EVALUATION OF THE SCIENCE AND TECHNOLOGY CURRICULUM AT GRADE LEVELS 4 AND 5: A PILOT STUDY

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Approval of the Graduate School of Natural and Applied Sciences

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I certify that this master thesis satisfies all the requirements as a thesis for the degree of Master of Science.

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

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ABSTRACT

EVALUATION OF THE SCIENCE AND TECHNOLOGY CURRICULUM AT GRADE LEVELS 4 AND 5: A PILOT STUDY

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The aim of the study is: (1) to investigate effects of new science and technology curriculum on 4th and 5th grade students' achievement in terms of knowledge and understanding levels outcomes and higher order thinking skills, (2) to investigate effects of new science curriculum on the students' attitudes towards science and (3) to examine teachers' classroom activities in lessons.

The study was conducted in three conveniently selected public elementary schools throughout Yenimahalle district of Ankara with a total of 302 4th and 5th grade students in 2004-2005 spring semester, two pilot schools implementing new science and technology curriculum were assigned to experimental group and one school applying the traditional science curriculum was assigned to control group.

The researcher developed the measuring tools, Science Achievement Test for 4th grade, Science Achievement Test for 5th grade, Science Attitude Scale and Teachers' Classroom Activities Scale.

The data were analyzed through multivariate analyses of variance (MANOVA). Results showed that the new science and technology curriculum made no difference on the fourth grade students' knowledge and understanding level outcomes and higher order thinking skills. On the other hand, it was effective on the fifth grade students' higher order thinking skills. The statistical analyses also showed that there were significant differences between the pilot and control group students' attitudes towards science in terms of interest, anxiety, and self-efficacy sub-categories in favor of pilot groups. In addition, there were significant differences between the classroom activities of the teachers of pilot and control groups.

Keywords: Science education, science assessment, curriculum development, cognitive development

ÖZ

İLKÖĞRETİM FEN VE TEKNOLOJİ MÜFREDATININ DÖRDÜNCÜ VE BEŞİNCİ SINIFLAR BAZINDA DEĞERLENDİRMESİ: PİLOT ÇALIŞMA

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Bu çalışmanın amacı: (1) yeni ilköğretim fen ve teknoloji dersi müfredatının 4üncü ve 5inci sınıf öğrencilerinin fen bilgisi başarılarına etkisini, bilgi ve kavrama düzeyi düşünme becerileri ve üst düzey düşünme becerileri açısından etkilerini araştırmak (2) yeni müfredatın, öğrencilerin fen ve teknoloji dersine karşı tutumlarına etkisini ve (3) fen ve teknoloji dersi öğretmenlerinin sınıf içi uygulamalarına etkisini araştırmaktır. Çalışma Ankara ili, Yenimahalle bölgesinden çalışmanın amacına uygun olarak seçilmiş 3 tane ilköğretim okulunda, toplam 302 dördüncü ve beşinci sınıf öğrencisine, 2004-2005 yılı bahar döneminde, iki tane yeni ilköğretim fen ve teknoloji müfredatını uygulayan pilot okul, bir tane geleneksel fen bilgisi müfredatını uygulayan ilköğretim okulunda gerçekleştirilmiştir.

Çalışmada, 4. Sınıf başarı testi, 5. Sınıf başarı testi, fen bilgisi tutum ölçeği ve öğretmenin sınıf içi uygulamaları ölçeği kullanılmıştır. Çalışmada kullanılan bu materyaller araştırmacı tarafından geliştirilmiştir.

Elde edilen verilerin analizinde çok yönlü varyans analizi(MANOVA) test tekniği kullanılmıştır. Analiz sonuçları, yeni ilköğretim fen ve teknolji dersi müfredatının dördüncü sınıf öğrencilerinin bilgi ve kavrama düzeyi ve üst düzey düşünme becerileri açısından etkisi olmadığını göstermiştir. Öte yandan, beşinci sınıf öğrencilerinin üst düzey düşünme becerilerini arttırmak açısından yeni müfredatın, önceki müfredata göre daha etkili olduğu gözlenmiştir. Bunun yanında sonuçlar, öğrencilerin fen dersine karşı tutumları açısından pilot ve kontrol grupları arasında, pilot grup yönünde anlamlı bir fark olduğunu göstermiştir. Ek olarak, öğretmenlerin sınıf içi uygulamalarında pilot ve kontrol gruplar arasında farklılıklar bulunmuştur.

Anahtar Kelimeler: Fen bilgisi eğitimi, müfredat geliştirme, bilişsel gelişim, fen bilgisinde ölçme değerlendirme.

To My Parents
Seyide and Çetin PEKİNER

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TABLE OF CONTENTS

LIST OF TABLES

TABLE

LIST OF SYMBOLS

SYMBOLS

SAT	:	Science Achievement Test
SAS	:	Science Attitude Scale
TCAS	:	Teachers' Classroom Activities Scale
4SAT	:	Science Achievement Test for 4th Grade
5SAT	:	Science Achievement Test for 5th Grade
KUL	:	Knowledge and Understanding Level
HOTS	:	Higher Order Thinking Skills
CANATCAS	:	Classroom Activities of the New Approach Sub-category of Teachers' Classroom Activities Scale
COTTCAS	:	Care of Teacher Sub-category of Teachers' Classroom Activities Scale
EUTCAS	:	Equipment Use Sub-category of Teachers' Classroom Activities Scale
CCATCAS	:	Classical Classroom Activities Sub-category of Teachers' Classroom Activities Scale
PSTCAS	:	Processing the Subject Sub-category of Teachers' Classroom Activities Scale
SP	:	Sub Problem
PG	:	Pilot Group
CG	:	Control Group
TIMMS	:	The Third International Mathematics and Science Study
PISA	:	Program for International Student Assessment
CFH	:	Chemistry for High Schools
CAC	:	Chemistry-A Challenge

UNESCO	:	United Nations Educational, Scientific and Cultural Organization
OECD	:	Organisation for Economic Co-operation and Development
NATO	:	North Atlantic Treaty Organization
MANOVA	:	Multiple Analysis of Variance
SD	:	Standard Deviation
df	:	Degrees of Freedom
N	:	Sample Size
%w.g.	:	Within Group Percentage
α	:	Significance Level

CHAPTER 1

INTRODUCTION

The New Elementary Science and Technology Curriculum for grades 1-5, developed by the Ministry of National Education (2005) underline the importance of students' cognitive developments and attitudes towards science and mentions about the importance of the required classroom applications of the teachers by means of the new approach in the science and technology lesson. One of the main points that The New Elementary Science and Technology Curriculum underlines is teaching science has been changed from a strict behaviorist approach to a cognitivist and constructivist approach (TTKB, 2005).

Constructivism is the theory that students learn by individually or socially transforming information (Slavin, 1997). The main principal of constructivist learning is that people construct their own understanding of the world, and in turn their own knowledge (Ishii, 2003).

Changing the curriculum to a constructivist way requires to change the approach of the teachers to the science teaching. Teaching strategies of science teachers should be more student-centered which begins with understanding students' points of view. It is a main argue that teachers should reject "traditional" modes of teaching and learning instead, embrace "new" ideas that are based on current constructivist principles. It is asserted that teachers should incorporate alternative modes of assessment that reach beyond paper

and pencil tests (Null, 2004). Therefore, one of the main concerns of the new science curriculum is the classroom activities of science teachers.

Although there are many expectations from the science teachers, changing the students' way of understanding science and attitude are the basic expectations of the new science and technology curriculum. The students should make observations, experiments, and research, observing the knowledge by themselves with a manner of creative and critical thinking. They should share the knowledge and apply the science to the real life.

However, current studies show that in Turkey, students have difficulties to integrate or contrast the scientific knowledge and they are unable to make connections of these facts with real-life applications. The new curriculum also aims to provide students to develop a full range of intellectual capacities. Therefore a major goal of science instruction is to develop student's ability to interpret and apply what they have learned (Sutman, 1993).

In science curricula, generally the purposes of science education are providing students with the opportunity to attain high levels of scientific literacy, to gain thinking and hand skills, and constituting the background for the profession in science and technology (Kaptan & Korkmaz, 2001). Scientific literacy is not only to know the concepts, but also being able to understand the developments of technology, improve the scientific inquiry techniques and gaining the problem solving skills (Hodson, 1988).

In addition, within the implication of the new elementary science and technology curriculum, appropriate application of the measurement and evaluation techniques required by the new approaches is also important.

Assessment should not be used to categorize the students as successful and unsuccessful. Instead, it should be used as a feedback of the students' development.

According to The National Science Education Standards (Center for Science, Mathematics, and Engineering Education, 1996), the word "assessment" is commonly equated with testing, grading, and providing feedback to students and parents. However, these are only some of the uses of assessment data. Assessment of students and formal and informal teaching, provides teachers with the data they need to make many decisions that are required to plan and conduct their teaching.

In Turkey, before the implication of the new elementary science and technology curriculum, many students pass their science exams without learning many concepts. Furthermore, the assessment techniques were not convenient to evaluate the students' cognitive skills and some of them were not up to date.

According to Kaptan (1999), science is the most important subject area for the students to achieve higher order thinking skills and scientific thinking process.

Since Turkey showed lower performance in the international exams such as TIMMS (The Third International Mathematics and Science Study) and PISA (Program for International Student Assessment), the government examined the education programs overall the world and stated the needs of Turkish education. In this manner, science programs were developed by means of constructivism and humanism, as implemented in the countries that had high performance levels in TIMMS and PISA exams. Moreover, the name of

the science program has changed to Science and Technology Education Program.

In brief, the aims of the new program are to help students to have the ability of thinking by basic science concepts, approach the problems with scientific methods, and apply these abilities to daily life and to have positive attitudes towards science (Kaptan & Önal, 2006).

An effective science program should offer students the opportunity to experiment with natural world around them. One of the greatest challenges in education is finding methods of making learning meaningful for the students. One way to meet this challenge is actively involve students in learning, allowing them to learn by example and experience the construction of knowledge.

The educators often mention the need for curriculum development activities to help students develop their learning skills. In this framework, the Turkish Ministry of National Education has developed and implemented new primary school curricula based on constructivist approach, student-centered instruction, multiple intelligence theory, and sensitivity to individual differences. (Gömleksiz & Bulut, 2006).

Teaching methods and teaching techniques used by teachers result in the difficulties in science learning. Generally, many teachers in Turkey widely use conventional lecturing method and classical test applications. Teachers emphasize the learning of answers more than exploration of the questions. They also fail to encourage students to work together, to share ideas and information with each other, or to use modern instruments to extend these intellectual capabilities. Therefore, it is also important that how teacher apply the new science and technology curriculum in the classrooms.

The purpose of the study is to compare the new science and technology curriculum with the traditional science curriculum with respect to science achievement, attitudes toward science and perceived classroom activities of the science classes of the students at the 4th and 5th grade levels.

1.1 The Main Problem and Sub-Problems

1.1.1 The Main Problem

The main problem of this study is stated as follows;

Are (a) students' science achievement in terms of knowledge and understanding levels and higher order thinking skills (b) attitudes of students towards science and (c) teachers' classroom activities different across the new science and technology curriculum and traditional curriculum at grade levels 4 and 5?

1.1.2 The Sub-Problems

The following sub-problems (SP) were investigated as part of the main problem.

SP1: Is there a significant difference in the mean scores of science achievement scores of 4th grade students across new science and technology curriculum and traditional curriculum in terms of students' knowledge and understanding level outcomes?

SP2: Is there a significant difference in the mean scores of science achievement scores of 4th grade students across new science and technology curriculum and traditional curriculum in terms of students' higher order thinking skills outcomes?

SP3: Is there a significant difference in the mean scores of science achievement scores of 5th grade students across new science and technology curriculum and traditional curriculum in terms of students' knowledge and understanding level outcomes?

SP4: Is there a significant difference in the mean scores of science achievement scores of 5th grade students across new science and technology curriculum and traditional curriculum in terms of students' higher order thinking skills outcomes?

SP5: Is there a significant difference in the mean scores of students across new science and technology curriculum and traditional curriculum in the attitude towards science?

SP6: Is there a significant difference in the mean scores of students across new science and technology curriculum and traditional curriculum in the teachers' classroom activities?

1.2 Definition of Important Terms

This section presents some important definitions related to this study.

Critical Thinking: Critical thinking is the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action. (National Council Draft Statement, 2000).

Achievement: Academic achievement is the outcome that students aquire after the learning process. It is measured by the score attained on the achievement tests designed by the researcher. Johnson (1992), states that achievement refers to the traditional indices of the degree to which a student has encountered success in school.

Attitude: Organized predispositions to think, feel, perceive, and behave toward a referent or cognitive abject was described as attitude (Kerlinger, 1986). Good (1973) claims that attitudes are usually accompanied by feelings and emotions and attitudes cannot be directly observed but must be inferred from overt behavior, both verbal and nonverbal. Martin (1984) also adds the three main factors as; attitude carries with a mental state of readiness, attitudes are not innate or inborn and they result from experience. The students' outcomes are affected by these factors.

Higher Order Thinking Skills: Higher order thinking skills involve an open-minded propensity to analyze, synthesize, and evaluate information in order to solve problems and make decisions (Halpern, 1997).

Knowledge and Understanding Level Learning Outcome: Students cognitive skills in terms of knowledge and understanding levels.

1.3 Significance of the Study

Previous studies provide us that the conventional lecturing method and classical test applications, which many teachers in Turkey used in science lessons, resulted in difficulties in learning science. Within the results of international exams such as TIMMS, PISA and PIRLS, improvement of the national education programs have become into existence and the new elementary science and technology curriculum for grades 1-5 was developed by the Ministry of National Education. However, no study investigated the effects of the new elementary science and technology curriculum, which has a new frame of teaching science other than conventional lecturing method, on the students' science achievement in terms of students' cognitive developments. This study will also investigate if the teachers are applying the new elementary science end technology curriculum's requirements properly in the classrooms and if these applications have a good impact on the students. In addition, the effect of the new elementary science and technology curriculum on the students' attitudes will be answered in this study.

The results of this study will be a kind of magnifier that pointing out a general view to the new elementary science and technology curriculum and what are the differences between the new and traditional science curriculums in terms of knowledge level outcomes of students, their attitudes toward science and activities and techniques used in science lessons.

1.4 Assumptions of the Study:

a) The administration of the SAT, SAS and TCAS were under standard conditions.
b) All units of the science curriculum were performed and finished before this study.
d) It was assumed that the subjects would respond to the measuring instruments
honestly and sincerely.
d) All test administrators followed the exam rules.
e) Science teachers were considered as equal in terms of their teaching skills and abilities.

1.5 Limitations of the Study:

a) This study was limited for 302 elementary school students in 4^{th} and 5^{th} grade.
b) The generalizability of the results is limited.
c) The new science curriculum has been implemented for 2004-2005 academic year by the government. (Pilot study was limited with one year)
d) The subjects of the control group were using the previous science curriculum.

CHAPTER 2

REVIEW OF THE LITERATURE

2.1 Science Teaching

Many education research indicates that the majority of elementary schools are using science textbooks, reading and memorizing science terms as primary activity in textbook-oriented science lessons. Çepni et al. (2006) sited that once traditional teaching methods are used in teaching science subjects, students understand subject at knowledge level and they usually memorize the science concepts without understanding the real meaning. As a result, they do not conceptualize the science concepts well as intended. All these factors have an influence on students' attitudes, cognitive developments, and achievement in science education.

Limited science instruction with only reading and memorization makes students become passive learners of facts. Studies have shown that the lecture approach is an ineffective way to teach science. However, traditional patterns of science education have remained largely unchanged for most of the last century. These traditional patterns are not effective to make students ready to real life. Therefore, educators should analyze and evaluate the trends, in order to decide on appropriate curricula and methods of instruction, which will make students ready for real life situations (Sungur et al., 2006).

According to the U.S. National Science Education Standards (1995), Science is an active process so learning science should be something that students do; not something, that is done to them. The primary aim of science education is to provide students with experiences that will help them become scientifically literate. Learning science by doing is a valid way to reach scientific literacy. (The U.S. National Science Education Standards, 1995).

As a developing country, avoiding the old and traditional methods and following the new trends in education is an important issue for Turkey. Starting with this point, Turkey's new elementary science and technology curriculum has been constructed based on the constructivist approach.

Constructivism is a concept that in recent years has garnered considerable attention among science education researchers. Essentially, it is a model or metaphor of how learning takes place. Prominent science educators have called it the most promising model. (Cobern, 1995).

Basically, constructivism views that knowledge is not 'about' the world, but rather 'constitutive' of the world (Sherman, 1995).The basic premise is that an individual learner must actively "build" knowledge and skills (Bruner, 1990).

Constructivism as a teaching approach has a philosophy. Constructivism has been said to be post-epistemological, meaning that it is not another epistemology, or a way of knowing. It cannot replace objectivism. Rather, constructivism is a way of thinking about knowing, a referent for building models of teaching, learning, and curriculum (Tobin and Tippin, 1993).

Watzawick (1984), also defined constructivism as the philosophical position which holds that any so-called reality is, in the most immediate and concrete sense, the mental construction of those who believe they have discovered and investigated it. In other words, what is supposedly found is an invention whose inventor is unaware of his act of invention and who considers it as something that exists independently of him; the invention then becomes the basis of his worldview and actions.

Lorsback and Tobin (1992) maintained that: constructivism asserts that knowledge resides in individuals; that knowledge cannot be transferred intact from the heads of students. The student tries to make sense of what is taught by trying to fit it with his or her experience.

Viewed in this way, teaching becomes the establishment and maintenance of a language and a means of communication between the teacher and students, as well as between students. Simply presenting material, giving out problems, and accepting answers back is not a refined enough process of communication for efficient learning. (Dougiamas, 1998)

Dougiamas (1998) follows as, a constructivist perspective views learners as actively engaged in making meaning, and teaching with that approach looks for what students can analyze, investigate, collaborate, share, build and generate based on what they already know, rather than what facts, skills, and processes they can parrot. To do this effectively, a teacher needs to be a learner and a researcher, to strive for greater awareness of the environments and the participants in a given teaching situation in order to continually adjust their actions to engage students in learning, using constructivism as a referent.

The constructivist approach that had been discussed for many years had taken its very last shape and became popular in recent years. The assumption of non-constructivist approaches to learning has been that as long as learners are provided with knowledge, they will be able to use it. Education based on that assumption is thus primarily concerned with transferring substance to the learner, and little importance is placed on the role of the learning activity (Hayati, 1998). From a constructivist view, on the other hand, learning is the process of constructing knowledge, not merely obtaining it, in social environments (Brooks & Brooks, 1993).

On the other hand, advocates of the constructivist approach suggest that educators first consider the knowledge and experiences students bring with them to the learning task. The school curriculum should then be built so that students can expand and develop this knowledge and experience by connecting them to new learning. Advocates of the behavioral approach, on the other hand, advocate first deciding what knowledge or skills students should acquire and then developing curriculum that will provide for their development. Those advocating the constructivist approach should consider there are a variety of principles from operant conditioning and information processing learning theories that can be utilized within this approach. For example, when mediating a student's learning it is certainly appropriate to teach a specific skill using direct instruction, observe students practicing the skill, and providing corrective feedback. The major issue is whether to start with a curriculum that is taught step-by-step in an inductive manner as suggested by the behaviorists or to start with the student's knowledge and understandings and help the child fill in gaps necessary to solve a situation-specific problem as suggested by the constructivists (Huitt, 2003).

Lotfi (2004) performed a study on using constructivism in teaching AP chemistry, which is equivalent to general chemistry course, taken during the

first year of the college. The study involved assessing the effectiveness of the constructivist approach in teaching the acid-base unit of AP chemistry and done in a high school, with 14 students included, 11 juniors and three seniors and the duration of the study was 24 days. Several activities and methods based on constructivist approach were implemented while teaching the acid-base unit. After the treatment, combinations of formal and informal assessments used to evaluate students' progress in this unit. Pre-test, post-test, lab rubric and several quizzes were administered. To analyze the critical thinking open-ended questions were used in these assessments. T-test method was used to analyze the difference between the pre-test and the post-test. The results of the study showed that, students' understanding of the concepts of this acid-base unit have been improved from pre-test to post-test that means the constructivist approach helped students to gain a better understanding of acid-base unit. In addition, it was observed that the higher order thinking skills suggested by Bloom's Taxonomy contributed to the students' ability to think clearly and to express their ideas with some degree of clarity and logic (Lotfi, 2004).

Holden (2003) conducted a study to compare traditionalist and constructivist approaches to learning and their effects on students' performance and motivations in solving math word problems. The participants of the study were two groups of 32 university students. The results of the study were that, the constructivist group had significantly higher post-test scores than the pre-test scores and the traditional groups' post-test scores. However, the motivation scores of both group increased at the end of the treatment and no significant difference found between the groups.

Therefore, it should be concluded that, alternative teaching approaches are needed to teach science concepts in science education. The first step of changing the teaching approach in a constructivist way should be the training

of teachers and to make teachers ready to apply this new approach. Carson (2005) argued that a causal relationship between readiness and the implementation of a constructivist educational system a teacher must accept the metaphysical and epistemological assumptions of a constructivist position before he can implement it.

Resnick (1989) states that, generally constructivist teaching practices focus on the creation of understandings by students based on an interaction between what they already know and believe and ideas and knowledge with which they come into contact.

Bisland et al. (2006) conducted a survey study about instructional practices of elementary school teachers. In the study, they asked the following questions to sixty-seven Teaching Fellows who graduated from an alternative certification program and working as teachers:

1. What percentage of the time and in which subjects do you use direct instruction (i.e., you the teacher direct all classroom activities)?

2. What percentage of the time and in which subjects do you use scripted lessons?

3. What percentage of the time and in which subject areas do you base your classroom instruction on your student's own experiences either inside or outside of school?

4. What percentage of the time and in which subject areas do you allow the students to come up with their own questions and base your classroom instruction on these student questions?

They claim that the purpose of the questions was to determine the extent to which new alternatively, certified teachers engage in constructivist teaching practices. After the study, they investigated that, when teachers can choose their own instructional methods they appear to favor constructivist pedagogy. A substantial number of the respondents said that they base their instruction on student experiences. A lesser amount however based their instruction on student questions. Reliance on direct instruction was less than the use of instruction based on student experiences. The use of scripted lessons was less than the use of direct instruction (Bisland et. al, 2006).

The applications such as making group works and using laboratory may seem to the teachers as time consumers than using the textbooks in a traditional way. The question of facilitating inquiry in the context of whole-class interactions versus individual work in the laboratory is not a new issue in science education. Science teachers have always been confronted with the question of the value added by the time and expense required for individual work in the science laboratory versus inquiry facilitated through whole-class demonstrations. (Bell, 2005)

The roles of constructivist science teachers and traditional science teachers in the classroom show differences. The traditional teacher transfers the knowledge from science books to the students. However, the constructivist teacher should guide the students to explore the knowledge themselves and derive the correct answers with their own investigations (Kılıç, 2001).

Sparani (1994) claimed that, classroom teachers are faced, daily, with students who have a variability of abilities, interests, and levels of achievement, much more so today than in years past. Teachers, therefore, need to be increasingly knowledgeable of methodologies that aid in the challenge of

individualization. In addition, teachers need to understand how to apply the instructional strategies.

The results concluded that, in science education using only textbooks, reading and memorizing makes students understand subject at knowledge level. However, they only memorize without understanding real meaning of the concepts and they are not able to apply it in their daily life. Therefore, for the educators to analyze and evaluate new approaches and teaching methods in science teaching becomes an important demand for an appropriate science teaching. Constructivism, which is one of the new approaches in science education, became popular in recent years. On the other hand, theachers tend to use the traditional approaches and think that it is easy to applicate in the classroom. Therefore, training teachers to understand and internalize the new approaches becomes an important issue and then, teachers will be able to use appropriate classroom activities that are required by new approaches.

