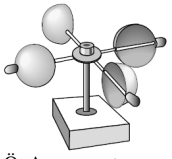
K. Kronometre

L. Dereceli silindir



M. Terazi

N. Büret



Ö. Anemometre

P. Prizma

R. Steteskop

S. Erlen

T. İspirto ocağı ve sacayak

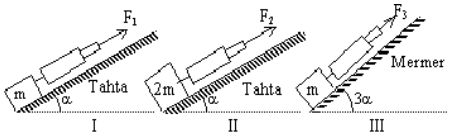
U. Teleskop

Z. Fotoğraf makinesi

a. Güvenlik amacıyla kullanılan laboratuar malzemeleri hangileridir?
b. Beyaz ışığı renklerine ayırmakta kullanılan laboratuar malzemeleri hangileridir?

9. Ahmet Bey menekşe yetiştirmektedir. Bu menekşelerin altısı kırmızı, altısı beyaz çiçek açmaktadır.
Bir arkadaşı ona sabah güneşi aldıklarında menekşelerin daha fazla çiçek açtıklarını söyler. Ahmet Bey sonra şu hipotezi kurar: ‘‘Menekşeler akşam güneşinden ziyade sabah güneşi aldığında daha fazla çiçek açar.’’ Ahmet Bey hipotezini sınamak için aşağıdakilerden hangisini yapmalıdır?
A) Menekşelerin hepsini sabah güneşi alan bir yere koyar. Bir ay boyunca her bir menekşenin oluşturduğu çiçekleri sayar.
B) Üç beyaz menekşeyi sabah güneşi alan bir yere, üç beyaz menekşeyi ise akşam güneşi alan bir yere koyar. Kırmızı menekşelere bir şey yapmaz. Dört hafta boyunca her bir beyaz menekşenin oluşturduğu çiçek sayısını hesaplar.
C) Menekşelerin hepsini dört hafta boyunca sabah güneşi alan bir yere koyar. Bu zaman süresince oluşan çiçeklerin sayısını hesaplar. Sonra tüm bitkilerini dört hafta boyunca akşam güneşi alan bir yere koyar. Bu zaman süresince oluşan çiçeklerin sayısını hesaplar.
D) Üç kırmızı ve üç beyaz menekşeyi sabah güneşi alan bir yere, üç kırmızı ve üç beyaz menekşeyi ise akşam güneşi alan bir yere koyar. Dört hafta boyunca her bir bitki tarafından oluşturulan çiçeklerin sayısını hesaplar.

10. Bir öğrenci eğik düzlemde sabit hızla çekilen bir cisme uygulanan kuvvet ile eğim açısı arasındaki ilişkiyi göstermek istiyor. Bunun için öğrenci yukarıdaki deney düzeneklerini kuruyor, ancak amacına ulaşamıyor. Bu amaca ulaşabilmek için düzeneklerde hangi değişiklikleri yapıp deneyi nasıl gerçekleştirmelidir, neden?



11. İki ayrı fabrika basketbol topu üretmektedir. Her iki fabrika da en yükseğe sıçrayan topu kendisinin ürettiğini avunmaktadır. Hangi fabrikanın ürettiği basketbol topunun en yükseğe sıçradığına karar vermede kullanılacak en bilimsel kanıt şağıdakilerden hangisidir?

A) 12 Dev Adam'dan İbrahim Kutluay topları yukarıya fırlatırken her bir topun ne kadar yükseğe çıktığının ölçülmesi.
B) Bir makine topları aynı kuvvetle yukarıya fırlatırken her bir topun ne kadar yükseğe çıktığının ölçülmesi.
C) Fabrikaların kendi toplarının ne kadar yükseğe çıktığını belirlemek için yapmış olduğu deneyin sonuçlarının okunması.
D) 12 Dev Adam'a topların ne kadar yükseğe çıktığının sorulması.

12. Fen Bilgisi dersinde Deniz, arkadaşlarının bir futbol topunu ne kadar uzağa atabildiklerini belirlemek için bir deney yapmıştır. Deniz, deneyinde elde ettiği ölçme sonuçlarını aşağıdaki tabloda göstermiştir. Hangi öğrenciye ait ölçüm olağan dışıdır? Neden?

Öğrencilerin Bir Futbol Topunu Atabildikleri Uzaklık

Öğrenci	Atılan Uzaklık
1	15
2	75
3	10
4	16
5	8

13. Yeni bulunan bir ilaç, kan pıhtılarını eritmektedir. Fakat ilaç çok fazla kullanıldığında, aşırı kanamaya neden olmaktadır. Alınması gereken en uygun ilaç miktarını belirlemek için aşağıdaki yöntemlerden hangisini kullanırsınız?

A) İlacı farklı zamanlarda vererek, zamanlamanın kanamaya etkisini belirlemek.
B) Deneklerin ilaçla birlikte çok çeşitli yiyecekler yemelerini sağlamak.
C) İlacı farklı yaşlardaki insanlarda uygulamak.
D) Herşeyi sabit tutarken sadece ilacın miktarını değiştirmek.

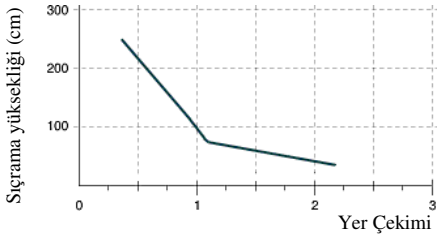
14. Tahılların kilo almaya etkisini bulmak için farelerle bir deney yapılmıştır. Deneyde mısır ile beslenen bir farenin 20 g, pirinç ile beslenen bir farenin 15 g, buğday ile beslenen bir farenin 18 g ve mısır-pirinç-buğday karışımı ile beslenen bir farenin de 22 g kilo aldığı görülmüştür. Başlangıçta mısır ile beslenen fare 95 g, pirinç ile beslenen fare 98 g, buğday ile beslenen fare 92 g, mısır-pirinç-buğday karışımı ile beslenen fare de 90 g idi. Bu verileri kullanarak bir tablo çiziniz.

15. Amonyak gazının sudaki çözünürlüğü sıcaklık arttıkça azalır. Bu bilgiye göre, amonyak gazının sıcaklık-çözünürlük grafiğini çiziniz.

16. Güneş sistemindeki bazı gezegenlerin yer çekimi ile sıçrama yüksekliği değerleri yandaki tabloda verilmiştir:

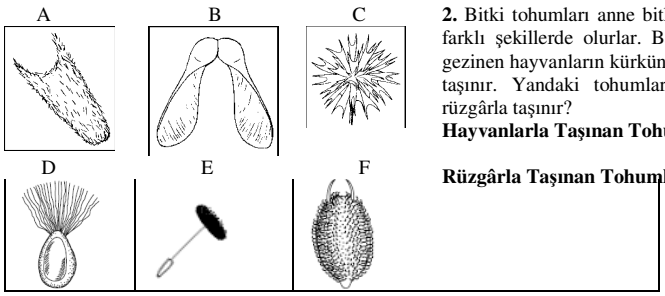
Gezegen	Yer Çekimi	Sıçrama Yüksekliği
Merkür	0.38	250
Venüs	0.90	184
Dünya	1.00	100
Satürn	1.15	87
Jüpiter	2.40	43

Bu değerlere göre yer çekimi ile sıçrama yüksekliği arasında yandaki grafikte gösterilen bir ilişki vardır:
Yer çekimi ile sıçrama yüksekliği ilişkisi hakkında ne söyleyebilirsiniz?



B.1.1.2 Second Science Process Skills Test Form

1. Bu fotoğraftan hangisi gözlemlenebilir?
A) Ay küre şeklindedir.
B) Ay ekseni etrafında döner.
C) Ay katı bir kayadır.
D) Ay'da çok az hava vardır.



2. Bitki tohumları anne bitkiden ayrılıp çoğalmayı sağlamak için farklı şekillerde olurlar. Bazı tohumlar anne bitkinin yakınında gezinen hayvanların kürküne yapışırken, bazıları rüzgârla uzaklara taşınır. Yandaki tohumlardan hangileri hayvanlarla, hangileri rüzgârla taşınır?
Hayvanlarla Taşınan Tohumlar:

Rüzgârla Taşınan Tohumlar:

3. Yazın bir deney yapmak isteyen öğrencilerin sınayacakları en iyi hipotez aşağıdakilerden hangisidir?
A) Hangi etkenler yıl boyunca bitki büyümesini etkiler?
B) Farklı miktarlarda suyun bitki büyümesine etkisi nedir?
C) Neden bitkiler yazın daha çok büyür?
D) Mıknatıslar nasıl çalışır?

4. Bir çiftçi yetiştirdiği çilek bitkisinin yeşil renkte meyveler oluşturduğunu gözlemler. Aşağıdakilerden hangisi çiftçinin çilekleriyle ilgili yapacağı bir tahmindir?
A) Yeşil renkli çilekler kırmızı renkli çileklere dönüşeceklerdir.
B) Çilek bitkisinin meşe ağacının altında gelişmektedir.
C) Yeşil çilekler yeni bir çilek türüdür.
D) Çilek bitkisine yeterince sulanmamaktadır.

5. Yandaki tabloya göre, hangi gezegen en yüksek sıcaklığa sahip olur?

Gezegen	Güneşten Ortalama Uzaklık (kilometre)
Dünya	150 milyon
Jübiter	778 milyon
Mars	228 milyon
Merkür	58 milyon
Venüs	108 milyon

6. Gül, fasulye tohumlarının çimlenmesiyle oluşan filizlerin uzunluğunu neyin etkilediğini bulmak ister. On benzer deney tüpünün her birine nemli bir kâğıt mendile sarılı fasulye tohumu yerleştirir. Deney tüplerinin beşini bir tüplüğe dizerek güneşli bir pencereye yerleştirir. Geri kalan beş deney tüpünü de başka bir tüplüğe dizerek karanlık bir buzdolabına yerleştirir. Bir hafta sonra her bir gruptaki fasulye filizlerinin uzunluğunu ölçer. Bu deneyde aşağıdaki değişkenlerden hangisi fasulye filizlerinin uzunluğunu etkiler?
A) Sıcaklık ve nem.
B) Nem ve deney tüpünün uzunluğu.
C) Işık ve sıcaklık.
D) Işık ve zaman

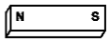
7. 50 metrelik bir yarışı koşmadan önce ve koştuktan sonra, nabzınız ve nefes alıp verme oranlarınız ölçülüyor. Nabız ve nefes alıp verme oranlarında hangi değişikliklerin olmasını beklersiniz?

8. **Bilinen Laboratuar Malzemeleri**


A. Büyüteç


B. Pil


C. Eldiven



D. Mıknatıs


E. Gözlük

F. Cetvel

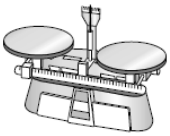

G. Mikroskop


H. Damlalık

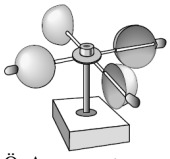

J. Termometre

K. Kronometre

L. Dereceli silindir


M. Terazi

N. Büret


Ö. Anemometre


P. Prizma


R. Steteskop


S. Erlen


T. İspirto ocağı ve sacayak


U. Teleskop

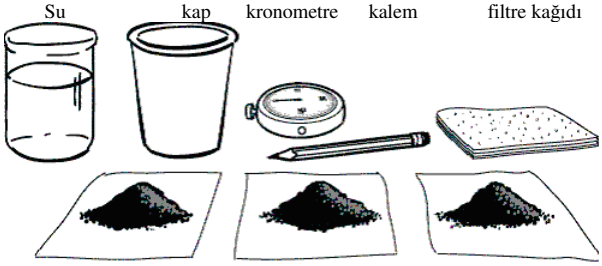

Z. Fotoğraf makinesi

a. Bir taşın kütlesini ölçmede kullanılan laboratuar malzemeleri hangileridir? (İlgili kutulardaki harfleri yazınız)
b. 250 mL'lik suyu tam olarak ölçmekte kullanılan laboratuar malzemeleri hangileridir?

9. soruyu cevaplamak için aşağıdaki metni ve resmi kullanınız.

Su farklı türdeki topraklardan ne kadar süratte geçer? Bir öğrenci bu soruya cevap bulmak için bir deney düzeneği hazırladı. Öğrencinin deneyinde kullandığı araç-gereçler aşağıda görülmektedir:

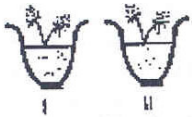
Su kap kronometre kalem filtre kağıdı



A toprağı B toprağı C toprağı

Öğrencinin deney düzeneği kurmada izlediği basamaklar şunlardır:
1. Bir kalemin ucun kullanarak kâğıt bardağın tabanında bir delik aç.
2. Filtre kâğıdından daire şeklinde bir parça keserek, bu parçayla bardağın içindeki deliği kapat.
3. Bardağı A toprağı ile doldur.
4. Deliği parmağınla kapatırken, bardağa 20 mililitre su ekle.
5. İkinci bir bardağı birincisinin altına doğru tut. Parmağını gevşet. Suyun ne kadar sürede boşaldığını ölç.
6. İki bardağı da boşalt. B ve C toprakları için 2.-5. basamakları tekrarla.

9. Bu deneyde filtre kâğıdının kullanılma amacı nedir?
A) Toprağı bardağın içinde tutarken suyun süzülmesine imkân vermek. D) Suyu bardakta tutmak.
B) Toprağın içindeki hava boşluklarını temsil etmek. C) Öğrencilerin bardağın içini görmelerini sağlamak.

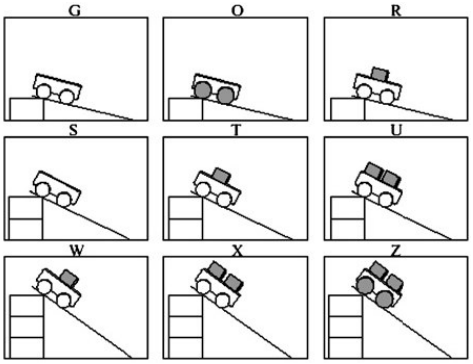


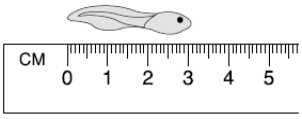
10. Bir öğrenci kullanılan gübre miktarının bitkilerin büyümesine olan etkisini incelemek istemektedir. Bu öğrenci aynı ortamda bulunan I. saksıya düzenli olarak bir miktar gübre koyarken aşağıdakilerden hangisini yaparsa araştırdığı soruya cevap verebilir?
A) II. saksıya hiç gübre koymadan, her iki saksıyı aynı ölçüde sulayarak.
B) II. saksıya I. saksı ile aynı miktarda gübre koyarak her iki saksıyı aynı ölçüde sulayarak.
C) II. saksıya I. saksıdakinin yarısı kadar gübre koyarak her iki saksıyı aynı ölçüde sulayarak.
D) II. saksıya I. saksının iki katı kadar su ve gübre koyarak.

11. K, M, N ve O türleri birbiriyle beslenmeyen türlerdir. Y türü, bu türlerle dört ayrı ortamda bir araya konduğunda, sayısındaki artış ve azalış tablodaki gibi gözleniyor. Buna göre hangi tür canlının Y türü canlı ile beslendiği söylenebilir?

Y türü canlı sayısı	Y türü canlılarla aynı ortamda bulunan canlılar
Artıyor	K, M, N
Azalıyor	M, N,O
Azalıyor	O, K
Artıyor	N, M

12. Yandaki şekiller Abdullah'ın farklı büyüklükte tekerlekleri olan arabalarla yaptığı denemeleri göstermektedir. Denemelerinde arabalarını farklı yüksekliklerdeki rampalardan aşağıya bırakan Abdullah'ın arabalara eklediği tahta blokların kütlesi birbirlerine eşittir. Abdullah "Araba ne kadar ağırsa, rampanın aşağısındaki hızı o kadar fazladır" hipotezini test etmek istemektedir. Abdullah hangi üç denemeyi karşılaştırmalıdır? Neden?





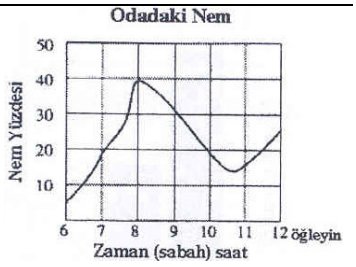
13. Yanda görülen iribaş safhasındaki kurbağanın boyu ne kadardır?

14. Bir belediye şehirdeki hava kirliliğini karşı önlem almaya gerek olup olmadığını belirlemek için hava ölçümleri apmaktadır. Aşağıdakilerden hangisi hava kirliliğini ölçmek için en uygun zamandır?
A) Günde bir defa, trafiğin yoğun olduğu iş gidişi veya çıkışında.
B) Yılda bir defa trafiğin az olduğu bir günde.
C) Havanın en az kirli olduğu geceleri.
D) Günde birkaç defa, her türlü hava koşulunda.

15. Bir maddenin 1 cm^3 ünün kütlesine yoğunluk denir. Buna göre tabloda gösterilen maddelerin hangisinin yoğunluğu en yüksektir?

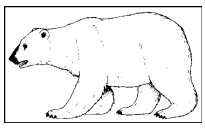
Madde	Maddenin kütlesi	Maddenin hacmi
T	11.0 gram	24 santimetreküp
V	11.0 gram	12 santimetreküp
Y	5.5 gram	4 santimetreküp
Z	5.5 gram	11 santimetreküp

16. Yandaki grafik bir sabah bir sınıfta kaydedilen nemliliği göstermektedir. Grafikte gösterilen sabah, saat 6:00 ile 12:00 arasında nemlilik kaç kez tam olarak yüzde 20 idi?



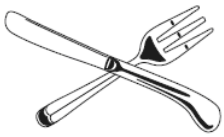
B.1.1.3 Third Science Process Skills Test Form

1. Aşağıdakilerden hangisi bir gözlem olmayıp, sonuçtur?
A) Resimdeki ayı soğuk iklimde yaşar.
B) Resimdeki ayının dişleri büyüktür.
C) Resimdeki ayının pençeleri siyahtır.
D) Resimdeki ayının kulakları ve gözleri küçüktür.



2. Aşağıdakilerden hangisinin kütlesi bir raptiyenin kütlesine yakındır?

A 

B 

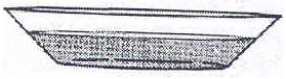
C 

D 

3. Bir öğrenci aşağıdaki ağzı açık kapların her birine 100 ml su koyuyor ve bu kapları 1 gün güneşte bırakıyor. Buharlaşma nedeniyle en çok su kaybı hangi kapta olur?

A) 

B) 

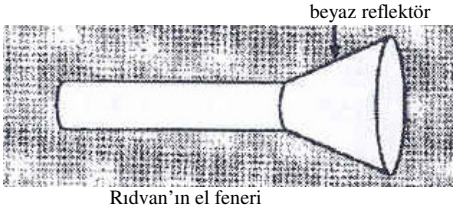
C) 

D) 

4. Rıdvan ve Sabahat, özdeş pil ve özdeş ampul kullanarak birer el feneri yapıyorlar. Yapılan el feneri aşağıdaki şekilde görülmektedir.

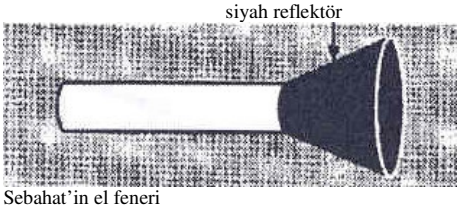
Sonra el fenerine aşağıdaki şekillerde gösterildiği gibi karton reflektör ekliyorlar. Rıdvan'ın reflektörü beyaz kartondan, Sebahat'inki ise siyah kartondandır.

beyaz reflektör



Rıdvan'ın el feneri

siyah reflektör



Sebahat'in el feneri

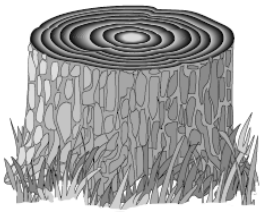
Rıdvan ve Sebahat sonra el fenerlerini açıyorlar.

a) Hangi el feneri iki metre uzaklıktaki duvar üzerine daha fazla ışık düşürür?

Rıdvan'ınki (beyaz reflektörlü) ☐ Sebahat'inki (siyah reflektörlü) ☐

b) Cevabınızı yazınız.

5. Bir ağacın enine kesitinde görülen biri açık biri koyu renk olan iki halka o ağacın bir yıllık büyümesine karşılık gelmektedir. Resimde görülen ağacın kaç büyüme halkası vardır?



6.- 9. sorular şu durumla ilgilidir:

Beyaz sıçanlarla bir laboratuar araştırması yapılmaktadır. Araştırmayı yapan bilim insanı, anne sıçanların aldığı A Vitamini miktarının doğan yavru sayısını etkileyip etkilemediğini bilmek istemektedir. Bilim insanı, araştırmasında aynı tür sıçanları kullanır. Her sıçana aynı miktar besin verir ve günlük egzersiz uygular. Tüm kafeslerdeki sıcaklığı da aynı tutar.

6. Bilim insanı, araştırmasında aşağıdaki değişkenlerden hangisini kontrol etmektedir?

A) A vitamini miktarı, besin miktarı ve egzersiz miktarı
B) Besin miktarı, egzersiz miktarı ve sıcaklık
C) Sıçan türü, A vitamini miktarı ve sıcaklık
D) Egzersiz miktarı, sıçan türü ve A vitamini miktarı

7. Bilim insanının araştırmasında sınadığı hipotez aşağıdakilerden hangisidir?

A) Kafesteki sıcaklık arttıkça, anne sıçanın doğurduğu yavru sayısı artar.
B) Anne sıçan ne kadar çok A vitamini alırsa, o kadar çok yavruya sahip olur.
C) Anne sıçanlar ne kadar fazla egzersiz yaparsa, o kadar çok yavruya sahip olur.
D) Anne sıçanlar günlük ne kadar çok besin alırsa, o kadar çok yavruya sahip olur.

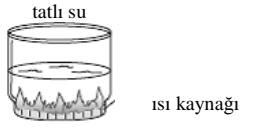
8. Bilim insanının araştırmasındaki bağımsız değişken aşağıdakilerden hangisidir?

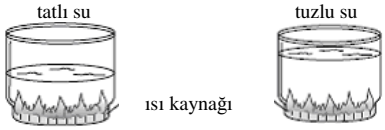
A) Her bir sıçana verilen besin miktarı.
B) A vitamini miktarı
C) Anne sıçanları sayısı
D) Doğan yavru sayısı.

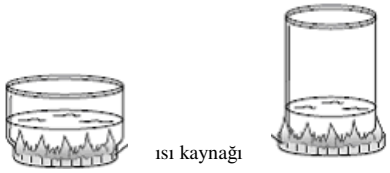
9. Bu çalışmadaki bağımlı değişken aşağıdakilerden hangisidir?

A) Her bir sıçana verilen besin miktarı
B) A vitamini miktarı
C) Anne sıçanların sayısı
D) Doğan yavru sayısı

10. Aşağıdakilerden hangisi tuzlu suyun tatlı sudan daha hızlı kaynadığını bulmak için en iyi yoldur?

A)


B)


C)


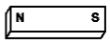
D)


11. **Bilinen Laboratuar Malzemeleri**


A. Büyüteç

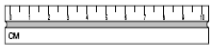

B. Pil


C. Eldiven



D. Mıknatıs


E. Gözlük



F. Cetvel

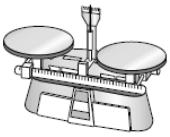

G. Mikroskop


H. Damlalık

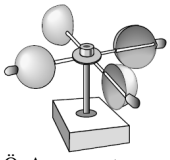

J. Termometre

K. Kronometre

L. Dereceli silindir


M. Terazi

N. Büret


Ö. Anemometre


P. Prizma


R. Steteskop


S. Erlen


T. İspirto ocağı ve sacayak


U. Teleskop


Z. Fotoğraf makinesi

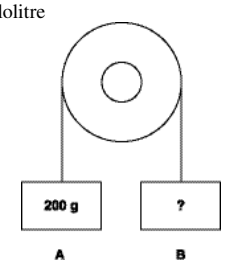
Sıcaklık ölçmede kullanılan laboratuar malzemeleri hangileridir? (İlgili kutulardaki harfleri yazınız)

12. Öğrenci deneyinde bitkilerini eşit oranda su ile sulamakta ve aynı oranda güneş ışığı almalarını sağlamaktadır. Ayrıca bitkilere her hafta bir fincan dolusu sıvı gübre vermektedir. Öğrenci, her bir bitkiye verdiği gübreyi doğru olarak ölçmek için, gübrenin hacmini hangi birimle ifade etmelidir?

A) Santimetreküp B) Mililitre C) Metre küp D) Kilolitre

13. A ağırlığını dengelemek için B ağırlığının ne kadar olması gereklidir?

A) 20 kilogram
B) 2000 miligram
C) 0.2 kilogram
D) 20 gram



14. Füsun Fen Bilgisi dersinde yaptığı deneyde iki elini birbirine sürtmek suretiyle elini ısıttı. Sonra elinin sıcaklığını ölçtü. Füsun bu deneyi dört defa tekrarladı. Yandaki tablo, Füsun'un yaptığı deneyin sonuçlarını göstermektedir. Tablodaki verilere göre denemelerin hangisi normal değildir? Neden?

Deneme	Sıcaklık (^{0}C)
1	41
2	40
3	31
4	42

15. Birkaç öğrenci, mahallelerinde bulunan kuş türlerini ve her bir türdeki kuş sayısını hesapladı. Öğrencilerin çalışmalarda topladıkları bu verileri gösterecekleri en uygun grafik şekli sizce nasıldır?

16. Aşağıdaki tabloda verilen bilgilerle aşağıdaki sonuçlardan hangisine ulaşılamaz?

A) Gebelik süresi büyük vücutlu canlılarda daha uzundur. B) Çoğalma miktarı küçük vücutlu canlılarda daha fazladır.
C) Üreme sıklığı çevre koşulları ile ilişkilidir. D) Bir doğumdaki yavru sayısı en büyük vücutlu canlıda en azdır.

Canlı türü	Üreme sıklığı (yılda)	Bir doğumdaki yavru sayısı (en fazla)	Yaklaşık gebelik süresi (gün)
Ev faresi	7-8	13	21
Tavşan	6-7	6	42
Köpek	2	10	60
Fil	2 yılda bir	1	660

B.1.2 Science Process Skills Test Key

B.1.2.1 First Science Process Skills Test Key

1. C

2. Coding Guide

Code	Response
Correct Response	
20	Sinek Kuşu: Uzun boru şekilli çiçeklerdeki nektar Atmaca: Kemiriciler Ağaçkakan: Ağaçların kabuklarının içindeki böcekler
Partial Response	
10	Sinek Kuşu: Uzun boru şekilli çiçeklerdeki nektar
11	Atmaca: Kemiriciler
12	Ağaçkakan: Ağaçların kabuklarının içindeki böcekler
Incorrect Response	
70	Sinek Kuşu: Kemiriciler, Atmaca: Ağaçların kabuklarının içindeki böcekler, Ağaçkakan: Uzun boru şekilli çiçeklerdeki nektar. Sinek Kuşu: Ağaçların kabuklarının içindeki böcekler, Atmaca: Uzun boru şekilli çiçeklerdeki nektar Ağaçkakan: Kemiriciler
No Response	
99	BLANK

3. C
4. D
5. B
6. B
7. B

8. a. Coding Guide

Code	Response
Correct Response	
20	C. Eldiven ve E. Gözlük
Partial Response	
10	C. Eldiven
11	E. Gözlük
Incorrect Response	
70	Other incorrect (including crossed out/erased, stray marks, illegible, or off task).
No Response	
99	BLANK

8. b.