2.2 Science Curriculum Developments

Many efforts have been made to sketch the history of science curriculum (e.g., Akker, 1998; Fensham, 1992; Jenkins, 1994). These authors have, in common, suggested that there was a shift in emphasis in science curriculum from the late 1950s to the 1980s onwards in their purposes and content. For the 1950/1960s, science curriculum might be summarized as the elite orientation, which aims to train future scientific professionals. For the 1980/1990s, science curriculum might be called the future citizenry orientation, which focuses increasingly on preparing students as qualified citizens in society. In the view of the aforementioned interpretation of scientific literacy, the first orientation mainly focuses on scientific meanings while the second one emphasizes companion meanings. Although curriculum

theorists have identified the changing tendency of science curriculum from the late 1950s to the present, few empirical studies have been conducted to discern such a change in a specific science curriculum. That is to say, there is little evidence showing that this change has really occurred within a given science curriculum (Wei &Thomas, 2006).

In recent years developed countries such as the USA, Australia, Finland and New Zealand made some arrangements and used constructivist approach in developing curriculum (Yaşar, 2005).Discussions on improving and reorganizing the education system make it necessary to change teaching-learning paradigms and determine new ways that will help the students think (Özden, 1999).

Kumar (2006) mentions that in efforts at encouraging reflective teaching practices amongst educators and transformational learning amongst learners, many schools and tertiary institutions are encouraging the design and implementation of constructivist-based curriculum models.

Zwick and Miller (1996) compared the impact of an outdoor education curriculum and traditional textbook curriculum on American Indian students. The researchers developed an activity-based science program that require students to do the following: (1) utilize the processes of science (collection of data, measuring, classifying, etc.); (2) analyze the data collected (critical thinking, processing data, interpreting data); (3) apply the knowledge or insights gained through data analysis to solve problems or use as a basis for group discussion; (4) evaluate the meaning of data collected and the validity of the method of using the data when applied to problem solving or in class discussion; (5) work in groups and have input into group discussions concerning the activities; and (6) make connections between science, society, art and the language arts. The “hands-on” activities developed for use in a

rural district with a high percentage of Native American students are performed in groups in which much discussion within and between groups takes place. Students learn to respect, value, and critically evaluate the opinions of others, as well as their own opinions. The activities require students to use various methods in the processing of data collected and to integrate and apply the science concepts learned to the fields of social sciences, art, language arts, and mathematics.

In Zwick and Miller's (1996) study, two fourth grade classes were studied. The control group used a traditional, textbook driven curriculum. The experimental group used the activity-based science program. Students in the experimental group achieved significantly greater gains than the control class.

Curriculum change also affects the students' attitudes. In an effort to improve students' interests in science, Avi (1986) conducted a study to evaluate students' attitudes toward science relative to a two chemistry curriculum. These curricula were Chemistry for High Schools (CFH) and Chemistry-A Challenge (CAC), the latter of which was mainly based on inquiry techniques, concept formation, and laboratory investigation. The sample of this study was 1958 students from 52 10th grade classes in 17 academic high schools. Achievement pre- and post-test and semantic differential questionnaires were used in this study by the researcher. This study concluded that a curriculum geared to the needs and interests of students can help developing positive attitudes towards science.

In education field, a series of arrangements, essential renewals, and program content innovations have been made throughout the last century. Bruner (1996) states that for learning to be effective it must be an active process in which learners construct new ideas or concepts based upon their framework of prior knowledge. For this reason, almost all the major science

curriculum developments of the 1960s and 1970s promoted practical works as an enjoyable form of learning (Hodson, 1990).

At this point, without a unifying theory as to how the different learning theories interact within a single individual to produce behavior, we have to study these different viewpoints independently and then piecemeal them together into a school curriculum. However, acceptance of a particular viewpoint provides a different starting point for curriculum development. Fennimore and Tinzmann (1990) suggest a difference between a behaviorally oriented curriculum in which knowledge and skills are taught discretely and then inductively connected versus the constructivistically oriented classroom in which students acquire content while carrying out tasks requiring higher-order thinking.

An example should help clarify this characteristic of a thinking curriculum. Summarizing is a common skill learned in school. In conventional curricula, young students frequently are expected to learn how to summarize by first learning each "step" in the summarizing process. They are taught these steps one at a time. Ample time is given to practice the first step; for example, categorizing items or activities described in a text under a more inclusive label. Indeed, they may complete numerous worksheets on categorizing. Then, the teacher may teach them a second "step" for example, deleting redundant information. Again, the students practice. This approach continues until students have been taught all the steps or sub processes thought to be involved in summarizing. In short, curriculum tends to reutilize the task. Finally, students are asked to put all these sub skills together. Unfortunately, many students can not do this---they are stuck at the sub skill level, each of which they might perform beautifully, but which they cannot integrate into a smooth process of summarizing (Fennimore & Tinzmann, 1990).

Fennimore and Tinzmann (1990), suggest that, in a thinking curriculum, summarizing would be conceived and taught as a holistic process. Rather than fragmenting the process, it would be taught in a context or environment in which students can succeed. For young children, this might mean asking them first to summarize relatively short paragraphs that deal with information with which they are very familiar. The teacher may also ask students to work collaboratively to summarize information at this initial learning stage. As students gain skill and confidence in summarizing, the teacher would ask them to summarize longer paragraphs, perhaps containing less familiar information. In summary, a thinking curriculum always treats tasks as indivisible wholes; variations that acknowledge the novice status of the learner are changes the teacher can make in the environment.

Besides the curriculum developments in all over the world, Turkey attempted extensive studies for the development of science curricula since 1960s. With the cooperation of UNESCO, OECD, NATO, FORD FOUNDATION, and European Council, Turkey started science education projects.

In 1962, Modern Mathematics and Science Program (the same program as in America and some other countries) administered in Science High School. After this Science High School Project, BAYG-E projects started. From 1967 to 1979, four BAYG-E projects implemented. They were BAYG-E-7, BAYG-E-14, BAYG-E-23, and BAYG-E-33 respectively. The aim of the BAYG-E-7 was to investigate the applicability of Modern Mathematics and Science Program in high schools rather than Science High School (Tübitak, 1984). BAYG-E-14 project was based on the revisions, developments, and pilot studies of this new Program piloted in 9 high schools. At the end of this project, The Ministry of National Education decided to

continue the generalization studies of the Modern Mathematics and Science Program.

Between the years, 1971 and 1976, BAYG-E-23 project was executed. Besides the development and adaptation of the Modern Mathematics and Science Program, teacher training was one of the priorities of this project. In summer holidays, the administrators and teachers were included into certain seminars and courses.

As a result, BAYG-E-23 project concluded that students studied modern mathematics and science program were more successful than students studied the classical program (M.E.B., 1976).

The last project including the modern mathematics and science program was BAYG-E-33 project. Application of the modern programs in high schools required changing the elementary school science Program of the grades 6, 7 and 8. In this manner, the experts examined the programs of seven developed countries (Baysen, 2003). This project was executed between 1976-1979 years. However, in 1985, The Board of Education decided to end the implementations of the modern mathematics and science Program and to return to the classical programs.

Yılmaz & Morgül (1992) made a study to evaluate the science education studies in Turkey. With this study, they concluded the followings:

- Except BAYG-E projects, the studies in science education were limited with the decisions about the hours of the science lessons.

- The studies performed for the development of science education of Turkey were succeeded with the support of TÜBİTAK. However, these studies were dropped out and could not be generalized to whole country.

On the other hand, Turkey's The New Elementary Science and Technology Curriculum states that like in the world, there have been many attempts to increase the quality of science education in primary schools in Turkey in recent years. If the students could not get the basic concepts concerning the science, it is almost impossible to progress in this area in middle or high schools. In order to improve the quality of the science education, Turkish National Science Curriculum was changed in 1992. According to the innovations in science education, Turkish National Science Curriculum was changed again in 2001. In this curriculum, the three main goal of science education were explained as to explain the basis concepts about science to students (scientific literacy), to develop positive attitudes in students towards science and teach the skills of the ways reaching scientific knowledge. With this new curriculum, the expectations from the teacher and students were different. Teachers were expected to implement student-centered lessons and encourage them to reach the knowledge by themselves, to make observations, researches, and experiments and to share their knowledge with other students. The expectations from the students are realizing that they can solve every problem by creative, constructive, and scientific thinking, acquiring the skills of making observations, researches, experiments, reaching the knowledge by themselves, sharing the knowledge with others, applying the learned topics to real life.

Özcan (2003) performed a study for the evaluation of this new elementary science Program that started to be implemented in 2001. The subjects of the study were 272 4^{th} and 5^{th} grade science teachers in Uşak

province of Turkey. The research material used in this study was a Likert type scale including the achievement of the students to reach the objectives of the new science Program. T-test and the ANOVA analyses were used for the data. The results of the analyses showed that 92% of 4^{th} grade students and 80.3% of 5^{th} grade students could not be able to achieve the objectives of the program. This study showed that this science program needed developments on the objectives.

The results of the studies showed that, there were major improvements in science curricula since 1950s. Constructivist science teaching approach has become widely used in developed countries' education systems. In recent studies, the teaching methods other than traditional method like outdoor education, activity based education showed improvement in science achievement of students. In addition to these results, teaching methods like inquiry techniques, concept formation, and laboratory investigation improved students' attitudes towards science.

In Turkey, curricula improvement studies started in 1962. Between 1962 and 1979 modern mathematics and science program was implemented. However, in 1985 this program was ended by the decision of government. Till 1992 there was no curricula change and development studies in Turkey.

According to the innovations and studies about science education in developed countries, Turkish National Science Curriculum was changed in 1992 and 2001. The applications and developments of the new approaches were first met in 2001 curricula change. After these studies and developments in science education The Ministry of National Education developed and started to implementation of The New Elementary Science and Technology Curriculum for grade 1-5 in 2004-2005 education year. One of the main aims

for this new curriculum was to improve the students' cognitive developments in science and technology lesson.

2.3. Cognitive Development

In science education, improving student's cognitive skills have always been one of the main issues. Educators can be in no doubt of demands of society for lifelong capable learners who are able to perform cognitive, metacognitive and metacognitive tasks and demonstrate competencies such as problem solving, critical thinking, questioning, searching for information, making judgments and evaluating information (Reeves, 2000; Oliver & McLoughlin, 2001). Educational objectives referring to students "knowing about" or "understanding a topic" are common in education, but are too broad to guide teaching and testing. Bloom's taxonomy does not explicitly define critical thinking. Rather, it includes six knowledge levels that constitute critical thinking (Aviles, 1999).

Benjamin S. Bloom is a famous name in educational researches. Bloom and his colleagues worked on creating taxonomy of educational objectives.

Instead examining how to teach, what to teach or when to teach it, Bloom focused his research on educational outcomes. For any given curriculum, knowing the intended outcome or objective determines the what, how, and when of teaching. As with many areas of life, achievement of a goal is only met by understanding the goal, then working towards it. Thus, Bloom's research and work "focused educators on outcomes...what students should know and be able to do" (Woo, 1999).

"Taxonomy of Educational Objectives and Cognitive Domain" (Bloom, 1956), also referred to as "Bloom's Taxonomy", provided a six-leveled framework of educational outcomes. These levels are organized in a hierarchical way according to cognitive complexity. So abilities needed at lower levels also needed for success at each higher level. Krathwohl (2002) also explains the categories were ordered from simple to complex and from concrete to abstract. Further, it was assumed that the original Taxonomy represented a cumulative hierarchy; that is, mastery of each simpler category was prerequisite to mastery of the next more complex one.

A description of Bloom's six levels follows.

Level I- Knowledge. The knowledge objective id primarily concerned with recall, remembering facts and information (process, directions, criteria, methodology), and use of cues to retrieve information from the file cabinet of the mind. Examples: Recall multiplication facts; name the criteria for classifying rocks... This is the lowest level of learning outcomes.

Level II – Comprehension. This is considered the lowest level of understanding and involves interpreting the material. "The emphasis on the ability to grasp the meaning and intent of the material." (Bloom, 1956)

Level III – Application. "A demonstration of comprehension shows that a student can use an abstraction when the use is specified. A demonstration of application shows he/she will use it correctly, given an appropriate situation, without prompting" (Bloom, 1956). In other words the ability to apply information or concepts in a new situation or to problem-solve using the information. (Rule et. al., 2003)

Level IV – Analysis. This outcome asks the learner to be able to sort through the elements, relationships, or organizational principles of the material to understand its organizational structure. Examples include distinguishing fact from hypothesis, detecting logical fallacies in an argument, recognizing form and pattern. (Bloom, 1956)

Level V – Synthesis. Synthesis is ".....the putting together of elements and parts so as to form a new whole...the students must draw upon elements from many resources and put these together into a structure or pattern not clearly there before" (Bloom, 1956). This can be thought of as using previous knowledge to create new concepts, relating knowledge to several areas, predicting, drawing conclusions and hypothesizing. Examples: writing creatively, giving extemporaneous speeches, planning a unit of instruction, and making mathematical discoveries and generalizations (Bloom, 1956).

Level VI – Evaluation. This level is defined as "the making of judgments about the material. It involves the use of criteria as well as standards" (Bloom, 1956) for evaluating. Learning outcomes are at the highest level here because it contains elements of all other categories.

Furthermore, Aviles (1999) made the following descriptions about application of the six levels of Bloom's Taxonomy on test items. Creating knowledge test items can be as simple as removing the key word from a sentence and making it a choice among multiple choices, omitting a key word or phrase students must apply, or having students decide if a complete sentence is either true or false. On the other hand, creating comprehension questions are more difficult than creating knowledge questions because aspects of comprehension involve translation, interpretation, and exploration. The next level, application, is an important level for social work since the students must eventually apply what they learn to the problems clients will

present. The fourth level of Bloom's taxonomy, analysis requires examination of parts or elements of concepts, analyzing the relationships between conclusion s and evidence, organizing knowledge based on a principle, or making inferences based on data.

Furthermore, synthesis level may be thought of as creativity because it involves the production of things that are new or unique. The creative demonstration of learning and skills lends itself more to the essay format. The highest level, evaluation, requires students to make judgments based on external criteria or internal evidence. We must give students the external criteria and demonstrate how to utilize it to render judgments.

After these explanations, Aviles (1999) suggests that, testing for critical thinking involves advance preparation; however, the effort is well worth it. It makes the tests more challenging by teaching and testing to higher knowledge levels instead of by burying essential information within other information not intended for testing, or by making finer discriminations between response choices. He also advises the teachers try to utilizing Bloom's taxonomy to create teaching and testing materials.

One of the most frequent uses of the Taxonomy has been to classify curricular objectives and test items in order to show the breadth, or lack of breadth, of the objectives and items across the spectrum of categories. Usually, these analyses have shown a heavy emphasis on objectives requiring only recognition or recall of information, objectives that fall in the Knowledge category. Nevertheless, it is objectives that involve the understanding and use of knowledge, those that would be classified in the categories from Comprehension to Synthesis that are usually considered the most important goals of education. Such analyses, therefore, have repeatedly provided a basis

for moving curricula and tests toward objectives that would be classified in the more complex categories (Krathwohl, 2002).

Recent standards documents for science and mathematics list metacognition and higher order thinking skills as an important educational goal for students. (National Council for Teachers of Mathematics, 2000; American Association for the Advancement of Science, 1993).

As a result, improving students' cognitive skills is important for their lifelong capabilities. Developing and testing for critical thinking in terms of higher order thinking skills make science education aimed to improve students' cognitive tasks and their problem solving, questioning and evaluating information. Bloom's Taxonomy plays an important role in creating teaching and testing materials and it is helpful for teachers to evaluate their materials and decide the knowledge level of their materials.

2.3.1 Teachers' Cognitive Development Applications

If it is concerned to develop the students' critical thinking skills, the teachers' teaching-learning methodologies should be considered first.

Although teachers believe the necessity of the issue, a major problem with the area of critical thinking is for teachers to understand just what it is. The critical thinking does not have one certain definition. While experts agree that critical-thinking behaviors involve an open-minded propensity to analyze, synthesize, and evaluate information in order to solve problems and make decisions (Halpern, 1997; Kurfiss, 1988; Watson & Glaser, 1994), an agreed upon definition for critical thinking has not been established. Definitions of higher order thinking have also been influenced by the writings of John

Dewey (1933), who defined critical thinking as "reflective thought," characterized by careful and persistent consideration of beliefs or conclusions and the reasoning that supports them. In defining and describing critical or higher order thinking, a number of researchers include the concept of dispositions or habits of mind. Dispositions are learners' intentional inclinations to approach thinking and learning in a particular way, or the characteristics of self-regulated learners (Ormrod, 2004).

Although there are a lot of definitions of the critical thinking or higher order thinking in practice, definitions of critical thinking and preferred ways of teaching critical thinking are unique and heavily influenced by institutional missions/goals, standards, student needs, and the instructional objectives of individual faculty members (Kassem, 2005).

Because critical thinking can be improved, they also share the focus that it is an important construct to use in shaping curricula across disciplines. Nevertheless, what teachers can do to improve their integration of critical thinking into their curriculum is still left largely to the vast array of products on shelves that sell critical-thinking "stuff" to teachers, rather than train them in the understanding of how to implement critical thinking in all activities (Dixon et. al, 2004).

Some of the previous studies addressed various aspects of teachers' pedagogical knowledge in the context of teaching higher-order thinking, identifying several important components of teachers' knowledge in this field (Zohar, 1999, 2004; Zohar & Nemet, 2002; Zohar, Vaaknin, & Degani, 2001). The three most significant findings from these studies are the following; (a) many teachers adopt a transmission of knowledge approach to the teaching of higher-order thinking, thereby compromising reform curriculum in this field. Since teachers are missing the pedagogical knowledge that is appropriate for

teaching thinking, they often compromise the "thinking" curriculum. Consequently, teachers have been found to block students' opportunities to engage in active thinking even when they use learning materials that were specifically designed to stimulate students' thinking; (b) Most teachers believe that instruction of higher-order thinking is indeed a worthwhile and important educational goal. However, they do not conceive of this goal as equally appropriate for all students. Many teachers thus believe that, although teaching thinking is appropriate for students with high academic achievements, it is inappropriate for students with low academic achievements. This belief is dangerous because it is likely to create unequal opportunities for all students; (c) Finally, the findings from these studies show that most teachers do not have the metacognitive knowledge that is necessary for teaching of higher-order thinking (Zohar & Schwartzer, 2005)

Mc Millan and Lawson (2001) conducted a study to investigate the assessment and grading practices of 261 secondary science teachers representing urban, suburban, and rural schools and determine if meaningful relationship exist between these practices and grade level and ability levels of different classes. Teachers indicated extend to which they used various factors in grading students, the types of assessments used, and the cognitive level of these assessments. The foundations of the survey study were that, secondary science teachers separate the cognitive level of assessments into two main categories: recall knowledge and higher-order thinking (student reasoning, understanding, and application of material). It appears that for many science teachers there is nearly as much emphasis at the recall level as at understanding.

In addition, Bol and Strage (1996) performed a study by interviewing ten high school biology teachers and reviewing their course documents. They resulted that, while teachers wanted their students to develop higher-order

thinking skills, their assessment practices did not support these goals. Specifically, 50% of the items required only basic knowledge, while almost none required application. They also claimed that, the interviews with the teachers revealed that they were not aware of this contradiction.

From the research, it was concluded that critical thinking is a skill. Like any other skill, it can be taught, it can be learned, and it can be improved with practice and daily use. Teachers still need help about developing the students' thinking skills.

As a result, if the main concern is to develop the students' critical thinking skills, the teachers' teaching-learning methodologies should be considered first.

2.4 Performance Assessment in Science

Development in the society and science requires the development of knowledge. As the educators demand to develop the knowledge and skills of the students, to assess how successful they are becomes a new problem.

Assessments of the learning abilities and achievements of students must be designed and used in ways that take account of the goals of modern society and of present knowledge of human learning. New perspectives are now offered on the nature of knowledge and abilities that are brought to learning, and on the nature of competent achievement that results from instruction. Innovative systems that integrate access to learning, instruction and assessment can now drive the design of educational environments that support and respect human cognitive ability, and prepare people for dignified lives, competent work and social growth (Glaser, 1998).

LeMahieu and Leinhardt (1985) claimed that tests could be influential in deciding what content and skills to teach and control the opportunity to learn the full curriculum.

The new trend in educational assessment is based on criticism against the extended use of multiple-choice achievement tests that are seen as too limited in capturing students' conceptual understanding and problem-solving skills and to have had a negative impact on teaching (Shepard, 1989). Multiple choice achievement tests also are seen to assess learning outcome in an artificial, decontextualised manner removed from the ways students actually learn and will apply knowledge outside the classroom (Resnick and Klopfer, 1989). The new perspective therefore calls more "authentic" (Wiggens, 1989) and "balanced" (Bell, Burkhadt and Swan, 1992) assessment. Now students should be given tasks that are set in a real world context and which require higher level thinking and problem solving skills (Aschbacer, 1991).

Performance assessment in science including open-ended investigative tasks is a method to assess higher level thinking and problem solving skills. However, Kind, in his study of "TIMMS Performance Assessment-a cross national comparison of practical work" claimed that performance assessment in science including open-ended investigative tasks is a phenomenon known from rather few countries. He also claimed that, it was not felt "fair" for the students to give them an open-ended task and expect a specific type of response. In his study, he performed an assessment in TIMMS including five science tasks. He discussed that, the results have displayed important differences in some countries. Some of these differences probably may be explained from general factors in the schooling system, which affect student's achievement across subjects. The similar positions of the countries also indicate that content knowledge in science help the students on responding to

the performance assessment tasks. He follows his discussion with the results from the detailed analysis, however; clearly indicate that the assessment has managed to reflect interesting differences in practical work within countries. From Kind's study, it can be concluded that exterior effects influence the students' science performance.

Enger (1997) presented a research; with this research, she investigated the link between instruction in middle school science and assessment in ninth grade science with open-ended science questions. The subjects of the study were 117 6th and 8th grade students and their 13 science teachers. The survey instrument included open-ended questions developed from a standardized test, the Iowa Tests of Educational Development. Separate student and teacher questionnaires were developed to ascertain perceptions about the science inquiry learning opportunities that existed in the middle school science classrooms. As the results of her survey study, she suggested that the use of open-ended question format does provide diagnostic information about student performance. When Birenbaum and Tatsuoka (1987) compared open-ended versus multiple-choice formats, they also found considerable differences between the forms. As they noted, while multiple-choice formats are considerably easier to score, this format may not provide the appropriate information for identifying students' misconceptions. In addition, precisely the kinds of errors that students make in relation to the nature of the cognitive demands of the items mat are more difficult to assess with the multiple-choice format.

In testing, question confidence is an important issue when someone wants to test the cognitive developments. Fasko (1983) suggested that questions might direct these student's attention and processing effort, which would provide the link between the use of both higher order questions (HOQs) and lower order questions (LOQs) and the assessment of their effects on

student academic performance. Interestingly, Fasko (1983, 1988) found that students were more confident about their ability to respond accurately to lower order questions than they were to higher order questions. Perhaps this is because of the past failures (Chuska, 1995). Chuska follows his suggestion as, the accuracy of student respond could be affected by his or her attentiveness in class. Fasko (1983, 1988) recommended that once students' confidence was strengthened by using LOQs, then HOQs could be presented to facilitate the students' higher level of cognitive processing. Researches also support this idea and recommend asking questions at a variety of levels. Fasko (1983, 1988) speculated that assessing a student's question answering confidence to HOQs and LOQs would assist educators and researchers in determining the type of student cognitive processing and in determining the student's cognitive ability. In addition, Chuska (1995) suggests that using open-ended questions will grab students' attention.

At the end of his study, Fasko (1983) contends that to reduce anxiety and increase attentiveness educators should pose an equal mix of HOQs and LOQs during lectures to obtain uniform question answering performance.

However, perhaps Fasko's (1983, 1988) findings can be explained by certain personality or situational variables such as anxiety and self-efficacy.

"Anxiety states are characterized by subjective feelings of tension, apprehension, nervousness and worry..." (Spielberger, 1983). Dillon (1981) reminds that teachers who use too many questions in class may evoke anxiety in their students.

On the other hand, within the context of cognition and other personal factors, conceptions of self, self-worth and conceptions of competence to achieve explicit goals (i.e., self-efficacy) affect the selection and construction

of environments (Bandura, 1986). Therefore, self-efficacy, an individual's beliefs about his/her capabilities to control his/her level of functioning within a specific context or attaining mastery of a specific task, is a pervasive influence in academic and personal achievement, also affecting the goal challenges people set and their commitment to explicit goals (Bandura, 1991). Furthermore, Bandura (1977) listed three elements that affect self-efficacy: (a) prior success and failures, (b) learners' perception of how others view them, and (c) observing success or failure in other individuals.

Jackson (2002) expounded upon past studies and his own, which showed that average students achieve the highest gains from self-efficacy enhancement. Below-average students often do not have the skills to achieve the task without scaffolding. Above-average high achieving students usually do well at the task without scaffolding. However, his study showed that, without motivation, some above average students who are not high achievers, yet possess high efficacy, may not achieve the level of learning.

Fasko & Skidmore (1999) conducted a study to examine the effects of questions and anxiety on attention, question confidence, and metacognition. They studied the effects of questions of different cognitive levels in four undergraduate classes with a total of 80 students. The instruments of the study were a Likert type scale named The Worry Emotionally Scale and a questionnaire with four subscales named motivated strategies for Learning Questionnaire. The questionnaire was used in the assessment of the learner variables, which were metacognitive self-regulation, task specific self-efficacy, the learners' perceived ability to control their learning and performance and, test anxiety. The results of the study show that, the lower the anxiety score the higher the self-efficacy learning performance. Whereas the higher the metacognitive self-regulation the higher the attentiveness score were. Question confidence was related to higher scores in metacognitive self-

regulation, control of beliefs, and self-efficacy of learning and performance. Thus, they claim that, it appears that students' ability to plan, monitor, and regulate their cognitions are good predictors of their ability to attend and respond questions (Fasko & Skidmore, 1999).

Feldunsen and Klausmeier (1962) discovered from their research studies that individuals dissociated from the actual incident that incited anxiety and fear. Increased anxiety also made it difficult for the learner to react positively to the instructor. They also claim that, learners possessing low self-efficacy in adapting to and overcoming difficult academic situations can develop achievement anxiety that severely inhibits their performance.

Research has demonstrated that self-efficacy can be a valid predictor of performance outcomes, including academic achievement and behavior (Oliver & Shapiro, 1993; Schunk, 1991).

Students' interest plays an important role in the accommodation of concepts (Palmer, 2005). Interest includes feeling-related and value-related valences (Schiefele, 2001). Value-related valences refer to person's expectations from interest objects to have significant experiences for his or herself. Feeling-related valences refer to person's expectations from interest objects to have experiences that make them feel positively. A person will engage with the interest objects if he feels positively about them and gives value to them (Krapp, 2002a)

There are many ways to increase students' interest towards science. Research suggests that real-life applications may be a way to engage students' interest in learning science (McComas, 1996; Simon, 2000). From a learning theory perspective, students become more engaged in their learning when they see the wide usefulness of the knowledge they are studying (McCombs, 1996;

Posner et al., 1982). The studies provide evidence supporting the idea that student interest is enhanced by involvement in real-world science projects and investigations (Edelson, 2001; Williams, 1992). Another aspect for increasing students' engagement to science lessons is hands-on practical activities (Fraser, 1980; Freedman, 1997). In addition, motivating activities such as, jokes and humor, games, role plays, dramatic events and rewards help to capture students' interest. Shringley and Koballa (1992) said that, telling anecdotal stories are related to changes in students' attitudes.

As a conclusion of the studies, the new trends in educational assessment claims that using only multiple choice questions in science assessments is too limited, instead teachers should use open-ended items which are set in a real world context and which require higher level thinking and problem solving skills.

While assessing the science achievement, assessment of cognitive developments of students in terms of lower order and higher order thinking skills shoul be conducted. Attitude affects science achievement of students. While assessing the students' performance, students' attitudes should take into account according to the new science teaching methodologies.

2.5 Summary of the Literature Review

As a result of the reviewed of literature, there are several researches on the methods of teaching science, its evaluation and new approaches about testing methodology in science. Although multiple-choice questions are still used by science teachers, there is a trend in using open-ended tasks in science exams to evaluate the students' cognitive developments. A limited number of

studies however emphasize the difficulties of open-ended questions for the students.

Furthermore, in a developing world, the need to reach the optimum level in science teaching becomes the main issue. To accomplish this mission, many research activities such as, applications of the new approaches in classrooms, measurement and evaluation techniques have been carried out intensely. The constructivist approach is one of the newest in its kind to apply the student-centered education. This approach is so complex that the teachers and the experts developing curricula should understand and consider the objectives of the approach before it becomes operative including the science concepts, equipment use in science lessons, teachers approach to the students, development of new and effective assessment techniques, understanding the philosophy of the new approaches. The review also pointed out that, there have been many studies about the curriculum developments and the new approaches integrated to the curricula. However, a limited number of studies, which investigates New Elementary Science and Technology Curriculum, were stated in Turkey. Thus, in order to provide contributions and suggestions by the findings of this study, new and previous science curricula were compared.

CHAPTER 3

METHOD

In this chapter, the aim was to report the procedures of the study. Description of variables, methodology of the research, population and sampling, the measuring instruments, procedure, and methods used to analyze data, will be explained briefly.

3.1 Variables

There were 13 variables classified as dependent and independent variables.

3.1.1 Dependent Variables

With the consideration of 4^{th} and 5^{th} grade levels and three different measuring tools, 12 dependent variables were considered in the research.

3.1.1.1 The Dependent Variables for Science Achievement Tests

i. 4^{th} grade students' Science Achievement Scores from knowledge and understanding level part of the Science Achievement Test (4SATKUL).

ii. 4th grade students' Science Achievement Scores from Higher Order Thinking Skills part of the Science Achievement Test (4SATHOTS).

iii. 5th grade students' Science Achievement Scores from knowledge and understanding level part of the Science Achievement Test (5SATKUL).

iv. 5th grade students' Science Achievement Scores from Higher Order Thinking Skills part of the Science Achievement Test (5SATHOTS).

3.1.1.2 The Dependent Variables for Science Attitude Scale

The three dependent variables for Science Attitude Scale are the scores of the students from the three categories of the Science Attitude Scale, which are:

i. Students' Science Attitude Scale Interest Scores (SASIS)
ii. Students' Science Attitude Scale Anxiety Scores (SASAS)
iii. Students' Science Attitude Scale Self-efficacy Scores (SASSCS)

3.1.1.3 The Dependent Variables for Teachers' Classroom Activities Scale

The five dependent variables for Teachers' Classroom Activities Scale (TCAS) were the scores of the students from the five categories of the Teachers' Classroom Activities Scale.

i. Students' Teachers' Classroom Activities Scale scores from the Classroom Activities of the New Approach category (CANATCAS).

ii. Students' Teachers' Classroom Activities Scale scores from the Care of Teacher category (COTTCAS).

iii. Students' Teachers' Classroom Activies Scale scores from the Equipment Use category (EUTCAS).

iv. Students' Teachers' Classroom Activities Scale scores from the Classical Classroom Activities category (CCATCAS).

v. Students' Teachers' Classroom Activities Scale scores from the Processing the Subject category (PSTCAS).

3.1.2 Independent Variable

The independent variable of this study was school types of the subject named SCHOOL. School type of the subject was in categorical scale of measurement and it labels the schools of pilot group (schools implementing the new science and technology curriculum) and school of control group (school implementing the traditional curriculum): 1 and 2 for the students in pilot schools and 3 for the students in school implementing the previous curriculum.

3.2 Methodology of the Research

3.2.1 Design of the Study

In this study, the static-group comparison design was used. The measuring tools were used as post-tests. There were two pilot groups and one control group, which were conveniently assigned. While assigning the groups the two subject characteristics were taken into account, demographic characteristics and gender of the students. Therefore, the schools were chosen to be in the same region.

Science Achievement Test for 4^{th} grade (4SAT) was applied to 162 fourth graders as post-test. Similarly, Science Achievement Test for 5^{th} grade (5SAT) was applied to 140 fifth graders as post-test in order to determine whether there would be a significant difference between the groups. Before the administration researcher was sure that the teachers finished all units in science curriculum.

Science Attitude Scale and Teachers' Classroom Activities Scale were applied to 302 4^{th} and 5^{th} grade students as post-test in order to determine whether there would be a significant difference between the groups. The Table 3.1 summarizes the static-group post-test only comparison design of the study.

Table 3.1 The Static-Group Comparison Design of the Study

	Post-test	
Groups	4th grade	5th grade
Pilot Group 1	4SAT	5SAT
	SAS	
	TCAS	
Pilot Group 2	4SAT	5SAT
	SAS	
	TCAS	
Control Group	4SAT	5SAT
	SAS	
	TCAS	

3.2.2. Population and Sample

The subjects of this study consisted of 302 4th and 5th grade students from three public elementary schools. Two schools implementing the new science and technology curriculum and one school implementing the traditional science curriculum were chosen. Three schools were located in Yenimahalle district, Ankara. There were 25 pilot schools in Ankara implementing the new science and technology curriculum in 2004-2005 education term. Convenience sampling was used to obtain a representative sample of the pilot schools. First, the district was chosen by the convenience sampling method and all schools were conveniently selected with the consideration of being close to each oher. From these selected schools, classes to which the instruments were administered were selected by taking into consideration of the convenience of administration and teachers. Distribution

of the characteristics of the sample with respect to groups and grade levels was given in Table 3.2.

Table 3.2 Sample Distribution

	4th Grade	5th Grade
Pilot Groups	100	85
Control Group	62	55
Total	162	140

For subject characteristics, data on seven characteristics were collected in the first part of TCAS. Collected data included: (a) gender; (b) attendance to the school (absence); (c) science personal study hours; (d) parental education level (mother education level, father education level); (e) number of books at home; (f) house assets (computer, private room, private study table, dictionary, encyclopedia, experiment kit, washing machine, and dishwasher); (g) number of people at home. Each of these items had a multiple-choice format (See Appendix C). The data from the questions for sample characteristics were displayed in the following tables indicating the within group percentages and total percentages of responses.

Table 3.3 Gender

		girl	boy
Pilot Group 1	Count	42	54
	% wg*	43,8%	56,3%
Pilot Group 2	Count	37	52
	% wg*	41,6%	58,4%
Control Group	Count	53	64
	% wg*	45,3%	54,7%
TOTAL	Count	132	170
	% of Total	43,7%	56,3%

* %wg: % within group

Table 3.4 Absence

		0 day	1-11 day	Above 11 day
Pilot Group 1	Count	36	58	2
	% wg*	37,5%	60,4%	2,1%
Pilot Group 2	Count	32	55	2
	% wg*	36,0%	61,8%	2,2%
Control Group	Count	56	56	5
	% wg*	47,9%	47,9%	4,3%
TOTAL	Count	124	169	9
	% of Total	41,1%	56,0%	3,0%

Table 3.5 Personal Science Study Hours

		0 hour	Below 1 hour	1-3 hours	Above 3 hours
Pilot Group 1	Count	1	21	54	20
	% wg*	1,0%	21,9%	56,3%	20,8%
Pilot Group 2	Count	3	17	50	18
	% wg*	3,4%	19,3%	56,8%	20,5%
Control Group	Count	5	17	64	31
	% wg*	4,3%	14,5%	54,7%	26,5%
TOTAL	Count	9	55	168	69
	% wg*	3,0%	18,3%	55,8%	22,9%

Table 3.6 Mother Education Level

		none	Primary school	Secondary school	Lycee	university	Master	I don't know
PG1	Count	8	36	14	24	10	1	3
	% wg*	8,3%	37,5%	14,6%	25,0%	10,4%	1,0%	3,1%
PG2	Count	6	36	17	15	12		3
	% wg*	6,7%	40,4%	19,1%	16,9%	13,5%		3,4%
CG	Count	5	53	30	19	6		4
	% wg*	4,3%	45,3%	25,6%	16,2%	5,1%		3,4%
TOTAL	Count	19	125	61	58	28	1	10
	% wg*	6,3%	41,4%	20,2%	19,2%	9,3%	,3%	3,3%

Table 3.7 Father Education Level

		none	Primary school	Secondary school	Lycee	university	Master	I don't know
PG1	Count	2	29	18	21	22	2	2
	% wg*	2,1%	30,2%	18,8%	21,9%	22,9%	2,1%	2,1%
PG2	Count	1	24	24	22	13	1	4
	% wg*	1,1%	27,0%	27,0%	24,7%	14,6%	1,1%	4,5%
CG	Count		28	35	36	11	4	3
	% wg*		23,9%	29,9%	30,8%	9,4%	3,4%	2,6%
TOTAL	Count	3	81	77	79	46	7	9
	% wg*	1,0%	26,8%	25,5%	26,2%	15,2%	2,3%	3,0%

Table 3.8 Number of Books at Home

		0 or very few	Full of One shelf	full of 1 book shelves	full of 2 book shelves	Much than 2 full book shelves
PG1	*Count*	*3*	*22*	*35*	*24*	*12*
	*% wg**	*3,1%*	*22,9%*	*36,5%*	*25,0%*	*12,5%*
PG2	*Count*	*6*	*35*	*27*	*13*	*8*
	*% wg**	*6,7%*	*39,3%*	*30,3%*	*14,6%*	*9,0%*
CG	*Count*	*8*	*28*	*36*	*30*	*15*
	*% wg**	*6,8%*	*23,9%*	*30,8%*	*25,6%*	*12,8%*
TOTAL	*Count*	*17*	*85*	*98*	*67*	*35*
	*% wg**	*5,6%*	*28,1%*	*32,5%*	*22,2%*	*11,6%*

Table 3.9 Computer at Home

		no	*Yes*
PG1	Count	49	47
	% wg*	51,0%	49,0%
PG2	Count	51	37
	% wg*	58,0%	42,0%
CG	Count	55	62
	% wg*	47,0%	53,0%
TOTAL	Count	155	146
	% wg*	51,5%	48,5%

Table 3.10 Private Room at Home

		no	*Yes*
PG1	Count	46	50
	% wg*	47,9%	52,1%
PG2	Count	45	44
	% wg*	50,6%	49,4%
CG	Count	58	59
	% wg*	49,6%	50,4%
TOTAL	Count	149	153
	% wg*	49,3%	50,7%

Table 3.11 Private Study Table at Home

		no	*Yes*
PG1	Count	30	64
	% wg*	31,9%	68,1%
PG2	Count	39	50
	% wg*	43,8%	56,2%
CG	Count	43	74
	% wg*	36,8%	63,2%
TOTAL	Count	112	188
	% wg*	37,3%	62,7%

Table 3.12 Dictionary at Home

		no	*Yes*
PG1	Count	3	92
	% wg*	3,2%	96,8%
PG2	Count	2	84
	% wg*	2,3%	97,7%
CG	Count	5	92
	% wg*	5,2%	94,8%
TOTAL	Count	10	268
	% wg*	3,6%	96,4%

Table 3.13 Encyclopedia at Home

		no	*Yes*
PG1	Count	42	54
	% wg*	43,8%	56,3%
PG2	Count	37	52
	% wg*	41,6%	58,4%
CG	Count	49	68
	% wg*	41,9%	58,1%
TOTAL	Count	128	174
	% wg*	42,4%	57,6%

Table 3.14 Experiment Kit at Home

		no	*Yes*
PG1	Count	77	19
	% wg*	80,2%	19,8%
PG2	Count	67	22
	% wg*	75,3%	24,7%
CG	Count	94	23
	% wg*	80,3%	19,7%
TOTAL	Count	238	64
	% wg*	78,8%	21,2%

Table 3.15 Washing Machine at Home

		no	*Yes*
PG1	Count	6	88
	% wg*	6,4%	93,6%
PG2	Count	2	83
	% wg*	2,4%	97,6%
CG	Count	8	95
	% wg*	7,8%	92,2%
TOTAL	Count	16	266
	% wg*	5,7%	94,3%

Table 3.16 Dishwasher at Home

		no	*yes*
PG1	Count	45	50
	% wg*	47,4%	52,6%
PG2	Count	40	49
	% wg*	44,9%	55,1%
CG	Count	49	68
	% wg*	41,9%	58,1%
TOTAL	Count	134	167
	% wg*	44,5%	55,5%

Table 3.17 Number of People at Home

		3	*4*	*5*	*6*	*7*
PG1	Count	9	48	30	8	1
	% wg*	9,4%	50,0%	31,3%	8,3%	1,0%
PG2	Count	9	46	25	3	4
	% wg*	10,3%	52,9%	28,7%	3,4%	4,6%
CG	Count	12	51	42	10	2
	% wg*	10,3%	43,6%	35,9%	8,5%	1,7%
TOTAL	Count	30	145	97	21	7
	% wg*	10,0%	48,3%	32,3%	7,0%	2,3%

In addition, chi-square tests were conducted with the alpha value of 0.05 on the variables to determine if there were significant differences between three groups of the students on these characteristics. When the frequency in any cell was too small to meet the chi-square test criterion, response categories were merged to form two dichotomous categories for analysis. Table 3.18 shows the Pearson chi-square value, df, p and Cramer's V values of the data.

Table 3.18 Chi-Square Values for Sample Characteristics Data

Item	*Pearson Chi-Square Value*	*df*	*p*	*Cramer's V*
Gender	,285	2	,867	,031
Absence	5,510	4	,239	,096
Personal Science Study Hours	4,660	6	,588	,088
Mother Education Level	14,128	12	,293	,153
Father Education Level	16,031	12	,190	,163
Number of Books at Home	11,909	8	,155	,140
Computer at Home	2,421	2	,298	,090
Private Room at Home	,133	2	,935	,021
Private Study Table at Home	2,797	2	,247	,097
Dictionary at Home	1,132	2	,568	,064
Encyclopedia at Home	,109	2	,947	,019
Experiment Kit at Home	,940	2	,625	,056
Washing Machine at Home	2,683	2	,261	,098
Dishwasher at Home	,649	2	,723	,046
Number of People at Home	6,874	8	,550	,107

From the Table 3.18, it was obtained that no chi-square values were significant, $p>.05$. As a result, it was concluded that there were no significant differences between three groups of the students on these seven characteristics.

Therefore, the sample characteristics of three groups in terms of gender, attendance to school, personal science study hours and socio economic status were equal.

3.3 Instrumentation

In this study 4th grade Science Achievement Test (4SAT), 5th grade Science Achievement Test (5SAT), Science Attitude Scale (SAS), and Teachers' Classroom Activities Scale (TCAS) were administered as instruments.

3.3.1 Science Achievement Test

Since the classroom population was high for the public elementary schools, the tests were distributed to the students in two groups (Group A booklet and Group B booklet) for both 4th and 5th grades in order to decrease the interaction between the students while answering the tests.

There were four booklets of SAT. The SAT for 4th grade (4SAT) was composed of two booklets of Group A (4SATA) and Group B (4SATB). The SAT for 5th grade (5SAT) was also composed of two booklets of Group A (5SATA) and Group B (5SATB).

These tests were used to assess the 4th and 5th grade students' knowledge and understanding level outcomes and higher order thinking skills.

3.3.1.1 4th Grade Science Achievement Test

The content of the new science and technology curriculum for 4th grade was composed of 7 units named as "solve the puzzle of our body", "identify the matter", "force and motion", "light and sound", "our planet world", "recognize the livings' world", "electricity in our life". 4SAT includes items covering these seven units.

There were 10 open-ended science questions in 4SAT and these questions were settled in terms of cognitive domain of Bloom's Taxonomy. A table of specification (See Appendix G) was prepared to show the levels of the questions. The test was divided into two, one part of the test was composed of four questions referring to knowledge and understanding level (KUL) named 4SATKUL, and the other part of the test was composed of six questions referring to the higher order thinking skills (HOTS) named 4SATHOTS. Possible scores ranges from 0 to 108 for 4SAT.

3.3.1.1.1 Equivalence of 4SATA, 4SATB Booklets and Groups

In this part, in order to show the equivalence of 4SATA and 4SATB booklets basic descriptive statistics were used. T-test was used to show the equivalence of 4A and 4B groups.

Table 3.19 shows the basic descriptive statistics of the equivalent questions in 4SATA and 4SATB.

Table 3.19 4SAT Basic Descriptive Statistics for Equivalent Questions

	A_1	B_3	A_2	B_2	A_3	B_5
Mean	4,8101	4,5318	1,4810	1,5823	2,9873	1,1013
S.D.	3,4718	3,5346	1,7458	1,6917	3,0191	2,4734
Skewness	,073	,067	1,164	,963	,735	1,290
Kurtosis	-,863	-,730	1,175	,623	-,568	1,723
Minimum	,00	,00	,00	,00	,00	,00
Maximum	12,00	12,00	10,00	7,00	10,00	10,00

As seen from Table 3.19 the equivalent questions show similar statistical characteristics. Therefore, the booklets were identical.

An independent samples t-test was conducted to check the equivalence of the students' scores in both groups on the same questions in 4SATA and 4SATB booklets.

Table 3.20 The Analysis of Data for A_4 and B_4 Questions Comparison With Respect to 4SATA and 4SATB Groups

Group	*N*	*mean*	*S*	*df*	*t-value*	*p*
A	80	5.15	4.94	158	-1.372	0.172
B	80	6.25	5.20			

The result of t-test was not significant, t (158) = -1.372, p = .172. There was no significant difference in the mean scores of the students' A_4 and B_4 questions.

Table 3.21 The Analysis of Data for A_5 and B_1 Questions Comparison With Respect to 4SATA and 4SATB Groups.

Group	*N*	*mean*	*S*	*df*	*t-value*	*p*
A	80	2.55	2.72	158	-0.555	0.580
B	80	2.77	2.4			

The result of t-test was not significant, t (158) = -0.555, p = .580. There was no significant difference in the mean scores of the students' responds to A_5 and B_1 questions.

Table 3.22 The Analysis of Data for A_6 and B_6 Questions Comparison With Respect to 4SATA and 4SATB Groups.

Group	*N*	*mean*	*S*	*df*	*t-value*	*p*
A	80	5.5	3.8	158	-1.009	0.314
B	80	6.03	4.03			

The result of t-test was not significant, t (158) = -1.009, p = .314. There was no significant difference in the mean scores of the students' responds to A_6 and B_6 questions.

Table 3.23 The Analysis of Data for A_7 and B_7 Questions Comparison With Respect to 4SATA and 4SATB Groups.

Group	*N*	*mean*	*S*	*df*	*t-value*	*p*
A	80	4,175	2,4689	158	-0.570	0.569
B	80	4,425	3,0472			

The result of t-test was not significant, t (158) = -0.570, p = .569. There was no significant difference in the mean scores of the students' responds to A_7 and B_7 questions.

Table 3.24 The Analysis of Data for A_8 and B_9 Questions Comparison With Respect to 4SATA and 4SATB Groups.