Code	Response
Correct Response	
10	P. Prizma
Incorrect Response	
70	Other incorrect (including crossed out/erased, stray marks, illegible, or off task).
No Response	
99	BLANK

9. D

B.1.2.1 (Cont.'d)

10. Coding Guide

Code	Response
Correct Response	
10	Açılar farklı, kütleler ve yüzeyler aynı. Düzeneklerdeki açıları sırası ile α, 2α ve 3α yaparak tüm düzeneklerdeki kütleleri eşitlerim (m veya 2m) ve sürtünen yüzeyleri aynı yaparım (tahta ya da mermer). F_2 m olmalıdır. F_2'nin eğim açısı 2α olmalıdır. F_3 tahta olmalıdır. Çünkü burada 3. Düzenekte tahta kullanmalı. 2. Düzenekte kütleyi m'e düşürtmeli. 2. Düzenekte eğim açısını 2α'ya çıkartmalı. Çünkü, eğim açısının etkisini bulmak istiyor. Eğim açısı dışında tüm etkenler eşit olmalı.
Incorrect Response	
10	Tahta: Tahta kısa olduğu için ve çok hafif olduğu için çekince düşer. 2m tahta: 2 m tahta uzun ama o da hafif çekilince herhangi bir cisme takılınca düşer. Mermer: Mermer ağır ve dörtgen olduğu için herhangi bir cisme takılınca düşmez.
No Response	
99	BLANK

11.B

12. Coding Guide

Code	Response
Correct Response	
20	2. Öğrenci 75. Çünkü çok uzağa atıyor.
Partial Response	
10	2. Öğrenci 75
Incorrect Response	
70	5 çünkü çok az atmıştır.
No Response	
99	BLANK

13. D

14. Coding Guide

Code	Response
Correct Response	
20	

Tahıl	Başlangıç g	Aldıkları g	Toplam g
Mısır	95 g	20 g	115 g
Pirinç	98 g	15 g	113 g
Buğday	92 g	18 g	110 g
Mısır Pirinç Buğday (Hepsi)	90 g	22 g	112 g

Partial Response	
10	Veriler sadece bir tabloda kaydedilmiş, analiz edilmemiş:

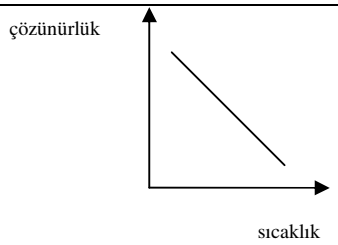
Beslendiği Tahıl	Eski kg	Aldığı kg
Mısır	95	20
Pirinç	98	15
Buğday	92	18
Mısır-buğday-Pirinç	90	22

Incorrect Response	
70	Verilerden tablo çizilmeye çalışılmış:

20 g	90 g
15 g	Pirinç
95 g	Buğday
98 g	Buğday
92 g	pirinç

No Response	
99	BLANK

15. Coding Guide

Code	Response
Correct Response	
10	

Incorrect Response	
70	İlişki yazıyla ifade edilmiş:

Amonyak gazı arttıkça azalır	Sonra da bekledikten sonra çoğalır.

No Response	
99	BLANK

B.1.2.1 (Cont.'d)

16. Coding Guide

Code	Response
Correct Response	
10	Yer çekimi ne kadar azsa sıçrama yüksekliği o kadar fazladır.
Partial Response	
10	Merkür'de yer çekimi az olduğu için sıçrama yüksekliği artar.
Incorrect Response	
70	Yerçekimi sıçramadan daha da aşağıdadır.
No Response	
99	BLANK

B.1.2.2 Second Science Process Skills Test Key

1. A

2. Coding Guide

Code	Response
Correct Response	
20	Hayvanlarla Taşınan Tohumlar: A, C, F Rüzgârla Taşınan Tohumlar: B, D, E
Partial Response	
10	Hayvanlarla Taşınan Tohumlar: A
11	Hayvanlarla Taşınan Tohumlar: C
12	Hayvanlarla Taşınan Tohumlar: F
13	Rüzgârla Taşınan Tohumlar: B
14	Rüzgârla Taşınan Tohumlar: D
15	Rüzgârla Taşınan Tohumlar: E
Incorrect Response	
70	Hayvanlarla Taşınan Tohumlar: B, D, E; Rüzgârla Taşınan Tohumlar: A, C, F
No Response	
99	BLANK

3. C
4. A

5. Coding Guide

Code	Response
Correct Response	
10	Merkür
Incorrect Response	
70	Others
No Response	
99	BLANK

6. C

7. Coding Guide

Code	Response
Correct Response	
20	Yarıştan önce nabız ve soluk alıp verme normalken, yarıştan sonra nabız ve soluk alıp verme oranlarında artış olur.
Partial Response	
10	Yarışı koşmadan önce ve sonrasından bahsedilmez: Nefes alıp verme hızlanır.
11	Sadece nabızdaki değişiklikten bahsedilir: Nabzımız bir yerde otururken nabzımız rahat olur. Bir yeri koşarak gidersek nabzımız ve kalbimiz çok fazla artar.
12	Sadece soluk alıp vermedeki değişiklikten bahsedilir: 50 metreyi koşunca nefes alıp verme oranlarımız çoğalır. Nefes nefese kalırız.
Incorrect Response	
70	Yavaş yavaş atmasını beklerim.
No Response	
99	BLANK

8. a. Coding Guide

Code	Response
Correct Response	
10	M Terazi
Incorrect Response	
70	Others
No Response	
99	BLANK

8.b Coding Guide

Code	Response
Correct Response	
10	L. Dereceli Silindir
Incorrect Response	
70	Others
No Response	
99	BLANK

9. A
10. C

11. Coding Guide

Code	Response
Correct Response	
10	O
Incorrect Response	
70	Others
No Response	
99	BLANK

12. Coding Guide

Code	Response
Correct Response	
20	S, T, U. Boş olduğunda, 1 tahta olduğunda ve 2 tahta olduğunda ne olduğunu ve ne kadar hızı olduğunu öğrenmek için.
21	S, T ve U'dan 2'si: U ile S harfini karşılaştırmalıdır. Çünkü Abdullah araba ne kadar ağırsa, rampanın aşağısındaki hızı o kadar fazladır dediği için U harfi ile S harfini örnek verebiliriz.
Partial Response	
10	S, T ve U
Incorrect Response	
70	Others
No Response	
99	BLANK

B.1.2.2 (Cont.'d)

13. Coding Guide

Code	Response
Correct Response	
10	3.1 cm.
11	3 cm.
12	3.5 cm.
Incorrect Response	
70	Others
No Response	
99	BLANK

14. D

15. Coding Guide

Code	Response
Correct Response	
10	Y
Incorrect Response	
70	Others
No Response	
99	BLANK

16. Coding Guide

Code	Response
Correct Response	
10	7:00, 10:00 ve 11:30 3 kez
11	7:00 ve 10:00 2 kez
Incorrect Response	
70	Others
No Response	
99	BLANK

B.1.2.3 Third Science Process Skills Test Key

1. A
2. A
3. C

4. Coding Guide

Code	Response
Correct Response	
20	Rıdvan'ınki. Beyaz reflektör ışığı daha çok yansıtır.
Partial Response	
10	Rıdvan'ınki.
Incorrect Response	
70	Others
No Response	
99	BLANK

5. Coding Guide

Code	Response
Correct Response	
10	8 16
Incorrect Response	
70	Others
No Response	
99	BLANK

6. B
7. B
8. B
9. D
10. A

11. Coding Guide

Code	Response
Correct Response	
10	J
Incorrect Response	
70	Others
No Response	
99	BLANK

12. B
13. C

B.1.2.3 (Cont.'d)

14. Coding Guide

Code	Response
Correct Response	
20	3. deneme. Çünkü; elimizi sürttükçe ısınır.
Partial Response	
10	3
Incorrect Response	
70	Others
No Response	
99	BLANK

15. Coding Guide

Code	Response
Correct Response	
10	Sütun grafiği. Sütün grafiği çizilmiş.
11	Çizgi grafiği çizilmiş.
Incorrect Response	
70	Others
No Response	
99	BLANK

16. C

B.1.3 Cognitive Processes of the Science Process Skills Test Forms

Table B.1 Cognitive processes of the science process skills tests

	First	Second	Third	Fourth
1	Gözlem	Gözlem	Gözlem	Gözlem
2	Karşılaştırma-Sınıflama	Karşılaştırma-Sınıflama	Karşılaştırma-Sınıflama	Karşılaştırma-Sınıflama
3	Çıkarım Yapma	Çıkarım Yapma	Çıkarım Yapma	Çıkarım Yapma
4	Tahmin	Tahmin	Tahmin	Tahmin
5	Kestirme	Kestirme	Kestirme	Kestirme
6	Değişkenleri Belirleme	Değişkenleri Belirleme	Değişkenleri Belirleme	Değişkenleri Belirleme
7	Hipotez Kurma	Hipotez Kurma	Hipotez Kurma	Hipotez Kurma
8	Deney Malzemelerini ve Araç-Gereçlerini Tanıma ve Kullanma	Deney Malzemelerini ve Araç-Gereçlerini Tanıma ve Kullanma	Değişkenleri Belirleme	Deney Malzemelerini ve Araç-Gereçlerini Tanıma ve Kullanma
9	Deney Düzeneği Kurma	Deney Tasarlama	Değişkenleri Belirleme	Deney Düzeneği Kurma
10	Değişkenleri Kontrol Etme ve Değiştirme	Deney Düzeneği Kurma	Değişkenleri Kontrol Etme ve Değiştirme	Değişkenleri Kontrol Etme ve Değiştirme
11	İşlevsel Tanımlama	Değişkenleri Kontrol Etme ve Değiştirme	Deney Malzemelerini ve Araç-Gereçlerini Tanıma ve Kullanma	İşlevsel Tanımlama
12	Ölçme	İşlevsel Tanımlama	İşlevsel Tanımlama	Ölçme
13	Bilgi ve Veri Toplama	Ölçme	Ölçme	Bilgi ve Veri Toplama
14	Verileri Kaydetme	Bilgi ve Veri Toplama	Bilgi ve Veri Toplama	Verileri Kaydetme
15	Veri İşleme ve Model Oluşturma	Veri İşleme ve Model Oluşturma	Veri İşleme ve Model Oluşturma	Veri İşleme ve Model Oluşturma
16	Yorumlama ve Sonuç Çıkarma	Yorumlama ve Sonuç Çıkarma	Yorumlama ve Sonuç Çıkarma	Yorumlama ve Sonuç Çıkarma
17				Gözlem
18				Karşılaştırma-Sınıflama
19				Çıkarım Yapma
20				Tahmin
21				Kestirme
22				Değişkenleri Belirleme
23				Hipotez Kurma
24				Deney Düzeneği Kurma
25				Değişkenleri Kontrol Etme ve Değiştirme
26				İşlevsel Tanımlama
27				Ölçme
28				Bilgi ve Veri Toplama
29				Veri İşleme ve Model Oluşturma
30				Yorumlama ve Sonuç Çıkarma

B.1.4 References for the Items of the Science Process Skills Test Forms

Table B.2 Reference of the first science process skills test

Item No	Source
1	Illinois Standards Achievement Test Science Samples http://www.isbe.net/assessment/pdfs/2008/ISAT_Sample_Book_Gr_7_s.pdf
2	2003 VDOE Released Items Grade 8: Science http://www.iq.poquoson.org/2003vasol/8sci03v5.html
3	TIMSS 1999 Science Items Released Set for Eighth Grade DO2 http://timss.bc.edu/timss1999i/pdf/t99science_items.pdf
4	Vırgınıa Standards of Learnıng Assessments Spring 2001 Released Test Grade 8 Scıence http://www.kidsnewsroom.org/resources/sol/VA/G08S01.pdf
5	Grade 5: Science (2000 VDOE Released Items) http://www.iq.poquoson.org/5sci00v5.htm
6	Grade 8: Science - VDOE 2004 Released Items http://www.iq.poquoson.org/2004vasol/8sci/8sci04v5.html
7	McGraw-Hill Science © 2000, Texas Edition TAKS Practice Test Grade 5, Chapter 1 The Importance of Plants http://www.mhtexas.com/correlations/pdf/G5_C01_SciTAKS.pdf
8	Grade 5: Science - VDOE 2004 Released Items http://www.iq.poquoson.org/2004vasol/5sci/5sci04v5.html Grade 5: Science (2002 VDOE Released Items) http://www.iq.poquoson.org/5sci02v5.htm Illinois Standards Achievement Test Science Samples http://www.isbe.net/assessment/pdfs/2008/ISAT_Sample_Book_Gr_4_s.pdf
9	Utah State Office of Education Biology Standard 8 Objective 1 http://www.usoe.k12.ut.us/curr/Science/core/assess/bio/8-1.html
10	2001 Özel Okullar Sınavı http://egitek.meb.gov.tr/Sinavlar/Sorular/OzelOkullar2005/2001OzelOkullarSnv.pdf
11	Illinois Standards Achievement Test Science Samples http://www.isbe.net/assessment/pdfs/2008/ISAT_Sample_Book_Gr_7_s.pdf
12	Grade 5: Science (2003 VDOE Released Items) http://www.iq.poquoson.org/2003vasol/5sci03v5.html
13	Grade 8: Science (2002 VDOE Released Items) http://www.iq.poquoson.org/8sci02v5.htm
14	Comprehensive Science Review (2002 VDOE Released Items) http://www.iq.poquoson.org/compscirevhs02v5.htm
15	2001 Devlet Parasız Yatılı ve Bursluluk Sınavları 91011/9.sınıf http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2001/Dpy9_Test2001.pdf
16	Grade 5: Science - VDOE 2004 Released Items http://www.iq.poquoson.org/2004vasol/5sci/5sci04v5.html

Table B.3 Reference of the second science process skills test

Item No	Source
1	Grade 5: Science (2003 VDOE Released Items) http://www.iq.poquoson.org/2003vasol/5sci03v5.html
2	Grade 5: Science (2002 VDOE Released Items) http://www.iq.poquoson.org/5sci02v5.htm
3	Test of Integrated Process Skills (Dillashaw & Okey, as cited in Moore 2001, p. 77-92; Turpin, 2000, p. 99-104.)
4	Grade 5: Science (2002 VDOE Released Items) http://www.iq.poquoson.org/5sci02v5.htm
5	2003 VDOE Released Items Grade 8: Science http://www.iq.poquoson.org/2003vasol/8sci03v5.html
6	Test of Integrated Process Skills (Dillashaw & Okey, as cited in Moore 2001, p. 77-92; Turpin, 2000, p. 99-104.)
7	TIMSS 1999 Science Items Released Set for Eighth Grade XO3 http://timss.bc.edu/timss1999i/pdf/t99science_items.pdf
8	Grade 5: Science (2002 VDOE Released Items) http://www.iq.poquoson.org/5sci02v5.htm Grade 5: Science (2000 VDOE Released Items) http://www.iq.poquoson.org/5sci00v5.htm Grade 5: Science (2002 VDOE Released Items) http://www.iq.poquoson.org/5sci02v5.htm
9	McGraw-Hill Science © 2000, Texas Edition TAKS Practice Test Grade 5, Chapter 9 Earth, Your Home http://www.mhtexas.com/correlations/pdf/G5_C09_SciTAKS.pdf
10	1999 Orta Öğretim Kurumları Öğrenci Seçme ve Yerleştirme Sınavı http://egitek.meb.gov.tr/Sinavlar/Sorular/Ook/Ook1999/Ook1999Test_Key.pdf
11	2001 Orta Öğretim Kurumları Öğrenci Seçme ve Yerleştirme Sınavı http://egitek.meb.gov.tr/Sinavlar/Sorular/Ook/Ook2001/Ook2001Test_Key.pdf
12	TIMSS Released Set for Population 2 (Seventh and Eighth Grades) I12 http://timss.bc.edu/timss1995i/TIMSSPDF/BSitems.pdf
13	Grade 5: Science (2002 VDOE Released Items) http://www.iq.poquoson.org/5sci02v5.htm
14	Grade 8: Science - VDOE 2004 Released Items http://www.iq.poquoson.org/2004vasol/8sci/8sci04v5.html
15	TIMSS 1999 Science Items Released Set for Eighth Grade BO3 http://timss.bc.edu/timss1999i/pdf/t99science_items.pdf
16	Test of Integrated Process Skills (Dillashaw & Okey, as cited in Moore 2001, p. 77-92; Turpin, 2000, p. 99-104.)

Table B.4 Reference of the third science process skills test

Item No	Source
1	Grade 5: Science (2000 VDOE Released Items) http://www.iq.poquoson.org/5sci00v5.htm
2	Grade 5: Science (2003 VDOE Released Items) http://www.iq.poquoson.org/2003vasol/5sci03v5.html
3	TIMSS 1999 Science Items Released Set for Eighth Grade JO4 http://timss.bc.edu/timss1999i/pdf/t99science_items.pdf
4	TIMSS 1999 Science Items Released Set for Eighth Grade N1O http://timss.bc.edu/timss1999i/pdf/t99science_items.pdf
5	Grade 5: Science (2000 VDOE Released Items) http://www.iq.poquoson.org/5sci00v5.htm
6	Test of Integrated Process Skills (Dillashaw & Okey, as cited in Moore 2001, p. 77-92; Turpin, 2000, p. 99-104.)
7	Test of Integrated Process Skills (Dillashaw & Okey, as cited in Moore 2001, p. 77-92; Turpin, 2000, p. 99-104.)
8	Test of Integrated Process Skills (Dillashaw & Okey, as cited in Moore 2001, p. 77-92; Turpin, 2000, p. 99-104.)
9	Test of Integrated Process Skills (Dillashaw & Okey, as cited in Moore 2001, p. 77-92; Turpin, 2000, p. 99-104.)
10	Grade 5: Science - VDOE 2004 Released Items http://www.iq.poquoson.org/2004vasol/5sci/5sci04v5.html
11	Grade 5: Science (2000 VDOE Released Items) http://www.iq.poquoson.org/5sci00v5.htm Grade 5: Science (2002 VDOE Released Items) http://www.iq.poquoson.org/5sci02v5.htm
12	Comprehensive Science Review (2002 VDOE Released Items) http://www.iq.poquoson.org/8sci02v5.htm
13	Test of Integrated Process Skills (Dillashaw & Okey, as cited in Moore 2001, p. 77-92; Turpin, 2000, p. 99-104.)
14	Grade 5: Science (2002 VDOE Released Items) http://www.iq.poquoson.org/5sci01v5.htm
15	Comprehensive Science Review (2002 VDOE Released Items) http://www.iq.poquoson.org/8sci02v5.htm
16	2000 Orta Öğretim Kurumları Öğrenci Seçme ve Yerleştirme Sınavı http://egitek.meb.gov.tr/Sinavlar/Sorular/Ook/Ook2000/Ook2000Test_Key.pdf

B.1.5 Item difficulty (p) and corrected item-total correlation coefficient (r) values of the items of the science process skills test forms developed from the pilot study

Table B.5 Item difficulty (p) and corrected item-total correlation coefficient (r) values of the items of the science process skills test forms developed from the pilot study

	First		Second		Third	
	p	r	p	r	p	r
1	.64	,401	.53	,245	.60	,195
2	.35	,599	.14	.541	.85	,216
	.47	.484	.15	.506		
	.48	.528	.07	.263		
			.10	.457		
			.13	.494		
			.19	.537		
3	.64	,396	.47	,383	.71	,351
4	.43	,382	.74	,370	.26	,364
5	.67	,421	.59	,512	.27	,104
6	.35	,324	.42	,352	.26	-,122
7	.43	,517	.49	,437	.57	,348
8	.43	,612	.56	,312	.25	,216
	.22	.500	.25	.468		
9	.30	,297	.29	,446	.31	-,006
10	.21	,543	.32	,143	.25	,710
11	.45	,398	.13	,504	.31	,455
					(not in the pilot)	(not in the pilot)
12	.35	,309	.26	,379	.09	,425
13	.35	,370	.55	,246	.46	,540
14	.09	,450	.40	,263	.19	,502
15	.23	,472	.27	,356	.22	,271
16	.28	,529	.31	,491	.48	,319
	.19	.706				
	(items combined)	(items combined)				

B.2 The Attitudes toward Science Lesson Questionnaire Developed from the Pilot Study

B.2.1 The Attitudes toward Science Lesson Questionnaire Form (and Its' Subtests) Developed from the Pilot Study

Anxiety
Fen Bilgisi dersinde başarılı olmak için gerekli yeteneğe sahibim.
Fen Bilgisi dersini kolayca anlayabiliyorum.
Fen Bilgisi dersi konularına yakın olduğumu düşünüyorum.
Lise ve üniversitede Fen Bilgisi ile ilgili derslerde başarısız olacağımı düşünüyorum.
Fen Bilgisi dersinde yapılan sınavlarda kendimi rahat hissederim.
Fen Bilgisi dersinde yapılan sınavlardan korkarım.

Interest/Curiosity
Fen Bilgisi dersi ile ilgili televizyon programı ve CD izlemekten hoşlanırım.
Fen Bilgisi dersinde öğrendiklerimi arkadaşlarımla paylaşırım.
Fen Bilgisi dersinde öğrendiklerimi ailemle paylaşırım.
Okulumda Fen Bilgisi topluluğu olsaydı üye olmak isterdim.

Career
Bilim, teknoloji ve çevre ilgili sorunları çözmek için bilim insanları ile çalışmak isterim.
Fen Bilgisi ile ilgili sahip olabileceğim meslekleri öğrenmek isterim.
Bana hediye olarak fen bilgisi dersi ile ilgili bir kitap ya da oyuncak verilmesinden hoşlanırım.
Fen Bilgisi dersinde öğrendiklerimi ileride kullanmayı düşünüyorum.

Enjoyment
Fen Bilgisi dersinden zevk alırım.
Fen Bilgisi dersine çalışmaktan hoşlanırım.
Fen Bilgisi dersi sıkıcıdır.
Fen Bilgisi dersinde rahatımdır.
Fen Bilgisi dersine karşı ilgiliyimdir.
Fen Bilgisi dersi eğlenceli değildir.
Fen Bilgisi dersi beni huzursuz eder.
Fen Bilgisi dersinden hoşlanmıyorum.
Çalışma zamanımın önemli bir kısmını Fen Bilgisi dersine ayırmak isterim.
Aldığım diğer dersler Fen Bilgisi dersinden daha ilgi çekicidir.
Fen Bilgisi dersini sevmiyorum.

Motivation
Fen Bilgisi dersi ödevlerini, ne kadar zor olursa olsun yapmayı denerim.
Fen Bilgisi dersinde iyi olmaya çalışırım.
Fen Bilgisi dersinde sorulan soruların cevaplarını çeşitli kaynaklardan (kitap, internet gibi) araştırırım.

Relation to Daily Life.
Fen Bilgisi dersinde sorulan sorular gerçek hayatla ilgilidir.
Fen Bilgisi dersi doğa olaylarını daha iyi anlamama yarar.
Fen Bilgisi dersinde sorulan soruları cevaplamaktan hoşlanırım.

Importance
Fen Bilgisi dersinin gereksiz olduğunu düşünüyorum.
Fen Bilgisi dersi düşünme yeteneğimi geliştirir.

B.2.2 Corrected item-total correlation coefficient (r) values of the items of the attitudes toward science and technology course questionnaire in the pilot study

Table B.6 Corrected item-total correlation coefficient (r) values of the items of the attitudes toward science and technology course questionnaire in the pilot study

İtems	r
1	,642
2	,521
3	,694
4	,514
5	,600
6	,429
7	,504
8	,504
9	,481
10	,527
11	,454
12	,470
13	,490
14	,618
15	,706
16	,737
17	,673
18	,530
19	,746
20	,704
21	,721
22	,707
23	,545
24	,499
25	,603
26	,539
27	,504
28	,522
29	,410
30	,413
31	,568
32	,634
33	,597

APPENDIX C

DEMOGRAPHIC FORM

	1993	1994	1995	1996
Doğum tarihiniz nedir?				

Anne ve babanızın mesleği nedir?	Ev hanımı	İşsiz	İşçi	Memur	Serbest meslek	Diğer(yazınız)
Annem						
Babam						

Anne ve babanızın eğitim düzeyi nedir?	Okur-yazar değil	Okur-yazar	İlkokul	Ortaokul	İlköğretim Okulu	Lise	Üniversite	Yüksek Lisans/ Doktora
Annem								
Babam								

	Hiç yok	1	2	3	4	5 ve 5'ten fazla
Kaç kardeşiniz var?						

Ailenizin aylık geliri yaklaşık ne kadar olabilir? (YTL olarak)

0–350	351-500	501-750	751-1000	1001-1250	1251-1500	1501-1750	1751'den fazla

Evinizde aşağıdakilerden hangisi bulunmaktadır?	Var
Kullandığımız bir bulaşık makinesi	
Bilgisayar	
Kendime ait bir çalışma odası	

Aşağıdaki soruları cevaplayınız.	Evet	Hayır
Okul dışı zamanınızda para kazanmak için çalışıyorum.		
Okul öncesi eğitim (ana okulu) aldım.		

	5	6	7	8	9	10	11
İlköğretim 1. sınıfa kaç yaşında başladınız?							

	0-10	11-25	26-100	101-200	200'den fazla kitap
Evinizde kaç tane kitap vardır?					

	Evet	Hayır
Evinize gazete, dergi alınıyor mu?		

APPENDIX D

ATTITUDES TOWARD SCIENCE AND TECHNOLOGY COURSE QUESTIONNAIRE FORM

Self-Concept

Fen Bilgisi dersinde başarılı olmak için gerekli yeteneğe sahibim.
Fen Bilgisi dersini kolayca anlayabiliyorum.
Fen Bilgisi dersi konularına yakın olduğumu düşünüyorum.
Fen Bilgisi dersinde yapılan sınavlarda kendimi rahat hissederim.

Anxiety

Lise ve üniversitede Fen Bilgisi ile ilgili derslerde başarısız olacağımı düşünüyorum.
Fen Bilgisi dersinde yapılan sınavlardan korkarım.
Fen Bilgisi dersi sıkıcıdır.
Fen Bilgisi dersi beni huzursuz eder.
Fen Bilgisi dersinden hoşlanmıyorum.
Fen Bilgisi dersi eğlenceli değildir.
Aldığım diğer dersler Fen Bilgisi dersinden daha ilgi çekicidir.
Fen Bilgisi dersini sevmiyorum.
Fen Bilgisi dersinin gereksiz olduğunu düşünüyorum.