Group	*N*	*mean*	*S*	*df*	*t-value*	*p*
A	80	2,6125	2,7025	158	0.966	0.336
B	80	2,2125	2,5343			

The result of t-test was not significant, t (158) = 0.966, p = .336. There was no significant difference in the mean scores of the students' responds to A_8 and B_9 questions.

Table 3.25 The Analysis of Data for A_9 and B_10 Questions Comparison With Respect to 4SATA and 4SATB Groups.

Group	*N*	*mean*	*S*	*df*	*t-value*	*p*
A	80	4,5500	4,1973	158	-0.279	0.780
B	80	4,7375	4,2953			

The result of t-test was not significant, t (158) = -0.279, p = .780. There was no significant difference in the mean scores of the students' responds to A_9 and B_10 questions.

Table 3.26 The Analysis of "Data for A_10 and B_8 Questions Comparison" With Respect to 4SATA and 4SATB Groups.

Group	*N*	*mean*	*S*	*df*	*t-value*	*p*
A	80	2,3750	3,7294	158	0.217	0.828
B	80	2,2500	3,5489			

The result of t-test was not significant, t (158) = 0.217, p = .828. There was no significant difference in the mean scores of the students' responds to A_10 and B_8 questions.

The overall results of the t-test analyses as seen from the tables 3.20, 3.21, 3.22, 3.23, 3.24, 3.25, 3.26 showed that there was no significant difference between the mean of the students' scores of the same questions of 4SATA and 4SATB booklets. In addition, it could be concluded that the

students in group A and group B should be considered in equal level of achievement, which means that the two groups were identical and the booklets were equivalent.

Table 3.27 showed the identification of the questions in both booklets. 7 questions in the booklet 4SATA and 4SATB were the same questions and 3 questions were equivalent. These three equivalent questions were equal in terms of content (See Appendix E) and show similar characters statistically.

Table 3.27 4SATA and 4SATB Questions Match

4SATA test item numbers	*4SATB test item numbers*	
A_4	*B_4*	*same*
A_5	*B_1*	*same*
A_6	*B_6*	*same*
A_7	*B_7*	*same*
A_8	*B_9*	*same*
A_9	*B_10*	*same*
A_10	*B_8*	*same*
A_1	*B_3*	*equivalent*
A_2	*B_2*	*equivalent*
A_3	*B_5*	*equivalent*

In the statistical analyses, these two booklets were treated as one booklet and named 4SAT.

3.3.1.2 5th Grade Science Achievement Test

The content of the 5th grade new science and technology curriculum was composed of 7 units named as "solve the puzzle of our body", "identify the matter and change of matter", "force and motion", "electricity in our life",

"world, sun and moon", "recognize the livings' world" and "light and sound". 5SAT items cover the contents of these seven units.

There were 11 open-ended science questions in the 5SAT and these questions were settled in terms of cognitive domain of Bloom's Taxonomy. A table of specification (See Appendix H) was prepared to show the levels of the questions. The test was divided into two, one part of the test was composed of five questions referring to the knowledge and understanding level (KUL), and the other part of the test was composed of six questions referring to the higher order thinking skills (HOTS). Possible scores ranges from 0 to 120 for 5SAT.

3.3.1.2.1 Equivalence of 5SATA, 5SATB Booklets and Groups

In this part, in order to show the equivalence of 5SATA and 5SATB booklets, basic descriptive statistics were used. T-test was used to show the equivalence of 5A and 5B groups.

Table 3.28 shows the basic descriptive statistics of the equivalent questions in 5SATA and 5SATB.

Table 3.28 5SAT Basic Descriptive Statistics for Equivalent Questions

	A_2	*B_2*	*A_5*	*B_5*	*A_7*	*B_1*	*A_9*	*B_9*	*A_11*	*B_11*
Mean	2,649	1,754	8,245	6,157	4,736	4,473	6,666	7,947	7,789	6,736
S.D	3,763	3,837	3,837	3,735	3,4617	3,7422	3,8235	3,1871	4,7462	5,2048
Skewness	1,065	1,753	-1,753	,728	,070	,175	-,187	-1,391	-,626	-,245
Kurtosis	-,358	1,111	1,111	-,829	-,848	-1,167	-1,553	,804	-1,184	-1,644
Minimum	,00	,00	,00	,00	,00	,00	,00	,00	,00	,00
Maximum	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	12,00	12,00

As seen from Table 3.28, the equivalent questions show similar statistical characteristics.

An independent samples t-test was conducted to check the equivalence of the students' scores in both groups on the same questions in 5SATA and 5SATB booklets.

Table 3.29 The Analysis of Data for A_1 and B_4 Questions Comparison With Respect to 5SATA and 5SATB Groups.

Group	*N*	*mean*	*S*	*df*	*t-value*	*p*
A	67	6,89	3,88	132	-0.533	0.595
B	67	7,25	3,91			

The result of t-test was not significant, t (132) = -0.533, p = .595. There was no significant difference in the mean scores of the students' responds to A_1 and B_4 questions.

Table 3.30 The Analysis of Data for A_3 and B_3 Questions Comparison With Respect to 5SATA and 5SATB Groups.

Group	*N*	*mean*	*S*	*df*	*t-value*	*p*
A	67	6,72	4,731	132	0.854	0.394
B	67	6,00	4,973			

The result of t-test was not significant, t (132) = 0.854, p = .394. There was no significant difference in the mean scores of the students' responds to A_3 and B_3 questions.

Table 3.31 The Analysis of Data for A_4 and B_7 Questions Comparison With Respect to 5SATA and 5SATB Groups.

Group	*N*	*mean*	*S*	*df*	*t-value*	*p*
A	67	6,26	6,27	132	0.742	0.459
B	67	5,62	5,12			

The result of t-test was not significant, t (132) = 0.742, p = .459. There was no significant difference in the mean scores of the students' responds to A_4 and B_7 questions.

Table 3.32 The Analysis of Data for A_6 and B_6 Questions Comparison With Respect to 5SATA and 5SATB Groups.

Group	*N*	*mean*	*S*	*df*	*t-value*	*p*
A	67	9,02	4,48	132	-0.950	0.344
B	67	9,73	4,25			

The result of t-test was not significant, t (132) = -0.950, p = .344. There was no significant difference in the mean scores of the students' responds to A_6 and B_6 questions.

Table 3.33 The Analysis of Data for A_8 and B_8 Questions Comparison With Respect to 5SATA and 5SATB Groups.

Group	*N*	*mean*	*S*	*df*	*t-value*	*p*
A	67	7,69	4,02	132	1.720	0.088
B	67	6,43	4,51			

The result of t-test was not significant, t (132) = 1.720, p = .088. There was no significant difference in the mean scores of the students' responds to A_8 and B_8 questions.

Table 3.34 The Analysis of Data for A_10 and B_10 Questions Comparison With Respect to 5SATA and 5SATB Groups.

Group	*N*	*mean*	*S*	*df*	*t-value*	*p*
A	67	1,79	2,89	132	-1.330	0.186
B	67	2,51	3,33			

The result of t-test was not significant, t (132) = -1.330, p = .186. There was no significant difference in the mean scores of the students' responds to A_10 and B_10 questions.

The results overall results of the t-tests as seen from tables 3.29, 3.30, 3.31, 3.32, 3.33, 3.34 showed that there was no significant difference between the mean of the students' scores from the same questions of 5SATA and 5SATB booklets.

In addition, it could be concluded that the students in group A and group B should be considered in equal level of achievement, which means the two groups were identical and the booklets were equivalent.

Table 3.35 shows the identification of the questions in both booklets. Six questions in the booklet 5SATA and 5SATB were the same questions and five questions were equivalent. These five equivalent questions were equal in terms of content (See Appendix F) and show similar characters statistically.

Table 3.35 5SATA and 5SATB Questions Match

5SATA	*5SATB*	
A_1	*B_4*	*same*
A_3	*B_3*	*same*
A_4	*B_7*	*same*
A_6	*B_6*	*same*
A_8	*B_8*	*same*
A_10	*B_10*	*same*
A_2	*B_2*	*equivalent*
A_5	*B_5*	*equivalent*
A_7	*B_1*	*equivalent*
A_9	*B_9*	*equivalent*
A_11	*B_11*	*equivalent*

In the following analyses, these two booklets were treated as one booklet and named 5SAT.

3.3.2 Science Attitude Scale

Science Attitude Scale (SAS) was developed by the researcher (See Appendix D). Same SAS was distributed for both 4^{th} and 5^{th} grades. The items used in the scale were to be rated on a 5-point likert type response format (absolutely disagree, disagree, neutral, agree, absolutely agree). It consisted of 20 items. The possible scores ranges from 20 to 100 in which getting higher scores indicates positive on the other hand getting lower scores indicate negative attitudes towards science.

To test the construct validity of SAS and to find its sub categories factor analysis was done. According to the principal component analysis with varimax rotation, the first three eigen values were 6.24, 3.2 and 1.2.

Table 3.36 Varimax Rotated Factor Loadings for SAS

Item no	Factor 1	Factor 2	Factor 3
13	,736	,220	,549
16	,713	,134	,561
1	,711	,287	,295
15	,681	,239	,366
10	,678	,254	-,103
12	,677	,317	,293
5	,673	,101	,124
8	,650	,250	,102
4	,604	-,451	,172
9	,122	,755	,113
7	,201	,736	,182
3	,385	,658	,212
6	,223	,656	,193
11	,150	,623	,289
14	,122	,581	,316
2	,391	,566	,302
18	-,252	,204	,771
7	,181	,286	,675
20	-,465	,376	,671
19	,244	,491	,536

Extraction Method: Principal Component Analysis

As considering the output of the factor analyses from Table 3.36 it was decided that, the scale contains three sub categories; Interest, Anxiety and Self-efficacy. Each category includes items written in the negative form. The item numbers written in negative form are 2, 3, 6, 7, 9, 11, 14, 17, 18, 19, and 20.

Interest category includes the items 1, 4, 5, 8, 10, 12, 13, 15, and 16. This factor accounted for 21.8% of the total variation in the attitude scores. Anxiety category includes the items 2, 3, 6, 7, 9, 11, and 14. This factor accounted for 19.1% of the total variation in the attitude scores. Self-efficacy category includes the items 17, 18, 19, and 20. This factor accounted for 11.8% of the total variation in the attitude scores.

Interest category relates with students personal interest and interest behaviors towards the science lesson. Anxiety category relates with students' anxious feelings and emotions about science lesson. Self-efficacy category answers the belief in students' capabilities to manage the requirements of science lesson of their own.

3.3.3 Teachers' Classroom Activities Scale

The researcher developed TCAS. (Appendix C) TCAS was distributed for both 4^{th} and 5^{th} grades. The items used in the scale are to be rated on a 5-point response format of frequencies (almost every day, 1-2 times in a week, 1-2 times in a month, 1-2 times in a term, never). It consists of 45 items. The possible scores ranges from 45 to 225 in which getting higher scores indicates the higher frequency of the teachers' applications on the other hand getting lower scores indicate higher frequency of the teachers' activities.

To test the construct validity of TCAS and to find the sub categories factor analyses was done.

Table 3.37 Varimax Rotated Factor Loadings for TCAS

item no	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
22	,790				
23	,769		,252		
27	,762	,139			
21	,761		,228	,127	
26	,758	,194			
19	,691		,321		
12	,618	,123	,365		,109
20	,617	,220	,256	,120	
25	,596	,133			
37	,504	,149	,169	,270	,187
28	,492	,106			,157
33	,487				,351
35	,466		,153		,333
41	,435	,379	,104		,345
42	,365	,167	,131		,354
3	,177	,729	-,171		
5		,666	,113	-,104	-,130
6		,634	,264		,144
9		,542	,179		,121
1	,444	,528	-,100	-,245	-,161
10	,232	,472	,170	-,149	,261
8	,166	,460			,331
2	,240	,451			,150

Table 3.36 continued

14		,434	,371	,179	,247
11	-,187	,341	,200	,198	,244
44		,249	,236		,138
16	,329		,583	-,123	
18	,284		,580	,111	,204
7	,130	,424	,536		-,246
15	,465	,138	,494	,260	
13	,243	,194	,469	-,138	,132
17	,435		,461		,243
43	,171		,275		,248
39	-,215	,126	,138	,608	,136
29	,160		-,350	,582	
45		-,126	,111	,562	
38	-,161	,166	,455	,560	
32			,171	,559	,159
36	,147	-,172		,534	
24	,281	-,108	-,186	,530	-,137
30	,338		-,174	,479	,276
31				,191	,692
34			,119		,592
4	,294	,338	,330		-,403
40	,303	,228	,159	,112	,344

Extraction Method: Principal Component Analysis

According to the output of the factor analysis from Table 3.37 it was decided that, the scale contains five sub categories; Classroom Activities of the New Approach (CANATCAS), Care of Teacher category (COTTCAS),

Equipment Use category (EUTCAS), Classical Classroom Activities category (CCATCAS), Processing the Subject category (PSTCAS). According to the principal components factor solution with varimax rotation, the first five eigenvalues were 10.1, 3.4, 2.9, 1.94 and 1.89.

Classroom Activities of the New Approach (CANATCAS) category includes 15 items, which are 12, 19, 20, 21, 22, 23, 25, 26, 27, 28, 33, 35, 37, 41, and 42. This factor accounted for 16.6 % of the total variation in the TCAS scores. Care of Teacher category, (COTTCAS) category includes 11 items, which are 1, 2, 3, 5, 6, 8, 9, 10, 11, 14, and 44. This factor accounted for 8.6% of the total variation in the TCAS scores. Equipment Use category (EUTCAS) includes 7 items which are 7, 13, 15, 16, 17, 18, 43. This factor accounted for 7.3% of the total variation in the TCAS scores. Classical Classroom Activities category (CCATCAS) includes 8 items which are 24, 29, 30, 32, 36, 38, 39, and 45. This factor accounted for 6.6% of the total variation in the TCAS scores. Processing the Subject category (PSTCAS) includes 4 items which are 4, 31, 34, and 40. This factor accounted for 5.6% of the total variation in the TCAS scores.

The science teachers' classroom activities that stipulated by the new science and technology curriculum were called as CANATCAS category, and measured with 15 items. The personal relationship and care of the science teacher to the student individually was called COTTCAS category and measured with 11 items. EUTCAS category measured with 7 items and explained the usage classroom equipment frequency of the teacher CCATCAS category which was measured with 8 items was related with the classical classroom activities of the science teacher which are mostly used in the implementation of the traditional science curriculum. PSTCAS category answers how teacher use the methods required by the new curriculum while beginning the new subject.

3.4 Validity and Reliability of Measuring Tools

The meaning of validity and reliability of the instrument is defined by Fraenkel and Wallen (1993): "Validity refers to the appropriateness, meaningfulness and usefulness of inferences a researcher makes. Reliability refers to the consistency of scores of answers from one administration of an instrument to another, and from one set of items to another" (p.138).

3.4.1 Validity and Reliability of Science Achievement Test

The researcher developed the science achivement tests by making use of wide range of sources (review of the related literature, OKS exam questions, TIMMS 95, TIMMS 99, TIMMS 2003, PISA 2000, PISA 2003, 1-5 grades science and technology programs published by TTKB 2005, science books and sample questions given in the new elementary science and technology program).

For 4^{th} and 5^{th} grade SAT, the questions were prepared according to the objectives, subjects, and units of the new science and technology curriculum which were published by The Board of Education (TTKB, 2005). The tests were divided into two, knowledge and understanding level and higher order thinking skills according to Bloom's Taxonomy. To establish the face and content validity, two elementary school Turkish lesson teachers checked the fluency of items. One instructor from the department of Primary Education at Gazi University, and one doctoral student from the department of Measurement and Evaluation at Ankara University checked the appropriateness of the items to the grade levels and to the selected objectives in the new elementary science and technology curriculum, representativeness of the content by the selected items and format of the tests (size of type, clarity

of directions). All the suggestions were taken into consideration in the revision of the instruments. The adapted versions of the instruments were given in Appendix A and Appendix B.

Furthermore, the researcher discussed the grading criteria with two elementary school teachers. The researcher and the two teachers then came to agreement on the meaning of criteria and grading values. After the administration of the tests one elementary school teacher were asked to grade 30 randomly selected tests. The researcher found that, the teacher followed the grading criteria on these random tests, giving similar points.

Reliability analyses were performed for the 4^{th} grade Science Achievement Test scores and the 5^{th} grade Science Achievement Test scores. The value of α (alpha) was 0.62 and 0.67, respectively.

3.4.2 Validity and Reliability of Science Attitude Scale

The researcher developed SAS by making use of sources Aşkar (1986), Physics Attitude Scale by Taşlıdere (2002), Pell & Jarvis (2001) and review of the related literature.To establish the face and content validity, two elementary school Turkish lesson teachers checked the fluency of items. One instructor from the department of Measurement and Evaluation at Ankara University checked the appropriateness of the instrument. Suggestions were taken into consideration for the revision of instrument. The adapted version of the instrument was given in Appendix D.

Reliability analyses were performed for the Science Attitude Scale scores. The value of α (alpha) was 0.88 for SAS. This implies that scores obtained on the SAS are reliable.

3.4.3 Validity and Reliability of Teachers' Classroom Activities Scale

The researcher developed TCAS by making use of the new science and curriculum expects from the science teachers (TTKB, 2005) and review of the literature. The demographic data parts, items from 1 to 7 are translated from the 4th grade student questionnaire of TIMMS (2003). To establish the face and content validity, two elementary school Turkish lesson teachers checked the fluency of items. Two elementary school teachers and one instructor from the department of Elementary School Science and Mathematics Education at METU checked the appropriateness of the instrument. Suggestions were taken into consideration for the revision of instrument. The adapted version of the instrument was given in Appendix C.

Reliability analyses were performed for the TCAS (Teachers' Classroom Activities Scale) scores. The value of α (alpha) was 0.90 for the TCAS. This implies that scores obtained on the TCAS are reliable.

3.5 Procedure

The study started with a detailed review of literature. A keyword list was determined. Educational Resources Information Center (ERIC), International Dissertation Abstracts (DAI), Social Science Citation Index (SSCI), Ebscohost, Kluwer Online Databases, Science Direct, and Internet were searched systematically. Moreover, Ebscohost, Science Direct, Kluwer and Internet (Google, Altavista, and Scirus) were searched systematically. For the previous studies made in Turkey were also searched from YÖK, Hacettepe Eğitim Dergisi, and Eğitim ve Bilim. The photocopies of the available documents were obtained from METU library, Hacettepe University Library, Bilkent and Tubitak Ulakbim. The content of previous and new constructed elementary school science curriculum were investigated. All these documents

were read; results of the studies were compared with each other. Next the Science Achievement Tests, the Science Attitude Scale and Teachers' Classroom Activities Scale were developed by the help of findings from the literature.

The participant schools and the subject of the study were determined conveniently. The administration time of the test was decided according to the completion of all science units in the curriculum. Then the revised forms of the tests were given to the total of 302 students from 4^{th} and 5^{th} grades at 25^{th} May 2005.

The teachers who would administer the test were acquainted with the test application procedure. They were warned about the duration of testing and independency of the students responds. In addition, they were talked that it was not allowed to give responds to students' questions.

The SAT, SAS and TCAS were administered to both pilot groups and the control group and the students were informed that the grades from these tests would have no effect on the students' science grades. The time given for SAT was one class hour (40 minutes) and for SAS and TCAS together it was one class hour (40 minutes) and these hours were enough to complete the instruments. The tests and scales were scored and first entered to the computer as an excell document.

3.6 Analysis of Data

The statistical analyses were carried out by using statistical package for the social sciences program (SPSS 10.0). The data obtained in the study were analyzed in the two parts. In the first part, descriptive statistics, and in the second part inferential statistics were used.

CHAPTER 4

RESULTS

This chapter was divided into four sections. First section was missing data analysis, second was descriptive statistics section includes the descriptive studies associated with the data obtained from the implementation of Science Achievement Test, Science Attitude Scale and Teachers' Classroom Activities Scale. The third was inferential statistics section in which data is produced from analyzing the sub problems. The last section concludes the findings of the inferential statistics.

4.1 Missing Data Analysis

In the Science Achievement Test, the missing responses were recorded as incorrect. In the Science Attitude Scale there were 10 subjects did not response to any items. Since the missing data constitutes a range smaller than 5% of the whole data, these ten subjects were excluded from the analysis of SAS. The statistical analysis of SAS scores were done with the sample of 292. In the Teachers' Classroom Activities Test, missing data in the test constitutes a range smaller than 5% of the whole data so they easily replaced with the series mean of the entire subjects. The rest of the data did not include any missing data.

4.2 Descriptive Statistics

The mean, median, mode, standard deviation, skewness, kurtosis, maximum, and minimum values of the variables were presented.

4.2.1 Descriptive Statistics for 4SAT and 5SAT

Descriptive statistics related to the Science Achievement Test Scores of 4th grade (4SAT) and 5th grade students (5SAT) in terms of knowledge and understanding level scores and higher order thinking skills scores for two pilot groups and one control group were given in Table 4.1 and Table 4.2. Basic descriptive statistics related to the three sub-categories of Science Attitude Scale Test Scores and five sub-categories of Teachers' Classroom Activities Scale were given in Table 4.3 and Table 4.4.

4.2.1.1 Basic Descriptive Statistics for 4SAT

Table 4.1 Basic Descriptive Statistics Related to 4SAT

	Pilot Group		Control Group	
	KUL	HOTS	KUL	HOTS
N	102	102	67	67
Mean	50,11	49,75	49,83	50,38
Median	49,54	47,47	47,77	50,75
Mode	41	56	45	50
S.D.	10,12	10,22	9,89	9,72
Skewness	,351	,544	,033	,003
Kurtosis	-,590	-,185	-,573	-,412
Range	47	50	43	42
Minimum	29	31	29	31
Maximum	76	81	71	73

The scores of 4th grade students on 4SAT-KUL part, for the pilot school change from 29 to 76 with higher scores meaning greater achievement and the scores of students on 4SAT for the control group change from 29 to 71.

The mean of the 4SATKUL part is 50.11 for the pilot schools and 49.83 for the control group. There is a mean increase of 0.28 in favor of the pilot group.

The scores of 4th grade students on 4SATHOTS part, for the pilot group change from 31 to 81 with higher scores meaning greater achievement and the scores of students on 4SATHOTS part for the control group change from 31 to 73.

The mean of the 4SATHOTS part is 49.75 for the pilot schools and 50.38 for the control group. There is a mean increase of 0.63 in favor of the control group.

Table 4.1 also presents some other basic descriptive statistics like standard deviation, skewness, kurtosis, range, minimum and maximum values. For the pilot group, the value of skewness for the 4SATKUL was 0.351, and 0.033 for the control group. For the pilot group, the value of kurtosis for the 4SATKUL was -0.590, and -0.573 for the control group.

For the pilot group, the value of skewness for the 4SATHOTS was 0.544, and 0.003 for the control group. For the pilot group, the value of kurtosis for the 4SATHOTS was -0.185, and -0.412 for the control group.

4.2.1.2 Basic Descriptive Statistics for 5SAT

Table 4.2 Basic Descriptive Statistics Related to 5SAT

	Pilot Group		Control Group	
	KUL	HOTS	KUL	HOTS
N	94	94	52	52
Mean	50,60	53,52	48,92	43,64
Median	49,91	53,74	50,70	43,49
Mode	61	59	51	51
S.D.	10,53	9,07	8,96	8,38
Skewness	-,542	-,261	-,754	,259
Kurtosis	-,270	-,301	,817	-,041
Range	44	44	44	38
Minimum	23	30	23	27
Maximum	67	75	67	65

The scores of 5th grade students on 5SATKUL part, for the pilot group change from 23 to 67 with higher scores meaning greater achievement and the scores of students on 5SATKUL part for the control group change from 23 to 67.

The mean of the 5SATKUL part is 50.60 for the pilot group and 48.92 for the control group. There is a mean increase of 1.68 in favor of the pilot group.

The scores of 5th grade students on 5SATHOTS part, for the pilot group change from 30 to 75 with higher scores meaning greater achievement and the scores of students on 5SATHOTS part for the control group change from 27 to 65.

The mean of the 5SATHOTS part is 53.52 for the pilot group and 43.64 for the control group. There is a mean increase of 9.88 in favor of the pilot group.

Other basic descriptive statistics for 5SAT like standard deviation, skewness and kurtosis, range, minimum and maximum values are also mentioned in Table 4.2 for the pilot group, the value of skewness for the 5SATKUL was -0.542, and -0.754 for the control group.

For the pilot group, the value of kurtosis for the 5SATKUL was -0.270, and 0.817 for the control group.

For the pilot group, the value of skewness for the 5SATHOTS was -0.261, and 0.259 for the control group. For the pilot group, the value of kurtosis for the 5SATHOTS was -0.301, and -0.041 for the control group.

The skewness and kurtosis values for the Science Achievement Tests for both 4^{th} and 5^{th} grades in terms of knowledge and understanding part and higher order thinking skills part can be accepted as approximately normal as suggested by Kunnan (as cited in Ağazade, 2001). He stated that the skewness and kurtosis values between -2 and +2 can be assumed as approximately normal.

4.2.2 Descriptive Statistics for SAS

Science Attitude Scale has three sub categories and the students' attitude scores range from 1 to 5 in which higher scores mean more positive attitude towards science, lower scores mean negative attitudes. Table 4.3

showed the descriptive values for the scores of the students on these three sub categories, which were interest, anxiety, and self-efficacy.

Table 4.3 Basic Descriptive Statistics Related to SAS

	Pilot Group			Control Group		
	interest	Anxiety	self-efficacy	interest	anxiety	self-efficacy
N	180	180	180	112	112	112
Mean	4,0938	3,8659	3,8361	3,8105	3,6441	3,4754
Median	4,3333	4,1429	4,0000	3,8889	3,8571	3,5000
Mode	5,00	5,00	5,00	5,00	3,86	4,00
S.D	,8294	1,0365	1,0890	,8711	,8450	1,0419
Skewness	-1,162	-,727	-,705	-,754	-,298	-,256
Kurtosis	1,220	-,464	-,432	,117	-,687	-,679
Range	4,00	4,00	4,00	3,67	3,43	4,00

As Table 4.3 indicated, pilot group shows a mean of 4,0938 while the mean for control group is 3,8105 for the interest category of SAS. There is a mean increase of 0,2833 in favor of the pilot group students' attitudes in terms of interest to the science and technology lesson.

For the anxiety sub category of SAS, the mean of the pilot group is 3,8659 while the mean of the control group is 3,6441. The mean difference between the pilot group and control group is 0.2218 in the favor of the pilot group.

For the self-efficacy sub category of SAS, the mean of the pilot group is 3, 8361 while the mean of the control group is 3, 4754. The mean difference between the pilot group and control group is 0.3607 in the favor of the pilot group.

The skewness values for the pilot group for interest, anxiety and self-efficacy sub categories were -1.162, -0.727 and -0.705 respectively. The skewness values for the control group for interest, anxiety and self-efficacy are -0.754, -0.298 and -0.256 respectively. The kurtosis values for the pilot group for interest, anxiety and self-efficacy sub categories were -1.220, -0.464 and -0.432 respectively. The kurtosis values for the control group for interest, anxiety and self-efficacy sub categories are 0.117, -0.687 and -0.679 respectively. These values of skewness and kurtosis can be accepted as approximately normal.

4.2.3 Descriptive Statistics for TCAS

Table 4.4 Basic Descriptive Statistics Related to TCAS

		CANATCAS	COTTCAS	EUTCAS	CCATCAS	PSTCAS
Pilot Group	N	185	185	185	185	185
	Mean	4,2616	4,5649	4,4694	3,3174	4,4378
	Median	4,4000	4,7000	4,6667	3,2857	4,5000
	S.D.	,6013	,4797	,5628	,7990	,5712
	Skewness	-1,290	-1,317	-1,197	,046	-1,329
	Kurtosis	2,356	1,573	1,229	-,684	2,076
	Range	3,53	2,10	2,50	3,57	3,00
Control Group	N	117	117	117	117	117
	Mean	3,4695	4,3692	3,8647	3,4310	4,1410
	Median	3,6000	4,5000	4,0000	3,4286	4,2500
	S.D.	,9500	,6106	,7887	,7454	,7510
	Skewness	-,561	-1,477	-,551	-,181	-,801
	Kurtosis	-,249	2,091	-,247	-,534	,002
	Range	3,80	2,80	3,33	3,29	3,25

TCAS has five sub categories and the students' TCAS scores range from 1 to 5 in which higher scores mean higher frequency of the classroom activities and lower scores mean lower frequency of the classroom activities. Table 4.4 gives the descriptive values for these five sub categories which are Classroom Activities of the New Approach category (CANATCAS), Care of Teacher category (COTTCAS), Equipment Use category (EUTCAS), Classical Classroom Activities category (CCATCAS), Processing the Subject category (PSTCAS).

As Table 4.4 indicates, pilot group shows a mean of 4,2616 while the mean for control group is 3,4695 for the CANATCAS category. There is a mean increase of 0.7921 in favor of the pilot group students' scores in terms of teacher's classroom activities of the new approach in science and technology lesson.

For the COTTCAS sub category, the mean of the pilot group is 4,5649 while the mean of the control group is 4,3692. The mean difference between the pilot group and control group is 0.1957 in the favor of the pilot group.

For the EUTCAS sub category, the mean of the pilot group is 4,4694 while the mean of the control group is 3,8647. The mean difference between the pilot group and control group is 0.6047 in the favor of the pilot group.

For the CCATCAS sub category, the mean of the pilot group is 3,3174 while the mean of the control group is 3,4310. The mean difference between the pilot group and control group is 0.1136 in the favor of the pilot group.

For the PSTCAS sub category, the mean of the pilot group is 4,4378 while the mean of the control group is 4,1410. The mean difference between the pilot group and control group is 0.2968 in the favor of the pilot group.

The skewness values for the pilot group for CANATCAS, COTTCAS, EUTCAS, CCATCAS and PSTCAS sub categories are -1.290, -1.317, -1,197, 046 and -1,329 respectively. The skewness values for the control group for these five sub categories are -0.561, -1,477, -0.551, -0.181 and -0.801 respectively. The kurtosis values for the pilot group for these five sub categories are 2.356, 1.573, 1.229, -0.684, 2.076 respectively. The kurtosis values for the control group for these five sub categories are -0.249, 2,091, -0.247, -0.534 and 0.002 respectively. Except the skewness values of

CANATCAS, PSTCAS for the control group and the kurtosis value of COTTCAS for the control group, these values of skewness and kurtosis can be accepted as approximately normal.

4.3 Inferential Statistics

In order to test the hypotheses, statistical technique named multivariate analysis of variance (MANOVA) was used to investigate the relationship between a set of interrelated dependent variables and three grouping variables. While conducting the analysis the probability of rejecting true null hypothesis (probability of making Type 1-error) was set to 0.05 mostly used value in educational studies.

4.3.1 4th Grade Science Achievement Test

A one way MANOVA test was used in this study to see the mean difference of 4th grade students' knowledge and understanding level outcomes and higher order thinking skills outcomes in the science achievement test with respect to the new elementary science and technology curriculum versus traditional science curriculum.

4.3.1.1 The Assumptions of MANOVA

The assumptions of MANOVA are multivariate normality, equality of variances and independency of observations (Stevens, 2002).

As seen from Table 4.1 (Basic descriptive Statistics Related to 4SAT), skewness and kurtosis values of the 4SATKUL and 4SATHOTS were in approximately acceptable range in order to verify the univariate normality. Therefore, it was assumed that data have multivariate normality in the score distribution.

The second assumption of MANOVA is the homogeneity of variance covariance matrices, that is, the variance covariance matrices are equal across groups. The statistical procedure that was used to examine this assumption was Box's test. As seen from Table 4.5, the result indicated that p>.05 (p= .444), so the assumption was met.

Table 4.5 Box's Test of Equality of Covariance Matrices of 4SAT

Box's M	5,920
F	,969
df1	6
df2	459452
Sig.	,444

As seen from Table 4.6, Levene's Test of Equality of Error Variances was used to determine the equality of variance assumption. The error variances for both the 4SATKUL and 4SATHOTS dependent variables across groups were equal.

Table 4.6 Levene's Test of Equality of Error Variances of 4SAT

	F	*df1*	*df2*	*Sig.*
4SATLOTS	,192	2	166	,826
4SATHOTS	,525	2	166	,593

The other assumption is each one of the students responded tests without being affected by others. When conducting the study, the researcher made sure that each student responded the achievement test separately.

4.3.1.2 Multivariate Analysis of Variance Model for 4SAT

The dependent variables of the study were 4SATKUL scores and 4SATHOTS scores of 4th grade students from Science Achievement Test. Table 4.7 presented the results of MANOVA. As seen from the table, School type (SCHOOL) explained 0.2 % variance of model for the dependent variables of the 4SATKUL and 4SATHOTS.

4.7 Multivariate Tests of 4SAT

Effect	Wilks' Lambda	F	Hypothesis df	Error df	Sig.	Eta Squared	Observed Power
SCHOOL	,995	,189	4,000	330,000	,944	,002	,090

Null Hypothesis:

There is no significant difference in the mean science achievement scores of 4th grade students across new science and technology curriculum and

traditional science curriculum in the knowledge and understanding level outcomes and higher order thinking skills outcomes.

As Table 4.7 indicates, the first null hypothesis was not rejected which means that there were no significant differences among teaching science with the new science and technology curriculum versus traditional science curriculum in terms of 4th grade students' science achievement scores on the common dependent variables of the 4SATKUL and 4SATHOTS: $F(4, 330) = .189$, $\lambda = 0.995$, $p = .994$.

4.3.2 5th Grade Science Achievement Test

A one way MANOVA test was used in this study to see the mean effect of 5th grade students' knowledge level outcomes in the science achievement test with respect to the new science curriculum versus the traditional science curriculum.

4.3.2.1 The assumptions of MANOVA

As seen from Table 4.2 (Basic Descriptive Statistics Related to 5SAT), skewness and kurtosis, values of the 5SATKUL and 5SATHOTS were in approximately acceptable range in order to verify the univariate normality. Therefore, it was assumed that data have multivariate normality in the score distribution.

The second assumption of MANOVA is the homogeneity of variance covariance matrices, that is, the variance covariance matrices are equal across groups. The statistical procedure that was used to examine this assumption

was Box's test. As shown in Table 4.8, the result indicated that p>.05 (p= .065), so the assumption was met.

Table 4.8 Box's Test of Equality of Covariance Matrices of 5SAT

Box's M	12,121
F	1,977
df1	6
df2	217533
Sig.	,065

As seen from Table 4.9, Levene's Test of Equality of Error Variances was used to determine the equality of variance assumption. The error variance for the dependent variables 5SATKUL was not equal while it was equal for 5SATHOTS.

Table 4.9 Levene's Test of Equality of Error Variances of 5SAT

	F	df1	df2	Sig.
5SATLOTS	3,075	2	143	,049
5SATHOTS	3,040	2	143	,051

The other assumption is each one of the students responded tests without affected by others. When conducting the study, the researcher made sure that each student responded the achievement test separately.

4.3.2.2 Multivariate Analysis of Variance Model for 5SAT

The dependent variables of the study were 5SATKUL scores and 5SATHOTS scores of 5th grade students from Science Achievement Test. Table 4.10 presents the results of MANOVA. As seen from the table, School type (SCHOOL) explains 13.7 % variance of model for the collective dependent variables of the 5SATKUL and 5SATHOTS.

Table 4.10 Multivariate Tests of 5SAT

Effect	Wilks' Lambda	F	Hypothesis df	Error df	Sig.	Eta Squared	Observed Power
SCHOOL	,744	11,304	4,000	284,000	,000	,137	1,000

Null Hypothesis:

There is a significant difference in the mean science achievement scores of 5th grade students across new science and technology curriculum and traditional science curriculum in the knowledge and understanding level outcomes and higher order thinking skills outcomes.

As Table 4.10 indicates, the null hypothesis was rejected which means that there was significant difference among teaching science with new science and technology curriculum versus traditional science curriculum in terms of 5th grade students' science achievement test scores on the common dependent variables of the 5SATKUL and 5SATHOTS: $F(4, 284) = 11.34$, $\lambda = 0.744$, $p = .00$.

In order to find the effect of independent variable SCHOOL on each dependent variable, tests of between subjects effects were used.

Table 4.11 Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Eta Squared	Observed Power
SCHOOL	KUL	128,999	2	64,500	,642	,528	,009	,156
	HOTS	3379,101	2	1689,551	21,725	,000	,233	1,000

As shown in Table 4.11, the new science and technology curriculum was not effective on the 5th grade students' knowledge and understanding level learning outcomes: (F (2, 143) = .642, p= .528).

However in the case of higher order thinking skills level outcomes, the new science and technology curriculum was effective on the 5th grade students' higher order thinking skills (F (2, 143) = 21.725, p= .00).

Additionally, a post-hoc (Bonferroni) test was used to conduct multiple comparisons between the groups on the dependent variable HOTS. As seen from Table 4.12, there was a significant difference in the mean scores of Pilot Groups (Pilot Group 1, Pilot Group 2) and Control Group on the dependent variable of 5SATHOTS.

Table 4.12 Multiple Comparisons for HOTS

Dependent Variable		(I) Group	(J) Group	Mean Difference (I-J)	S.D.	p
HOTS	Bonferroni	PG1	PG2	2,29	1,87	,668
			CG	10,75*	1,68	,000
		PG2	PG1	-2,29	1,87	,668
			CG	8,46*	1,91	,000
		CG	PG1	-10,75*	1,68	,000
			PG2	-8,46*	1,91	,000

*The mean difference is significant at the, 05 level.

Table 4.13 indicated the estimated marginal means of the groups in terms of dependent variables. With the observation of the estimated marginal means, it was concluded that this difference on the students' 5SATHOTS scores was in the favor of Pilot Groups. The students in Pilot Group1 (Mean = 54,294, SD=1,316) had significantly higher means of 5SATHOTS scores than the students in the Control Group (Mean = 43,644, SD=1,223).

Table 4.13 Estimated Marginal Means of 5SAT

Dependent Variable	SCHOOL	Mean	S.D.
KUL	Pilot Group 1	51,076	1,316
	Pilot Group 2	49,827	1,671
	Control Group	48,919	1,390
HOTS	Pilot Group 1	54,394	1,158
	Pilot Group 2	52,102	1,470
	Control Group	43,644	1,223

As a result, the new science and technology curriculum was effective on increasing the 5th grade students' science achievement test scores in terms of higher order thinking skills outcomes.

4.3.3 Science Attitude Scale

A one way MANOVA test was used in this study to see the mean difference of the students' attitude scale score with respect to the new science and technology curriculum versus the traditional science curriculum.

4.3.3.1 The Assumptions of MANOVA

As seen from Table 4.3 (Basic Descriptive Statistics Related to SAS), skewness and kurtosis values of the interest, anxiety and self-efficacy were in approximately acceptable range in order to verify the univariate normality assumption for this study. Therefore, it was assumed that data have multivariate normality in the score distribution.

The second assumption of MANOVA is the homogeneity of variance covariance matrices, that is, the variance covariance matrices are equal across groups. The statistical procedure that was used to examine this assumption was Box's test. The result indicated that $p<.05$ ($p= .014$), so this assumption was not validated. It is very unlikely that the equal covariance matrices assumption would ever literally be satisfied in practice (Stevens, 2002).

Table 4.14 Box's Test of Equality of Covariance Matrices of SAS

Box's M	25,495
F	2,092
df1	12
df2	363334
Sig.	,014

From Table 4.15, Levene's Test of Equality of Error Variances was used to determine the equality of variance assumption. The error variance for the dependent variable interest and self-efficacy was equal, while it was not equal for anxiety.

Table 4.15 Levene's Test of Equality of Error Variances of SAS

	F	df1	df2	Sig.
Interest	,520	2	289	,595
Anxiety	6,036	2	289	,003
Self-efficacy	2,832	2	289	,061

The other assumption is each one of the students responded tests without being affected by others. When conducting the study, the researcher made sure that each student responded the achievement test separately.

4.3.3.2 Multivariate Analysis of Variance Model for SAS

The dependent variables of the study were Interest scores, Anxiety scores, and Self-efficacy scores of the students from Science Attitude Scale. Table 4.16 presents the results of MANOVA.

Table 4.16 Multivariate Tests of SAS

Effect	Wilks' Lambda	F	Hypothesis df	Error df	Sig.	Eta Squared	Observed Power
SCHOOL	,932	3,437	6,000	574,000	,002	,035	,945

Null Hypothesis:

There was a significant difference in the mean scores of students across new science and technology curriculum and traditional curriculum in the attitude towards science.

As Table 4.16 indicated, the null hypothesis was rejected which means that there was significant difference among teaching science with new science and technology curriculum versus traditional science curriculum in terms of the students' attitudes towards science on the common dependent variables of the interest, anxiety and self-efficacy: $F(6, 574) = 3.437$, $\lambda= 932$, $p= .002$. As seen from the table, SCHOOL explains 3.5 % variance of model for the dependent variables of interest, anxiety, and self-efficacy.

In order to find the effect of independent variable SCHOOL on each dependent variables interest, anxiety, self-efficacy, tests of between-subjects effects test was run. For multiple comparisons between groups, post-hoc tests were used.

i. Dependent Variable Interest

Table 4.17 showed the results of tests of between-subjects effects for interest category.

Table 4.17 Tests of Between-Subjects Effects for Interest

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Eta Squared	Observed Power
SCHOOL	interest	9,230	2	4,615	6,549	,002	,043	,907

As shown in Table 4.17, the new science and technology curriculum was significantly effective on the students' science attitude scale scores in terms of interest: (F (2, 289) = 6.549, p= .002).

As observed from Table 4.15, error variances of interest variable were equal. Therefore, a post-hoc (Bonferroni) test was used to conduct multiple comparisons between the groups. Table 4.18 showed the multiple comparisons of interest scores.

Table 4.18 Multiple Comparisons for Interest

Dependent Variable		(I) Group	(J) Group	Mean Difference (I-J	S.D.	p
interest	Bonferroni	PG1	PG2	,2868	,1253	,069
			CG	,4187*	,1171	,001
		PG2	PG1	-,2868	,1253	,069
			CG	,1320	,1208	,826
		CG	PG1	-,4187*	,1171	,001
			PG2	-,1320	,1208	,826

*The mean difference is significant at the, 05 level.

The results of post-hoc test indicated that, there was significant difference in the mean scores of Pilot Group 1 and Control Group. On the other hand, the mean scores of the interest variable of the students in Pilot Group 2 were not significantly different from the mean scores of the students in the Control Group.

Table 4.19 indicated the estimated marginal means of the groups in terms of dependent variable Interest.

Table 4.19 Estimated Marginal Means of Interest

Dependent Variable	SCHOOL	Mean	S.D.
interest	Pilot Group 1	4,229	,086
	Pilot Group 2	3,942	,091
	Control Group	3,811	,079

With the observation of the estimated marginal means, it was concluded that this difference on the students' interest scores was in the favor of Pilot Group 1. The students in Pilot Group 1 (Mean = 4,229, SD=.086) had significantly higher means of interest scores than the students in the Control Group (Mean = 43,644, SD=1,223).

Although the mean scores of the interest variable of the students in Pilot Group 2 were not significantly different from the mean scores of the students in the Control Group, they were slightly higher in the favor of Pilot Group 2.

As a result, the new science and technology curriculum was effective on increasing the students' personal interests towards science lesson.

ii. Dependent Variable Anxiety

Table 4.20 showed the results of tests of between-subjects effects, in order to find the effect of Independent Variable SCHOOL on the dependent variable Anxiety.

Table 4.20 Tests of Between-Subjects Effects for Anxiety

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Eta Squared	Observed Power
SCHOOL	anxiety	4,496	2	2,248	2,402	,092	,016	,483

As shown in Table 4.20, the new science and technology curriculum was not significantly effective on the students' science attitude scale scores in terms of anxiety: (F (2, 289) = 2,402, p= .092). That is, new science curriculum was not effective on the students' anxious feelings and emotions towards science and technology lesson.

iii. Dependent Variable Self-efficacy

Table 4.21 showed the results of tests of between-subjects effects, in order to find the effect of Independent Variable SCHOOL on the dependent variable Self-efficacy.

Table 4.21 Tests of Between-Subjects Effects for Self-Efficacy

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Eta Squared	Observed Power
SCHOOL	self-efficacy	11,837	2	5,918	5,184	,006	,035	,826

As shown in Table 4.21, the new science and technology curriculum was significantly effective on the students' science attitude scale scores in terms of self-efficacy: (F (2, 289) = 5,184, p= .006).

As observed from Table 4.15, error variances of self-efficacy variable were equal. Therefore, a post-hoc (Bonferroni) test was used to conduct multiple comparisons between the groups. Table 4.22 showed the multiple comparisons of self-efficacy scores.

Table 4.22 Multiple Comparisons for Self-Efficacy

Dependent Variable		(I) Group	(J) Group	Mean Difference (I-J	S.D.	p
self-efficacy	Bonferroni	PG1	PG2	,2523	,1595	,344
			CG	,4798*	,1490	,004
		PG2	PG1	-,2523	,1595	,344
			CG	,2275	,1537	,420
		CG	PG1	-,4798*	,1490	,004
			PG2	-,2275	,1537	,420

*The mean difference is significant at the, 05 level.

Based on the result of the data observed from the post-hoc (Bonferroni) test, there was significant difference in the mean scores of the students of Pilot

Group 1 and the Control Group in the dependent variable of Self-efficacy. On the other hand, the mean scores of the students in Pilot Group 2 were not significantly different from the Control Group for the common variable.

Table 4.23 indicated the estimated marginal means of the groups in terms of dependent variable Self-efficacy.

Table 4.23 Estimated Marginal Means of Self-Efficacy

Dependent Variable	SCHOOL	Mean	S.D.
self-efficacy	Pilot Group 1	3,955	,110
	Pilot Group 2	3,703	,116
	Control Group	3,475	,101

With the observation of the estimated marginal means, it was concluded that this difference on the students' self-efficacy scores was in the favor of Pilot Group 1. The students in Pilot Group1 (Mean = 3,955 SD=.110) had significantly higher means of self-efficacy scores than the students in the Control Group (Mean = 3,475, SD=.101).

Although the mean scores of the Self-efficacy variable of the students in Pilot Group 2 were not significantly different from the mean scores of the students in the Control Group, they were slightly higher in the favor of Pilot Group 2.

As a result, the new science and technology curriculum was effective on increasing the students' believes in capabilities to manage the requirements of science lesson on their own.

4.3.4 Teachers' Classroom Activities Scale

A one way MANOVA test was used in this study to observe the mean difference of the students' answers for Classroom Activities of the New Approach (CANATCAS), Care of Teacher (COTTCAS), Equipment Use (EUTCAS), Classical Classroom Activities (CCATCAS), Processing the Subject (PSTCAS) scores in the Teachers' Classroom Activities Scale with respect to the new science and technology curriculum versus traditional science curriculum.