Interest

Fen Bilgisi dersi ile ilgili televizyon programı ve CD izlemekten hoşlanırım.
Okulumda Fen Bilgisi topluluğu olsaydı üye olmak isterdim.
Bilim, teknoloji ve çevre ilgili sorunları çözmek için bilim insanları ile çalışmak isterim.
Bana hediye olarak fen bilgisi dersi ile ilgili bir kitap ya da oyuncak verilmesinden hoşlanırım.

Career

Fen Bilgisi dersinde öğrendiklerimi ailemle paylaşırım.
Fen Bilgisi ile ilgili sahip olabileceğim meslekleri öğrenmek isterim.
Fen Bilgisi dersinde öğrendiklerimi ileride kullanmayı düşünüyorum.
Çalışma zamanımın önemli bir kısmını Fen Bilgisi dersine ayırmak isterim.

Enjoyment

Fen Bilgisi dersinden zevk alırım.
Fen Bilgisi dersine çalışmaktan hoşlanırım.
Fen Bilgisi dersinde rahatımdır.
Fen Bilgisi dersine karşı ilgiliyimdir.

Usefulness

Fen Bilgisi dersinde iyi olmaya çalışırım.
Fen Bilgisi dersinde sorulan sorular gerçek hayatla ilgilidir.
Fen Bilgisi dersi doğa olaylarını daha iyi anlamama yarar.
Fen Bilgisi dersinde sorulan soruları cevaplamaktan hoşlanırım.
Fen Bilgisi dersi düşünme yeteneğimi geliştirir.

APPENDIX E

MISSING DATA IN ATTITUDES TOWARD SCIENCE AND TECHNOLOGY COURSE QUESTIONNAIRE

E.1 Missing Data in the First Attitudes toward Science and Technology Course Questionnaire

yetenek1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1,2	1,2	1,2
	3	20	11,9	11,9	13,1
	4	73	43,5	43,5	56,5
	5	73	43,5	43,5	100,0
	Total	168	100,0	100,0	

anlama1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1,2	1,2	1,2
	2	4	2,4	2,4	3,6
	3	17	10,1	10,1	13,7
	4	70	41,7	41,7	55,4
	5	75	44,6	44,6	100,0
	Total	168	100,0	100,0	

basarisiz1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1,2	1,2	1,2
	1	18	10,7	10,7	11,9
	2	15	8,9	8,9	20,8
	3	46	27,4	27,4	48,2
	4	46	27,4	27,4	75,6
	5	41	24,4	24,4	100,0
	Total	168	100,0	100,0	

sinavdarahat1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	4	2,4	2,4	2,4
	1	6	3,6	3,6	6,0
	2	10	6,0	6,0	11,9
	3	29	17,3	17,3	29,2
	4	58	34,5	34,5	63,7
	5	61	36,3	36,3	100,0
	Total	168	100,0	100,0	

E.1 (Cont.'d)

korkma1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	4	2,4	2,4	2,4
	1	17	10,1	10,1	12,5
	2	12	7,1	7,1	19,6
	3	25	14,9	14,9	34,5
	4	53	31,5	31,5	66,1
	5	57	33,9	33,9	100,0
	Total	168	100,0	100,0	

tvcd1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	3	1,8	1,8	1,8
	1	11	6,5	6,5	8,3
	2	14	8,3	8,3	16,7
	3	21	12,5	12,5	29,2
	4	48	28,6	28,6	57,7
	5	71	42,3	42,3	100,0
	Total	168	100,0	100,0	

aile1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	3	1,8	1,8	1,8
	1	4	2,4	2,4	4,2
	2	8	4,8	4,8	8,9
	3	25	14,9	14,9	23,8
	4	58	34,5	34,5	58,3
	5	70	41,7	41,7	100,0
	Total	168	100,0	100,0	

uyelik1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	4	2,4	2,4	2,4
	1	6	3,6	3,6	6,0
	2	4	2,4	2,4	8,3
	3	47	28,0	28,0	36,3
	4	46	27,4	27,4	63,7
	5	61	36,3	36,3	100,0
	Total	168	100,0	100,0	

blmnsncalisma1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	4	2,4	2,4	2,4
	1	6	3,6	3,6	6,0
	2	2	1,2	1,2	7,1
	3	25	14,9	14,9	22,0
	4	39	23,2	23,2	45,2
	5	92	54,8	54,8	100,0
	Total	168	100,0	100,0	

E.1 (Cont.'d)

meslek1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	3	1,8	1,8	1,8
	1	1	,6	,6	2,4
	2	5	3,0	3,0	5,4
	3	18	10,7	10,7	16,1
	4	48	28,6	28,6	44,6
	5	93	55,4	55,4	100,0
	Total	168	100,0	100,0	

kitapoyuncak1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	3	1,8	1,8	1,8
	1	7	4,2	4,2	6,0
	2	10	6,0	6,0	11,9
	3	15	8,9	8,9	20,8
	4	52	31,0	31,0	51,8
	5	81	48,2	48,2	100,0
	Total	168	100,0	100,0	

ileridekullanma1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	3	1,8	1,8	1,8
	1	1	,6	,6	2,4
	2	5	3,0	3,0	5,4
	3	23	13,7	13,7	19,0
	4	50	29,8	29,8	48,8
	5	86	51,2	51,2	100,0
	Total	168	100,0	100,0	

zevkalma1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	3	1,8	1,8	1,8
	1	2	1,2	1,2	3,0
	2	5	3,0	3,0	6,0
	3	11	6,5	6,5	12,5
	4	59	35,1	35,1	47,6
	5	88	52,4	52,4	100,0
	Total	168	100,0	100,0	

hoslanma1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	7	4,2	4,2	4,2
	1	2	1,2	1,2	5,4
	2	1	,6	,6	6,0
	3	11	6,5	6,5	12,5
	4	62	36,9	36,9	49,4
	5	85	50,6	50,6	100,0
	Total	168	100,0	100,0	

E.1 (Cont.'d)

sikici1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	8	4,8	4,8	4,8
	1	12	7,1	7,1	11,9
	2	14	8,3	8,3	20,2
	3	18	10,7	10,7	31,0
	4	39	23,2	23,2	54,2
	5	77	45,8	45,8	100,0
	Total	168	100,0	100,0	

dersterahat1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	3	1,8	1,8	1,8
	1	3	1,8	1,8	3,6
	2	6	3,6	3,6	7,1
	3	20	11,9	11,9	19,0
	4	57	33,9	33,9	53,0
	5	79	47,0	47,0	100,0
	Total	168	100,0	100,0	

ilgili1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	,6	,6	,6
	1	9	5,4	5,4	6,0
	2	6	3,6	3,6	9,5
	3	18	10,7	10,7	20,2
	4	65	38,7	38,7	58,9
	5	69	41,1	41,1	100,0
	Total	168	100,0	100,0	

huzursuz1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	4	2,4	2,4	2,4
	1	15	8,9	8,9	11,3
	2	9	5,4	5,4	16,7
	3	18	10,7	10,7	27,4
	4	37	22,0	22,0	49,4
	5	85	50,6	50,6	100,0
	Total	168	100,0	100,0	

hoslanmamak1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	5	3,0	3,0	3,0
	1	33	19,6	19,6	22,6
	2	13	7,7	7,7	30,4
	3	14	8,3	8,3	38,7
	4	29	17,3	17,3	56,0
	5	74	44,0	44,0	100,0
	Total	168	100,0	100,0	

E.1 (Cont.'d)

eglenceliolmama1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	8	4,8	4,8	4,8
	1	8	4,8	4,8	9,5
	2	16	9,5	9,5	19,0
	3	18	10,7	10,7	29,8
	4	35	20,8	20,8	50,6
	5	83	49,4	49,4	100,0
	Total	168	100,0	100,0	

ayirma1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	,6	,6	,6
	1	5	3,0	3,0	3,6
	2	9	5,4	5,4	8,9
	3	45	26,8	26,8	35,7
	4	59	35,1	35,1	70,8
	5	49	29,2	29,2	100,0
	Total	168	100,0	100,0	

ilgicekici1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	3	1,8	1,8	1,8
	1	20	11,9	11,9	13,7
	2	37	22,0	22,0	35,7
	3	70	41,7	41,7	77,4
	4	18	10,7	10,7	88,1
	5	20	11,9	11,9	100,0
	Total	168	100,0	100,0	

sevmeme1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	8	4,8	4,8	4,8
	1	40	23,8	23,8	28,6
	2	29	17,3	17,3	45,8
	3	9	5,4	5,4	51,2
	4	23	13,7	13,7	64,9
	5	59	35,1	35,1	100,0
	Total	168	100,0	100,0	

iyiolma1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	3	1,8	1,8	1,8
	1	2	1,2	1,2	3,0
	3	10	6,0	6,0	8,9
	4	52	31,0	31,0	39,9
	5	101	60,1	60,1	100,0
	Total	168	100,0	100,0	

E.1 (Cont.'d)

gercekhayat1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1,2	1,2	1,2
	1	1	,6	,6	1,8
	2	1	,6	,6	2,4
	3	34	20,2	20,2	22,6
	4	57	33,9	33,9	56,5
	5	73	43,5	43,5	100,0
	Total	168	100,0	100,0	

iyianlama1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	4	2,4	2,4	2,4
	1	6	3,6	3,6	6,0
	2	2	1,2	1,2	7,1
	3	22	13,1	13,1	20,2
	4	46	27,4	27,4	47,6
	5	88	52,4	52,4	100,0
	Total	168	100,0	100,0	

cevaphoslanma1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	4	2,4	2,4	2,4
	1	1	,6	,6	3,0
	2	3	1,8	1,8	4,8
	3	20	11,9	11,9	16,7
	4	64	38,1	38,1	54,8
	5	76	45,2	45,2	100,0
	Total	168	100,0	100,0	

gereksiz1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	4	2,4	2,4	2,4
	1	17	10,1	10,1	12,5
	2	11	6,5	6,5	19,0
	3	8	4,8	4,8	23,8
	4	24	14,3	14,3	38,1
	5	104	61,9	61,9	100,0
	Total	168	100,0	100,0	

dusunmegelistirme1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1,2	1,2	1,2
	1	2	1,2	1,2	2,4
	2	3	1,8	1,8	4,2
	3	18	10,7	10,7	14,9
	4	44	26,2	26,2	41,1
	5	99	58,9	58,9	100,0
	Total	168	100,0	100,0	

E.2 Missing Data in the Second Attitudes toward Science and Technology Course Questionnaire

anlama2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1,2	1,2	1,2
	2	2	1,2	1,2	2,4
	3	12	7,1	7,1	9,5
	4	63	37,5	37,5	47,0
	5	89	53,0	53,0	100,0
	Total	168	100,0	100,0	

yakinolma2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	5	3,0	3,0	3,0
	1	2	1,2	1,2	4,2
	2	2	1,2	1,2	5,4
	3	27	16,1	16,1	21,4
	4	48	28,6	28,6	50,0
	5	84	50,0	50,0	100,0
	Total	168	100,0	100,0	

basarisiz2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	3	1,8	1,8	1,8
	1	29	17,3	17,3	19,0
	2	19	11,3	11,3	30,4
	3	34	20,2	20,2	50,6
	4	30	17,9	17,9	68,5
	5	53	31,5	31,5	100,0
	Total	168	100,0	100,0	

sinavdarahat2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	3	1,8	1,8	1,8
	1	5	3,0	3,0	4,8
	2	8	4,8	4,8	9,5
	3	22	13,1	13,1	22,6
	4	59	35,1	35,1	57,7
	5	71	42,3	42,3	100,0
	Total	168	100,0	100,0	

korkma2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	4	2,4	2,4	2,4
	1	29	17,3	17,3	19,6
	2	24	14,3	14,3	33,9
	3	17	10,1	10,1	44,0
	4	29	17,3	17,3	61,3
	5	65	38,7	38,7	100,0
	Total	168	100,0	100,0	

E.2 (Cont.'d)

tvcd2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	,6	,6	,6
	1	3	1,8	1,8	2,4
	2	12	7,1	7,1	9,5
	3	21	12,5	12,5	22,0
	4	45	26,8	26,8	48,8
	5	86	51,2	51,2	100,0
	Total	168	100,0	100,0	

uyelik2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1,2	1,2	1,2
	1	5	3,0	3,0	4,2
	2	5	3,0	3,0	7,1
	3	45	26,8	26,8	33,9
	4	43	25,6	25,6	59,5
	5	68	40,5	40,5	100,0
	Total	168	100,0	100,0	

blmnsncalisma2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	4	2,4	2,4	2,4
	1	1	,6	,6	3,0
	2	5	3,0	3,0	6,0
	3	22	13,1	13,1	19,0
	4	31	18,5	18,5	37,5
	5	105	62,5	62,5	100,0
	Total	168	100,0	100,0	

meslek2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1,2	1,2	1,2
	1	2	1,2	1,2	2,4
	2	7	4,2	4,2	6,5
	3	10	6,0	6,0	12,5
	4	40	23,8	23,8	36,3
	5	107	63,7	63,7	100,0
	Total	168	100,0	100,0	

kitapoyuncak2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1,2	1,2	1,2
	1	2	1,2	1,2	2,4
	2	8	4,8	4,8	7,1
	3	18	10,7	10,7	17,9
	4	48	28,6	28,6	46,4
	5	90	53,6	53,6	100,0
	Total	168	100,0	100,0	

E.2 (Cont.'d)

ileridekullanma2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	3	1,8	1,8	1,8
	1	3	1,8	1,8	3,6
	2	4	2,4	2,4	6,0
	3	18	10,7	10,7	16,7
	4	44	26,2	26,2	42,9
	5	96	57,1	57,1	100,0
	Total	168	100,0	100,0	

zevkalma2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	6	3,6	3,6	3,6
	1	1	,6	,6	4,2
	2	3	1,8	1,8	6,0
	3	12	7,1	7,1	13,1
	4	46	27,4	27,4	40,5
	5	100	59,5	59,5	100,0
	Total	168	100,0	100,0	

hoslanma2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	8	4,8	4,8	4,8
	1	5	3,0	3,0	7,7
	2	5	3,0	3,0	10,7
	3	12	7,1	7,1	17,9
	4	42	25,0	25,0	42,9
	5	96	57,1	57,1	100,0
	Total	168	100,0	100,0	

sikici2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	4	2,4	2,4	2,4
	1	26	15,5	15,5	17,9
	2	14	8,3	8,3	26,2
	3	15	8,9	8,9	35,1
	4	19	11,3	11,3	46,4
	5	90	53,6	53,6	100,0
	Total	168	100,0	100,0	

dersterahat2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	5	3,0	3,0	3,0
	1	6	3,6	3,6	6,5
	2	3	1,8	1,8	8,3
	3	21	12,5	12,5	20,8
	4	44	26,2	26,2	47,0
	5	89	53,0	53,0	100,0
	Total	168	100,0	100,0	

E.2 (Cont.'d)

ilgili2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1,2	1,2	1,2
	1	8	4,8	4,8	6,0
	2	6	3,6	3,6	9,5
	3	15	8,9	8,9	18,5
	4	59	35,1	35,1	53,6
	5	78	46,4	46,4	100,0
	Total	168	100,0	100,0	

huzursuz2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	4	2,4	2,4	2,4
	1	27	16,1	16,1	18,5
	2	10	6,0	6,0	24,4
	3	11	6,5	6,5	31,0
	4	26	15,5	15,5	46,4
	5	90	53,6	53,6	100,0
	Total	168	100,0	100,0	

hoslanmamak2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	5	3,0	3,0	3,0
	1	29	17,3	17,3	20,2
	2	18	10,7	10,7	31,0
	3	16	9,5	9,5	40,5
	4	15	8,9	8,9	49,4
	5	85	50,6	50,6	100,0
	Total	168	100,0	100,0	

eglenceliolmama2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	6	3,6	3,6	3,6
	1	22	13,1	13,1	16,7
	2	19	11,3	11,3	28,0
	3	10	6,0	6,0	33,9
	4	22	13,1	13,1	47,0
	5	89	53,0	53,0	100,0
	Total	168	100,0	100,0	

ayirma2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	5	3,0	3,0	3,0
	1	9	5,4	5,4	8,3
	2	5	3,0	3,0	11,3
	3	30	17,9	17,9	29,2
	4	46	27,4	27,4	56,5
	5	73	43,5	43,5	100,0
	Total	168	100,0	100,0	

E.2 (Cont.'d)

ilgicekici2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	7	4,2	4,2	4,2
	1	32	19,0	19,0	23,2
	2	41	24,4	24,4	47,6
	3	49	29,2	29,2	76,8
	4	23	13,7	13,7	90,5
	5	16	9,5	9,5	100,0
	Total	168	100,0	100,0	

sevmeme2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1,2	1,2	1,2
	1	44	26,2	26,2	27,4
	2	20	11,9	11,9	39,3
	3	15	8,9	8,9	48,2
	4	18	10,7	10,7	58,9
	5	69	41,1	41,1	100,0
	Total	168	100,0	100,0	

iyiolma2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	5	3,0	3,0	3,0
	1	2	1,2	1,2	4,2
	2	4	2,4	2,4	6,5
	3	5	3,0	3,0	9,5
	4	32	19,0	19,0	28,6
	5	120	71,4	71,4	100,0
	Total	168	100,0	100,0	

gercekhayat2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	4	2,4	2,4	2,4
	1	1	,6	,6	3,0
	2	2	1,2	1,2	4,2
	3	25	14,9	14,9	19,0
	4	41	24,4	24,4	43,5
	5	95	56,5	56,5	100,0
	Total	168	100,0	100,0	

iyianlama2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	3	1,8	1,8	1,8
	1	1	,6	,6	2,4
	2	5	3,0	3,0	5,4
	3	21	12,5	12,5	17,9
	4	37	22,0	22,0	39,9
	5	101	60,1	60,1	100,0
	Total	168	100,0	100,0	

E.2 (Cont.'d)

cevaphoslanma2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	5	3,0	3,0	3,0
	1	2	1,2	1,2	4,2
	2	3	1,8	1,8	6,0
	3	14	8,3	8,3	14,3
	4	50	29,8	29,8	44,0
	5	94	56,0	56,0	100,0
	Total	168	100,0	100,0	

gereksiz2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	,6	,6	,6
	1	30	17,9	17,9	18,5
	2	15	8,9	8,9	27,4
	3	11	6,5	6,5	33,9
	4	10	6,0	6,0	39,9
	5	101	60,1	60,1	100,0
	Total	168	100,0	100,0	

dusunmegelistirme2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	3	1,8	1,8	1,8
	2	2	1,2	1,2	3,0
	3	18	10,7	10,7	13,7
	4	45	26,8	26,8	40,5
	5	100	59,5	59,5	100,0
	Total	168	100,0	100,0	

E.3 Missing Data in the Third Attitudes toward Science and Technology Course Questionnaire

yetenek3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	,6	,6	,6
	2	1	,6	,6	1,2
	3	17	10,1	10,1	11,3
	4	32	19,0	19,0	30,4
	5	117	69,6	69,6	100,0
	Total	168	100,0	100,0	

yakinolma3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	3	1,8	1,8	1,8
	1	3	1,8	1,8	3,6
	2	1	,6	,6	4,2
	3	20	11,9	11,9	16,1
	4	46	27,4	27,4	43,5
	5	95	56,5	56,5	100,0
	Total	168	100,0	100,0	

basarisiz3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	,6	,6	,6
	1	51	30,4	30,4	31,0
	2	27	16,1	16,1	47,0
	3	27	16,1	16,1	63,1
	4	21	12,5	12,5	75,6
	5	41	24,4	24,4	100,0
	Total	168	100,0	100,0	

sinavdarahat3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1,2	1,2	1,2
	1	3	1,8	1,8	3,0
	2	3	1,8	1,8	4,8
	3	23	13,7	13,7	18,5
	4	38	22,6	22,6	41,1
	5	99	58,9	58,9	100,0
	Total	168	100,0	100,0	

korkma3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1,2	1,2	1,2
	1	34	20,2	20,2	21,4
	2	26	15,5	15,5	36,9
	3	15	8,9	8,9	45,8
	4	26	15,5	15,5	61,3
	5	65	38,7	38,7	100,0
	Total	168	100,0	100,0	

E.3 (Cont.'d)

tvcd3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	,6	,6	,6
	1	5	3,0	3,0	3,6
	2	11	6,5	6,5	10,1
	3	23	13,7	13,7	23,8
	4	24	14,3	14,3	38,1
	5	104	61,9	61,9	100,0
	Total	168	100,0	100,0	

blmnsncalisma3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	4	2,4	2,4	2,4
	1	7	4,2	4,2	6,5
	2	7	4,2	4,2	10,7
	3	20	11,9	11,9	22,6
	4	25	14,9	14,9	37,5
	5	105	62,5	62,5	100,0
	Total	168	100,0	100,0	

meslek3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	,6	,6	,6
	1	2	1,2	1,2	1,8
	2	6	3,6	3,6	5,4
	3	17	10,1	10,1	15,5
	4	35	20,8	20,8	36,3
	5	107	63,7	63,7	100,0
	Total	168	100,0	100,0	

ileridekullanma3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	,6	,6	,6
	1	2	1,2	1,2	1,8
	2	5	3,0	3,0	4,8
	3	17	10,1	10,1	14,9
	4	36	21,4	21,4	36,3
	5	107	63,7	63,7	100,0
	Total	168	100,0	100,0	

zevkalma3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1,2	1,2	1,2
	1	3	1,8	1,8	3,0
	2	8	4,8	4,8	7,7
	3	12	7,1	7,1	14,9
	4	31	18,5	18,5	33,3
	5	112	66,7	66,7	100,0
	Total	168	100,0	100,0	

E.3 (Cont.'d)

sikici3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1,2	1,2	1,2
	1	39	23,2	23,2	24,4
	2	18	10,7	10,7	35,1
	3	13	7,7	7,7	42,9
	4	21	12,5	12,5	55,4
	5	75	44,6	44,6	100,0
	Total	168	100,0	100,0	

dersterahat3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1,2	1,2	1,2
	1	8	4,8	4,8	6,0
	2	3	1,8	1,8	7,7
	3	21	12,5	12,5	20,2
	4	28	16,7	16,7	36,9
	5	106	63,1	63,1	100,0
	Total	168	100,0	100,0	

ilgili3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1,2	1,2	1,2
	1	8	4,8	4,8	6,0
	2	7	4,2	4,2	10,1
	3	20	11,9	11,9	22,0
	4	40	23,8	23,8	45,8
	5	91	54,2	54,2	100,0
	Total	168	100,0	100,0	

huzursuz3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	3	1,8	1,8	1,8
	1	36	21,4	21,4	23,2
	2	17	10,1	10,1	33,3
	3	22	13,1	13,1	46,4
	4	19	11,3	11,3	57,7
	5	71	42,3	42,3	100,0
	Total	168	100,0	100,0	

hoslanmamak3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	,6	,6	,6
	1	52	31,0	31,0	31,5
	2	24	14,3	14,3	45,8
	3	13	7,7	7,7	53,6
	4	20	11,9	11,9	65,5
	5	58	34,5	34,5	100,0
	Total	168	100,0	100,0	

E.3 (Cont.'d)

eglenceliolmama3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	,6	,6	,6
	1	40	23,8	23,8	24,4
	2	17	10,1	10,1	34,5
	3	20	11,9	11,9	46,4
	4	22	13,1	13,1	59,5
	5	68	40,5	40,5	100,0
	Total	168	100,0	100,0	

ayirma3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	5	3,0	3,0	3,0
	1	7	4,2	4,2	7,1
	2	9	5,4	5,4	12,5
	3	32	19,0	19,0	31,5
	4	31	18,5	18,5	50,0
	5	84	50,0	50,0	100,0
	Total	168	100,0	100,0	

sevmeme3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	7	4,2	4,2	4,2
	1	55	32,7	32,7	36,9
	2	18	10,7	10,7	47,6
	3	19	11,3	11,3	58,9
	4	11	6,5	6,5	65,5
	5	58	34,5	34,5	100,0
	Total	168	100,0	100,0	

iyiolma3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	,6	,6	,6
	1	1	,6	,6	1,2
	2	3	1,8	1,8	3,0
	3	14	8,3	8,3	11,3
	4	29	17,3	17,3	28,6
	5	120	71,4	71,4	100,0
	Total	168	100,0	100,0	

iyianlama3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1,2	1,2	1,2
	1	2	1,2	1,2	2,4
	2	6	3,6	3,6	6,0
	3	17	10,1	10,1	16,1
	4	22	13,1	13,1	29,2
	5	119	70,8	70,8	100,0
	Total	168	100,0	100,0	

E.3 (Cont.'d)

cevaphoslanma3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	,6	,6	,6
	1	3	1,8	1,8	2,4
	2	5	3,0	3,0	5,4
	3	17	10,1	10,1	15,5
	4	33	19,6	19,6	35,1
	5	109	64,9	64,9	100,0
	Total	168	100,0	100,0	

gereksiz3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	,6	,6	,6
	1	54	32,1	32,1	32,7
	2	16	9,5	9,5	42,3
	3	16	9,5	9,5	51,8
	4	16	9,5	9,5	61,3
	5	65	38,7	38,7	100,0
	Total	168	100,0	100,0	

dusunmegelistirme3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	,6	,6	,6
	1	7	4,2	4,2	4,8
	2	6	3,6	3,6	8,3
	3	16	9,5	9,5	17,9
	4	23	13,7	13,7	31,5
	5	115	68,5	68,5	100,0
	Total	168	100,0	100,0	

E.4 Missing Data in the Fourth Attitudes toward Science and Technology Course Questionnaire

anlama4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	,6	,6	,6
	1	2	1,2	1,2	1,8
	2	2	1,2	1,2	3,0
	3	14	8,3	8,3	11,3
	4	42	25,0	25,0	36,3
	5	107	63,7	63,7	100,0
	Total	168	100,0	100,0	

yakinolma4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	,6	,6	,6
	1	1	,6	,6	1,2
	2	3	1,8	1,8	3,0
	3	20	11,9	11,9	14,9
	4	35	20,8	20,8	35,7
	5	108	64,3	64,3	100,0
	Total	168	100,0	100,0	

sinavdarahat4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1,2	1,2	1,2
	1	5	3,0	3,0	4,2
	2	7	4,2	4,2	8,3
	3	14	8,3	8,3	16,7
	4	45	26,8	26,8	43,5
	5	95	56,5	56,5	100,0
	Total	168	100,0	100,0	

korkma4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1,2	1,2	1,2
	1	30	17,9	17,9	19,0
	2	16	9,5	9,5	28,6
	3	16	9,5	9,5	38,1
	4	26	15,5	15,5	53,6
	5	78	46,4	46,4	100,0
	Total	168	100,0	100,0	

uyelik4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1,2	1,2	1,2
	1	6	3,6	3,6	4,8
	2	5	3,0	3,0	7,7
	3	27	16,1	16,1	23,8
	4	36	21,4	21,4	45,2
	5	92	54,8	54,8	100,0
	Total	168	100,0	100,0	