4.3.4.1 The Assumptions of MANOVA

As seen from Table 4.4 (Basic Descriptive Statistics Related to TCAS), the basic descriptive statistics of some variables show deviations from the normality. Since according to Stevens (1996), the MANOVA test is robust to violations of multivariate normality, the researcher concludes that the presence of this small violation in the normality would not have much effect on the accuracy of the analysis.

The second assumption of MANOVA is the homogeneity of variance covariance matrices, that is, the variance covariance matrices are equal across groups. The statistical procedure that was used to examine this assumption was Box's test. The result indicated that $p<.05$ ($p= .00$), so this assumption was not validated.

Table 4.24 Box's Test of Equality of Covariance Matrices of TCAS

Box's M	175,542
F	5,709
df1	30
df2	257974
Sig.	,000

As seen from table 4.25, Levene's Test of Equality of Error Variances was used to determine the equality of variance assumption. The error variance for the dependent variable CCATCAS was equal, while it was not equal for the other four dependent variables, CANATCAS, COTTCAS, EUTCAS and PSTCAS.

Table 4.25 Levene's Test of Equality of Error Variances of TCAS

	F	df1	df2	Sig.
CANATCAS	17,818	2	299	,000
COTTCAS	5,080	2	299	,007
EUTCAS	21,901	2	299	,000
CCATCAS	1,913	2	299	,149
PSTCAS	8,629	2	299	,000

The other assumption is each one of the students' responded tests without being affected by others. When conducting the study, the researcher made sure that each student responded the achievement test separately.

4.3.4.2 Multivariate Analysis of Variance Model for TCAS

The dependent variables of the study was CANATCAS scores, COTTCAS scores, EUTCAS scores, CCATCAS scores and PSTCAS scores of the students from Teachers' Classroom Activities Scale. Table 4.26 presents the results of MANOVA.

Table 4.26 Multivariate Tests of TCAS

Effect	Wilks' Lambda	F	Hypothesis df	Error df	Sig.	Eta Squared	Observed Power
SCHOOL	,615	16,215	10,000	590,000	,000	,216	1,000

Null Hypothesis:

There is a significant difference in the mean scores of students across new science and technology curriculum and traditional curriculum in the teacher's classroom activities scale.

As Table 4.26 indicates, the null hypothesis was rejected which means that there were significant differences among teaching science with new curriculum versus traditional curriculum in terms of the students' TCAS scores on the common dependent variables: $F(10, 590) = 16.215$, $\lambda = .615$, $p = .00$. As seen from the table, School type (SCHOOL) explains 21.6 % variance of model for the dependent variables.

In order to determine the effect of independent variable SCHOOL on each dependent variables, CANATCAS, COTTCAS, EUTCAS, CCATCAS and PSTCAS, tests of between-subjects effects test were run. Additionally, post-hoc tests were used for the multiple comparisons of the dependent variables for each group.

i. Dependent Variable CANATCAS

Table 4.27 showed the results of tests of between-subjects effects for CANATCAS (Classroom Activities of the New Approach) category.

Table 4.27 Tests of Between-Subjects Effects for CANATCAS

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Eta Squared	Observed Power
SCHOOL	CANATCAS	50,997	2	25,498	46,148	,000	,236	1,000

As shown in Table 4.27, the new science and technology curriculum was significantly effective on the mean scores of students' Teachers' Classroom Activities Scale on the Classroom Activities of the New Approach (CANATCAS) dependent variable : (F (2, 299) = 46.148, p= .000).

As observed from Table 4.25, error variances of CANATCAS variable were not equal. Therefore, a post-hoc (Dunnet-C) test was used to conduct multiple comparisons between the groups. Table 4.28 showed the multiple comparisons of CANATCAS scores for each group.

Table 4.28 Multiple Comparisons for CANATCAS

Dependent Variable		(I) Group	(J) Group	Mean Difference (I-J)	S.D.
CANATCAS	Dunnett C	PG1	PG2	,3613*	,1094
			CG	,9659*	,1024
		PG2	PG1	-,3613*	,1094
			CG	,6046*	,1046
		CG	PG1	-,9659*	,1024
			PG2	-,6046*	,1046

Post-hoc test resulted that, there was a significant difference in the mean scores of Pilot Groups (Pilot Group 1, Pilot Group 2) and Control Group on the dependent variable of CANATCAS with a value of .9659 and, .6046, respectively.

Table 4.29 indicated the estimated marginal means of the groups in terms of dependent variable CANATCAS.

Table 4.29 Estimated Marginal Means of CANATCAS

Dependent Variable	SCHOOL	Mean	S.D.
CANATCAS	Pilot Group 1	4,435	,076
	Pilot Group 2	4,274	,079
	Control Group	3,470	,069

With the observation of the estimated marginal means, it was concluded that the difference on the students' CANATCAS scores was in the

favor of Pilot Groups. The students in Pilot Group1 (Mean = 4,435, SD=.076) and in Pilot Group 2 (Mean = 4,274, SD = 4,274) had significantly higher means of CANATCAS scores than the students in the Control Group (Mean = 3,470, SD=.069).

As a result, the classroom activities stipulated by the new curriculum were carried out more frequently in the pilot groups than the control group.

ii. Dependent Variable COTTCAS

Table 4.30 showed the results of tests of between-subjects effects for COTTCAS (Care of Teacher) category.

Table 4.30 Tests of Between-Subjects Effects for COTTCAS

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Eta Squared	Observed Power
SCHOOL	COTTCAS	6,971	2	3,485	12,808	,000	,079	,997

As shown in Table 4.30, the new science and technology curriculum was significantly effective on the mean scores of students' Teachers' Classroom Activities Scale on the Care of Teacher (COTTCAS) dependent variable : (F (2, 299) = 12.808, p= .000).

As observed from Table 4.25, error variances of COTTCAS variable were not equal. Therefore, a post-hoc (Dunnet-C) test was used to conduct

multiple comparisons between the groups. Table 4.31 showed the multiple comparisons of COTTCASS scores for each group.

Table 4.31 Multiple Comparisons for COTTCAS

Dependent Variable		(I) Group	(J) Group	Mean Difference (I-J)	S.D.
COTTCAS	Dunnett C	PG1	PG2	,3026*	7,676E-02
			CG	,3412*	7,184E-02
		PG2	PG1	-,3026*	7,676E-02
			CG	3,863E-02	7,337E-02
		CG	PG1	-,3412*	7,184E-02
			PG2	-3,8634E-02	7,337E-02

Post-hoc test resulted that, there was significant difference in the mean scores of Pilot Group 1 and Control Group on the dependent variable of COTTCAS with a value of .3412. However, there was no significant difference in the mean scores of Pilot Group 2 and Control Group in the common dependent variable.

Table 4.32 indicated the estimated marginal means of the groups in terms of dependent variable COTTCAS.

Table 4.32 Estimated Marginal Means of COTTCAS

Dependent Variable	Group	Mean	S.D.
COTTCAS	Pilot Group 1	4,710	,053
	Pilot Group 2	4,408	,055
	Control Group	4,369	,048

With the observation of the estimated marginal means, it was concluded that the difference on the students' COTTCAS scores was in the favor of Pilot Groups. The students in Pilot Group1 (Mean = 4,710, SD=.053) and in Pilot Group 2 (Mean = 4,408, SD = .055) had significantly higher means of COTTCAS scores than the students in the Control Group (Mean = 4,369, SD=.048).

As a result, the personal relationship and care of the science teacher for the each student personally were more frequent in the classes of Pilot groups.

iii. Dependent Variable EUTCAS

Table 4.33 showed the results of tests of between-subjects effects for EUTCAS (Equipment Use) category.

Table 4.33 Tests of Between-Subjects Effects for EUTCAS

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Eta Squared	Observed Power
SCHOOL	EUTCAS	34,532	2	17,266	42,278	,000	,220	1,000

As seen from Table 4.33, the new science and technology curriculum was significantly effective on the mean scores of students' Teachers' Classroom Activities Scale on the Equipment Use (EUTCAS) dependent variable : (F (2, 299) = 42.278, p= .000).

As observed from Table 4.25, error variances of EUTCAS variable were not equal. Therefore, a post-hoc (Dunnet-C) test was used to conduct multiple comparisons between the groups. Table 4.34 showed the multiple comparisons of EUTCAS scores for each group.

4.34 Multiple Comparisons for EUTCAS

Dependent Variable		(I) Group	(J) Group	Mean Difference (I-J)
EUTCAS	Dunnett C	PG1	PG2	,4245*
			CG	,8089*
		PG2	PG1	-,4245*
			CG	,3844*
		CG	PG1	-,8089*
			PG2	-,3844*

Post-hoc test results showed that, there was significant difference in the mean scores of Pilot Groups (Pilot Group 1, Pilot Group 2) and Control Group on the dependent variable of EUTCAS with a value of .8089 and, .3844 respectively.

The results also indicated that, there was significant difference in the mean scores of Pilot Groups (Pilot Group 1, Pilot Group 2) and Control Group in the dependent variable of EUTCAS with a value of .8089 and, .3844 respectively.

Table 4.35 showed the estimated marginal means of the groups in terms of dependent variable EUTCAS.

Table 4.35 Estimated Marginal Means of EUTCAS

Dependent Variable	Group	Mean	S.D.
EUTCAS	Pilot Group 1	4,674	,065
	Pilot Group 2	4,249	,068
	Control Group	3,865	,059

From the estimated marginal means, it was concluded that the difference on the students' EUTCAS scores was in the favor of Pilot Groups. The students in Pilot Group1 (Mean = 4,674, SD=.065) and in Pilot Group 2 (Mean = 4,249, SD = .068) had significantly higher means of EUTCAS scores than the students in the Control Group (Mean = 3,865, SD=.059).

As a result, the equipment use of the science teachers in science lessons was more frequent in pilot groups than control group.

iv. Dependent Variable CCATCAS

Table 4.36 showed the results of tests of between-subjects effects for CCATCAS category.

Table 4.36 Tests of Between-Subjects Effects for CCATCAS

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Eta Squared	Observed Power
SCHOOL	CCATCAS	9,997	2	4,998	8,646	,000	,055	,968

As seen from Table 4.36, the new science and technology curriculum was significantly effective on the mean scores of students' Teachers' Classroom Activities Scale on the Classical Classroom Activities (CCATCAS) dependent variable : (F (2, 299) = 8.646, p= .000).

As observed from Table 4.25, error variances of CCATCAS variable were equal. Therefore, a post-hoc (Bonferroni) test was used to conduct multiple comparisons between the groups. Table 4.37 showed the multiple comparisons of CCATCAS scores for each group.

4.37 Multiple Comparisons for CCATCAS

Dependent Variable		(I) Group	(J) Group	Mean Difference (I-J)	S.D.	p
CCATCAS	Bonferroni	PG1	PG2	-,4432*	,1119	,000
			CG	-,3268*	,1047	,006
		PG2	PG1	,4432*	,1119	,000
			CG	,1163	,1069	,833
		CG	PG1	,3268*	,1047	,006
			PG2	-,1163	,1069	,833

Post-hoc test results showed that, there was significant difference in the mean scores of Pilot Group 1 and Control Group on the dependent variable CCATCAS. On the other hand, there was no significant difference in the mean scores of Pilot Group 2 and Control Group in the dependent variable of CCATCAS.

Table 4.38 showed the estimated marginal means of the groups in terms of dependent variable CCATCAS

Table 4.38 Estimated Marginal Means of CCATCAS

Dependent Variable	Group	Mean	S.D.
CCATCAS	Pilot Group 1	3,104	,078
	Pilot Group 2	3,547	,081
	Control Group	3,431	,070

Estimated marginal means showed that, the mean difference on the students' CCATCAS between Pilot Gorup 1 (Mean = 3,104, SD = .78) and the Control Group (Mean = 3,431, SD = .70) was in the favor of Control Group.

As a result, the traditional classroom activities were more frequent in the Control Group than the Pilot Group 1. However, the teachers in the Pilot Group 2 showed tendency to use these traditional activities.

v. Dependent Variable PSTCAS

Table 4.39 showed the results of tests of between-subjects effects for PSTCAS category.

Table 4.39 Tests of Between-Subjects Effects for PSTCAS

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Eta Squared	Observed Power
SCHOOL	PSTCAS	6,848	2	3,424	8,196	,000	,052	,959

As seen from Table 4.39, the new science and technology curriculum was significantly effective on the mean scores of students' Teachers' Classroom Activities Scale on the Performing New Subject (PSTCAS) dependent variable : (F (2, 299) = 8.196, p= .000).

As observed from Table 4.25, error variances of PSTCAS variable were not equal. Therefore, a post-hoc (Dunnet C) test was used to conduct multiple comparisons between the groups. Table 4.40 showed the multiple comparisons of PSTCAS scores for each group.

Table 4.40 Multiple Comparisons for PSTCAS

Dependent Variable		(I) Group	(J) Group	Mean Difference (I-J)	S.D.
PSTCAS	Dunnett C	PG1	PG2	,1076	,951
			CG	,3486*	,890
		PG2	PG1	-,1076	,511
			CG	,2410*	,091
		CG	PG1	-,3486*	,901
			PG2	-,2410*	,091

Post-hoc test resulted that, there was significant difference in the mean scores of Pilot Groups (Pilot Group 1, Pilot Group 2) and Control Group on the dependent variable of PSTCAS with a value of .3486 and, .2410 respectively.

Table 4.41 showed the estimated marginal means of the groups in terms of dependent variable PSTCAS.

Table 4.41 Estimated Marginal Means of PSTCAS

Dependent Variable	Group	Mean	S.D.
PSTCAS	Pilot Group 1	4,490	,066
	Pilot Group 2	4,382	,069
	Control Group	4,141	,060

With the observation of the estimated marginal means, it was concluded that the difference on the students' PSTCAS scores was in the favor of Pilot Groups. The students in Pilot Group 1 (Mean = 4,490, SD=.066) and in Pilot Group 2 (Mean = 4,382, SD = .069) had significantly higher means of PSTCAS scores than the students in the Control Group (Mean = 4,141, SD=.060).

As a result, pilot group teachers showed tendency to use the methods required by the new curriculum while beginning the new subject than the teachers of control group.

4.4 Summary of the Results

In this part, overall findings of the inferential statistics are gained for four instruments of the study 4th Grade Science Achievement Test, 5th Grade Science Achievement Test, Science Attitude Scale and Teachers' Classroom Activities Scale.

4.4.1 Results of 4th Grade Science Achievement Test

There were no significant differences among teaching science with the new science and technology curriculum versus traditional science curriculum in terms of 4th grade students' science achievement test scores on the common dependent variables: knowledge and understanding level learnimg outcomes and higher order thinking skills.

4.4.2 Results of 5th Grade Science Achievement Test

The new science and technology curriculum was not effective on the 5th grade students' knowledge and understanding level learning outcomes.

The new science and technology curriculum was effective on increasing the 5th grade students' higher order thinking skills.

4.4.3 Results of Science Attitude Scale

The new science and technology curriculum:

A) was effective on increasing the students' personal interests towards science lesson.

B) was not effective on the students' anxious feelings and emotions towards science and technology lesson.

C) was effective on increasing the students' believes in capabilities to manage the requirements of science lesson on their own.

4.4.4 Results of Teachers' Classroom Activities Scale

A) Classroom activities requiered by the new science and technology curriculum were carried out more frequently in the pilot groups than the control group.

B) Personal relationships between teacher and students are stronger in pilot groups.

C) Equipment use in science lessons is more frequent in pilot groups than control group.

D) Traditional classroom activities were more frequent in the Control Group than the Pilot Group 1. However, the teachers in the Pilot Group 2 still showed tendency to use traditional activities.

E) Teachers in pilot groups use the methods required by the new curriculum more frequently while beginning the new subject than the teachers of control group.

CHAPTER 5

CONCLUSIONS, DISCUSSIONS, AND IMPLICATIONS

This chapter consists of six sections. First section presents the summary of the research study, while the second section presents the conclusions and discussions based on the result. The third and fourth sections deal with the internal and external validities respectively. Implications of the study are explained in fifth section. Recommendations for further studies are given in the last section.

5.1 Summary of the Research Study

This study investigated the effects of the new science and technology curriculum on the 4th and 5th grade students' science achievement scores in terms of knowledge and understanding level learning outcomes and higher order thinking skills. In addition, students' attitudes toward science and the activities of science teachers in the classroom were examined. In this manner 4th graders were administered the Science Achievement Test for 4th grade (4SAT) and 5th graders were administered the Science Achievement Test for 5th grade (5SAT). Furthermore, the Science Attitude Scale (SAS) and Teachers' Classroom Activities Scale (TCAS) were administered. SAS and TCAS were used for both 4th and 5th grade students together. These instruments were used as post-tests. The sampling method was convenience sampling and thedesign of the study was the static group comparison design.

Since pre-test method was not used, the subjects' characteristics were considered and the schools of close region were preferred. Chi-square test was used to check if the subject characteristics showed any difference between groups. The results of chi-square test showed no significant difference among the subjects' characteristics in terms of gender, attendance, science study hours and socio economic status.

5.2 Conclusions and Discussions

Concerning about the need for curriculum development activities The Ministry of National Education performed the new science curriculum and implemented in 2004-2005 education terms in 120 pilot schools in 9 cities and 25 pilot schools in Ankara. The new curriculum was concentrated on constructivist approach, student-centered education, multiple intelligence theory, and sensitivity to individual differences. There are several studies (Bulut, 2006; Gömleksiz, 2005; Gözütok, Akgün & Karacaoğlu, 2005; Aykaç ve Başar, 2005; Yaşar, Gültekin, Türkan, Yıldız ve Girmen, 2005) on the effectiveness of the new curriculum. These previous studies determine the strong and weak sides of the new curriculum.

An achievement test 4SAT was administered to 4^{th} graders to observe if the new science and technology curriculum made any difference on the students' knowledge and understanding level learning outcomes and higher order thinking skills with respect to traditional science curriculum.The results of the MANOVA for 4SAT suggested no significant difference in the mean achievement scores of 4^{th} grade students across new science and technology curriculum and traditional curriculum on both knowledge and understanding level learning outcomes and higher order thinking skills. Increasing the students' scientific process skills and critical thinking abilities were some of

the priorities of the new curriculum (TTKB, 2005). However, the new science and technology curriculum for 4th grade was mostly made up of tasks and objectives referring to the students' knowledge level.

Bozyılmaz & Kılıç (2005) analysed the new science and technology curriculum for 4th and 5th grade in terms of scientific literacy. They concluded that, 4th grade science curriculum gave point to "scientific knowledge dimension" more than other scientific process skills. This finding supports the results of the study.

EARGED (2005), in the second evaluation report for fourth grade science and technology lesson, mentioned that the percentages of the teachers who understand the measurement and evaluation parts of the new curriculum are lower than the ones don't understand. Also teachers in the pilot schools pointed out that the measurement and evaluation techniques on the new curriculum are too complex to understand and also time consuming.

Therefore, training of the teachers for the new measurement and evaluation techniques becomes an important issue. However the priority should be given to improvement of the objectives and suggested activities of 4th grade science and technology curriculum. They should be prepared in order to support the development of students' scientific process skills.

Furthermore, Gözütok et al. (2005) claimed that the implementation of the pilot study in all grades was not fair because the students should be prepared for receiving these new applications. Since many studies showed that, the readiness of the students affects their learning. They discussed the readiness of the students was not taken into account while the new curriculum was implemented. In this research, finding no difference among the groups in terms of fourth grade students' higher order thinking skills supports the idea

that the readiness of the students for the implementation of the new curriculum was not enough.

The other achievement test of the study, 5SAT, administered to 5th graders to observe if the new science and technology curriculum made any difference on the students' knowledge and understanding level learning outcomes and higher order thinking skills. The results of the MANOVA showed that there was a significant difference in the mean achievement scores of 5th grade students across the new science and technology curriculum and traditional curriculum in terms of the students' higher order thinking skills outcome. This means that, the new elementary science and technology curriculum was effective on the 5th grade students' higher order thinking skills. In contrast to the new 4th grade science and technology curriculum, the objectives and suggested activities of the 5th grade's curriculum were more successful to come up to the higher order thinking skills. This result is consistent with the study of Bozyılmaz & Kılıç (2005). The findings of their analysis on 5th grade new science curriculum showed that, 5th grade's curriculum includes scientific process skills more than the 4th grade's curriculum. Results of the science achievement tests for both 4th and 5th grades should be explained with the content of the curriculum, levels of the objectives and the activities suggested in the curriculum.

Constructivist approach is the fundamental of the new curriculum. Kıyıcı (2004) found in his study that constructivist approach in science lessons effects students' academic achievement in a positive way. Erdem & Demirel (2002) stated that, in constructivist approach, the main aim should be the internalization of the students to the usage of higher order thinking skills while solving complex problems. In constructivist approach, students should be able to use their higher order thinking skills while solving the problems involving daily life.

Students of the teachers who internalized student-centered approach showed increase on their higher order cognitive developments and showed more positive personal characteristics than the students of the teachers who are still using teacher-centered approach in their classrooms (Gömleksiz, 2005).

Multiple intelligence theory is also one of the fundamental principles of fhe new science and technology curriculum. When the related literature is rewieved, it was observed that the researchers were studied on its effectivness on students' achievement levels. Aşçı (2003), Coşkungönüllü (1998), Kaptan & Korkmaz (2000), and Tertemiz (2004) found in their research that activities based on multiple intelligence theory have positive effects on students' achievement in different areas.

Almost most of the teachers in pilot schools who are to be use the new curriculum are performing student-centered education and multiple intelligence approach in their classroom activities (Collins, 2005).

Bağcı (2003) mentioned that, development in the cognitive skills of the students should be the fundamental aim of the education sytem in Turkey. Learning by understanding requires scientific process skills more than just memorizing the knowledge.

The literature and results of the research are consistent with the findings of the study for 5^{th} grade. Difference in the pilot schools and control school students' achievement should be explained by the successful application of the new approaches.

The other instrument of the study was Science Attitude Scale. Results of Science Attitude Scale were examined through its sub-categories, interest, anxiety, and self-efficacy. The results of the MANOVA showed that there were significant differences among teaching science with the new science and

technology curriculum versus traditional curriculum in terms of the students' attitudes towards science on interest and self-efficacy categories. Furthermore, results clarified that the new science and technology curriculum increased the students' interest and self-efficacy, while it had no significant effect on the students' anxiety towards science and technology lesson. Many studies in literature proved that the student- centered instruction, constructivism and multiple intelligence theory which are the basic approaches of the new curriculum has a positive effect on the students' achievement and attitudes towards science lessons. A research of Kıyıcı (2004) resulted that constuctivist approach used in science lessons increase students' motivation and interest towards science. Another study performed by Özkan (2001) found that, constructivist learning environment has positive effects on students' cognitive and emotional reactions and it increases motivation of the students through learning.

Maiden and Foreman (1998) found a significant relationship between the learning encironment and the studens' acheivement and educational behaviours. Another factor effected this increase on the students' attitudes might be improvement in the physical conditions of the pilot schools. The Ministry of Education provided new equipments and materials to the pilot schools.

The literature supports the finding of this study about students' attitudes towards science. However, this study searched attitude for three sub-categories, interest, anxiety and self-efficacy. Further research shoul be performed to investigate the other dimensions of the students' attitudes towards science.

Another aspect of this study was to examine if the new science and technology curriculum's requirements had an affect on the teachers' classroom

activities. In other words, to investigate how teachers apply the new curriculum and the frequencies of their classroom activities required by the new science and technology curriculum.