E.4 (Cont.'d)

blmnsncalisma4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	,6	,6	,6
	1	4	2,4	2,4	3,0
	2	4	2,4	2,4	5,4
	3	18	10,7	10,7	16,1
	4	35	20,8	20,8	36,9
	5	106	63,1	63,1	100,0
	Total	168	100,0	100,0	

meslek4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1,2	1,2	1,2
	1	5	3,0	3,0	4,2
	2	4	2,4	2,4	6,6
	3	17	10,1	10,2	16,8
	4	33	19,6	19,8	36,5
	5	107	63,1	63,5	100,0
	Total	168	99,4	100,0	

ileridekullanma4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	,6	,6	,6
	1	1	,6	,6	1,2
	2	5	3,0	3,0	4,2
	3	18	10,7	10,7	14,9
	4	34	20,2	20,2	35,1
	5	109	64,9	64,9	100,0
	Total	168	100,0	100,0	

sikici4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	,6	,6	,6
	1	23	13,7	13,7	14,3
	2	24	14,3	14,3	28,6
	3	13	7,7	7,7	36,3
	4	15	8,9	8,9	45,2
	5	92	54,8	54,8	100,0
	Total	168	100,0	100,0	

dersterahat4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	,6	,6	,6
	1	4	2,4	2,4	3,0
	2	8	4,8	4,8	7,7
	3	11	6,5	6,5	14,3
	4	39	23,2	23,2	37,5
	5	105	62,5	62,5	100,0
	Total	168	100,0	100,0	

E.4 (Cont.'d)

huzursuz4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1,2	1,2	1,2
	1	29	17,3	17,3	18,5
	2	20	11,9	11,9	30,4
	3	10	6,0	6,0	36,3
	4	19	11,3	11,3	47,6
	5	88	52,4	52,4	100,0
	Total	168	100,0	100,0	

hoslanmamak4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1,2	1,2	1,2
	1	43	25,6	25,6	26,8
	2	18	10,7	10,7	37,5
	3	14	8,3	8,3	45,8
	4	16	9,5	9,5	55,4
	5	75	44,6	44,6	100,0
	Total	168	100,0	100,0	

ilgicekici4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	,6	,6	,6
	1	58	34,5	34,5	35,1
	2	32	19,0	19,0	54,2
	3	45	26,8	26,8	81,0
	4	13	7,7	7,7	88,7
	5	19	11,3	11,3	100,0
	Total	168	100,0	100,0	

iyiolma4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	,6	,6	,6
	1	1	,6	,6	1,2
	2	4	2,4	2,4	3,6
	3	13	7,7	7,7	11,3
	4	31	18,5	18,5	29,8
	5	118	70,2	70,2	100,0
	Total	168	100,0	100,0	

iyianlama4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	,6	,6	,6
	1	5	3,0	3,0	3,6
	2	3	1,8	1,8	5,4
	3	11	6,5	6,5	11,9
	4	38	22,6	22,6	34,5
	5	110	65,5	65,5	100,0
	Total	168	100,0	100,0	

E.4 (Cont.'d)

cevaphoslanma4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	1	,6	,6	,6
	1	4	2,4	2,4	3,0
	2	8	4,8	4,8	7,7
	3	16	9,5	9,5	17,3
	4	28	16,7	16,7	33,9
	5	111	66,1	66,1	100,0
	Total	168	100,0	100,0	

gereksiz4

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	1,2	1,2	1,2
	1	31	18,5	18,5	19,6
	2	23	13,7	13,7	33,3
	3	8	4,8	4,8	38,1
	4	13	7,7	7,7	45,8
	5	91	54,2	54,2	100,0
	Total	168	100,0	100,0	

APPENDIX F

UNIT ACHIEVEMENT TESTS

F.1 Unit Achievement Test Forms

F.1.1 Reproduction, Development, and Growth In Living Things Achievement Test Form

1. Aşağıdaki seçeneklerden hangisi sadece canlıları içermektedir?

A) bulutlar, ateş, akarsular B) ateş, akarsular, ağaçlar C) akarsular, kuşlar, ağaçlar D) kuşlar, ağaçlar, solucanlar

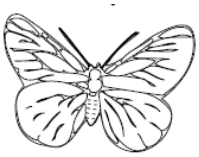
2. Bir civciv, yumurtadan çıkmadan önce, onun içinde 21 gün gelişir. Sizce civciv yumurtadan çıkmadan önce besinini nereden alır?

A) Civciv kendi besinini kendisi yapar.
B) Civciv anne tavuk tarafından beslenir.
C) Civciv yumurtanın kabuğunu yer.
D) Civciv yumurtanın içindeki besini kullanır.

3. Can, bir tabağın içine birkaç tane tohum koydu, üzerlerine pamuk yerleştirerek bastırdı, sonra pamuğu suyla ıslattı. Mert de kendi tohumlarını aynı şekilde ekip, tabağını Can'ın tabağının yanına yerleştirdi ama pamuğu suyla ıslatmak yerine, tabağı suyla doldurdu. İki gün sonra Can'ın ektiği tohumlar filizlenirken, Mert'in ektiği tohumlar filizlenmedi. Sizce bunun nedeni aşağıdakilerden hangisidir?

A) Mert'in ektiği tohumların daha fazla havaya ihtiyacı vardı.
B) Mert'in ektiği tohumların daha fazla ışığa ihtiyacı vardı.
C) Mert tabağı sıcak bir yere koymadı.
D) Mert farklı bir tohum türü kullanmalıydı.

4. Bir yaprağa konan kelebek, oraya yumurtalarını bıraktı. Aşağıda yumurtaların geçirdiği değişim görülmektedir. Sizce bu değişiklikler hangi sırada gerçekleşir?

1  2  3  4 

A) 1, 2, 3, 4 B) 1, 3, 2, 4 C) 1, 4, 3, 2 D) 1, 4, 2, 3

5. Mikroskopta hayvan hücresini inceleyen bir öğrenci aşağıdaki kısımlardan hangisini göremez?

A) Hücre zarı B) Çekirdek C) Kloroplast D) Sitoplazma

6. Aşağıdakilerden hangileri bitki tohumlarının yayılmasında etkilidir?

I- Rüzgâr II- İnsan III- Hayvan

A) Yalnız I B) I – II C) II – III D) I - II – III

7. Bir hücredeki kısımların dıştan içe doğru sıralanışı aşağıdakilerin hangisinde verilmiştir?

A) Çekirdek - Sitoplâzma - Hücre zarı B) Sitoplazma - Hücre zarı – Çekirdek

C) Hücre zarı - Sitoplâzma – Çekirdek D) Çekirdek - Hücre zarı - Sitoplazma

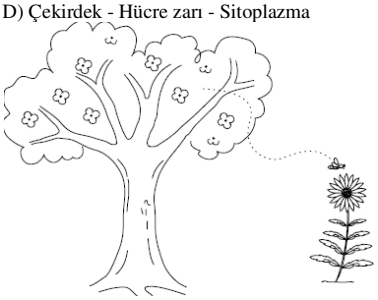
8. Yanda bir böceğin ağacın çiçeklerinden aldığı çiçek tozlarını (polen) küçük bitkinin çiçeklerine nasıl taşıdığı görülmektedir. Sizce bitkiden oluşacak yavrular ne olacaktır?

A) Ağacın yavruları bitkiye benzeyecektir.

B) Bitkinin yavruları ağaca benzeyecektir.

C) Bitkinin yavruları hem ağaca hem de bitkiye benzeyecektir.

D) Hiçbir şey olmayacaktır çünkü hiç bir yavru oluşmayacaktır.



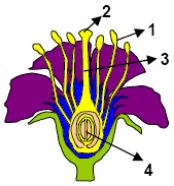
Ağaç Bitki

9. Aşağıdaki resimler bir kurbağanın farklı gelişme evrelerini göstermektedir.

1 2 3 4

Aşağıdakilerden hangisi kurbağanın gelişme evrelerini gençlikten yaşlılığa doğru en doğru sıralanmasıdır?

A) 1, 2, 3, 4 B) 2, 3, 4, 1 C) 3, 4, 2, 1 D) 4, 1, 3, 2



10. Yandaki çiçekte tohum kaç numaralı kısımda oluşur?

A) 1 B) 2 C) 3 D) 4

11. Yandaki çiçekte polen kaç numaralı kısımda oluşur?

A) 1 B) 2 C) 3 D) 4

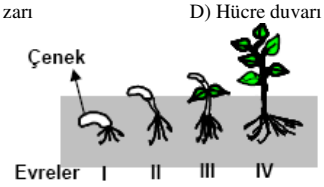
12. Aşağıdakilerden hangisi tüm canlıların ortak özelliğidir?

A) Hücreli olma B) Besin yapma C) Eşeyli üreme D) Yer değiştirme

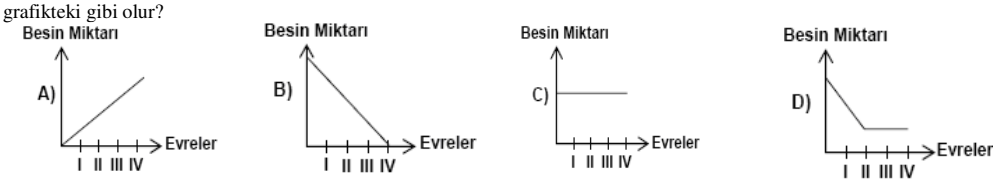
13..Hücrede canlılık olaylarını kontrol eden ve kalıtsal maddeyi içeren kısım nedir?

A) Sitoplazma B) Çekirdek C) Hücre zarı D) Hücre duvarı

14. Gelişmiş bitkilerin tohumlarında çenek denilen yapılar vardır. Çenekler, tohum çimlenirken embriyoya besin sağlar. Aşağıda bir fasulye tohumunun çimlenerek genç bir bitki haline gelmesi gösterilmiştir.



Buna göre tohumun çimlenerek genç fideyi oluşturmasına kadar çeneklerindeki besin miktarının evrelere göre değişimi hangi grafikteki gibi olur?



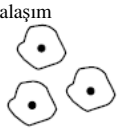
15. Bir öğrenci, aşağıdakilerden hangisinin hücresini incelediğinde hücre duvarını görür?

A) Karaciğerin B) Bağırsağın C) Kurbağa derisinin D) Üzüm yaprağının

16. Polenlerin, dişi organ üzerindeki yapışkan bölüme taşınmasına ne denir?

A) Tozlaşma B) Mayalanma C) Döllenme D) Başkalaşım

17. Mikroskopta hücreleri inceleyen bir öğrenci yandaki şekli görmüştür. Bu şekle bakıp hücreyle ilgili hangi soruya cevap verebilir?



A) Kaç kısımdan oluşur? B) Hangi canlıya aittir?

C) Nasıl bölünür? D) Nasıl beslenir?

18. Aşağıdakilerden hangisi tohumun kısımlarından değildir?

A) Embriyo B) Yumurtalık C) Çenek D) Tohum kabuğu (kılıfı)

19. Aşağıdakilerden hangileri çimlenmeyi etkiler?

I- Isı II- Oksijen III- Nem

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

20. Aşağıdakilerden hangisi tohum oluşturmaz?

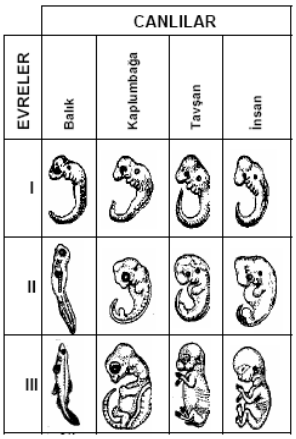
A) Eğrelti B) Gelincik C) Papatya D) Buğday

21. Aşağıdakilerden hangisi doğurarak çoğalır?

A) Kurbağa B) Alabalık C) Kertenkele D) Fare

22. Aşağıdakilerden hangisi kuluçkaya yatar?

A) Kanarya B) Kertenkele C) Kaplumbağa D) İstavrit



23. Tabloda bazı canlıların embriyolarının gelişim evreleri verilmiştir. Tabloyu inceleyen bir öğrenci aşağıdaki sonuçlardan hangisine ulaşamaz?

A) I. evredeki tüm embriyolar benzerdir.

B) II. evrede balık embriyosu belirgin olarak farklıdır.

C) Her embriyo III. evrede kendi türünün belirgin özelliklerinin çoğuna sahiptir.

D) Her embriyo I. evreyi aynı sürede tamamlar.

24. Molekül, atom ve bileşik kelimelerini kullanarak aşağıdaki cümleyi oluşturabiliriz:

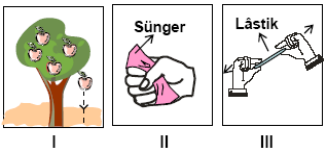
Şekerler, atomların oluşturduğu moleküllerden meydana gelen bileşiklerdir.

Organ, doku ve hücre kelimelerini kullanarak aşağıdaki cümleyi tamamlayınız:

Akciğerler, …… oluşturduğu …….. meydana gelen ……..

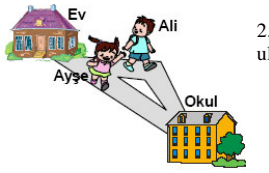
25. Siz büyüdükçe vücudunuzda hangi değişiklikler meydana gelir? Gözlemlediklerinizi ve bildiklerinizi yazınız.

F.1.2 Force and Motion Achievement Test Form



1. Şekil I, II ve III'te verilen durumların hangilerinde cisimlere etkiyen kuvvet diğerlerinden farklıdır?

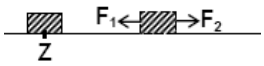
A) Yalnız I B) Yalnız II C) I ve II D) I ve III



2. Ali ile Ayşe evlerinden aynı anda çıkarak şekildeki yollardan giderek okula 20 dakikada ulaşıyorlar. Buna göre Ayşe ile Ali'nin hareketi için aşağıdakilerden hangileri aynıdır?

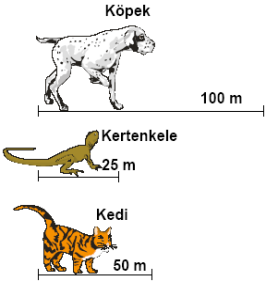
I- Süratleri II- Yer değiştirmeleri III- Aldıkları yollar

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



3. Sürtünmesiz yatay bir düzlemdeki cisme F1 ve F2 kuvvetleri şekildeki gibi etkirse, cisim Z noktasına geliyor. Bu duruma göre aşağıdakilerden hangisi söylenemez?
A) F1 kuvveti F2 den büyüktür. B) Bileşke kuvvet F1 yönündedir.
C) F2 bileşke kuvvet ile zıt yöndedir. D) Bileşke kuvvet F2'ye eşittir.

4. Bir cismin birim zamanda aldığı yola sürat denir. Buna göre hangisindeki hareketlinin sürati en fazla olur?
A) 40. km'den 60. km'ye 30 dakikada koşan sporcu. B) 10. m'den 15. m'ye 2 dakikada varan karınca.
C) 100 km'yi 25 saatte alan helikopter. D) 40. km'den 140. km'ye 25 saatte varan traktör.

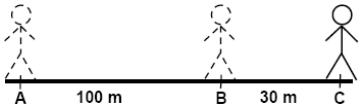


5. Şekildeki hayvanlar aynı anda koşuya başlayıp, aynı anda yollarını tamamlıyor. Buna göre hayvanların süratlerinin büyükten küçüğe göre sıralanışı hangisinde verilmiştir?

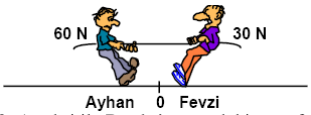
A) Köpek, kedi, kertenkele
B) Kertenkele, köpek, kedi
C) Köpek, kertenkele, kedi
D) Kedi, kertenkele, köpek

6. Tabloda K, L, M ve N araçlarının çeşitli sürelerde aldıkları yol verilmektedir. Tabloya göre, hangi aracın sürati en büyüktür?
A) K B) L C) M D) N

Araçlar	Geçen Zaman(saniye)	Alınan Yol(metre)
K	40	40
L	180	40
M	180	100
N	40	100



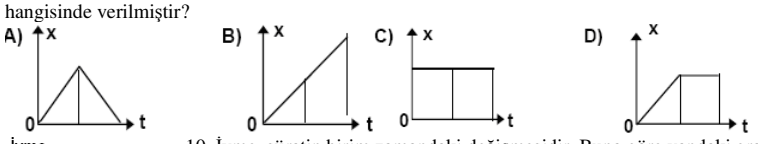
7. Bir öğrenci, AB yolunu 40 s de, BC yolunu ise 50 s de durmaksızın yürüyor.
Buna göre, aşağıdakilerden hangisi kesinlikle doğrudur?
A) AB yolunu sabit süratle yürümüştür.
B) BC yolunu sabit süratle yürümüştür.
C) AB yolunu daha süratle yürümüştür.
D) BC yolunu daha süratle yürümüştür.

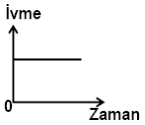


8. Şekilde halat çekme yarışı yapan Ayhan ve Fevzi'nin dengede kalabilmesi için hangisinin çekme yönüne kaç N'luk kuvvet eklenmelidir?

A) Ayhan'a, 30 B) Fevzi'ye, 30 C) Ayhan'a, 60 D) Fevzi'ye, 60

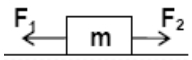
9. A şehri ile B şehri arasındaki mesafeyi sabit süratle gidip gelen bir otomobilin alınan yol(x)-geçen zaman(t) grafiği hangisinde verilmiştir?





10. İvme, süratin birim zamandaki değişmesidir. Buna göre yandaki grafik aşağıdaki hareketlerden hangisi için doğru olabilir?
A) Yüksekten düşen bir kutu B) Otoyolda sabit süratle giden bir araba
C) Sabit süratle giderken ani fren yapan otobüs D) Duran bir top

11. 30 m/s sabit süratle hareket eden bir otomobil 10 dakikada kaç km yol alır?
A) 18 B) 20 C) 25 D) 30

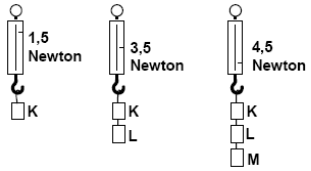


12. Yatay F1 ve F2 kuvvetleri, şekildeki gibi m cismine uygulandığında, cisim F1 yönünde hareket ediyor. Buna göre bileşke kuvvet aşağıdakilerden hangisi ile bulunur?
A) F1 + F2 B) F1/F2 C) F2/F1 D) F1 - F2

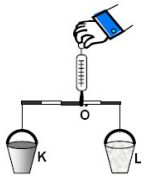
13. Düşey doğrultuda aşağıya doğru atılan taş ile ilgili bilgilerden hangisi doğrudur?
A) İlk sürati ile son sürati birbirine eşittir. B) Sürati aldığı yola bağlı olarak azalır.
C) Birim zamanda aldığı yol sürekli artar. D) Yer değiştirme süresince sürati sabit kalır.

14. Başlangıç çizgisinden aynı anda koşmaya başlayan Metin ve Mustafa 100 metrelik doğrusal yol boyunca yarışarak bitiş çizgisine varmaktadırlar. Yapılan yarışla ilgili aşağıdakilerden hangisi kesinlikle yanlış olur?
A) Bitiş çizgisine vardıklarında Metin ve Mustafa'nın yer değiştirmeleri eşit olur.
B) Metin yarışı Mustafa'dan daha önce bitiriyorsa, Metin'in sürat ortalaması daha büyüktür.
C) Süratleri eşitse, Metin yarışı daha önce bitirir.
D) Mustafa'nın yarışı önce bitirmesi için Metin'den daha süratli koşması gerekir.

15. Süratin tam olarak bilinmesi için büyüklüğünün yanında başlangıç noktasının, doğrultusunun ve yönünün de belirtilmesi gerekir. Buna göre, sürat aşağıdaki olayların hangisinde tüm özellikleriyle verilmiştir?
A) Araba, Bolu Ankara karayolunda 90 km/saat süratle gidiyor. B) Uçak, kuzeyden güneye gidiyor.
C) Boğaz vapuru, Üsküdar'dan Beşiktaş'a 40 km/saat süratle gidiyor. D) Araba, saatte 50 km yol alıyor.

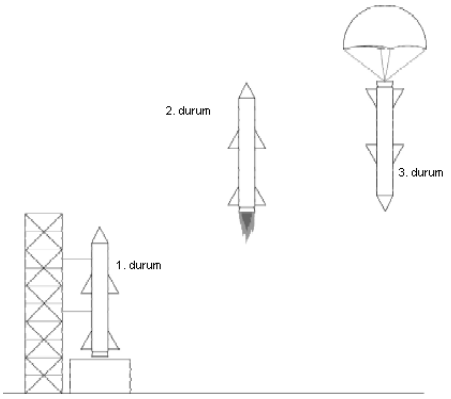


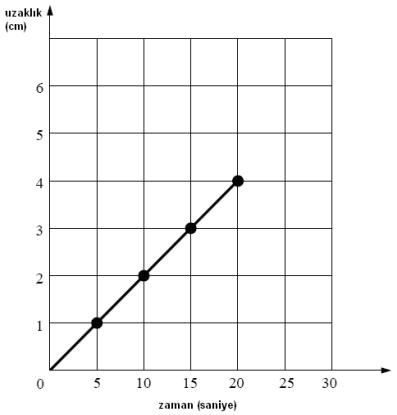
16. Dinamometre ile yukarıdaki ölçümleri yapan bir öğrenci, aşağıdaki sonuçlardan hangisine ulaşır?
A) K ve L cisimleri eşit ağırlıktadır.
B) Ağırlığı en küçük olan cisim K'dır.
C) Ağırlığı en küçük olan cisim M'dir.
D) L ve M cisimleri eşit ağırlıktadır.



17. Bir öğrenci ağırlığı önemsenmeyen eşit bölmeli, homojen çubuğa asılı K ve L boş kovalarını dinamometre ile O noktasından kaldırdığında çubuğun yatay konumda kaldığını görüyor. Öğrenci, bu deneyle aşağıdaki sonuçlardan hangisine ulaşamaz?
A) O noktası sistemin denge noktasıdır.
B) K kovası L kovasından ağırdır.
C) Dinamometreden okunan değer K ve L kovalarının ağırlıkları toplamı kadardır.
D) K ve L kovasının kütleleri birbirinden farklıdır.

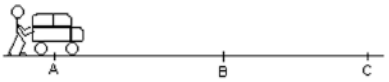
18. Şekiller Dünya'dan fırlatılan ve sonra geri dönen bir roketi göstermektedir. Yerçekimi roket üzerine etki eder mi? Hangi durumlarda? Neden?





19. Yandaki grafik düz bir çizgi boyunca hareket eden bir karıncanın yaptığı hareketi göstermektedir.

Eğer bu karınca aynı süratte gitmeye devam ederse 30 saniye sonunda ne kadar uzağa gitmiş olur?

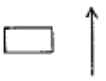


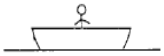
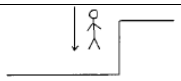
20. Buzlu bir yolda A noktasında duran araba (motoru çalışmayan ve fireni tutmayan) şoför tarafından sabit bir kuvvetle itilerek B'ye getiriliyor.

a. Sizce araba neden hareket etmiştir?

b. Sizce araba B'den C'ye gelir mi? Nasıl?

21. Yerçekimi hangilerine etki eder? Kutucuğa çarpı koyunuz.

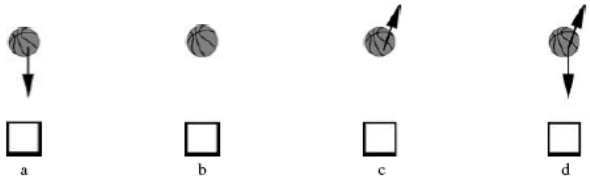
 Yukarı atılmış bir top	 Yukarı atılmış bir tuğla	 Tramplende sıçrayan bir çocuk	 Yerdeki bir top

 Kayıktaki bir çocuk	 Toprağa gömülü bir tuğla	 Aşağı düşen bir top	 Aşağı atlayan bir çocuk	 Aşağı düşen tuğla

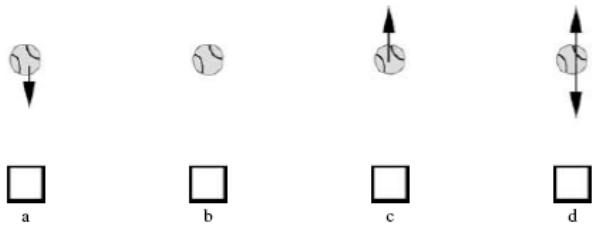
22. Bir cismin kütlesini baskül ve eşit kollu terazi ile dünyada ve ayda ölçersek aynı değeri mi buluruz? Neden?

23. Dünyadaki yerçekimini düşünerek ve rüzgârın direncini hesaba katmayarak aşağıdakileri cevaplayınız.

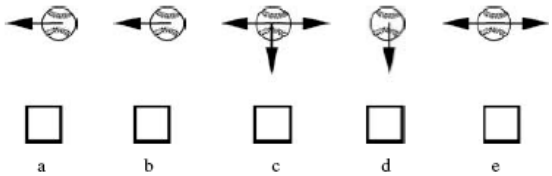
Bir basketbol oyuncusu topu potaya fırlatır.
Aşağıdakilerden hangisi top en yukardayken topa etki eden kuvvetleri göstermektedir.
Neden?



Raketini kötü bir şekilde tutan bir tenis oyuncusu topu yukarı doğru vurur.
Aşağıdakilerden hangisi top en yukardayken topa etki eden kuvvetleri göstermektedir.
Neden?



Bir beysbol oyuncusu sopasıyla topa yatay olarak vurur.
Aşağıdakilerden hangisi hareketi sırasında topa etki eden kuvvetleri göstermektedir.
Neden?



F.2. Unit Achievement Tests Key

F.2.1 Reproduction, Development, and Growth in Living Things Unit Achievement Test Key

1. D
2. D
3. A
4. B
5. C
6. D
7 C
8. D
9. D
10. D
11. A
12. A
13. B
14. B
15. D
16. A
17. A
18. B
19. D
20. A
21. D
22. A
23. D

24. Coding Guide

Code	Response
Correct Response	
10	Hücre-Doku-Organ
Incorrect Response	
70	Hücre-Organ-Doku
71	Doku-Organ-Hücre
72	Doku-Hücre-Organ
73	Organ-Hücre-Doku
74	Organ-Doku-Hücre
79	Other incorrect (including crossed out/erased, stray marks, illegible, or off task).
No Response	
99	BLANK

Note: Developed from "JO3 Coding Guide", TIMSS 1999 Science Items Released Set for Eighth Grade. Retrieved February 1, 2006 from http://timss.bc.edu/timss1999i/pdf/t99science_items.pdf, last

F.2.1 (Cont.'d)

25. Coding Guide

Code	Response
Correct Response	
10	Refers to growth such as increases in height, weight, strength. *Example: They get bigger.* Kollarımız, bacaklarımız, dişlerimiz, kafamız, ayaklarımız vb. gibi değişiklikler oluyor. En önemlisi büyüyoruz.
11	Refers to sexual maturation. Explanation may include secondary sexual features such as voice, hair. Koltuk altında kıllanma cinsel bölgede kıllanma .
12	Refers to appearance [Use code 10, 11 for those explicitly mentioned above.] *Examples: Their nails grow. Their hair might darken.* Büyüyünce sivilceler çıkar.
13	Refers to both growth and sexual maturation. Göğüs belirginleşme, boyumuzun uzaması, kilo almamız.
14	Refers to both appearance and sexual maturation. Sivilce, koltuk altı ve cinsel bölgelerde kıllanma vb.
15	Refers to growth, appearance and sexual maturation. Biz büyüdükçe boyumuz uzar, sivilcelerimiz çıkar, hormonlarımız çalışmaya başlar.
16	Refers to both growth and appearance Sesimiz değişir. Boyumuz uzar. Yüz şeklimiz değişebilir.
17	Other acceptable. *Example: They lose teeth.* Dişlerim, Vücudum ve Sesim değişir.
18	Refers to both growth and other Boyum uzar. Kollarım ve bacaklarım uzar. Eski dişler yerine yeni dişler gelir.
19	Refers to both growth, sexual maturation and other Boyum uzar, eller, ayaklar büyür. Kıllanmaya başlarız. Dişlerim çıkar.
20	Ilnesses associated with becoming old. Alerji, çiçek olduğunu gördüm.
21	Refers to both growth and emotional or intellectual changes. Boyumuz uzar, iyiyi kötüyü daha iyi ayırt ederiz daha çabuk gelişiriz.
22	Refers to both appearance and other Sivilce çıkal, dişlerimiz dökülür.
23	Refers to both sexual maturation and emotional or intellectual changes. Koltuk altında kıllanma, sivilcelerin çıkması, duygusallık meydana gelen değişikliklerdir.
24	Refers to both growth, emotional or intellectual changes and sexual maturation. Vücudumuzda bedensel ve ruhsal değişiklikler meydana gelir. Boyumuz uzar, kilomuz artar, sivilceler çıkar, derimiz yağlanır. Kızlar adet görür.
Incorrect Response	
70	Refers to emotional or intellectual changes. *Examples: The don't cry.* *Their minds expand in intelligence.* Büyürler. Herkes büyüdüğünü sanırlar.
71	Refers to social changes. *Examples: They can decide more themselves. They wear fashion clothes.* Büyüdüğümüzde 7 yaşına geldğimizde okula gider sonra daha da büyüdüğümüzde ergen oluruz.
72	Refers to changes associated with aging such as losing hair. Boyumuz artık sabit olur. Kilomuz da sabit olur.
76	Repeats information in the stem, such as referring to children becoming adults. *Example: They get older.* Olgunlaşırız. Biz büyüdükçe bedenimiz kilomuz uzunluğumuz değişir. Ergenlik çağına.
77	Refers to emotional or intellectual changes and repeats information in the stem, such as referring to children becoming adults. Konuşmamız davranışlarımız değişir. Birçok değişikliğe uğrarız
78	Refers to changes not associated with aging. Ben vücudumda karnım ağrıyor falan.
79	Other incorrect. *Example: Bones.* Vücudumuzun koltuk altında olur. Kemikleri, vücudu.
No Response	
90	Crossed out/erased, illegible, or impossible to interpret. Süt, yoğurt, Danone bunlardan bazıları.
99	BLANK

Note: Developed from "Y-2 Coding Guide", TIMSS Released Set for Population 1 (Third and Fourth Grades). http://timss.bc.edu/timss1995i/TIMSSPDF/ASitems.pdf, last accessed date: 20 February, 2006.

F.2.2 Force and Motion Unit Achievement Test Key

1. A
2. B
3. D
4. A
5. A
6. D
7. C
8. B
9. B
10. A
11. A
12. D
13. D
14. C
15. C
16. C
17. B

18. Coding Guide

Code	Response
Correct Response	
20	1., 2. ve 3. durumlarda. Çünkü ...
	Eder. Yer çekimi her maddeye etki eder.
21	Etki eder. Uzay'a fırlatılırken güç yerçekimin yener. İnerken yer çekimi kuvveti etki eder.
Partial Response	
10	1, 2, 3.
	Hepsinde.
11	Eder. Yerçekiminin kuvveti çoktur.
Incorrect Response	
70	Situation 1 (with explanation).
	Yerçekimi roket üzerinde etki eder. 1. durumda çünkü roket hala hareket etmemiş olur.
71	Situation 2 (with explanation).
	2. durum
72	Situation 3 (with explanation).
	3. durum
73	Situation 1 and 2 (with explanation).
	Etki eder. 1. 2. durumda. Çünkü 3. durumda paraşüt kullanıldığı için.
74	Situation 2 and 3 (with explanation).
	Yerçekimi roket üzerine etki eder. Geliniş ve gidiniş durumundadır. Çünkü geliş ve gidişi aynıdır.
75	Situation 1 and 3 (with explanation).
	Hayır. 1. durumda eder. 2. durumda etmez. 3. durumda eder.
76	Situation 2 (with explanation).
	2. durum. Çünkü yukarı çıkarken yer çekimi etki eder.
77	Situation 3 (with explanation).
	Etki eder. Çünkü roket aşağıya iniyor.
78	Situation 1 (with explanation).
	Evet. Roket hareket halinde değilken.
79	In no situation.
	Etmez. Çünkü onu göze alarak roketler yapılmıştır.
No Response	
90	Crossed out/erased, illegible, or impossible to interpret.
	Evet. Kuvvetle. Mesela bir … attığımızda, yere düşer. Buna yerçekimi denir.
99	BLANK

F.2.2 (Cont.'d)

19. Coding Guide

Code	Response
Correct Response	
20	6 cm uzağa gitmiş olur.
21	30 saniyede 60 cm gidiyor.
	2 santimetre uzağa gitmiş olur.
Partial Response	
10	6'ya kadar gider.
11	Grafikte gösterilmiş
Incorrect Response	
70	Other responses
	5 cm
No Response	
90	Crossed out/erased, illegible, or impossible to interpret.
	Çapraz gider.
99	BLANK

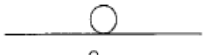
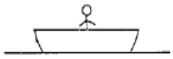
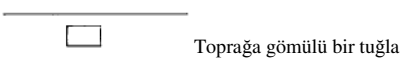
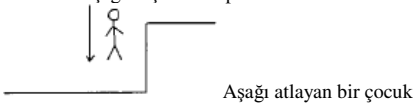
20. a. Coding Guide

Code	Response
Correct Response	
10	İtme kuvvetiyle b'ye getirilmiştir.
11	Buzlu yol olduğu için kayarak gider.
	Arabanın el freni inik ve vites boştaysa gider.
Incorrect Response	
70	A'dan B'ye gelebilir.
71	Benzinlikten benzin alarak
No Response	
90	Crossed out/erased, illegible, or impossible to interpret.
99	BLANK

20. b. Coding Guide

Code	Response
Correct Response	
10	Gelir. Yine itilerek.
11	Gelir. Kayarak.
	El frenini indirip vitesi boşa alınca araba B'den C'ye gider.
12	Gelmez. Kuvveti yetmez.
Incorrect Response	
70	Gelir.
71	B'den C'ye gider. Benzinlikten benzin alarak
72	Gelmez.
No Response	
90	Crossed out/erased, illegible, or impossible to interpret.
	C noktası daha
99	BLANK

21. Coding Guide

Code	Response
Correct Response	
20	All
Partial Response	
21	 Yukarı atılmış bir top
22	 Yukarı atılmış bir tuğla
23	 Tramplende sıçrayan bir çocuk
23	 Yerdeki bir top
25	 Kayıktaki bir çocuk
26	 Toprağa gömülü bir tuğla
27	 Aşağı düşen bir top
28	 Aşağı atlayan bir çocuk
29	 Aşağı düşen bir tuğla
No Response	
99	BLANK

22. Coding Guide

Code	Response
Correct Response	
10	Çünkü ayda sadece ağırlık değişir. Aynı değeri buluruz. Uzayda isi havada kalacak ama ikisi aynı olacak. E Evet. Çünkü kütle değişmeyen madde miktarıdır.
Partial Response	
17	Aynı kütlede bulunur. Ağırlığına fazla bir madde koymadığımız içindir.
Incorrect Response	
70	*Yes or no type answers.* Buluruz. Bulamayız.
71	No with explanations: Bulamayız. Çünkü ayda yer çekimi yoktur.
No Response	
90	Crossed out/erased, illegible, or impossible to interpret. Yerçekiminden.
99	BLANK

F.2.2 (Cont.'d)

23. 1. Coding Guide

Code	Response
Correct Response	
10	*A with explanation.* En yukardayken aşağı iner. Yer çekimi çeker.
Partial Response	
17	A.
Incorrect Response	
70	A with incorrect explanation A. Çünkü hızlı giden bir top yer çekimidir.
71	Others B. Hava onu kaldırıp attığı için.
No Response	
90	Crossed out/erased, illegible, or impossible to interpret. Çünkü kuvvet uygulanıyor.
99	BLANK

23. 2. Coding Guide

Code	Response
Correct Response	
10	*A with explanation.* A. Top yukardayken aşağı iner. Yer çekimi çeker.
Partial Response	
17	A.
Incorrect Response	
70	A with incorrect explanation A'dır. Çünkü tenis topuna vururken kuvvetle yukarıya gider.
71	Others B düzdür o yüzden.
No Response	
90	Crossed out/erased, illegible, or impossible to interpret. Çünkü topa daha hızlı vurmuştur.
99	BLANK

23. 3. Coding Guide

Code	Response
Correct Response	
10	*D with explanation.* D. Tekrar aşağıya düşer. Çünkü; yer çekimi vardır.
Partial Response	
17	D.
Incorrect Response	
70	D with incorrect explanation D. Adam topa çok hızlı vuruyor.
71	Others B. Çünkü çok hızlı gidiyor.
No Response	
90	Crossed out/erased, illegible, or impossible to interpret. Sopanın gücü olduğu için.
99	BLANK

F.3 Unit Achievement Test Blueprints

Table F.1 Reproduction, development, and growth in living things achievement test blueprint

İtems	Subject Matters	Cognitive Processes
1	Canlılık Hücreyle Başlar (Hücre)	Knowledge (Knowledge of classifications)
2	Hayvanlarda Üreme, Büyüme ve Gelişme (Hayat Döngüsü)	Knowledge (Knowledge of facts)
3	Tohumdan Fidana (Çimlenme)	Comprehension (Prediction)
4	Hayvanlarda Üreme, Büyüme ve Gelişme (Başkalaşım)	Knowledge (Knowledge of sequences)
5	Canlılık Hücreyle Başlar (Organel)	Knowledge (Knowledge of classifications)
6	Çiçekli Bitkilerde Üreme (Tozlaşma)	Knowledge (Knowledge of facts)
7	Canlılık Hücreyle Başlar (Organel)	Knowledge (Knowledge of sequences)
8	Çiçekli Bitkilerde Üreme (Tozlaşma)	Comprehension (Prediction)
9	Hayvanlarda Üreme, Büyüme ve Gelişme (Hayat Döngüsü)	Knowledge (Knowledge of sequences)
10	Çiçekli Bitkilerde Üreme (Tohum)	Knowledge (Knowledge of classifications)
11	Çiçekli Bitkilerde Üreme (Tozlaşma)	Knowledge (Knowledge of classifications)
12	Canlılık Hücreyle Başlar (Hücre)	Knowledge (Knowledge of facts)
13	Canlılık Hücreyle Başlar (Organel)	Knowledge (Knowledge of facts)
14	Tohumdan Fidana (Çimlenme)	Comprehension (Translation of knowledge from one form into another)
15	Canlılık Hücreyle Başlar (Organel)	Comprehension (Giving Example)
16	Çiçekli Bitkilerde Üreme (Tozlaşma)	Knowledge (Knowledge of teminology)
17	Canlılık Hücreyle Başlar (Hücre)	Science Process (Recognition of a problem)
18	Çiçekli Bitkilerde Üreme (Tohum)	Knowledge (Knowledge of classifications)
19	Tohumdan Fidana (Çimlenme)	Knowledge (Knowledge of facts)
20	Çiçekli Bitkilerde Üreme (Tohum)	Knowledge (Knowledge of classifications)
21	Hayvanlarda Üreme, Büyüme ve Gelişme (Hayat Döngüsü)	Knowledge (Knowledge of classifications)
22	Hayvanlarda Üreme, Büyüme ve Gelişme (Hayat Döngüsü)	Knowledge (Knowledge of classifications)
23	Hayvanlarda Üreme, Büyüme ve Gelişme (Hayat Döngüsü)	Science Process (Conclusion according to evidences)
24	Canlılık Hücreyle Başlar (Organizma)	Knowledge (Knowledge of sequences)
25	İnsanlarda Üreme, Büyüme ve Gelişme	Science Process (Description of observation)

Table F.2 Force and motion achievement test blueprint

İtems	Subject Matters	Cognitive Processes
1	Kuvveti Keşfedelim (Kuvvet)	Knowledge (Knowledge of classifications)
2	Yaşamımızdaki Sürat (Sürat)	Comprehension (Comment)
3	Kuvvetler İş Başında (Net, Bileşke Kuvvet)	Comprehension (Comment)
4	Yaşamımızdaki Sürat (Sürat)	Solving Problem (Show the answer in required form)
5	Yaşamımızdaki Sürat (Sürat)	Comprehension (Prediction)
6	Yaşamımızdaki Sürat (Sürat)	Comprehension (Prediction)
7	Yaşamımızdaki Sürat (Sürat)	Comprehension (Prediction)
8	Kuvvetler İş Başında (Dengelenmiş Kuvvet)	Solving Problem (Finding required principle for solution)
9	Yaşamımızdaki Sürat (Sürat)	Comprehension (Translation of knowledge from one form into another)
10	Yaşamımızdaki Sürat (Sürat)	Comprehension (Translation of knowledge from one form into another)
11	Yaşamımızdaki Sürat (Sürat)	Solving Problem (Show the answer in required form)
12	Kuvvetler İş Başında (Net (Bileşke) Kuvvet)	Comprehension (Identification of knowledge in a new context)
13	Yaşamımızdaki Sürat (Sürat)	Comprehension (Relation)
14	Yaşamımızdaki Sürat (Sürat)	Comprehension (Relation)
15	Yaşamımızdaki Sürat (Sürat)	Comprehension (Identification of knowledge in a new context)
16	Kuvveti Keşfedelim (Dinamometre)	Comprehension (Translation of knowledge from one form into another)
17	Kuvveti Keşfedelim (Dinamometre)	Comprehension (Prediction)
18	Ağırlık Bir Kuvvettir (Kütle Çekim Kuvveti)	Comprehension (Comment)
19	Yaşamımızdaki Sürat (Sürat)	Comprehension (Translation of knowledge from one form into another)
20. a	Kuvvetler İş Başında (Dengelenmiş Kuvvet)	Comprehension (Explanation)
20. b	Kuvvetler İş Başında (Dengelenmmemiş Kuvvet)	Comprehension (Prediction)
21	Ağırlık Bir Kuvvettir (Kütle Çekim Kuvveti)	Comprehension (Identification of criteria in a given information)
22	Ağırlık Bir Kuvvettir (Kütle Çekim Kuvveti)	Comprehension (Explanation)
23	Ağırlık Bir Kuvvettir (Kütle Çekim Kuvveti)	Comprehension (Explanation)

F.4 Subject Matters of Units

Table F.3 Subject matters of reproduction, development, and growth in living things unit

Subject Matters	Subject
Canlılık Hücreyle Başlar	Hücre
	Organel
	Organizma
İnsanlarda Üreme, Büyüme ve Gelişme	Yumurta
	Sperm
	Büyüme
	Olgunlaşma
	Gelişme
Çocuk Değilim Artık	Ergenlik
	Ergen
Hayvanlarda Üreme, Büyüme ve Gelişme	Hayat Döngüsü
	Başkalaşım
Çiçekli Bitkilerde Üreme	Tohum
	Meyve
	Tozlaşma
Tohumdan Fidana	Çimlenme
	Organik Tarım

Table F.4 Subject matters of force and motion unit

Subject Matters	Subject
Yaşamımızdaki Sürat	Sürat
	Hareket Enerjisi
Kuvveti Keşfedelim	Kuvvet
	Dinamometre
Kuvvetler İş Başında	Net (Bileşke) Kuvvet
	Dengelenmiş Kuvvet
	Dengelenmemiş Kuvvet
Ağırlık Bir Kuvvettir	Ağırlık
	Kütle Çekim Kuvveti

F.5 Cognitive Processes

Table F.5 Cognitive processes

Cognitive Processes	Objective
Knowledge	Knowledge of facts
	Knowledge of terminology
	Knowledge of concepts
	Knowledge of classifications
	Knowledge of sequences
	Knowledge of techniques and procedures
	Knowledge of principles and laws
	Knowledge of theories
Comprehension	Identification of knowledge in a new context
	Explanation
	Summarization
	Giving example
	Identification of criteria in a given information
	Relation
	Comment
	Translation of knowledge from one form into another
	Prediction
Solving Problem	Finding required principle for solution
	Bringing knowledge, law, and principle together
	Using formula and algorithms
	Using units correctly and making transition
	Show the answer in required form
Science Process	Observing
	Description of observation
	Comparison of results of observation
	Classification of results of observation
	Selection of appropriate measuring instrument
	Recognition of a problem
	Relation between elements of problem
	Formulation of a hypothesis to solve the problem
	Proposing procedure to verify (test) the hypothesis
	Design of experiment/think/formulate in figure
	Collection of data
	Processing/analyzing/interpreting data
	Discussing and evaluating hypotheses according to evidences
	Conclusion according to evidences
	Generalization (formulating models) and proposing new research questions
	Application of observation and research results to daily life or new situation

Note: It is developed from "Taxonomy of Educational Objectives" by the MONE, EARGED, 1995, 43 using Bloom's terminology.

F.6 References of Unit Achievement Tests

Table F.6 Reference of the reproduction, development, and growth in living things unit achievement test

Item	Source
1	TIMSS Released Set for Population 1 (3rd and 4th Grades): http://timss.bc.edu/timss1995i/TIMSSPDF/ASitems.pdf
2	TIMSS Released Set for Population 1 (3rd and 4th Grades): http://timss.bc.edu/timss1995i/TIMSSPDF/ASitems.pdf
3	TIMSS Released Set for Population 1 (3rd and 4th Grades): http://timss.bc.edu/timss1995i/TIMSSPDF/ASitems.pdf
4	TIMSS Released Set for Population 1 (3rd and 4th Grades): http://timss.bc.edu/timss1995i/TIMSSPDF/ASitems.pdf
5	2006 Devlet Parasız Yatılılık ve Bursluluk Sınavı: http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2006/DPY6SinifATesti_2006.pdf
6	2006 Devlet Parasız Yatılılık ve Bursluluk Sınavı: http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2006/DPY6SinifATesti_2006.pdf
7	2006 Devlet Parasız Yatılılık ve Bursluluk Sınavı: http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2006/DPY6SinifATesti_2006.pdf
8	TIMSS Released Set for Population 1 (3rd and 4th Grades): http://timss.bc.edu/timss1995i/TIMSSPDF/ASitems.pdf
9	TIMSS Released Set for Population 1 (3rd and 4th Grades): http://timss.bc.edu/timss1995i/TIMSSPDF/ASitems.pdf
10	2006 Devlet Parasız Yatılılık ve Bursluluk Sınavı: http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2006/DPY6SinifATesti_2006.pdf
11	2003 Devlet Parasız Yatılılık ve Bursluluk Sınavı: http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2003/DPY6Test_key2003.pdf
12	2004 Devlet Parasız Yatılılık ve Bursluluk Sınavı: http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2004/2006DPY_6SinifATesti_key.pdf
13	2003 Devlet Parasız Yatılılık ve Bursluluk Sınavı: http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2003/DPY4Test_key2003.pdf
14	2003 Orta Öğretim Kurumları Öğrenci Seçme ve Yerleştirme Sınavı: http://egitek.meb.gov.tr/Sinavlar/Sorular/Ook/Ook2003/Ook2003Test_Key.pdf
15	Devlet Parasız Yatılılık Ve Bursluluk Sınavı: http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2003/DPY4Test_key2003.pdf
16	Devlet Parasız Yatılılık Ve Bursluluk Sınavı: http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2003/DPY4Test_key2003.pdf
17	2003 Devlet Parasız Yatılılık ve Bursluluk Sınavı: http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2003/DPY6Test_key2003.pdf
18	2002 Devlet Parasız Yatılılık ve Bursluluk Sınavı: http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2002/DPY6Test_key2002.pdf
19	2001 Devlet Parasız Yatılılık ve Bursluluk Sınavı: http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2001/Dpy4_Test2001.pdf
20	2000 Devlet Parasız Yatılılık ve Bursluluk Sınavı: http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2000/DPY4Test_key2000.pdf
21	2000 Devlet Parasız Yatılılık ve Bursluluk Sınavı: http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2000/DPY4Test_key2000.pdf
22	1998 Devlet Parasız Yatılılık ve Bursluluk Sınavı: http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy1998/DpyTest_4_1998.pdf
23	2003 Özel Okullar Sınavı: http://egitek.meb.gov.tr/Sinavlar/Sorular/OzelOkullar2005/2003OzelOkullarSnv.pdf
24	TIMSS 1999 Science Items Released Set for 8th Grade: http://timss.bc.edu/timss1999i/pdf/t99science_items.pdf
25	TIMSS Released Set for Population 1 (3rd and 4th Grades): http://timss.bc.edu/timss1995i/TIMSSPDF/ASitems.pdf

Table F.7 Reference of the force and motion unit achievement test

Item No	Source
1	2006 Devlet Parasız Yatılılık ve Bursluluk Sınavı http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2006/DPY5SinifATesti_2006.pdf
2	2005 Devlet Parasız Yatılılık ve Bursluluk Sınavı http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2005/2007_DPY7_SINIF_A_TESTI.pdf
3	2004 Devlet Parasız Yatılılık ve Bursluluk Sınavı http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2004/2006DPY_7SinifATesti_key.pdf
4	2004 Devlet Parasız Yatılılık ve Bursluluk Sınavı http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2004/2006DPY_7SinifATesti_key.pdf
5	2003 Devlet Parasız Yatılılık ve Bursluluk Sınavı http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2003/DPY5Test_key2003.pdf
6	2002 Devlet Parasız Yatılılık ve Bursluluk Sınavı http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2002/DPY5Test_key2002.pdf
7	2002 Devlet Parasız Yatılılık ve Bursluluk Sınavı http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2002/DPY5Test_key2002.pdf
8	2002 Devlet Parasız Yatılılık ve Bursluluk Sınavı http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2002/DPY7Test_key2002.pdf
9	2001 Devlet Parasız Yatılılık ve Bursluluk Sınavı http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2001/Dpy6_Test2001.pdf
10	2002 Orta Öğretim Kurumları Öğrenci Seçme ve Yerleştirme Sınavı http://egitek.meb.gov.tr/Sinavlar/Sorular/Ook/Ook2002/Ook2002Test_Key.pdf
11	2001 Devlet Parasız Yatılılık ve Bursluluk Sınavı http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2001/Dpy6_Test2001.pdf
12	2000 Devlet Parasız Yatılılık ve Bursluluk Sınavı http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2000/DPY8Test_key2000.pdf
13	1998 Devlet Parasız Yatılılık ve Bursluluk Sınavı http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy1998/DpyTest_6_1998.pdf
14	2005 Özel Okullar Sınavı http://egitek.meb.gov.tr/Sinavlar/Sorular/OzelOkullar2005/2005OzelOkullarSnv.pdf
15	2005 Özel Okullar Sınavı http://egitek.meb.gov.tr/Sinavlar/Sorular/OzelOkullar2005/2002OzelOkullarSnv.pdf
16	2005 Devlet Parasız Yatılılık ve Bursluluk Sınavı http://egitek.meb.gov.tr/Sinavlar/Sorular/Dpy/Dpy2005/2007_DPY7_SINIF_A_TESTI.pdf
17	2003 Orta Öğretim Kurumları Öğrenci Seçme ve Yerleştirme Sınavı http://egitek.meb.gov.tr/Sinavlar/Sorular/Ook/Ook2003/Ook2003Test_Key.pdf
18	TIMMS 1999 Science Items. Released Set for Eight Grade. JO5 http://timss.bc.edu/timss1999i/pdf/t99science_items.pdf
19	TIMSS IEA's Third International Mathematics and Science Study TIMSS Science Items: *Released Set for Population 2 (Seventh and Eighth Grades)* P1 http://timss.bc.edu/timss1995i/TIMSSPDF/BSItems.pdf
20	Kurt, Ş. ve Akdeniz, A. R. [2004] Öğretmen Adaylarının Kuvvet Kavramı ile İlgili Yanılgılarını Gidermede Keşfedici Laboratuar Modelinin Etkisi. Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 27, 196-205.
21	Palmer, D. (2001) Students' alternative conceptions and scientifically acceptable conceptions about gravity. *International Journal of Science Education, 23* (7), 691- 706.
22	Developed by the researcher.
23	Jimoyiannis, A. ve Komis, V. (2003). Investigating Greek Students' Ideas about Forces and Motion. *Research in Science Education 33*, 375–392.