Therefore, the results of TCAS (Teachers' Classroom Activities Scale) was examined through five sub-categories which were classroom activities of the new approach (COTTCAS), care of teacher (COTTCAS), equipment use (EUTCAS), classical classroom activities (CCATCAS) and processing the subject (PSTCAS). Results of the MANOVA showed that there were significant differences among teaching science with the new science and technology curriculum versus traditional science curriculum in terms of the students' TCAS scores on the common dependent variables. When the sub-categories of the scale were considered, the followings outcomes were found:

1. The new elementary science and technology curriculum was effective on increasing the teachers' classroom activities by means of the new approaches. That means, teachers in the pilot school applied the teaching methods and techniques of the new approaches required by the new curriculum.

2. The new elementary science and technology curriculum was effective on increasing the personal relationship and care of the science teachers to the student individually. That means the pesonal relationship between the teacher and students increased in pilot schools.

3. The new elementary science and technology curriculum was effective on increasing the frequency of the teacher's use of classroom equipment and technology. This result showed that, teachers in the pilot schools used the technology and visuals more frequently than the teachers in control school.

4. With the comparison of two pilot schools, it was seen that, teachers in one of the pilot groups still showed tendency to use traditional classroom activities, whereas the other pilot groups' teachers became more distant from the classical applications that were mostly used in the implementation of the traditional science curriculum.

5. The new elementary science and technology curriculum was effective on increasing the teachers' activities about performing the new subject by means of the new approaches. This result explained that application of the methods required by the new curriculum at the beginning of the new subject was used in the pilot schools.

The results of this part showed that the new science and technology curriculum affected the pilot school teachers' way of teaching science. Teachers' classroom activities in terms of new approaches were one of the main debates of the new curriculum. This study proved that the teachers were trying to do their best to apply the requirements of the new curriculum. However, the teachers in two pilot groups showed differences in the traditional classroom activities. This result can be interpreted in a way that teachers need more training about the application of the new curriculum.

One of the most important requirements for the appropriate and effective application of the new curriculum is the understanding and internalization of the teachers to the new approaches.

As a consistent explanation of the results of this study, Akpınar & Ergin (2005) explained the role of science teachers in constructivist theory and concluded that, there were some specific characteristics that a science teacher should have according to newly developed science and technology curriculum. They stated some of these characteristics as; teachers should use the traditional

teaching methods rarely, instead they should prefer to prepare conditions for the students to reach the knowledge themselves. They should care about the students demands more, and their individual developments.

Pesen (2005) claimed that the explanation of the knowledge about the new approaches in the new curriculum was not enough for the teachers to understand and apply these new approaches and that is the main reason why the teachers are not able to apply the new approaches properly in their classrooms. In addition, Yaşar et al. (2005) studied about the readiness of the teachers and their needs for implementing the new curriculum. They resulted that the teachers had concerns and needs about the content, the process and the measurement and evaluation requirements of the new curriculum and the teachers needed training about these issues. They followed that there should be more in-service teacher training programs.

As seen from the literature and previous studies there are contradictory and paralell results with the findings of this study. The most important result derived from overall conclusions for teachers' classroom activities is teachers have positive thoughts about the new curriculum and they are trying to apply it in the classrooms. However, they need training to perform the new curriculum in a more appropriate way.

5.3 Internal Validity of the Study

Internal validity means to the degree to which the observed differences on the dependent variable are directly related to the independent variables, not to extraneous variables that may affect the results of the research (Fraenkel & Wallen, 2003).

Although the static group comparison design provides better control over history, maturation, testing and regression threats, main weakness of this design were subject characteristics. To cope with this weakness while choosing the sample, subject characteristics such as gender, attendance to school, personal science study hours and demographic characteristics of the population were considered. The results of the analyses showed that the subject characteristics of three schools were not different from each other.

Location and instrumentation could not be threats, since the instrument was administered to all groups in similar physical conditions of certain classrooms by the researcher.

Maturation could not be a threat to this study, as the data gathering procedure was performed in one day.

Finally, confidentiality was not a threat, since the names of the students were not used in anywhere of the study.

5.4 External Validity of the Study

The external validity is the extend to which the results of the study can be generalized. Population generalizability and ecological generalizability are the two types of external validity. Population generalizibility refers to the degree to which a sample represents the population of interest. Ecological generalizability refers to the degree to which the results of the study can be extended to other settings and conditions (Fraenkel & Wallen, 2003).

A total of 302 fourth and fifth graders were chosen as a sample of convenience. This condition limits the generalizability of this study.

Application of the testing procedure was performed in ordinary classrooms for both of pilot and control groups during the regular class time, there were possibly no remarkable differences among the environmental conditions. Therefore, it was believed that the external effects were sufficiently controlled by the setting used in the study.

5.5 Implications of the Study

The implications based on the conclusions of this current study are classified according to teachers, government, and education faculties' members:

To science teachers;

1. Teachers should consider more about increasing the students' cognitive levels.

2. The evaluation in science lessons should include the questions to evaluate the students' higher order thinking levels.

3. Teachers must give importance to the classroom activities in the implication of the new approaches suggested by the new science curriculum.

To government;

4. There should be more in service teacher trainings to explain teachers the new approaches.

5. The teachers' applications should be followed by the experts and should be supported.

6. The curriculum content should be studied and developed.

To Education Faculties;

7. Education faculties in universities should determine the deficiencies within the new curriculum then try to make recommendations to improve them.

8. A booklet consisting of various teaching methods and the ways of how implementing them in learning environment effectively should be prepared by one of expert commission.

5.6 Recommendations for Further Research

1. Similar research studies might be constructed for different fields and at different grade levels.

2. The similar evaluation studies of the new elementary science and technology curriculum might be constructed involving more number of groups.

3. The further studies might be implemented to the teachers to determine their strengths, weakness, and needs.

4. The further studies might be conducted to determine why the new science curriculum has no effect on fourth grade students' higher order thinking levels.

5. The measurement tools might be developed according to the new approaches mentioned in the new science and technology curriculum.

6. The factors of Science Attitude Scale might be discussed specifically in further studies.

7. The factors of Teachers' Classroom Activities Scale might be discussed specifically in further studies.

8. Content analyses for the Turkey's new curriculum for science and for different fields might be done.

9. The comparison of the Turkey's new science and technology curriculum and the science curriculums of the developed countries might be done.

REFERENCES

Ağazade, A. (2001). A linear structural relations modeling of individual learner factors affecting English medium Turkish university Non-English freshman students' general English proficiency level attainment. Unpublished Doctoral Thesis, Middle East Technical University, Ankara.

Akpınar, E., Ergin, Ö. (2005). The role of science teachers in constructivist theory. İlköğretim-Online, 4(2), 55-64, 2005 [On-line]Available: http://ilkogretim-online.org.tr., last accessed 2004, February.

American Association for the Advancement of Science. (1993). Benchmarks for science literacy. New York: Oxford University Press.

Aschbacer, P.R. (1991). Performance Assessment: State Activity, Interest and Concerns. Applied Measurement in Education, 4 (4), pp. 275-288

Aşcı, Z. (2003). The Effects of Multiple Intelligences Based Instruction on Ninth Graders' Ecology Achievement, Attitudes towards Ecology and Multiple Intelligences. Master Thesis. Middle East Technical University. January 2003.

Aşkar, P. (1986). "Matematik dersine yönelik likert tipi bir tutum ölçeğinin geliştirilmesi". Eğitim ve Bilim, 62, 31-36.

Atkin, J. M. (1998). The OECD study of innovation in science, mathematics and technology education. Journal of Curriculum Studies, 30(6), 647–660.

Avi, H. (1986). How to develop positive attitudes towards science and chemistry through a new chemistry curriculum. (ERIC Document Reproduction Service No. ED 276 577).

Aviles, C.B. (1999). Understanding and testing for "Critical Thinking" with Bloom's Taxonomy of Educational Objectives. (ED 446 025).

Aykaç, N. ve Başar, E. (2005). İlköğretim sosyal bilgiler dersi eğitim programının değerlendirilmesi. Eğitimde Yansımalar: VIII Yeni İlköğretim Programlarını Değerlendirme Sempozyumu Bildiriler Kitabı içinde (s. 343–361). Ankara: Sim Matbaası.

Bağcı, N. (2003). Öğretim sürecinde öğrenciye ve öğrenim amacına yönelik yeni yaklaşımlar. Milli Eğitim Dergisi, 159. Available online: http://yayim.meb.gov.tr/yayimlar/159/bagci.htm. Last accessed: 01.11.2006.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. Psychological Review, 84, 191-215.

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

Bandura, A. (1991). Self-regulation of motivation through anticipatory and self-regulatory mechanisms. Perspectives on motivation: Nebraska symposium on motivation. Vol 38 (pp.69-164).

Baysen, E. (2003). Fen Eğitiminde Yeni Gelişmeler ve (1960-1985 Dönemi) Türkiye'deki Uygulamaları. Yayınlanmamış Doktora Tezi, Gazi Üniversitesi, Eğitim Bilimleri Enstitüsü, Ankara

Bell, A., Buckhardt, H. & Swan, M. (1992). Balanced Assessment of Mathematical Performance. In Lesh, R and Lamon, S.O. (eds)., Assessment of Authentic Performance in School Mathematics. AAAS Press, Washington D.C..

Bell, R. 2005. Whole Class Inquiry:Science. International Society for Technology in Education, vol 32 (8), pp.45-47.

Biranbaum, M., & Tatsuoka, K. K. (1987). Open-ended versus multiple-choice response formats- It does make a difference for diagnostic purposes. Applied Psychological Measurement. Vol 11(4), 385-394.

Bisland, M. B., Micheline, S. M. and O'Connor E. A. (2006). Instructional Practices Among Alternatively Certified Elementary Teachers. Paper presentation at the American Educational Research Association Annual Conventio San Francisco, CA.

Bloom, B. (Ed.).(1956). Taxonomy of Educational Objectives Book 1 Cognitive Dpmain. New York: Longman

Bol, L. & Strage, A. (1996). The contradiction between teachers' instructional goals and their assessment practices in high school biology courses. Science Education, 80(2), 146-163.

Bozyılmaz, B., Kılıç, B. G. (2005). 4. ve 5. sınıf fen ve teknoloji dersi öğretim programının bilim okur-yazarlığı açısından analizi. Eğitimde Yansımalar: VIII. Yeni İlköğretim Programlarını Değerlendirme Sempozyumu Bildiriler Kitabı içinde (s. 319-327). Ankara: Sim Matbaası.

Brooks, J.G.,&Brooks, M. G. (1993). In search of understanding: The case for constructivist classrooms.Alexandria, VA: Association for Supervision and Curriculum. (ED 366 428)

Bruner, J. (1990). Acts of meaning. Cambridge, MA: Harvard University Press

Bulut, İ. (2006). Yeni ilköğretim birinci kademe programlarının uygulamadaki etkililiğinin değerlendirilmesi. Yayınlanmamış Doktora Tezi, Fırat Üniversitesi, Sosyal Bilimler Enstitüsü, Elazığ.

Carson, J. 2005. Objectivism and education: A rebuttal to David Elkind's 'The problem with constructivism.' The Educational Forum 69(3): 232–38.

Center for Science, Mathematics, and Engineering Education (1996). National Science Education Standards. [On-line] Available: http://www.soinc.org/aboutso/standards/index.htm., last accessed 2005, April.

Chuska. K.R. (1995). Improving classroom questions: A teacher's guide to increasing student motivation, participation and higher level thinking. Bloomington, IN: Phi Delta Kappa Educational Foundation.

Cobern, W. W. (1995). Constructivism for science teachers.Science Education International, vol. 6(3), pp.8-12.

Coşkungönüllü, R. (1998). The Effects of Multiple Intelligences Theory on Fifth Graders' Mathematics Achievement. Master Thesis. Middle East Technical University. June 1998.

Çepni S, Taş E., Köse E. (2006) The effects of computer-assisted material on students' cognitive levels, misconceptions and attitudes towards science. Computers and Education, (46) , pp. 192-205.

Dewey, J. (1933). How we think. Boston: D. C. Heath.

Dillon, J.T. (1981). To question or not question in discussion. Journal of Teacher Education. (32), pp.51-55.

Dixon F. A., Prater K. A., Vine H.M., Wark M., Williams T., Hanchon T., Shobe C. (2004). Teaching to Their Thinking: A Strategy to Meet the Critical-Thinking Needs of Gifted Students. Journal for the Education of the Gifted. Vol. 28, (1), pp. 56–76.

Doepken, D., Lawsky, E. , Padwa, L. (1970). Modified Fennema-Sherman Attitude Scales. [On-line] Available: http://www.woodrow.org/teachers/math/gender/08scale.html., last accessed 2005, March.

Dougimas, M. (1998)A journey into Constructivism. [On-line] Available: http://dougiamas.com/writing/constructivism.html., last accessed 2006, January.

EARGED (2005). Temel eğitime destek programı çerçevesinde hazırlanan ilköğretim 4-5. sınıf fen ve teknoloji dersi öğretim programları ile ilgili ikinci değerlendirme raporu. Available online: http://earged.meb.gov.tr last accessed: 15.12.2006.

Edelson, D.C. (2001). Learning-for-use: A Framework for the Design of Technologysupported Inquiry Activities. Journal of Research in Science Teaching, 38(3): 355–385.

Erdem E., Demirel Ö. (2002). Constructivism in Curriculum Development. Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 23, 81-87.

Fasko. D. (1983). The effects of teacher questions on student attending behaviors, academic achievement, retention and confidence to respond questions. Doctoral dessertation, Florida State University, Tallehessee, FL.

Fasko. D. (1988). The effects of dogmatism on ability to respond and to attend to questions of various cognitive levels. Journal of Human Behavior, vol 5(2), 17-23.

Fasko D., Skidmore R. (1999). The effects of questions and anxiety on attention, question confidence and metacognition. (ED 435 756).

Feldhusen, J. F., & Klausmeier, H. J. (1962). Anxiety, intelligence, and achievement in children of low, average, and high intelligence. *Child Development, 33*, 403-409.

Fennimore, T., & Tinzmann, M. (1990). What is a thinking curriculum? Oak Brook, IL: North Central Regional Educational Laboratory. [On-line] Available:http://www.ncrel.org/ncrel/sdrs/areas/rpl_esys/thinking.htm., last accessed 2006, September.

Fraenkel, J. & Wallen, N. (1993). How to design and evaluate research in education. New York: Mc Graw-Hill.

Fraenkel, J. & Wallen, N. (2003). How to design and evaluate research in education (5th Ed.). New York: Mc Graw-Hill.

Fraser, B.J. (1980). Science Teacher Characteristics and Student Attitudinal Outcomes. School Science and Mathematics, 80(4): 300–308.

Freedman, M.P. (1997). Relationship Among Laboratory Instruction, Attitude Toward Science, and Achievement in Science Knowledge. Journal of Research in Science Teaching, 34(4): 343–357.

Glaser R. (1998). The evaluation of education systems: the view at the end of the 1990s. Prospects. Vol 27 (1) p. 7.

Good, C. (1973). Dictionary of education. Phi Delta Kappa. New York: McGraw-Hill.

Gömleksiz M. N. (2005). Yeni ilköğretim programının uygulamadaki etkililiğinin değerlendirilmesi. Kuram ve Uygulamada Eğitim Bilimleri Dergisi, 5 (2), 339-384.

Gömleksiz, M.N., Bulut, İ. (2006). An Assessment of the Implementation of New Primary School Social Studies Curriculum. Educational Administration, vol.12 (47), p. 393-421.

Gözütok, F. D. (2005). Özensiz, altyapısı yetersiz bir program. Öğretmen Dünyası Dergisi, vol. 298, p. 7-8.

Gözütok, F. D., Ö. E. Akgün and Ö. C. Karacaoğlu (2005). İlköğretim programlarının öğretmen yeterlikleri açısından değerlendirilmesi. Yeni İlköğretim Programlarını Değerlendirme Sempozyumu. 17-40. Ankara:Sim Matbaası.

Halpern, D. (1997). Critical thinking across the curriculum: A brief edition of thought and knowledge. Hillsdale, NJ. Erlbaum.

Hayati, M.,A. (1998). Problem-Based Learning in Language Instruction: A Constructivist Model.(ED 423 550).

Hodson, D. (1988) Towards a philosophically more valid science curriculum. Science Education, (72), pp.19-40.

Holden R. L. (2003). Determining the best learning approach for understanding math word problems using presentation technology: traditionalist/constructivist. Doctoral Thesis. UMI Prorequest Dissertation Publication No: 3106928.

Huitt, W. (2003). Constructivism. Educational Psychology Interactive. Valdosta, GA: Valdosta State University. Retrieved [2.10.2006], from http://chiron.valdosta.edu/whuitt/col/cogsys/construct.html

Ishii, D.K. (2003). Constructivist Views of Learning in Science and Mathematics. ERIC Identifier: ED482722, pp.1-8.

Jackson, J. (2002). Enhancing self-efficacy and learning performance. Journal of Experimental Education, 70, 243-254.

Johnson, S, T. (1992). Extra-school factors in achievement, attainment, and aspiration among junior and senior high school-age African American youth. The Journal of Negro education, 61(1), 99-119.

Kaptan F. (1999). Fen Bilgisi Öğretimi. Ankara: MEB Yayınları.

Kaptan, F. & Korkmaz H. (2000). Çoklu Zeka Kuramı Tabanlı Fen Öğretiminin Öğrencilerin Fen Başarısına ve Fen Tutumlarına Etkisi. IV. Fen Bilimleri Eğitimi Kongresi (Hacettepe Üniversitesi & Heidelberg Üniversitesi Ortak Organizasyonu) 6-8 Eylül 2000. Ankara.

Kaptan, F. , Korkmaz, H. (2001) "Uygulanmakta Olan İlköğretim Fen Bilgisi Ders Programı ile 2001 – 2002 Öğretim Yılında Uygulamaya Konulacak Olan Yeni Fen Programının Karşılaştırılması." Çağdaş Eğitim Dergisi. Şubat 2001, Sayı: 273.

Kaptan, F. , Önal, İ (2006) "Fen ve Teknoloji Öğretiminde Süreç Temelli Ölçme ve Değerlendirme Yaklaşımları". Çağdaş Eğitim Dergisi. Haziran 2006 p. 6-18.

Kassem C. L. , (2005). A Conceptual Model for the Design and Delivery of Explicit Thinking Skills Instruction. Ref: L05P1002

Kerlinger, F. (1986). Foundations of behavioral research (3rd ed.) New York: Holt, Rinehart, and Winston.

Kılıç,G.B. (2001), Oluşturmacı Fen Öğretimi, Kuram ve Uygulamada Eğitim bilimleri Dergisi, vol 1, pp. 7-22.

Kıyıcı, F.B. (2004). Fen Bilgisi öğretiminde oluşturmacı yaklaşım uygulamasının akademik başarıya etkisinin belirlenmesi. Sakarya Üniversitesi Eğitim Fakültesi Dergisi, 7, 177-187.

Kind M., (date is not mentioned). TIMSS Performance Assessment- a cross national comparison of practical work.

Klopfer, L.E. (1971). Evaluation of learning in science. In B.S. Bloom, J.T. Hastings, and G.F. Madaus (eds.), Handbook on formative and summative evaluation of student learning, pp.559-642. McGraw Hill, New York.

Krapp, A. (2002). Structural and dynamic aspects of interest development: theoretical considerations from an ontogenetic perspective. *Learning and Instruction, 12*, 383–409.

Krathwohl David R., (2002) A Revision of Bloom's Taxonomy:An Overview. Theory into practice, vol 41(4) pp., 212-218.

LeMahieu, P., & Leinhardt, G. (1985). Overlap: Influencing what's taught: A process model of teacher's content selection. Journal of Classroom Interaction. Vol 21(1), 2-11.

Lotfi A. (2004). Using constructivism in teaching AP chemistry. Master Thesis. UMI Prorequest Dissertation Publication No: 1422596

Maiden, J., Foremnan, B. A. (1998). Cost, design and climate: Building a learning environment. School Business affairs, 64 (1), 40-44.

Martin, R. E. (1984). The credibility principle and teacher attitudes toward science. New York Press.

McComas, W.F. (1996). The Affective Domain and STS Instruction. In Yager, R.E. (Ed.), Science/Technology/Society as Reform in Science Education (pp. 70–83). Albany, NY: SUNY Press.

McCombs, B.L. (1996). Alternative Perspectives for Motivation. In L. Baker, P. Afflerback, and D. Reinking (Eds.), Developing Engaged Readers in School and Home Communities (pp. 67–87). Mahwah, NJ: Lawrence Erlbaum

McMillan, James H. ; Lawson, Sonya R. (2001). Secondary Science Teachers' Classroom Assessment and Grading Practices. (ED 450 158).

Milli Eğitim Bakanlığı (M.E.B), (1976). Yeni Orta Öğretim Sisteminde Modern Matematik ve Fen Programlarının Denenmesi v eTeşmili Üzerine Araştırmalar Projesi Kesin Değerlendirme Raporu (BYAG-E-23). Ankara:M.E.B. Fen Öğretimini Geliştirme Bilimsel Komisyonu.

Milli Eğitim Bakanlığı (MEB), (2005). İlköğretim Fen veTeknoloji dersi öğretim programı ve kılavuzu (1-5. sınıflar). Devlet Kitapları Müdürlüğü,Ankara.

Milli Eğitim Bakanlığı (MEB), (2006). Programların Geliştirilmesini Gerekli Kılan Nedenler. [On-line] Available:http://programlar.meb.gov.tr/prog_giris/prog_giris_1.html., last accessed September, 2006.

National Council of Teachers of Mathematics. (2000). Principles and standards for school mathematics. Reston, VA: National Council of Teachers of Mathematics.

Oliver, R., & Mc Loughlin, C. (2001). Exploring the practice and development of generic skills through Web-based learning. Journal of Educational Multimedia and Hypermedia, 10(3). 307-325.

Olivier, T.A., & Shapiro, F. (1993). Self-efficacy and computers. Journal of Computer- Based Instruction, 20, 81-85.

Ormrod, J. E. (2004). Human learning. (4th ed.). Upper Saddle River, NJ: Pearson.

Özcan, S. (2003). İlköğretim Fen Bilgisi Programının Değerlendirilmesi. Yayınlanmamış Master Tezi, Afyon Kocatepe Üniversitesi, Sosyal Bilimler Enstitüsü, Afyon.

Özkan, B. (2001). Yapılandırmacı öğrenme ortamlarında özgün etkinlik ve materyal kullanmanın etkililiği. Unpublished doctoral thesis. Hacettepe Universitesi Sosyal Bilimler Enstitüsü, Ankara.

Özden, Y. (1999). Öğrenme ve öğretme (3. Baskı). Ankara: Pegema Yayıncılık

Palmer, D. (2005). A motivational view of constructivist-informed teaching. International Journal of Science Education, 27(15), 1853-1881.

Pell, T., Jarvis, T. (2001). Developing Attitude to Science Scales for Use With Children of Ages From Five to Eleven Years. International Journal of Science Education, vol 23(8), pp.847-862.

Pesen, C. (2005).Yapılandırmacı öğrenme yaklaşımına göre yeni ilköğretim matematik öğretimi programının değerlendirilmesi. Yeni İlköğretim Programlarını Değerlendirme Sempozyumu. 272-281. Ankara: Sim Matbaası

Reeves, T.C. (2000). Alternative assessment approaches for online learning environments in higher education. Journal of Educational Computing Research, 23(1), 101-111.

Posner, G.J., Strike, K.A., Hewson, P.W., and Gertzog, W.A. (1982). Accommodation of a Scientific Conception: Toward a Theory of Conceptual Change. *Science Education, 66*(2): 211–227.

Resnick, L.B. (1989). Introduction. In L.B. Resnick (Ed.), Knowing, Learning and Instruction: Essays in Honor of Robert Glaser,1-24, Hillsdale, N.J.: Erlbaum.