APPENDIX G

RESULTS OF THE ANALYSIS OF STUDENTS' SOCIO-ECONOMIC STATUS VARIABLES

G.1 Results of the Descriptive Analysis of Students' Socio-Economic Status Variables

Table G.1 Mother education and group crosstabulation

		group		Total
		Experimental	Control	
mother education	illiterate	6	4	10
	Literate	4	7	11
	Primary school (5 years)	40	25	65
	Secondary school (8 years)	18	16	34
	Elementary education (8 year)	7	6	13
	Secondary education (11 year)	9	15	24
	University	0	5	5
	Masters/doctorate	0	1	1
	unknown	2	3	5
Total		86	82	168

Table G.2 Father education and group crosstabulation

		group		Total
		Experimental	Control	
father education	illiterate	0	1	1
	Literate	1	5	6
	Primary school (5 years)	25	28	43
	Secondary school (8 years)	22	20	42
	Elementary education (8 year)	3	3	6
	Secondary education (11 year)	29	19	48
	University	5	10	15
	Masters/doctorate	0	2	2
	unknown	1	4	5
Total		85	78	168

Table G.3 Number of sibling and group crosstabulation

		group		Total
		Experimental	Control	
number of sibling	no	3	3	6
	1	32	38	70
	2	32	17	49
	3	10	11	21
	4	5	6	11
	5 and more than 5	4	3	7
	unknown	0	4	4
Total		86	82	168

Table G.4 Income and group crosstabulation

		group		Total
		Experimental	Control	
İncome YTL	0-350	14	20	34
	351-500	15	11	26
	501-750	20	15	35
	751-1000	21	9	30
	1001-1250	6	6	12
	1251-1500	7	4	11
	1501-1750	1	4	5
	More than 1751	1	6	7
	unkown	1	7	8
Total		86	82	168

Table G.5 Dishwasher and group crosstabulation

		group		Total
		Experimental	Control	
dishwasher	Do not have	54	48	102
	have	32	32	64
	unkown	0	2	2
Total		86	82	168

Table G.6 Computer and group crosstabulation

		group		Total
		Experimental	Control	
computer	Do not have	57	45	102
	have	29	35	64
	unkown	0	2	2
Total		86	82	168

Table G.7 Study room and group crosstabulation

		group		Total
		Experimental	Control	
study room	Do not have	25	30	55
	have	61	50	111
	unkown	0	2	2
Total		86	82	168

Table G.8 Work and group crosstabulation

		group		Total
		Experimental	Control	
work	yes	83	79	162
	no	2	1	3
	unkown	1	2	3
Total		85	82	168

Table G.9 Kindergarten and group crosstabulation

		group		Total
		Experimental	Control	
kindergarten	yes	63	52	115
	no	21	26	47
	unkown	2	4	6
Total		84	78	168

Table G.10 Age of schooling and group crosstabulation

		group		Total
		Experimental	Control	
age of schooling	5	0	1	1
	6	9	19	28
	7	69	53	122
	8	6	6	12
	unkown	2	3	5
Total		86	82	168

Table G.11 Number of books and group crosstabulation

		group		Total
		Experimental	Control	
number of books	0-10	11	14	25
	11-25	30	22	52
	26-100	24	25	49
	101-200	13	10	23
	More than 200	6	8	14
	unkown	2	3	15
Total		86	82	168

Table G.12 Newspaper/magazine and group crosstabulation

		group		Total
		Experimental	Control	
newspaper/magazine	Yes	22	19	41
	No	48	56	104
	unkown	16	7	23
Total		86	82	168

G.2. Results of the Factor Analysis of Students' Socio-Economic Status Variables

G.2.1 Results of the Factor Analysis of Students' Socio-Economic Status Variables with Listwise Deletion

Table G.13 Descriptive statistics

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
mothereducation	3,92	1,534	131
fathereducation	4,66	1,582	131
numberofsibling	2,85	1,099	131
income	3,36	1,950	131
dishwasher	1,43	,497	131
computer	1,40	,491	131
studyroom	1,69	,465	131
work	1,02	,150	131
kindergarten	1,31	,465	131
ageofschooling	6,86	,523	131
numberofbooks	2,74	1,174	131
newspapermagazine	1,72	,452	131

Table G.14 KMO and bartlett's test result

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,825
Bartlett's Test of Sphericity	Approx. Chi-Square	318,540
	df	66
	Sig.	,000

Table G.15 Communalities

Communalities

	Initial	Extraction
mothereducation	1,000	,678
fathereducation	1,000	,625
numberofsibling	1,000	,562
income	1,000	,665
dishwasher	1,000	,497
computer	1,000	,512
studyroom	1,000	,674
work	1,000	,591
kindergarten	1,000	,599
ageofschooling	1,000	,632
numberofbooks	1,000	,577
newspapermagazine	1,000	,515

Extraction Method: Principal Component Analysis.

Table G.16 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	3,573	29,779	29,779	3,573	29,779	29,779	2,610	21,754	21,754
2	1,490	12,415	42,194	1,490	12,415	42,194	1,858	15,484	37,238
3	1,058	8,819	51,013	1,058	8,819	51,013	1,357	11,312	48,550
4	1,005	8,377	59,390	1,005	8,377	59,390	1,301	10,840	59,390
5	,837	6,977	66,368						
6	,801	6,677	73,044						
7	,669	5,573	78,617						
8	,659	5,494	84,111						
9	,603	5,023	89,134						
10	,552	4,598	93,732						
11	,400	3,333	97,064						
12	,352	2,936	100,000						

Extraction Method: Principal Component Analysis.

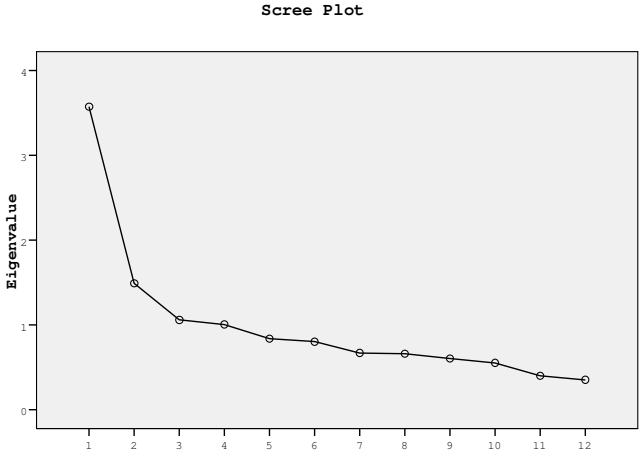


Figure G.1 Scree plot

Table G.17 Component matrix

Component Matrix[a]

	Component			
	1	2	3	4
income	,804	,110		
fathereducation	,775			-,140
mothereducation	,729			-,371
numberofbooks	,628	-,151	,388	
newspapermagazine	,583		,262	,322
computer	,527	,464	,127	
kindergarten	,511	,128	-,490	-,285
dishwasher	,501	,282	-,247	,326
studyroom	,300	-,647		,397
work		-,527	,378	-,406
ageofschooling		,503	,503	-,347
numberofsibling	-,412	,428	,329	,318

Extraction Method: Principal Component Analysis.

a. 4 components extracted.

Table G.18 Rotated component matrix

	Component			
	1	2	3	4
Numberofbooks	,742	,115	-,101	
newspapermagazine	,691		,135	-,140
income	,674	,379	,258	
fathereducation	,613	,488		
computer	,475	,151	,378	,347
kindergarten		,709	,305	
mothereducation	,468	,670		
numberofsibling		-,655	,173	,311
work			-,762	
dishwasher	,326	,177	,594	
ageofschooling	,113	-,144	-,135	,762
studyroom	,420		-,183	-,679

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a Rotation converged in 5 iterations.

Table G.19 Component transformation matrix

Component Transformation Matrix

Component	1	2	3	4
1	,786	,569	,234	-,059
2	-,047	-,118	,639	,758
3	,559	-,521	-,515	,388
4	,259	-,625	,521	-,520

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

G.2.2 Results of the Factor Analysis of Students' Socio-Economic Status Variables with Pairwise Deletion

Table G.20 Descriptive statistics

Descriptive Statistics

	Mean	Std. Deviation	Analysis N	Missing N
mothereducation	3,77	1,492	163	5
fathereducation	4,60	1,538	163	5
numberofsibling	2,89	1,162	164	4
income	3,30	1,909	160	8
dishwasher	1,39	,488	166	2
computer	1,39	,488	166	2
studyroom	1,67	,472	166	2
work	1,02	,134	165	3
kindergarten	1,29	,455	162	6
ageofschooling	6,89	,509	163	5
numberofbooks	2,69	1,152	163	5
newspapermagazine	1,72	,452	145	23

Table G.21 KMO and bartlett's test result

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,830
Bartlett's Test of Sphericity	Approx. Chi-Square	307,680
	df	66
	Sig.	,000

Table G.22 Communalities

Communalities

	Initial	Extraction
mothereducation	1,000	,617
fathereducation	1,000	,593
numberofsibling	1,000	,540
income	1,000	,633
dishwasher	1,000	,461
computer	1,000	,495
studyroom	1,000	,662
work	1,000	,657
kindergarten	1,000	,504
ageofschooling	1,000	,681
numberofbooks	1,000	,548
newspapermagazine	1,000	,526

Extraction Method: Principal Component Analysis.

Table G.23 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	3,497	29,144	29,144	3,497	29,144	29,144	2,225	18,544	18,544
2	1,339	11,156	40,300	1,339	11,156	40,300	2,206	18,381	36,925
3	1,068	8,898	49,198	1,068	8,898	49,198	1,311	10,922	47,847
4	1,014	8,454	57,652	1,014	8,454	57,652	1,177	9,805	57,652
5	,848	7,066	64,718						
6	,796	6,634	71,352						
7	,783	6,525	77,877						
8	,647	5,392	83,268						
9	,630	5,254	88,522						
10	,552	4,597	93,119						
11	,428	3,565	96,684						
12	,398	3,316	100,000						

Extraction Method: Principal Component Analysis.

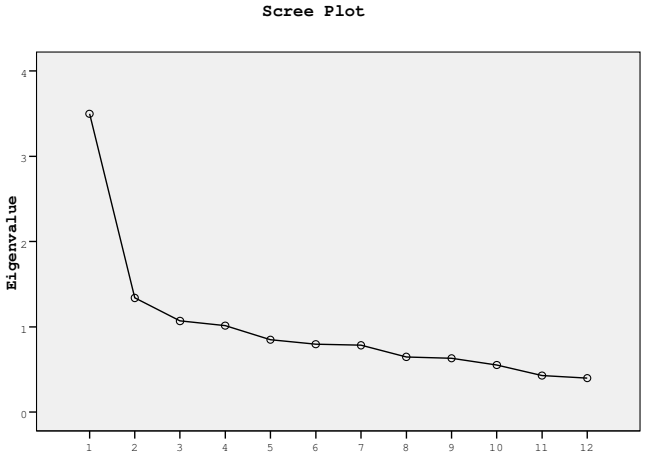


Figure G.2 Scree plot

Table G.24 Component matrix

Component Matrix[a]

	Component			
	1	2	3	4
income	,792			
fathereducation	,766			
mothereducation	,718		-,175	,251
numberofbooks	,609	-,145	,357	,168
computer	,551	,416		,117
newspapermagazine	,543		,462	-,113
dishwasher	,525	,217		-,371
kindergarten	,522	,130	-,455	
studyroom	,287	-,614	,324	-,312
work		-,603		,536
numberofsibling	-,398	,280	,506	-,217
ageofschooling		,492	,345	,561

Extraction Method: Principal Component Analysis.

a. 4 components extracted.

Table G.25 Rotated component matrix

	Component			
	1	2	3	4
newspapermagazine	,712		,134	
numberofbooks	,695	,223		
income	,534	,532	,251	
numberofsibling		-,685	,216	,153
mothereducation	,386	,678		
kindergarten		,639	,304	
fathereducation	,494	,569	,151	
work			-,798	
dishwasher	,348	,232	,528	
ageofschooling		-,169		,799
studyroom	,550		-,153	-,575
computer	,344	,339	,333	,389

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a Rotation converged in 10 iterations.

Table G.24 Component transformation matrix

Component Transformation Matrix

Component	1	2	3	4
1	,687	,685	,242	,004
2	-,199	-,046	,682	,702
3	,699	-,682	-,057	,209
4	-,014	,252	-,688	,681

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

APPENDIX H

RESULTS OF THE ANALYSES ON ASSUMPTIONS

H.1 Assumptions

H.1.1 Assumptions Common to Independent t-Test and GLM Repeated Measures ANOVA

H.1.1.1 Independence of Observations

Independence assumption means when the treatment is individually administered, observations are independent (Glass & Hopkins, as cited in Stevens, 2002, p. 259). The researcher collected the data for this study by administering various instruments to the students. She tried to ensure that the students answered the measurements independently by supervising the test administration or instructing the teachers who would supervise the others.

H.1.1.2 Normality

Normality assumption means that the population from which the sample is drawn is normally distributed. There are many techniques to assess the normality of the distribution of scores. Kolmogorov-Smirnow and Shapiro-Wilk tests are one of them. When the result of these tests is not significant, it means that the dependent variables were normally distributed across all levels of the independent variable (treatment groups).

H.1.1.3 Homogeneity of Variance

It means the population variances should be equal (Hale, 2008). Levene's Test for Equality of Variances shows if variances for the groups do not differ significantly from each other (George & Mallery, 2003, p. 140). When the result of this test is not significant, it means that the variances of students' scores on the dependent variable are equal in both experimental and control groups.

H.1.2 Assumption Unique to GLM Repeated Measures ANOVA

H.1.2.1 Sphericity (Circularity)

Sphericity means the covariance matrix for the new (transformed) variables is a diagonal matrix, with equal variances on the diagonal (Stevens, 2002, p. 501). Mauchly's Test of Sphericity shows whether the differences between the variances for all levels of within-subjects variable are similar. When the result of this test is not significant, it means that the differences between the variances for all levels of within-subjects variable are similar.

H.2 Results of Analyses on Assumptions

H.2.1 Result of Analyses on Assumptions of Independent Samples t-Test

Table H.1 Result of tests of normality

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	group	Statistic	df	Sig.	Statistic	df	Sig.
REGR factor score 1 for analysis 1	1	,076	64	,200*	,987	64	,716
	2	,057	67	,200*	,979	67	,314
REGR factor score 2 for analysis 1	1	,096	64	,200*	,983	64	,504
	2	,092	67	,200*	,968	67	,078

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Table H.2 Result of levene's test for equality of variances

		F	Sig.
REGR factor score	1 for analysis 1	.638	.426
REGR factor score	2 for analysis 1	.868	.353

H.2.2 Result of Analyses on Assumptions of Repeated Measures ANOVA for Reproduction, Development, and Growth in Living Things Unit Achievement Tests

Table H.3 Result of tests of normality

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	group	Statistic	df	Sig.	Statistic	df	Sig.
canli1	1	,117	86	,005	,983	86	,325
	2	,129	82	,002	,967	82	,035
canli2	1	,106	86	,019	,965	86	,021
	2	,140	82	,000	,970	82	,048
canli4	1	,120	86	,004	,963	86	,014
	2	,147	82	,000	,943	82	,001

a. Lilliefors Significance Correction

Table H.4 Result of levene's test of equality of error variances

	F	df1	df1	Sig.
canli1	2.724	1	166	.101
canli2	.015	1	166	.903
canli4	1.292	1	166	.257

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a

Design: Intercept+group
Within Subjects Design: canli

Table H.5 Result of mauchly's test of sphericity

Mauchly's Test of Sphericity[b]

Measure: MEASURE_1

					Epsilon[a]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
canli	,978	3,726	2	,155	,978	,996	,500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b.

Design: Intercept+group
Within Subjects Design: canli

H.2.3 Result of Analyses on Assumptions of Repeated Measures ANOVA for Force and Motion Unit Achievement Tests

Table H.6 Result of Tests of Normality

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	group	Statistic	df	Sig.	Statistic	df	Sig.
ontesttoplam	1	,142	86	,000	,946	86	,001
	2	,161	82	,000	,948	82	,002
khsontoplam	1	,153	86	,000	,916	86	,000
	2	,184	82	,000	,921	82	,000
khgecikmistoplam	1	,090	86	,082	,972	86	,062
	2	,103	82	,033	,973	82	,082

a. Lilliefors Significance Correction

Table H.7 Result of levene's test of equality of error variances

Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
ontesttoplam	,753	1	166	,387
khsontoplam	3,520	1	166	,062
khgecikmistoplam	,857	1	166	,356

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a.
Design: Intercept+group
Within Subjects Design: kuvvet

Table H.8 Result of mauchly's test of sphericity

Mauchly's Test of Sphericity[b]

Measure: MEASURE_1

					Epsilon[a]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
kuvvet	,989	1,752	2	,416	,990	1,000	,500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b.
Design: Intercept+group
Within Subjects Design: kuvvet

H.2.4 Result of Analyses on Assumptions of Repeated Measures ANOVA for Science Process Skills Tests

Table H.9 Result of tests of normality

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	grup	Statistic	df	Sig.	Statistic	df	Sig.
bsbir	1	,078	86	,200*	,973	86	,067
	2	,112	82	,013	,978	82	,160
bsiki	1	,094	86	,060	,976	86	,117
	2	,073	82	,200*	,981	82	,257
bsuc	1	,091	86	,074	,983	86	,337
	2	,103	82	,032	,975	82	,117
bsdort	1	,058	86	,200*	,985	86	,404
	2	,090	82	,097	,981	82	,278

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Table H.10 Result of levene's test of equality of error variances

Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
bsbir	,012	1	166	,912
bsiki	,187	1	166	,666
bsuc	3,871	1	166	,051
bsdort	1,974	1	166	,162

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a.
Design: Intercept+grup
Within Subjects Design: bsy

Table H.11 The result of mauchly's test of sphericity

Mauchly's Test of Sphericity[b]

Measure: MEASURE_1

					Epsilon[a]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
bsy	,920	13,766	5	,017	,952	,976	,333

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b.
Design: Intercept+grup
Within Subjects Design: bsy

H.2.5 Result of Analyses on Assumptions of Repeated Measures ANOVA for Self-Concept Subtests of Attitudes toward Science and Technology Course Questionnaire

Table H.12 Result of tests of normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
Subtest	group	statistic	df	Sig.	statistic	df	Sig.
Self-Concept 1	1	.129	86	.001	.948	86	.002
	2	.166	82	.000	.939	82	.001
Self-Concept 2	1	.166	86	.000	.907	86	.000
	2	.135	82	.001	.906	82	.000
Self-Concept 3	1	.242	86	.000	.773	86	.000
	2	.174	82	.000	.867	82	.000
Self-Concept 4	1	.230	86	.000	.740	86	.000
	2	.204	82	.000	.853	82	.000

Table H.13 Result of levene's test of equality of error variances

Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
self1	,319	1	166	,573
self2	,486	1	166	,487
self3	1,360	1	166	,245
self4	3,193	1	166	,076

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a.
Design: Intercept+grup
Within Subjects Design: self

Table H.14 Result of mauchly's test of sphericity

Mauchly's Test of Sphericity[b]

Measure: MEASURE_1

					Epsilon[a]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
self	,922	13,333	5	,020	,949	,973	,333

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b.
Design: Intercept+grup
Within Subjects Design: self

H.2.6 Result of Analyses on Assumptions of Repeated Measures ANOVA for Anxiety Subtests of Attitudes toward Science and Technology Course Questionnaire

Table H.15 Result of tests of normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
Subtest	group	statistic	df	Sig.	statistic	df	Sig.
Anxiety 1	1	.115	86	.007	.928	86	.000
	2	.135	82	.001	.921	82	.000
Anxiety 2	1	.094	86	.061	.949	86	.002
	2	.158	82	.000	.919	82	.000
Anxiety 3	1	.170	86	.000	.889	86	.000
	2	.084	82	.200*	.970	82	.051
Anxiety 4	1	.170	86	.000	.888	86	.000
	2	.108	82	.018	.940	82	.001

Table H.16 Result of levene's test of equality of error variances

Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
anx1	2,808	1	166	,096
anx2	1,302	1	166	,255
anx3	2,611	1	166	,108
anx4	1,768	1	166	,185

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a.
Design: Intercept+grup
Within Subjects Design: anx

Table H.17 Result of mauchly's test of sphericity

Mauchly's Test of Sphericity[b]

Measure: MEASURE_1

					Epsilon[a]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
anx	,882	20,696	5	,001	,916	,939	,333

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b.
Design: Intercept+grup
Within Subjects Design: anx

H.2.7 Result of Analyses on Assumptions of Repeated Measures ANOVA for Interest Subtests of Attitudes toward Science and Technology Course Questionnaire

Table H.18 Result of tests of normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
Subtest	group	statistic	df	Sig.	statistic	df	Sig.
Interest 1	1	.126	86	.002	.923	86	.000
	2	.181	82	.000	.845	82	.000
Interest 2	1	.180	86	.000	.905	86	.000
	2	.160	82	.000	.930	82	.000
Interest 3	1	.213	86	.000	.804	86	.000
	2	.163	82	.000	.869	82	.000
Interest 4	1	.213	86	.000	.784	86	.000
	2	.134	82	.001	.916	82	.000

Table H.19 Result of levene's test of equality of error variances

Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
int1	,548	1	166	,460
int2	1,358	1	166	,245
int3	5,594	1	166	,019
int4	,030	1	166	,863

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a.
Design: Intercept+grup
Within Subjects Design: int

Table H.20 Result of mauchly's test of sphericity

Mauchly's Test of Sphericity[b]

Measure: MEASURE_1

					Epsilon[a]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
int	,794	38,003	5	,000	,859	,879	,333

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b.
Design: Intercept+grup
Within Subjects Design: int

H.2.8 Result of Analyses on Assumptions of Repeated Measures ANOVA for Career Subtests of Attitudes toward Science and Technology Course Questionnaire

Table H.21 Results of the normality tests

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
Subtest	group	statistic	df	Sig.	statistic	df	Sig.
career 1	1	.112	86	.010	.921	86	.000
	2	.143	82	.000	.911	82	.000
career 2	1	.193	86	.000	.865	86	.000
	2	.136	82	.001	.918	82	.000
career 3	1	.197	86	.000	.843	86	.000
	2	.159	82	.000	.978	82	.000
career 4	1	.171	86	.000	.877	86	.000
	2	.158	82	.000	.884	82	.000

Table H.22 Result of levene's test of equality of error variances

Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
car1	2,053	1	166	,154
car2	,133	1	166	,716
car3	6,648	1	166	,011
car4	,317	1	166	,574

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a.
Design: Intercept+grup
Within Subjects Design: career

Table H.23 The result of mauchly's test of sphericity

Mauchly's Test of Sphericity[b]

Measure: MEASURE_1

					Epsilon[a]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
career	,863	24,181	5	,000	,911	,933	,333

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b.
Design: Intercept+grup
Within Subjects Design: career

H.2.9 Result of Analyses on Assumptions of Repeated Measures ANOVA for Enjoyment Subtests of Attitudes toward Science and Technology Course Questionnaire

Table H.24 Result of the normality tests

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
Subtest	group	statistic	df	Sig.	statistic	df	Sig.
Enjoyment 1	1	.130	86	.001	.906	86	.000
	2	.157	82	.000	.876	82	.000
Enjoyment 2	1	.182	86	.000	.822	86	.000
	2	.124	82	.003	.914	82	.000
Enjoyment 3	1	.233	86	.000	.779	86	.000
	2	.172	82	.000	.878	82	.000
Enjoyment 4	1	.250	86	.000	.732	86	.000
	2	.224	82	.000	.809	82	.000

Table H.25 Result of levene's test of equality of error variances

Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
enj1	,235	1	166	,628
enj2	,846	1	166	,359
enj3	12,818	1	166	,000
enj4	,474	1	166	,492

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept+grup
Within Subjects Design: enjoyment

Table H.26 Result of mauchly's test of sphericity

Mauchly's Test of Sphericity[b]

Measure: MEASURE_1

					Epsilon[a]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
enjoyment	,973	4,496	5	,480	,982	1,000	,333

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b. Design: Intercept+grup
Within Subjects Design: enjoyment

H.2.10 Result of Analyses on Assumptions of Repeated Measures ANOVA for Usefulness Subtests of Attitudes toward Science and Technology Course Questionnaire

Table H.27 Result of the normality tests

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
Subtest	group	statistic	df	Sig.	statistic	df	Sig.
Usefulness 1	1	.144	86	.000	.933	86	.000
	2	.180	82	.000	.868	82	.000
Usefulness 2	1	.193	86	.000	.852	86	.000
	2	.191	82	.000	.880	82	.000
Usefulness 3	1	.252	86	.000	.715	86	.000
	2	.196	82	.000	.858	82	.000
Usefulness 4	1	.256	86	.000	.694	86	.000
	2	.200	82	.000	.809	82	.000

Table H.28 Result of levene's test of equality of error variances

Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
use1	,263	1	166	,609
use2	,589	1	166	,444
use3	16,556	1	166	,000
use4	,915	1	166	,340

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a.
Design: Intercept+grup
Within Subjects Design: usefullness

Table H.29 Result of mauchly's test of sphericity

Mauchly's Test of Sphericity[b]

Measure: MEASURE_1

					Epsilon[a]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
usefullness	,936	10,918	5	,053	,958	,983	,333

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b.
Design: Intercept+grup
Within Subjects Design: usefullness

APPENDIX I

SYNTAXES

I.1 Syntax for Independent t-Test

```
T-TEST
  GROUPS = group(1 2)
  /MISSING = LISTWISE
  /VARIABLES = wealth impactofmother
  /CRITERIA = CI(.95) .
```

I.2 Syntax of the GLM Repeated Measures for Reproduction, Development, and Growth in Living Things Unit Achievement Test

```
DATASET ACTIVATE DataSet1.
DATASET CLOSE DataSet2.
GLM
  canli1 canli2 canli4 BY group
  /WSFACTOR = canli 3 Repeated
  /METHOD = SSTYPE(3)
  /PLOT = PROFILE( canli*group )
  /EMMEANS = TABLES(group*canli)
  /EMMEANS = TABLES(canli)
  /EMMEANS = TABLES(group)
  /PRINT = DESCRIPTIVE ETASQ OPOWER HOMOGENEITY
  /CRITERIA = ALPHA(.05)
  /WSDESIGN = canli
  /DESIGN = group .
```

I.3 Syntax of the GLM Repeated Measures for Attitudes toward Science and Technology Course Questionnaire

```
GLM
  self1 anx1 int1 car1 enj1 use1 self2 anx2 int2 car2 enj2 use2 self3 anx3
  int3 car3 enj3 use3 self4 anx4 int4 car4 enj4 use4 BY grup
  /WSFACTOR = time 4 Repeated att 6 Polynomial
  /METHOD = SSTYPE(3)
  /PLOT = PROFILE( time*grup*att )
  /EMMEANS = TABLES(grup*att)
  /EMMEANS = TABLES(grup*time)
  /EMMEANS = TABLES(att)
  /EMMEANS = TABLES(time)
  /EMMEANS = TABLES(grup)
  /PRINT = DESCRIPTIVE ETASQ OPOWER HOMOGENEITY
  /CRITERIA = ALPHA(.05)
  /WSDESIGN = time att
  /DESIGN = grup .
```

APPENDIX J

GUIDED (TEACHER-DIRECTED) INQUIRY INSTRUCTION

J.1 Pilot "Piller ve Lambalar"Lesson

J.1.1 Pilot "Piller ve Lambalar"Lesson Plan

Amaçlar: Pil ve lambalarla basit incelemeler yapmak ve devre kavramını ve devre kurallarını kullanarak gözlemlerini açıklamak.

Materyaller: 1.5 V Pil, Tel, Lamba, Büyüteç, Duy

Güvenlik İçin: Gözlük. Ayrıca öğrencilerinize ellerindeki materyalleri bir elektrik prizine sokmamalarını, gözlerini telin sivri uç kısımlarına karşı korumalarını söyleyin.

1. Ders (Engagement)

Derse şu hikayeyle başlayın: Ormanda kamp yapan izcilerden üçü kaybolur. Gece olmuştur. Yanlarında el lambaları da yoktur. Fakat içlerinden birinin pili, diğerinin lambası, sonuncunun da bakır teli vardır. İzciler pili, lambayı ve teli nasıl birleştireceklerini de bilmemektedirler (Pil, lamba ve telden bahsederken, bu materyalleri (1.5 V pili, el lambasının lambasını ve teli öğrenci gruplarınıza dağıtın.).

Sonra öğrencilerinize şunu sorun: "Önünüzde duran materyalleri kullanarak bir lamba yapıp izcilerin kamp alanlarına güvenle ulaşmalarına yardım edebilir misiniz?

(Explore)

Öğrenci grupları verdiğiniz görevi yerine getirirken onlara soru sorarak ve grup arkadaşlarının yardımcı olmasını isteyerek yardımcı olun.

2. Ders (Explore)

Ne Olduğunu Keşfet işleminden (1.-3. Etkinlikler) sonra sınıfın ya da laboratuarın lambasını söndürünüz ve gruplara pil ve tel kullanarak yaktıkları lambayla ortamı aydınlatmalarını isteyin.

Sonra Gözlemlediğini Göster (4.-5. Etkinlik) işlemine geçin. Öğrencilerin lamba düzenekleriyle ilgili çizimleri, onların bilgilerini materyal kullanarak elle lamba düzenekleri oluşturmalarından, ikonik hayal gücüne dönüştürür. Öğrenci gruplarının çizdiği resimleri inceleyerek onlara yardımcı olun.

Bu aşamadan sonra 1. Tahmin Yaprağı'nı verin, bu etkinlik hakkında açıklama yapın.

Öğrenci grupları bu çalışma yaprağını tamamladıktan sonra, sınıfça cevapları değerlendirin.

3. Ders (Explain)

Genelleştir işlemi için öğrencilerinize şunu sorun:

"Farzedin ki izcilerden birinin bir cep telefonu var ve sizi arayarak lambayı nasıl yakacaklarını sordu. Ona ne dersiniz? Cevabınızı yazınız."

Öğrencilerden, bu soruya önce bireysel sonra grup halinde cevap vermelerini isteyin.

Lambanın yanması için gerekli kural şudur:

1. Lambanın ucunu bir pilin uç kısmına değdir.
2. Bir teli lambanın metal kısma değdir.

3. Elektriğin akması için teli diğer ucunu pilin diğer ucuna değdir.

Ayrıca devre kavramını da verin.Tahtaya "Devre" diye yazın ve devrenin lambalar, piller ve tellerden oluşan bir düzenek olduğunu söyleyin. Eğer devre tamsa, bir pilin ucundan tel boyunca lambaya doğru ve ardından pilin diğer ucuna olan kesiksiz bir yol olduğunu belirtin. Soru-cevap ve anlatım yoluyla öğrencilerinizin devreler hakkındaki bilgisini önceki devre düzeneklerine uygulamasını sağlayın. Yani 1. Tahmin Yaprağı'ndaki elektiğin yönünü anlamada ve açıklamada kullanmalarını sağlayın.

4. Ders (Elaborate)

Bilgini Yeni Durumlara Uygula işlemini yürütünüz. Ayrıca öğrencilerinizin yapacakları model bir evi aydınlatmalarını isteyin ya da sınıf veya laboraturadaki lambaların nasıl bağlandığını düşünmelerini sağlayın.

5. Ders (Evaluate)

Öğrencilerin konuyla ilgili ve sorgulayıcı araştırma yöntemi bilgilerini ölçün. Yeni bir Tahmin Yaprağı verebilirsiniz.

İşlem	**Etkinlikler**
Ne Olduğunu Keşfet	1) Bir tel ve pil kullanarak bir lambayı yakmayı deneyin. 2) Lambayı yakma yolları bulun. 3) İki tel kullanarak, lambayı pile değdirmeden bir lambayı yakmayı deneyin.
Gözlemlediğini Göster	4) 1. ve 2. etkinliklerdeki lamba-pil-tel düzeneklerini gösteren şekiller çizin. 5) 3. etkinlikteki lamba-pil-tel düzeneklerini gösteren şekiller çizin.
Tahmin Et ve Sına	6) 1. Tahmin Yaprağı'nı tamamlayınız. İlk kutudan başlayarak, sırayla giderek öğrendiklerinizi bir sonraki kutuda kullanınız. Bir tahminde bulununuz. Tahmininizi sınayınız. Denemenizden öğreniniz. Öğrendiğinizi uygulayınız. 1. Tahmin Yaprağı Lamba yanacak mı? Emin değilseniz deneyin ve görün.
Genelleştir	7) Yanması için lambanın nereye değmesi gereklidir? Pil nereye temas etmelidir? Bir lambanın yanması için ne yapılması gerektiğiiyle ilgili genel bir kural yazınız. Genelleştirdiğiniz ifadeyi veya kuralı, 1. Tahmin Yaprağı'nda kutular halinda gösterilen durumları açıklamakta kullanınız.
Bilgini Sonuç Çıkarmada ve Açıklamada Kullan	8) Lambayı büyüteç yardımıyla inceleyin. Lamba içindeki sarılmış tele Filaman denir. Filaman elektrik enerjisini ışık oluşturmakta kullanır. Lambanın tabanına doğru kaybolan iki teli gördünüz mü? Bu tellerin lambanın tabanında birleştiğini biliyor musunuz? 7. Etkinlikle ilgili kuralınızı kullanarak yorumunuzu yapınız. 9) Bir duyu inceleyiniz. Duyun kısımları nelerdir? Duy, lambanın uç ve metal kısımlarna değecek şekilde nasıl yapılmıştır?
Bilgini Yeni Durumlara Uygula	10) İki pil kullanarak bir lambayı yakın. 11) İki lambayı nasıl yakacağınızı bulun. 12) Şekil A'da görülen devreyi kurunuz. Kaç tel gereklidir? Lambalardan birini duyundan çıkarınız. Ne oldu? Neden? Lambayı tekrar yerine takınız. Diğer lambayı duyundan çıkarınız. Ne oldu? Neden? Bir ya da iki pil daha ekleyiniz. Ne oldu? Neden? "Seri Bağlı Devre" ismi, Şekil A'da gösterilen devreyi nasıl tanımlar? 13) Şekil B'de görülen devreyi kurunuz. Kaç tel gereklidir? Lambalardan birini duyundan çıkarınız. Ne oldu? Neden? Lambayı tekrar yerine takınız. Diğer lambayı duyundan çıkarınız. Ne oldu? Neden? Bir ya da iki pil daha ekleyiniz. Ne oldu? Neden? "Paralel Bağlı Devre" ismi, Şekil B'de gösterilen devreyi nasıl tanımlar?

Kaynak: Carin, A. A., Bass, J. E., & Contant, T. L. (2005). Methods for Taeching Science as Inquiry. 9 th Edition. Pearson Education North Asia Ltd., p. 107-114.

J.1.2 Pilot “Piller ve Lambalar”Lesson Worksheet

İZCİ ARKADAŞLARA YARDIM EDELİM

Ormanda kamp yapan izcilerden üçü kaybolur. Gece olmuştur. Yanlarında el lambaları yoktur, fakat birincinin pili, ikincinin ampulü, üçüncünün de bakır teli vardır. İzciler el lamnbası yapmayı bilememektedir.

PİL, KABLO VE AMPUL

Sınıfa getirdiğiniz pil, ampul ve kablodan bir lamba yapıp izcilerin kamp alanına güvenle ulaşmalarına yardım edebilir misiniz?

Ne Olduğunu Keşfet

1. Bir kablo ve bir pil kullanarak bir ampulü yakmayı deneyin.
2. İki kablosu ve bir pil kullanarak bir ampulü yakmayı deneyin.

Gözlemle ve Genelleme Yap

1. Aşağıdaki boşluğa hazırladığınız düzenekleri gösteren şekiller çiziniz.
2. Aşağıdaki boşluğa bir ampulün yanması için ne yapılması gerektiğini yazınız. Ampul nereye değmelidir? Pil neye temas etmelidir?

ANAHTAR VE DUY

Ne Olduğunu Keşfet

İki bağlantı kablosu, bir pil, bir anahtar ve bir duy ile bir ampulü yakmayı deneyin.

Gözlemle ve Genelleme Yap

1. Aşağıdaki boşluğa hazırladığınız düzenekleri gösteren şekiller çiziniz.
2. Aşağıdaki boşluğa bir ampulün yanması için ne yapılması gerektiğini yazınız. Ampul nereye yerleştirilmelidir? Pil neye temas etmelidir. Anahtar ne yapılmalıdır?

EL LAMBASININ IŞIĞI

Küçük izciler ellerindeki materyallerden bir el lambası yapmışlardır. Ancak el lambasının ışığı etrafı tam aydınlatamamaktadır. Sizce izciler el lambalarının ışığını artırmak için ne yapmalıdır?

Tahmin Et

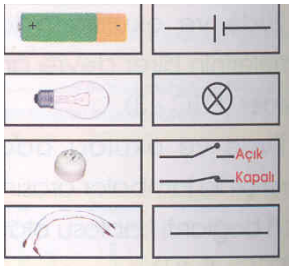
Aşağıdaki boşluğa hazırladığınız devredeki ampulün parlaklığını nasıl artırabileceğinizi yazınız.

Dene ve Sonuç Çıkar

1. Hazırladığınız devredeki ampulün parlaklığını artırmayla ilgili tahminlerinizi deneyin. Aşağıdaki boşluğa sonuçlarını yazınız.
2. Aşağıdaki boşluğa ampulün parlaklığını etkileyen değişkenleri yazınız. Bağımlı Değişken: Ampulün parlaklığı Bağımsız Değişken (Ampulün parlaklığını etkileyen değişken): Kontrollü Değişken (Sabit tutulan değişken):

DEVRE ELEMANLARI ve SEMBOLLERİ

Devre Elemanı	Resmi	Sembolü
Pil		
Ampul		
Anahtar		
Kablo		



Yanda bir elektrik devresinde yer alan elemanları ve sembollerini görüyorsunuz. Aşağıdaki boşluğa bu sembolleri kullanarak hazırladığınız devreleri çiziniz.

KAVRAMLARI AÇIKLAYALIM

Bugünkü derste yaptığınız etkinliklerden edindiğiniz bilgi ve deneyimlere de dayanarak, aşağıdaki kelimeleri birer cümle ile açıklayınız:
Pil:
Ampul:
Anahtar:
Kablo:
Duy:

J.2 Guided (Teacher-Directed) Inquiry Instruction on Reproduction, Development, and Growth in Living Things Unit

J.2.1 "The Cell" Lesson

J.2.1.1 "The Cell" Lesson Plan

Sınıf: 6
Öğrenme Alanı: Canlılar ve Hayat
Ünite: Canlılarda Üreme, Büyüme ve Gelişme
Konu: Hücre

HÜCRE

Hedefler

1. Öğrenciler yaşamın temel yapı taşının hücre olduğunu tanımlayabilir.
2. Öğrenciler bitki ile hayvan hücresi arasındaki farkları sıralayabilir.
3. Öğrenciler bitki ve hayvan hücrelerini tanımlayabilir.

Araç ve Gereçler

Blob (Yapılışı: Bir paket hazır jöle alarak, paketinin üzerindeki tarife uygun olarak jöleli tatlınızı hazırlayınız. Tatlınızı küçük boy bir buzdolabı poşetinin içine koyunuz. İçine hem yuvarlak hem de çubuk şeklindeki bisküvileri yerleştirdikten sonra poşetin ağzını sıkca bağlayınız. Bu hücre modelinde jöle tatlısı sitoplazmayı, buzdolabı poşeti hücre zarını, yuvarlak bisküviler çekirdeği, çubuk bisküviler ise hücredeki diğer organelleri temsil etmektedir.)
Öğrenci başına 2 lam, 2 lamel
Her bir öğrenci ya da iki öğrenci için kürdan
Soğan zarları
Her öğrenci için bir damlalık
Su
Bitki ve hayvan hücrelerin gösteren hazır preparatlar
Resim kağıdı
Resim kalemi

Yöntem

Girme

1. Her öğrenci grubuna bir blob veriniz. Öğrencilere bununla 5-7 dakika oynamalarına ve bunun neyi ifade ettiği hakkında bireysel olarak varsayımda bulunmalarını isteyin. Öğrenciler kendi hipotezlerini yazıp grupla paylaşmalılar.
2. Gruplardan hipotezlerini sınıfla paylaşmalarını ve bunları tahtaya yazmalarını isteyin.
3. Blobları öğrencilerin ilgisi dağılmasın diye sonra incelenmek üzere kaldırın.
4. Öğrencilerinize hipotezlerini test edecekleri bir laboratuar etkinliği yapacaklarını söyleyin.

Keşfetme

Öğrencilerin proparat hazırlama ve mikroskopta inceleme hakkında ön bilgileri olmalıdır.
Gözlemleri kaydetmede kullanılacak etkinlik kağıdı için Şekil 1e bakınız
5. Lam, lamel ve kürdanları kullanarak öğrencilerin bireysel olarak yanaklarının içini yavaşça sıyırarak alacakları yanak hücrelerinden preparat hazırlamalarını sağlayın (güvenlik önlemleri için Tartışma ve Bulgular kısmına bakınız)..
6. Öğrencileriniz küçük soğan zarı parçalarından preparat hazırlamalıdır. Öğrencilerinizin dikkatli gözlem yapmalarını ve ayrıntılı şekil çizmelerini sağlayın.
7. Öğrenci gruplarından iki preparatı karşılaştırarak benzerlik ve farklılıklarını listelemelerini isteyin.
8. Öğrenciler sonraki aşamaya geçmeden çalışma alanlarını temzlemelidirler.

Açıklama

9. Öğrencilere şu soruları sorun:
"Preparat incelemeniz, blobun neyi temsil ettiği hakkında size bir ipucu verdi mi?"
Öğrencilerden "hücre" cevabını alın.
10. Öğrencilerden Keşfetme etkinliğindeki gözlemlerini "hücre" kelimesini kullanarak açıklamalarını isteyin.
11. Hücrenin yaşamın temel yapıtaşı olduğunu söyleyin.
12. Öğrenci gruplarının her iki preparatttan yaptıkları gözlemleri tahtaya çizerek ya da yapıştırarak paylaşmalarını sağlayın. Çizimlerdeki farklılıkların nedenlerini tartışın.
13. Sonra gruplardan Keşfetme aşamasındaki hazırladıkları hücreler arasındaki benzerlik ve farklılıkları paylaşmalarını isteyin. Bu iki hücre türünün neden farklı gözüktüğü hakkında bir tartışma başlatın.
14. Öğrencilerinize farklı hücre türlerini incelediklerini söyleyin. Bitki ve hayvan hücreleri arasındaki farklılıkları açıklayın.
Bitki hücreleri hücre duvarlarından dolayı köşeli bir şekle sahiptir ve düzenli bir biçimde veya sırada dizilmişlerdir.
Bitki hücreleri yeşil kloroplastlar içerirler ve büyük vakuolleri vardır.
Hayvan hücreleri düzensiz şekildedir ve küme halindedir. Yeşil kloroplastları ve büyük vakuolleri yoktur.
Hem bitki hem de hayvan hücreleri bitki hücresininki hücre duvarından dolayı zor görünse de birer hücre zarına sahiptir. Bitki ve hayvan hücreleri benzer organelleri olsa ışık mikroskobunda iyi gözlemlenmeyebilir.
15.Şimdi öğrencilerinize blobu bir bitki hücresi olarak mı yoksa hayvan hücresi olarak mı sınıflandırdıklarını sorun. Verdikleri cevapların nedenlerini açıklamalarını isteyin.
16. Öğrencilerinize bir sonraki etkinliğin bitki ve hayvan hücreleri hakkındaki bilgilerini diğer gerçek preparatlara uygulamalarını sağlayacağını söyleyin.

Derinleştirme

Bu etkinlik hangi grubun preparatları doğru olarak tanımlayacağı bir sorgulayıcı araştırma halinde verilebilir.

17. Öğrencilerinizin bitki mi yoksa hayvan hücresi mi olduğu belirtilmemiş preparatları incelemelerini sağlayın. Preparat örnekleri öğrencilerinizin bildikleri canlılardan olmalıdır. Öğrenciler preparatları inceledikçe her bir preparatı bitki ya da hayvan olarak sınıflandırmalarını isteyin.
18. Tüm öğrenciler sekiz, on preparatı inceledikten sonra sınıflandırmalarını grup üyeleriyle tartışmalarını ve bir görüş birliğine ulaşmalarını isteyin. Sınıflandırma, Açıklama basamağında verilen bitki ve hayvan hücresi arasındaki farklara göre olmalıdır.
19. Sonra gruplardan sonuçlarını paylaşmalarını isteyin. Bu noktada sonuçları doğrular ve yarışmayı kimin kazandığını açıklar.

Değerlendirme

Bu değerlendirmeyi etkili olarak yapmak için öğrenciler kavram haritasının nasıl yapılacağını bilmelidir.
20. Öğrencilerinizden bireysel olarak hücre, bitki, hayvan, düzensiz şekil, kloroplast, çekirdek, hücre zarı ve hücre duvarı kelimelerini kullanarak bir kavram haritası oluşturmalarını isteyin (Şekil 2'ye bakınız).

Tartışma ve Bulgular

Yanak içi hücrelerini kullanırken dikkat edin. Güvenlik önlemleri olarak şunları göz önünde bulundurun:
Öğrenciler tüm etkinlik boyunca sadece kendi hücreleriyle uğraşmalıdırlar.
Temizlik sırasında lameller ayrı bir çöpe atılmalıdır. Lamlar ise iyice temizlenmelidir.
Çalışma alanı ve mikroskoplar su ile seyreltilmiş çamaşır suyu ile temizlenmelidir.
Tüm öğrenciler preparatları hazırlamadan önce ve hazırladıktan sonra ellerini iyice yıkamalıdır.
Keşfetme ve Açıklama aşamalarında etkili öğrenmenin gerçekleşmesi için öğrencilerin mikroskobu hücreleri görebilecek kadar iyi ayarlamaları gerekmektedir. Dolayısıyla mikroskop kullanma hakkında önceden bilgi vermek gerekir.
Bu etkinlikle öğrencilerin sorgulayıcı araştırma yeteneklerinin artırılması ve yapısalcı öğrenmenin gerçekleşmesi hedeflenmektedir. Blobların ne olduğu öğrencilerde merak uyandırmaktadır. Görsel/uzamsal zekâsı güçlü olan öğrenciler verilerini çizimler yoluyla kaydetmekten hoşlanır. Derinleştirme etkinliği bilinen cevaplar yerine doğru cevapları bulma konusunda öğrencileri güdüler.
Kavram haritası öğrencilerinizin bitki ve hayvan hücreleri arasındaki ayrımı anlayıp anlamadıklarını değerlendirmenizi sağlar.

Diğer Derslerle İlişkiler

Resim-İş: Resim-İş öğretmeni ile işbirliği yaparak etkili bir resmin nasıl çizileceğini öğrencilerinize verebilirsiniz.
Matematik: Matematik öğretmeni ile işbirliği yaparak oran ve orantı konusunu gözden geçirebilirsiniz. Öğrencileriniz böylece farklı hücre türlerinin büyüklüğünü fark edebilir.
Teknoloji: Teknoloji öğretmeni ile işbirliği yaparak kavram haritasını Inspiration gibi bir program aracılığıyla çizebilirsiniz. Hatta video mikroskop yardımıyla mikroskopta incelediğini hücrelerin kısımlarını tüm sınıfa gösterebilirsiniz.

Sonuç

5E Öğrenme Çemberi ile öğrencileriniz Girme aşamasındaki sorulara cevap vermesini sağlayabilirsiniz. Derinleştirme aşamasındaki etkinlik, bilgilerini doğru olarak uygulayabilmeleri için öğrencilerinizi güdüler.

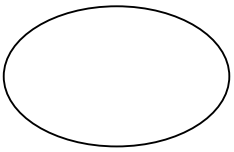
J.2.1.2 “The Cell” Lesson Worksheet

Bitki ve Hayvan Hücreleri Arasında Benzerlik ve Farklılık Var Mıdır?

Yukarıdaki soruyu cevaplamak için şu etkinliği ve soruları yapın.

1. Tırnağınızdan daha küçük boyutta bir soğan zarı alın ve üzerine bir damla su damlatılmış lam üzerine koyun.
2. Soğan zarının üzerine lameli dikkatlice kapatın.
3. Hazırladığınız peparatı mikroskopta inceleyin. Mikroskobu açık alanları görecek şekilde ayarlayın. Mikroskobu koyu alanları ayarlayacak şekilde ayarlayın. Preparatınızın bazı kısımları diğerlerine göre daha parlak gözüküyor mu?

4. Aşağıdaki ovalin içine preparatınızın neye benzediğini çizin.



a. Gördüğünüz şeylerin şeklini nasıl tanımlarsınız?

b. Blokların hepsi birbirine benziyor?

c. Hepsi aynı büyüklükte mi?

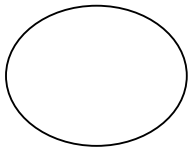
d. Hepsi aynı şekilde mi?

e. İçlerinde ne görüyorsun?

5. Lamın üstündeki soğan zarının üstüne Metilen mavisi boyasından kürdan yardımıyla biraz damlatın. Sonra bir damla su ekleyin ve lamelle kapatın.
6. Praparatınızı mikroskopla dikkatlice biraz inceleyin. Şimdi içinde ne görüyorsunuz?

7. Temiz bir lama küçük bir damla su damlatın.
8. Temiz bir kürdan alın. Kör olan ucuyla yanağınızın içini nazikçe kazıyın.
9. Kürdanda toplanan maddeyi lamın üzerindeki su damlasına değdirin.
10. Küçük bir damla metilen mavisi ekleyin. Lamelle kapatın.
11. Mikroskopla bakıncaya kadar preparatınızda bir şey görmeyebilirsiniz.

12. Aşağıdaki ovalin içine preparatınızın neye benzediğini çizin.



a. Gördüğünüz şeylerin şeklini nasıl tanımlarsınız?

b. Blokların hepsi birbirine benziyor?

c. Hepsi aynı büyüklükte mi?

d. Hepsi aynı şekilde mi?

e. İçlerinde ne görüyorsun?

13. Bir Venn diyagramı çizerek gözlemlediğiniz iki farklı hücre türünün benzerlik ve farklılıklarını anlatınız.

Reference

Wilder , M. Ve Shuttleworth, P. (2005). Cell Inquiry: A 5E Learning Cycle Lesson. *Science Activities, 41*(4), 37-43.

J.2.1.3 Evaluation of "The Cell" Lesson

Table J.1 Inquiry in the cell tasks and coding categories for the cell lesson plan

Essential features of classroom inquiry*	Task organizations according to inquiry features (task component and response format of performance assessment, by Solones-Flores & Shavelson, 1997, fig.1)	Coding categories (scoring system component of performance assessment, by Solones-Flores & Shavelson, 1997, fig.1)
Learner engages in scientifically oriented questions.	1st Task: Observation* Blob neyi ifade etmektedir? 2nd Task: Observation* (Soğan zarı ve yanak epiteli hicrelerini mikroskopta inceledikten sonra) Aşağıdaki ovalin içine preparatınızın neye benzediğini çizin. a. Gördüğünüz şeylerin şeklini nasıl tanımlarsınız? b. Blokların hepsi birbirine benziyor? c. Hepsi aynı büyüklükte mi? d. Hepsi aynı şekilde mi? e. İçlerinde ne görüyorsun? 3rd Task: Classification* Bir Venn diyagramı çizerek gözlemlediğiniz iki farklı hücre türünün benzerlik ve farklılıklarını anlatınız. 4th Task: Classification* Mikroskoplardaki preparatları inceleyerek, her birini bitki ya da hayvan olarak sınıflandırın.	Not assessed: Question is provided for learner.
Learner gives priority to evidence in responding to questions.	Learner makes observations of blobs to explore it and uses microscopes to find out: a. the structure of the onion and cheek tissues b. differences between plant and animal cells c. whether undefined samples are either from a plant or an animal.	Not assessed: Students are instructed how to use microscopes and prepare slides. They are given activity sheets to record their observations.
Learner formulates explanations from evidence.	Learner explains what living things are made of, the content of cells, the differences and similarities between plant and animal cells, and classifies samples into these cell types.	Whether students give the names of the organelles not observed through the microscope, such as endoplasmic reticulum, ribosome, etc. Which criteria do students use when comparing plant and animal cells? (Explanation type) What kind of reasoning students provide from the evidence?
Learner connects explanations to scientific knowledge.	Learner's explanation reflects the level of understanding about her/his knowledge of cells, cell parts, and cell types.	(Scientific knowledge use) How consistent and sophisticated are students' explanations in conjunction with scientific knowledge?
Learner communicates and justifies explanations.	Learner compares her/his explanations with other students' explanations and reference books.	(Prediction agreement) How well students predict that blobs represent cells. How many criteria do students use when comparing plant and animal cells? And whether these are correct or not. How many slides do students correctly classifies according to cell types.

Note: Developed from Table 1 of Lee & Butler Songer, 2003, and *Table 2 of Solano-Flores & Shavelson, 1997

REFERENCES

Solano-Flores, G., & Shavelson, R. J. (1997). Development of Performance Assessments in Science: Conceptual, Practical, and Logistical Issues. Educational Measurement: Issues and Practice, Fall 1997, 16-25.

Lee, H-S. & Butler Songer, N. (2003). Making authentic science accessible to students. *International Journal of Science Education (25)*,8, 923–948

J.2.2 “Reproduction, Development, and Growth in Human Beings” Lesson

J.2.2.1 “Reproduction, Development, and Growth in Human Beings” Lesson Activity 1

Sınıf: 6
Öğrenme Alanı: Canlılar ve Hayat
Ünite: Canlılarda Üreme, Büyüme ve Gelişme
Konu: İnsanlarda Üreme, Büyüme ve Gelişme

İnsanlarda Üreme, Büyüme ve Gelişme

Öğrencilerden anne veya babaları ile bir görüşme yaparak onların hayat hikâyelerini doğdukları andan itibaren öğrenmeleri ve bir rapor yazmaları istenecek. Öğrenciler ayrıca anne ve babalarının doğumlarından itibaren çekilmiş fotoğraflarını da bu rapora ekleyeceklerdir.
Öğrenciler sınıfta arkadaşlarına hazırladıkları raporları sunacaklardır.
Öğrencilere sunudan sonra şu soru sorulacaktır:
Anne veya babanızın fotoğraflarını onların hayat hikâyelerini doğumlarından itibaren anlattığınız raporda ilgili yerlere eklerken güçlük çektiniz mi? Size kim yardım etti? Fotoğrafları sıraya koyarken nelere dikkat ettiniz? gibi sorularla bu sınıflandırma-sıralama işlemini nasıl yaptıkları öğrenilir.
Öğrencilere daha sonra anne veya babalarının fotoğraflarla gösterilen hayat evrelerini adlandırmaları istenir.
Öğrencilere anne veya babalarının nasıl anne ve baba oldukları, kendilerinin nasıl doğdukları, varsa kardeşlerinin nasıl doğdukları, anne ve babalarının kendilerini ve kardeşlerini nasıl besleyip büyüttükleri sorulacak. Anne ve babalarının vücudundaki hangi kısımların anne ve baba olmaktan sorumlu olduğu sorulur.
Öğrencilere ayrıca kendileriyle ilgili ailelerini ve çevrelerini de etkileyen hangi önemli olayları (örneğin emzik emme, parmak emme, göbek bağının gömülmesi, diş çıkartma, süt dişlerinin çıkarılması, ana sınıfına başlama, okula başlama, kız/erkek arkadaşı olma, ergenlik gibi) hatırladıkları sorulacak. Ayrıca bu olayların aile ve çevredeki yansımalarını (gelenek, görenek) anlatmaları istenecek.

J.2.2.2 Evaluation of "Reproduction, Development, and Growth in Human Beings" Lesson

Table J.2 Inquiry in the Human Development tasks and coding categories for the Human Development lesson plan

Essential features of classroom inquiry*	Task organizations according to inquiry features (task component and response format of performance assessment, by Solones-Flores & Shavelson, 1997, fig.1)	Coding categories (scoring system component of performance assessment, by Solones-Flores & Shavelson, 1997, fig.1)
Learner engages in scientifically oriented questions.	1st Task: Classification* Anne veya babanızın hayat hikâyelerini onların ilgili fotoğraflarını da ekleyerek yazınız. Anne veya babanızın fotoğraflarını onların hayat hikâyelerini doğumlarından itibaren anlattığınız raporda ilgili yerlere eklerken güçlük çektiniz mi? Size kim yardım etti? Fotoğrafları sıraya koyarken nelere dikkat ettiniz? 2nd Task: Observation* Anne veya babalarınızın fotoğraflarla gösterilen hayat evrelerini adlandırın. 3rd Task: Classification* Anne veya babalarınız nasıl anne ve baba oldular? Nasıl doğdunuz, varsa kardeşleriniz nasıl doğdu? Anne ve babalarınız sizi ve kardeşlerinizi nasıl besleyip büyüttü? 4th Task: Classification* Anne ve babalarınızın vücudundaki hangi kısımlar anne ve baba olmaktan sorumludur?	Not assessed: Questions are provided for learner.
Learner gives priority to evidence in responding to questions.	Learners write biographies of their parents. They make observations of photographs of their parents according to some attributes such as age, physical appearance, presence of other people, etc. Learners make use of their autobiographies when considering how human are born and nurtured. Learners relate reproductive organs with reproduction.	Students are expected to prepare a report telling the life story of their parents. They are also expected to visualize the life of their parents with appropriate photographs. Students are expected to share their understanding of reproduction in human by giving examples from their own experiences.
Learner formulates explanations from evidence.	Learner explains that human life has some steps and we give different names to people in each step, such as fetus, newborn, infant, child, adolescence, adult, and old. Learner understands that each stage has important characteristics. Learner also explains that some of our body parts are responsible for our reproduction.	Whether students included all stages of human life in their stories, named the stages correctly. Whether students relate reproductive organs with their functions in human reproduction.
Learner connects explanations to scientific knowledge.	Learner's explanation reflects the level of understanding about her/his knowledge of human life stages, reproductive organs and reproduction.	(Scientific knowledge use) How consistent and sophisticated are students' explanations in conjunction with scientific knowledge?
Learner communicates and justifies explanations.	Learner compares her/his explanations with other students' explanations and reference books.	(Prediction agreement) How well students classified their parents' photographs according to the characteristics of life stages. How many criteria do students use when classifying human life stages? How students relate reproductive organs with reproduction.

Note: Developed from Table 1 of Lee & Butler Songer, 2003, and *Table 2 of Solano-Flores & Shavelson, 1997

REFERENCES

Solano-Flores, G., & Shavelson, R. J. (1997). Development of Performance Assessments in Science: Conceptual, Practical, and Logistical Issues. Educational Measurement: Issues and Practice, Fall 1997, 16-25.

Lee, H-S. & Butler Songer, N. (2003). Making authentic science accessible to students. *International Journal of Science Education (25)*,8, 923–948.

J.2.2.3 “Reproduction, Development, and Growth in Human Beings” Lesson Activity 2

Sınıf: 6

Öğrenme Alanı: Canlılar ve Hayat

Ünite: Canlılarda Üreme, Büyüme ve Gelişme

Konu: İnsanda Üreme, Büyüme ve Gelişme

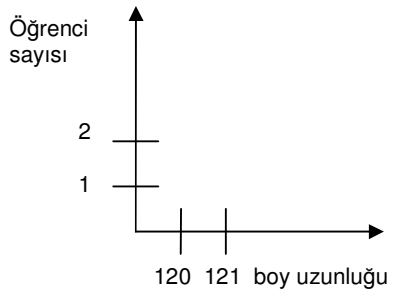
İnsanda Üreme, Büyüme ve Gelişme

Araştırma Konuları

1. Anasınıfı kendi sınıfınız, 7. ve 8. sınıftakilerin boylarını ölçün /ellerini, ayaklarını çizin.

En uzun boy nedir? vs.

Uzunluk	120	121	122	123	124
Öğrenci sayısı	1	4	5	2	1



J.2.3 “Reproduction, Development, and Growth in Animals” Lesson Activity

Sınıf: 6
Öğrenme Alanı: Canlılar ve Hayat
Ünite: Canlılarda Üreme, Büyüme ve Gelişme
Konu: Hayvanlarda Üreme, Büyüme ve Gelişme

Hayvanlarda Üreme, Büyüme ve Gelişme

Araştırma Konuları

1. Karşılaştırma: Araştırdığınız bitkilerin hayvanların hayat döngülerini insanın hayat döngüsüyle karşılaştırın. Karşılaştırmada hangi yöntemi kullandınız, neden? Hangi yargıya vardınız? Vardığınız yargı diğer gruplardakinden benzer mi, farklı mı?
2. Sınıflandırma: Araştırdığınız bitkilerin hayvanların çoğalma şekli, yavru bakımı, beslenme özellikleri, yaşam süresi, yavru sayısı vb. özellikleri bakımından sınıflandırınız. Tablo çıkarabilirsiniz. Sınıflandırmada hangi özellikleri (değişkenleri) kullandınız, neden? Bu özelliklere bakarak diğer canlıları da sınıflandırabilir misiniz?
3. Gözlem: Saklanmış hayvan örneklerinden birer tane alıp gözlemleyerek bu hayvanın bir önceki ve bir sonraki hayat evresini tahmin etmeye çalışın.

J.2.4 “Plant Reproduction, Development and Growth” Lesson

J.2.4.1 “Plant Reproduction, Development and Growth” Lesson Worksheet 1

Araştırma Sorumuz: **Meyve Büyüklüğü ile Tohum Sayısı Arasında Bir İlişki Var Mıdır?**

Kullanmam Gereken Materyaller: Meyve, cetvel

Varsayımımız/Hipotezimiz:

Değişkenler
1. Kontrol Edilen Değişken: Meyve türü
2. Bağımsız Değişken: Meyve Büyüklüğü
3. Bağımlı Değişken: Tohum Sayısı

İzlememiz Gereken Yöntem:
1. Meyvenin büyüklüğünü ölçeceğiz.
2. Meyveyi parçalayıp tohumlarını bulacağız.
3. Tohum sayılarını hesaplayacağız.

Toplamamız ve Kayıt Etmemiz Gereken Veriler: Meyvenin büyüklüğü (uzunluğu, çağı), tohum sayısı
Hatalara Nasıl Kontrol Edeceğiz? Aynı meyveyi hem arkadaşım hem de ben ölçeceğim. Tohumlarını da ikimiz sayacağız.

Bulgularımız:
(Verilerimizden Hazırladığım Tablo ve Grafik)

Yorumumuz:
Hipotezimiz Doğrulandı mı?

Kullandığımız ve Anladığımız Terimler:

Sonraki Araştırma Konumuz ve Dikkat Etmemiz Gerekenler:

Öğrendiklerimizin Diğer Konularla İlişkisi:

J.2.4.2 “Plant Reproduction, Development and Growth” Lesson Worksheet 2

OKUL BAHÇESİNDE

Bir Ağaç Evlat Edinin:

Öğrencilerden gösterilen ağaçlardan birini seçmeleri istenecek. Aynı ağacı seçen öğrenciler bir grup oluşturacak. Gruplar aşağıdaki soruları cevaplayacak:

1. Bu ağacı neden seçtiniz?
2. Ağacınıza once uzaktan bakın. Hangi özellikleri dikkat çekiyor?
   Sonra ağacınıza yaklaşın. Dikkatinizi çeken diğer özellikleri oldu mu? Neler?
3. (Daha sonra kolayca bulmak ve arkadaşlarınıza anlatmak için) Ağacınızın okul bahçesindeki yerini ve şeklini tanımlar mısınız? (Ağaç bahçenin neresinde? Şekli, kısımları, boyu, rengi, yapısı, yaprakları, gövdesi, meyvesi/tohumu, kokusu, vb. nasıl?
4. Bitkiye zarar vermeden gövdesini, yaprağını, meyve ve tohumunu elinize alıp inceleyin. Gördüklerinizi ve hissettiklerinizi kaydedin.
5. Ağacınızın özelliklerini daha once hangi ağaçlarda görmüştünüz?”
6. Sizce ağaç kaç yaşında?
7. Bulunduğu yere nasıl geldi?
8. Sonbaharda olduğumuzu düşünürsek kış gelince ağaca ne olacak? İlkbaharda ve yazın ne olacak?
9. Sizce ağacın diğer canlılarla nasıl ilişkileri var?

J.3 Guided (Teacher-Directed) Inquiry Instruction on Force and Motion Unit

J.3.1 "Rocket Balloon" Lesson

J.3.1.1 "Rocket Balloon" Lesson Plan

KUVVET VE HAREKET ROKET BALON

1. Ders: Roket Balon

Gerekli Malzemeler:

1 balon

1 kamış/pipet

İp

Bant

Yapılışı:

İp'i kamıştan geçirin.

Balonu şişirip ucunu bağlayın.

Şişirdiğiniz balonu pipete bant yardımıyla yapıştırın.

Balonun bağlı ucunu serbest bırakın (balon ip boyunca gidecektir).

Sorular:

1. Ne gözlemlediniz?
2. Sizce bu olay nasıl oldu?
3. Bu olaydan sorumlu olan kuvvet nedir? Bu kuvvet temas gerektiren bir kuvvet mi yoksa temas gerektirmeyen bir kuvvet mi?
4. Bu deneyi evde az şişmiş ya da çok şişmiş bir balonla tekrarladığınız takdirde nasıl sonuçlanmasını beklersiniz?

2. Ders: Roket Balon

Roket Balon'u tekrar yapın.

Roket balonunuz ne kadar uzaklığa gitti? Bunu nasıl ölçersiniz?

En uzağa giden roket balonu yapmak için hangi değişkeni değiştirmeniz gerekir?

Bu değişkenin balonun ip üzerinde aldığı yola etkisini bulmak için bir deney yapınız. Deneyinizle ilgili ikinci sayfada verilen örnekten faydalanarak bir rapor hazırlayınız.

J.3.1.2 “Rocket Balloon” Lesson Plan Worksheet

EN UZAĞA GİDEN ROKET BALON DENEYİ

Kullanmam Gereken Materyaller: Balonlar (en az 2), 1 kamış/pipet, İp, Bant, Cetvel/Mezura/Metre
Varsayımımız/Hipotezimiz: Balon ne kadar çok şişirilirse o kadar uzağa gider.

Değişkenler **1. Kontrol Edilen Değişken:** Balon
2. Bağımsız Değişken: Balonun büyüklüğü
3. Bağımlı Değişken: Balonun ip üzerinde aldığı yol

İzlememiz Gereken Yöntem:
1. Balonu şişirip ağzını bağlarız.
2. Şişirdiğimiz balonun büyüklüğünü ölçeriz.
3. Balonu içinden ip geçirilmiş pipete bantlarız.
4. Balonun ipini çözeriz.
5. Balonun ip üzerinde aldığı yolu cetvelle ölçeriz.
6. Daha az ya da daha çok şişirilmiş balonla karşılaştırırız.

Toplamamız ve Kayıt Etmemiz Gereken Veriler: Balonun büyüklüğü (çevre uzunluğu), balonun ip üzerinde aldığı yol
Hatalara Nasıl Kontrol Edeceğiz? Aynı balonun çevresini hem arkadaşım hem de ben ölçeceğim. Balonun ip üzerinde aldığı yolu ikimiz ölçeceğiz.
Bulgularımız:
(Verilerimizden Hazırladığım Tablo ve Grafik)

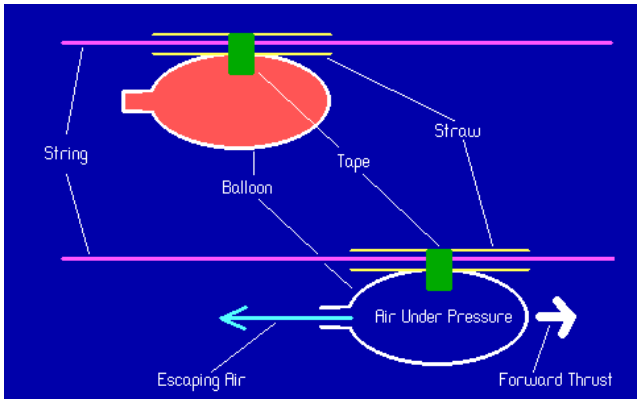
Yorumumuz (Hipotezimiz Doğrulandı mı?)

Kullandığımız ve Anladığımız Terimler:

Sonraki Araştırma Konumuz ve Dikkat Etmemiz Gerekenler:

Öğrendiklerimizin Diğer Konularla İlişkisi:

3. Ders: Roket Balon’la ilgili aşağıdaki sorulara cevap veriniz:
1. Roket Balon’a etki eden kuvvet ya da kuvvetler nelerdir? Bu kuvvetler temas gerektiren mi, yoksa temas gerektirmeyen kuvvetler midir? (Roket balona etki eden kuvvet balonun içindeki sıkıştırılmış havadır. Bu temas gerektiren bir kuvvettir. Balonun ağzı kapalı olduğunda tüm çeperine etki ederek onu iter.)
2. Roket balona etki eden kuvvetlerin yönü ve doğrultusu ne olur? Gösteriniz.
(Balon rokete etki eden kuvvet içteki basınçlı havadır. Balonun içindeki gaz balonu dışarı doğru bütün yönlerden iter ama çıkış olmadığından bir yere gidemez. Balonun ağzını açtığımızda bu çıkıştan yüksek hızla çıkar. Buna etki (aksiyon, eylem) denir. Bu etki balonu ters istikamette iter, buna da tepki (reaksiyon) denir.



(http://unmuseum.mus.pa.us/exjet.htm)

3. Roket balon hareket ederken etki ve tepki kuvvetleri birbirine eşit midir? Ne zaman eşit olur?

4. Roket balon ile gerçek roket birbirine nasıl benzer?

Roket sıkıştırılmış gazı bir seferde vermez, yakıtını yakarak sıkıştırılmış gazı oluşturur.

J.3.2 “Toy Car” Lesson

J.3.2.1 “Toy Car” Lesson Plan

KUVVET VE HAREKET OYUNCAK ARABA

1. Ders: Öğrencilere getirmiş oldukları oyuncak arabaları çıkarmaları istenir. Öğrencilere en süratli kimin arabası olduğu sorulur. Bu arabalardan birkaçı sınıfta tahta önündeki boşlukta yarıştırılır. En süratli gidene karar verilir. Beton üzerinde en süratli gidenin o araba olduğu, ama bununla birlikte asfalt, toprak gibi zeminlerin de olduğu ve en süratli giden arabanın değişeceği söylenir.

Öğrencilere bu zeminlerden hangisinde arabalarının en süratli gideceği sorulur.

Öğrencilere bu derste yapılacak bir deneyle buna karar verecekleri bildirilir.

Oyuncak arabanın en süratli gittiği zemini bulmak için ne yapacakları sorulur.

(Bunun için şu soru sorulabilir: Oyuncak arabanın en süratli gittiği zemini bulmak için hangi değişkeni değiştirmeniz gerekir?)

Öğrencilere deney hakkında bilgi verilir.

Deneyinizle ilgili ikinci sayfada verilen örnekten faydalanarak bir rapor hazırlamaları söylenir.

Öğrenciler bahçeye çıkarılır.

Gerekli Malzemeler:

Oyuncak Araba, Mezura/metre, Tebeşir, Saat/kronometre

Yapılışı:

Tebeşir yardımıyla okulun bahçesinde farklı zeminler (toprak, asfalt ve beton) üzerinde her biri eşit uzunlukta olan yarış pistleri (iki başlangıç noktası ve bir bitiş çizgisi olan) çizin

Oyuncak arabanızı ilk pistin ilk başlangıç noktası üzerine koyun ve elinizle ittirerek hareket etmesini sağlayın.

Oyuncak arabanız ikinci başlangıç noktasından geçerken saat tutun (oyuncak arabanız duran kadar).

Oyuncak arabanızın ikinci başlangıç noktasından bitiş çizgisine kadar olan pist boyunca durduğu yere kadar olan mesafeyi mezura ya da metre ile ölçün.

Yukarıda yaptıklarınızı diğer zeminler için de deneyerek oyuncak arabanızın hangi zemin üzerinde daha süratli gittiğine karar verin.

Sorular:

1. Ne gözlemlediniz? Oyuncak arabanız hangi zemin üzerinde daha süratli hareket etti?
2. Sizce bu durumdan sorumlu olan kuvvet ya da kuvvetler nelerdir? Bu kuvvetler temas gerektiren bir kuvvet mi yoksa temas gerektirmeyen bir kuvvet mi?
3. Bu deneyde iki başlangıç noktası çizmemizin amacı ne olabilir?
4. Bu deneyi başka bir zaman halı, cam, buz, tahta gibi yüzeyler üzerinde tekrarladığınız takdirde nasıl sonuçlanmasını beklersiniz? Neden?

J.3.2.2 “Toy Car” Lesson Worksheet

Oyuncak Arabam Hangi Zeminde En Süratli Gider?

Kullanmam Gereken Materyaller: Oyuncak Araba, Mezura/metre, Tebeşir, Saat/kronometre

Varsayımımız/Hipotezimiz: Oyuncak arabam en süratli asfalt zeminde gider.

Değişkenler **1. Kontrol Edilen Değişken:** Oyuncak araba, arabaya uygulanan kuvvet

2. Bağımsız Değişken: Zemin

3. Bağımlı Değişken: Oyuncak arabanın sürati

İzlememiz Gereken Yöntem:

Tebeşir yardımıyla okulun bahçesinde farklı zeminler (toprak, asfalt ve beton) üzerinde her biri eşit uzunlukta olan yarış pistleri (iki başlangıç noktası ve bir bitiş çizgisi olan) çizin

Oyuncak arabanızı ilk pistin ilk başlangıç noktası üzerine koyun ve elinizle ittirerek hareket etmesini sağlayın.

Oyuncak arabanız ikinci başlangıç noktasından geçerken saat tutun (oyuncak arabanız duran kadar).

Oyuncak arabanızın ikinci başlangıç noktasından bitiş çizgisine kadar olan pist boyunca durduğu yere kadar olan mesafeyi mezura ya da metre ile ölçün.

Yukarıda yaptıklarınızı diğer zeminler için de deneyerek oyuncak arabanızın hangi zemin üzerinde daha süratli gittiğine karar verin.

Toplamamız ve Kayıt Etmemiz Gereken Veriler: Zeminin niteliği, oyuncak arabanın sürati

Hatalara Nasıl Kontrol Edeceğiz? Oyuncak arabanın süratini hem arkadaşım hem de ben ölçeceğim. Oyuncak arabayı hem arkadaşım hem de ben ittireceğiz.

Bulgularımız:

(Verilerimizden Hazırladığım Tablo ve Grafik)

Yorumumuz (Hipotezimiz Doğrulandı mı?)

Kullandığımız ve Anladığımız Terimler:

Sonraki Araştırma Konumuz ve Dikkat Etmemiz Gerekenler:

Öğrendiklerimizin Diğer Konularla İlişkisi:

J.3.3 “Elastic Objects” Lesson

J.3.3.1 “Elastic Objects” Lesson Plan

KUVVET VE HAREKET
ESNEK CİSİMLER

Öğrencilere nesnelere uygulanan kuvvet onları nasıl etkiler? diye sorulacak. Örneğin bir tükenmez kaleme kuvvet uyguladığımızda ne olacağı sorulacak. Öğrencilerden cevap alındıktan sonra tükenmez kaleme elimizle kuvvet uygulanıp kırılacak. Sonra bu durumda kuvvetin ölçülemeyeceği vurgulanacak.

Sonra tükenmez kalemin yayı çıkarılarak gösterilecek. Buna kuvvet uyguladığımda ne olacağı sorulacak. buna kuvvet uygulanıp yay gerilecek. Sonra eski haline getirilecek.

Tükenmez kalemin yayı, sünger, lastik, oyun hamuru, silgi, kalem içi gibi cisimlere kuvvet uyguladıktan sonra bunların tekrar eski hallerine döndüklerinden kuvveti ölçmekte kullanılabileceği buldurulacak.

Yukarıda sayılan cisimlerin Esnek Cisimler olarak tanımlandığı söylenecek.

Kuvvet ölçmekte kullanılan Dinamometre’nin yapısı açıklanacak. Dinamometre’deki yayın kuvvet etkisiyle gerildiği, kuvvet etkisi ortadan kalktığında yayın tekrar eski haline geldiği için kuvvet ölçmekte kullanıldığı söylenecek.

Gerekli Malzemeler:

Tükenmez kalem, tükenmez kalemin yayı, dinamometre.

J.3.4 “Inclined Plane” Lesson

J.3.4.1 “Inclined Plane” Lesson Plan

KUVVET VE HAREKET
EĞİK DÜZLEM

Ders: EĞİK DÜZLEM

Sorular:

1. Yokuş çıkarken düz yola göre daha çok mu kuvvet harcarsınız? Neden? Peki, bisikletle ya da arabayla yokuş çıkarken ne olur? Ne yapmak gerekir?
2. Eğer yokuş dikse harcadığınız kuvvet artar mı azalır mı? Neden? Peki, bisikletle ya da arabayla dik bir yokuşa çıkarken ne olur? Ne yapmak gerekir?
3. Yokuş inerken harcadığınız kuvvet, düz yolda yürürken veya yokuş çıkarken harcadığınız kuvvetten daha mı azdır yoksa daha mı fazladır? Neden? Peki, bisikletle ya da arabayla yokuş inerken ne olur? Ne yapmak gerekir?
4. Bu olaylarda etkili olan kuvvetler nelerdir?

Gerekli Malzemeler:

Makas
İp
Bir kütle
Dinamometre
Ders Kitapları

Yapılışı:

Makasla ipten bir parça kesin. Kestiğiniz ip’i kütleye bağlayarak, ucuna dinamometrenin çengelini takın.
Ders kitaplarınızı üst üste koyarak eğik düzlem oluşturun.
Ders kitaplarınızdan birini de bu kitaplarla sıra arasına yerleştirerek bir rampa oluşturun.
Kütleyi rampanın en altına yerleştirerek dinamometreyi yukarı doğru çekin ve harcadığınız kuvveti hesaplayın.
Aynı şeyleri daha yüksek bir eğik düzlem oluşturarak deneyin.
Deneyinizle ilgili ikinci sayfada verilen örnekten faydalanarak bir rapor hazırlayınız.

J.3.4.1 “Inclined Plane” Lesson Worksheet

İsimlerimiz: Sınıfımız:

Bir Kütleyi Yukarı Çekerken Eğik Düzlemin Yüksekliği ile Uygulanan Kuvvet Arasında Bir İlişki Var Mıdır?

Kullanmam Gereken Materyaller: Makas, İp, Bir kütle, Dinamometre, Ders Kitapları

Varsayımımız/Hipotezimiz: Bir kütleyi yukarı çekerken eğik düzlemin yüksekliği arttıkça uyguladığımız kuvvet da artar.

Değişkenler **1. Kontrol Edilen Değişken:** Kütle miktarı, eğik düzlemin yüzeyi

2. Bağımsız Değişken: Eğik düzlemin yüksekliği

3. Bağımlı Değişken: Uygulanan kuvvet

İzlememiz Gereken Yöntem:

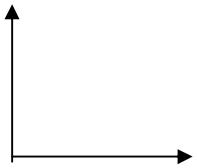
1. Farklı yüksekliklerde rampalar yapacağız.
2. Dinamometre yardımıyla kütleyi yukarı çerken uyguladığımız kuvveti ölçeceğiz

Toplamamız ve Kayıt Etmemiz Gereken Veriler: Eğik düzlemin yüksekliği (Kitap sayısı), kütleyi yukarı çekerken harcadığımız kuvvetin şiddeti (Dinamometredeki aralıklar).

Hatalara Nasıl Kontrol Edeceğiz? Dinamometre ile hem ben hem arkadaşım kuvveti ölçeceğiz. Bulduğumuz değerler birbirinden farklıysa aritmetik ortalamasını alacağız.

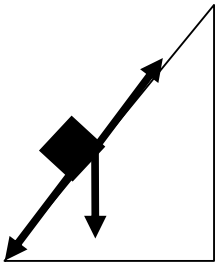
Bulgularımız (Verilerimizden Hazırladığım Tablo ve Grafik):

Eğik Düzlemin Yüksekliği	**Uygulanan Kuvvet**
Yüksekliği az(Hafif Eğimli) _____ Kitap	___ aralık
Yüksekliği fazla(Çok Eğimli) _____ Kitap	___ aralık



Yorumumuz (Hipotezimiz Doğrulandı mı? Eğik düzlemin yüksekliği ile kuvvet arasındaki ilişki neden kaynaklanmaktadır?)

Kullandığımız ve Anladığımız Terimler (Aşağıdaki şekilde açıklayınız):



Sonraki Araştırma Konumuz ve Dikkat Etmemiz Gerekenler: Örneğin; eğik düzlemin uzunluğu ile uygulanan kuvvet arasındaki ilişki.

Öğrendiklerimizin Diğer Konularla İlişkisi: Örneğin, eski Mısır’da piramitler yapılırken taşları taşımada eğik düzlemden yararlanılması.

CURRICULUM VITAE

PERSONAL INFORMATION

Surname, Name: Köksal, Ela Ayşe
Nationality: Turkish (TC)
Date and Place of Birth: 22 March 1972, Ankara
Marital Status: Single
Phone: +90 505 504 12 33
email: elaaysekoksal@gmail.com

EDUCATION

Degree	Institution	Year of Graduation
MS	METU Secondary Science and Mathematics Education	2002
MS	Ankara University Biology	2001
BS	METU Mechanical Engineering	1996
High School	Aktepe High School, Ankara	1992

WORK EXPERIENCE

Year	Place	Enrollment
2001-	METU	Dep of Sec Sci & Math Ed Research Assistant
1995-2001	Niğde University	Dep of Sci Ed Research Assistant
1994-1995	Ministry of National Education	Classroom Teacher

FOREIGN LANGUAGES

Advanced English, Basic Greek

HOBBIES

Photography, Tennis, Gourmet, Movies