Rule, Audrey C., Ed.;Lord, Linda H. (2003) Activities for differentiated instruction addressing all levels of Bloom's Taxonomy and eight multiple intelligences. (ED 475 517)

Schunk, D. H. (1991). Self-efficacy and academic motivation. Educational Psychologist, 26, 201-231.

Shepard, L.A. (1989). Why we need better assessment. Educational Leadership, 46(7),pp.4-9.

Sherman, L. W. (1995). A Postmodern, constructivist and cooperative pedagogy for teaching educational psychology, assisted by computer mediated communications. In Proceedings of CSCL 95' Conference.

Shrigley, R.L., and Koballa, T.R. (1992). A Decade of Attitude Research Based on Hovland's Learning Theory Model. Science Education, 76(1): 17–42.

Simon, S. (2000). Students' Attitudes Towards Science. In M. Monk and J. Osborne (Eds.), *Good Practice in Science Teaching* (pp. 104-119). Buckingham: Open University Press.

Slavin, R. E. 1997. Educational psychology: Theory and practice, 5th ed. Boston: Allyn & Bacon.

Sparani E., Edwards P. (1994) The thinking/ Learning System: A Brain-Compatible Strategy for Effective Teaching of Higher Order Thinking and Learning. Paper presented at the International Conference of Thinking (6th.Boston, July 17-22)

Spelberger, C.D. (1983). Manual for the State-Trait anxiety inventort (Form Y). Palo Alto, CA: Consulting Psycologists Press.

Sungur S., Tekkaya C, Geban Ö (2006) Improving achievement through problem-based learning. Journal of Biological Education. Vol 40 (4), p.155

Sutman, F.X., (1993). Teaching Science Effectively to Limited English Proficient Students. ERIC/CUE Digest, Number 87.Page 5 of 12 (ED357113).

Stevens, J., (2002). Applied multivariate statistics for the social sciences. (4th edition). Mahway, NJ: Lawrance Erlbaum.

Talim ve Terbiye kurulu başkanlığı ilkögretim programları (2005). Yeni İlköğretim programları ve yaklaşımlar sunusu. Available- online : http://www.ttkb.meb.gov.tr, last accessed 2006, December.

Taşlıdere, E. (2002). The effect of conceptual approach on students' achievement and attitudes toward physics. Unpublished master thesis, Middle East Technical University, Ankara, Turkey.

Tertemiz, N. I. (2004). Çoklu zeka kuramına göre bütünleştirilmiş etkinliklerin öğrenci başarısı üzerine etkisi. Eğitim ve Bilim dergisi, 134, s.1-10.

TIMMS (2003). Trends in International Mathematics and Science Study. Student Questionnaire, Grade 4. Available online:http://timss.bc.edu/timss2003i/mathD.html, last accessed 2006, December.

Tobin, K. & Tippins, D (1993) Constructivism as a Referent for Teaching and Learning.The Practice of Constructivism in Science Education, pp 3-21.

TTKB, 2005. Talim ve Terbiye Kurulu Başkanlığı. 1-5. Sınıflar Fen ve Teknoloji Dersi Öğretim Programları. Availeble-online: http://ttkb.meb.gov.tr, last accessed, 2006, December.

TÜBİTAK, (1984). XX. Yılda TÜBİTAK. Bilim Adamı Yetiştirme Grubu. Ankara: TÜBİTAK yayınları No: 604 BAYG Seri No: 52, TÜBİTAK Fotoğraf Klişe Laboratuvar ve Ofset Tesisleri.

Watzawick, P. (1984). The invented reality. New York: W.W. Norton.

Wei, B & Gregory P. Thomas (2006). An Examination of the Change of the Junior Secondary School Chemistry Curriculum in the P. R. China:In the View of Scientific Literacy. Researches in Science Education . 36. pp. 403-418

Wiggens, G. (1989). A true test: Toward more authentic and equitable assessment. Phi Delta Kappa 70 (9). pp. 703-713.

Williams, S.M. (1992). Putting Case-based Instruction into Context: Examples from Legal and Medical Education. *The Journal of the Learning Sciences, 2*(4): 367–427.

Wnull W. J. (2004) Is Constructivism Traditional? Historical and Practical Perspectives on a Popular Advocacy, The Educational Forum, vol. 68(4), pp. 180-188.

Woo, E. (1999). Obituary: Benjamin S. Bloom, education scholar's research influence head start program. The Los Angeles Times, p.A22.

Yaşar, Ş. (2005). Sosyal bilgiler programı ve öğretimi. Eğitimde Yansımalar: Yeni İlköğretim Programlarını Değerlendirme Sempozyumu Bildiriler Kitabı VIII (s. 329–342). Ankara: Sim Matbaası.

Yaşar, Ş., M., Gültekin, B., Türkkan, N., Yıldız, P. G. (2005). Yeni ilköğretim programlarının uygulanmasına ilişkin sınıf öğretmenlerinin hazırbulunuşluk düzeylerinin ve eğitim gereksinimlerinin belirlenmesi (Eskişehir ili örneği). Yeni İlköğretim Programlarını Değerlendirme Sempozyumu. 51-63. Ankara: Sim Matbaası

Yılmaz, A. & Morgül, İ. (1992). Türkiye'de Fen Öğretiminin Genel Bir Değerlendirmesi. Sonuçlar veÖneriler. Hacettepe Üniversitesi Eğitim Fakültesi Dergisi. Vol 7, 269-278.

Zohar, A. (1999). Teachers' metacognitive knowledge and instruction of higher order thinking. Teaching and Teachers' Education, 15, 413–429.

Zohar, A. (2004). Higher order thinking in science classrooms: students' learning and teachers' professional development. Dordrecht: Kluwer Academic Press.

Zohar, A. & Nemet, F. (2002). Fostering students' knowledge and argumentation skills through dilemmas in human genetics. Journal of Research in Science Teaching, 39, 35–62.

Zohar A., Schwartzer N.(2005).Assessing Teachers' PedagogicalKnowledge in the Context of Teaching Higher-order Thinking. International Journal of Science Education. Vol 27 (13), pp.1595-1620.

Zohar, A., Vaaknin, E., & Degani, A. (2001). Teachers' beliefs about low achieving students and higher order thinking. Teaching and Teachers' Education, 17, 469–485.

Zwick, T. T. & Miller, K. W., (1996). A Comparison of Integrated Outdoor Education Activities and Traditional Science Learning with American Indian Students. *Journal of American Indian Education, 35(2):* 1-9.

APPENDIX A

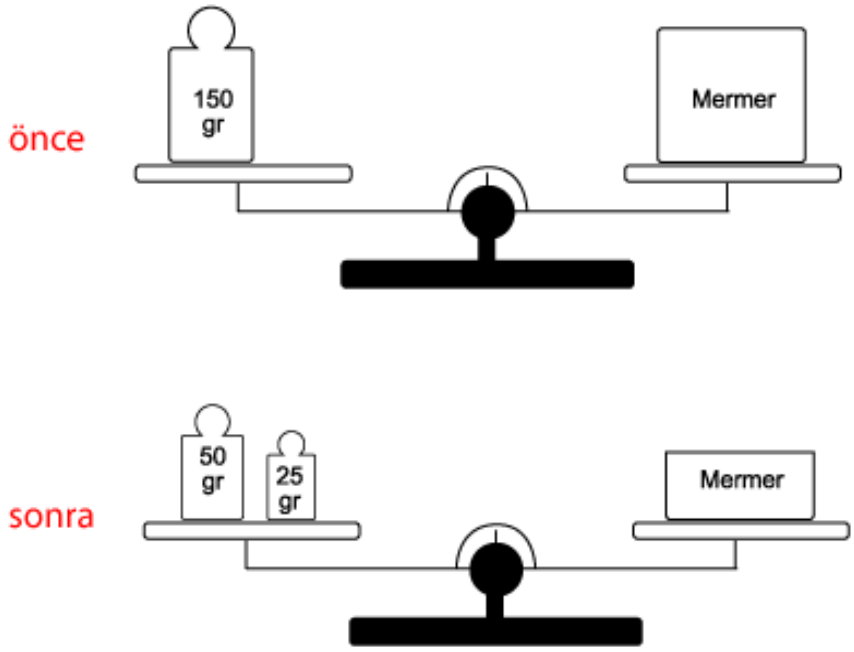
4SATA BOOKLET 4SATB BOOKLET

4. SINIF FEN BİLGİSİ BAŞARI TESTİ A GRUBU

Sevgili öğrenciler, aşağıdaki sorular sizin 1 yıl boyunca fen bilgisi dersinizde öğrendiklerinizi ölçmek için hazırlanmıştır. Cevaplarınızı verirken boş soru bırakmamaya gayret ediniz. Teşekkür ederim.

GÖZDE PEKİNER

SORU 1) ----------



Yukarıda bir mermer parçasının kesilmeden önceki ve sonraki halini görmekteyiz. Buna göre mermer parçasının kesildikten sonra değişen üç özelliği nelerdir ?

1).....

2).....

3).....

SORU 2) ----------

Bir grup öğrenciye öğretmenleri, küçük mermer taneleri, bir miktar demirtozu ve birkaç tane küçük taş verdi ve bunların hacimlerini ölçmelerini istedi.

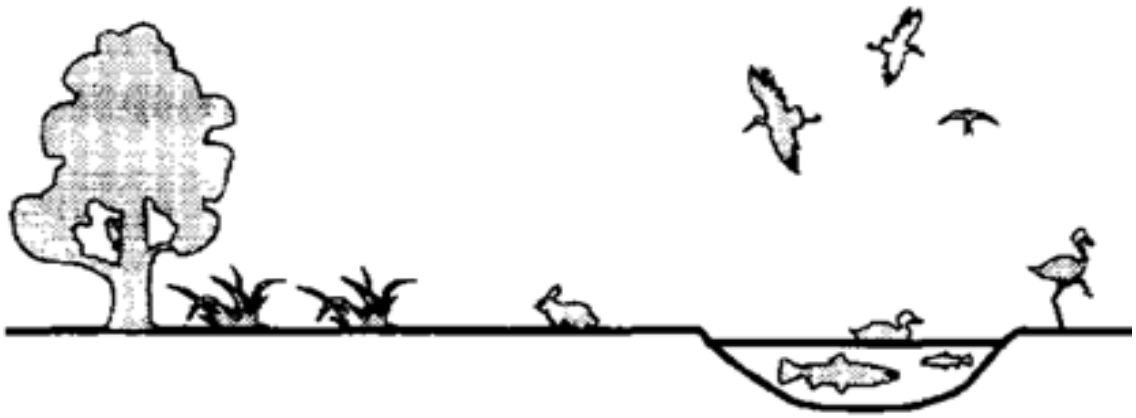
a) Siz olsaydınız bu maddelerin hacimlerini ölçmek için aşağıdaki aletlerden hangi ikisini kullanırdınız? Seçtiğiniz iki şıkkı işaretleyiniz

A) Terazi B) Su C) Cetvel D) Hesap makinesi

E) Dereceli silindir F) El kantarı G) Mikroskop

b) Bu aletlerle nasıl bir deney yapardınız?

SORU 3) ----------



1) Kaplumbağa	2) Balina	3) Timsah	4) Penguen	5) Kutup ayısı
6) Yunus	7) Kaktüs	8) Maymun	9) Arı	10)Yılan

A) Yukarıdaki yaşam alanına ait olamayacak canlıların numaralarını yazınız.Yanına neden bu yaşam alanında yaşayamayacağını açıklayınız .

Numara Nedeni

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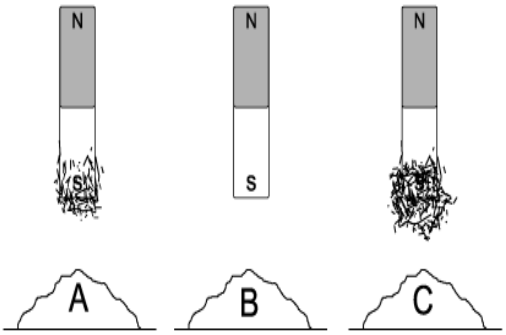
SORU 4) ----------

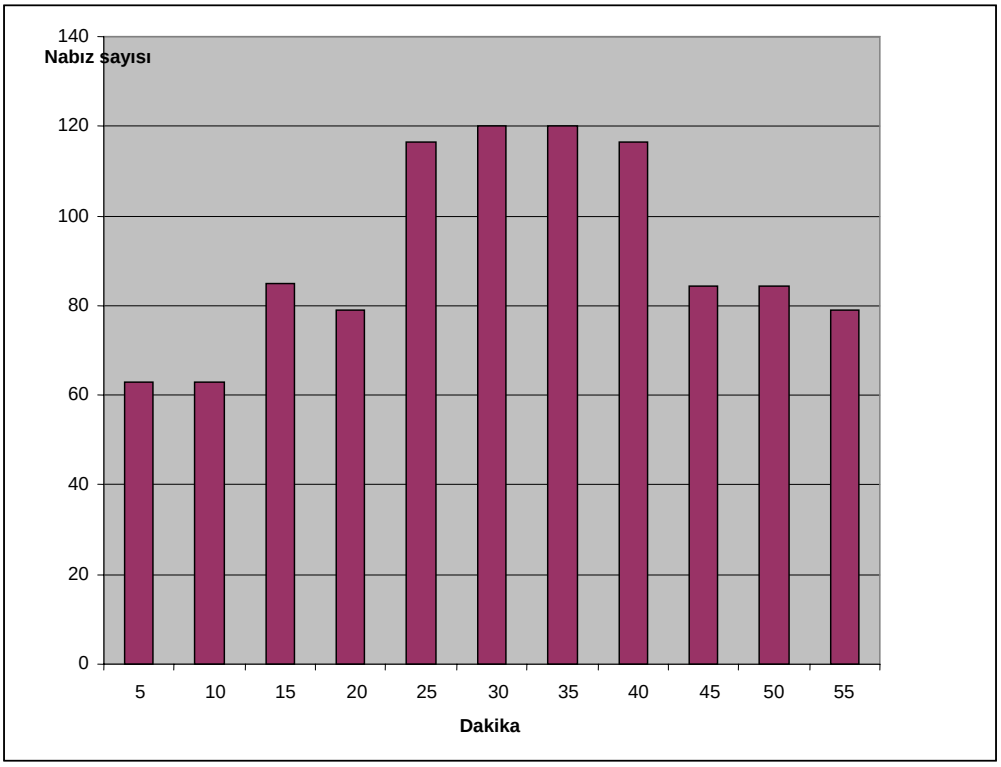


Herbir mıknatıs, aşağısında bulunan maddelere batırılıyor. A, B, C maddelerinin neler olduğu aşağıdaki kutularda verilmiştir. Şekli inceleyip, maddelerin adının altındaki kutulara uygun harfi yazınız.

Demir tozu- kum karışımı	Demir tozu	Un

Sonraki sayfaya geçiniz >>>

SORU 5) ----------



Ayşe odasında çizgi film seyrediyordu. Çizgi film bittiğinde arkadaşlarının kendisini çağırdığını duydu. Dışarı çıktı ve hep beraber koşup oynadılar, oturup sohbet ettiler akşama kadar vaktin nasıl geçtiğini anlamadılar.

Yukarıda, Ayşe'nin 55 dakikalık nabız sayısının grafiğini görmekteyiz. Bu grafiğe göre aşağıdaki sorulara yanıt veriniz?

a) Ayşe' nin nabız sayısı hangi dakikalarda <u>en azdır</u>? Sizce bu dakikalarda Ayşe parçaya göre ne yapıyor olabilir?

b) Ayşe'nin koştuğu dakikaları tahmin edebilir misiniz? Bu dakikalardaki nabız sayısı ve nefes alıp verme sıklığını grafikteki diğer dakikalarla kıyaslarsak ne söyleyebiliriz ?

Sonraki sayfaya geçiniz >>>

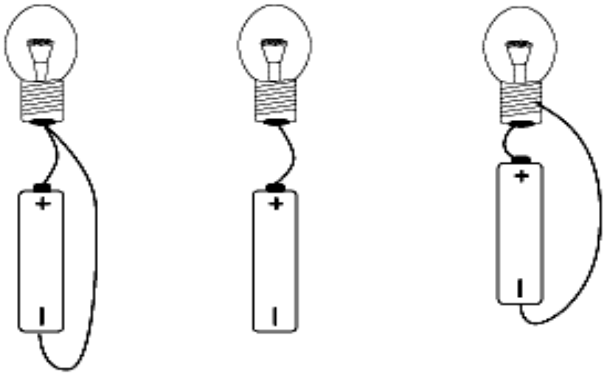
SORU 6) ----------

Aşağıdakilerden hangileri kendi ışığını yapar? Kendi ışığını yapanların numaralarını yuvarlak içine alınız.

1. Ayna **2.** Mum ışığı **3.** Elmas yüzük **4.** Büyüteç camı
5. Lamba

6. Meşale **7**. Sokak lambası **8.** El feneri **9.** Gözlük camı
10. Güneş

SORU 7) ----------



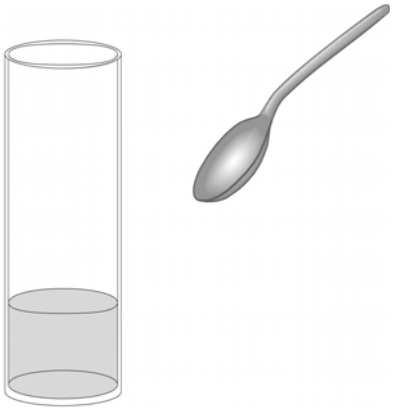
Yukarıda kurulan devrelerden hangisinde ampül yanar hangisinde yanmaz. Her bir devre için doğru kutuya X işareti koyarak, nedenini yanına açıklayınız.

A lambası Yanar ☐ Yanmaz ☐ Nedeni:

B lambası Yanar ☐ Yanmaz ☐ Nedeni:

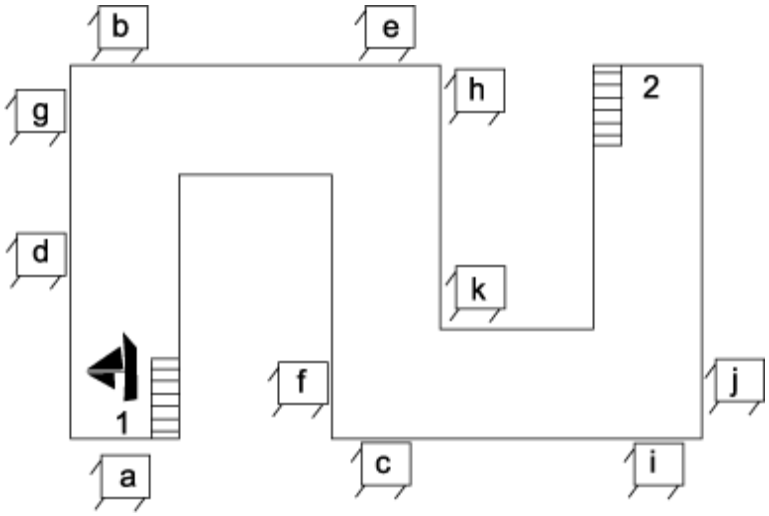
C lambası Yanar ☐ Yanmaz ☐ Nedeni:

SORU 8) ----------

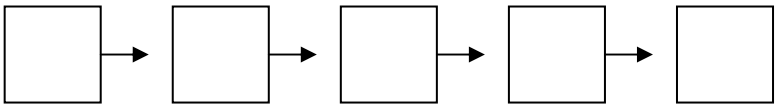


Arzu, bir bardağa bir miktar su doldurup, metal bir tatlı kaşığıyla vurdu ve bir ses duydu. Bardağa vurduğunda daha kalın bir ses duymak için ne yapmalı? Neden ?

SORU 9) ----------



Yukarıdaki su dolu havuz içerisindeki maket gemimizi harflerle gösterilen masalar üzerine, sadece vantilator koyarak, **1** noktasından **2** noktasına götürmek istiyoruz ve 5 masa kullanma hakkımız var. Vantilatörü koymamız gereken masaların harflerini aşağıdaki kutuların içerisine sırasıyla yazınız .



Sonraki sayfaya geçiniz >>>

SORU 10) ----------

Mehmet Ankara'dan bir uçağa biner. Uçak hiç durmadan ve yönünü değiştirmeden doğuya doğru uçarak yeniden Ankara'ya gelebilir mi ? Neden ?

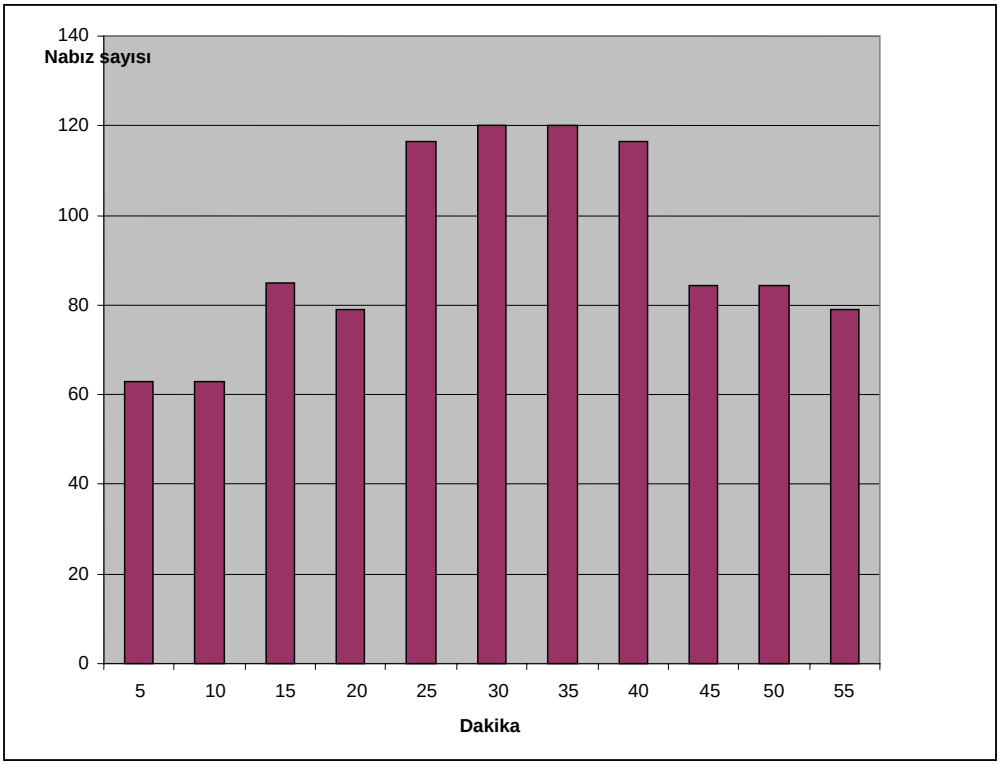
---------- TEST BİTTİ – Teşekkürler ----------

4. SINIF FEN BİLGİSİ BAŞARI TESTİ – B GRUBU

Sevgili öğrenciler, aşağıdaki sorular sizin 1 yıl boyunca fen bilgisi dersinizde öğrendiklerinizi ölçmek için hazırlanmıştır. Cevaplarınızı verirken boş soru bırakmamaya gayret ediniz. Teşekkür ederim.

GÖZDE PEKİNER

SORU 1) ----------



Ayşe odasında çizgi film seyrediyordu. Çizgi film bittiğinde arkadaşlarının kendisini çağırdığını duydu. Dışarı çıktı ve hep beraber koşup oynadılar, oturup sohbet ettiler akşama kadar vaktin nasıl geçtiğini anlamadılar.

Yukarıda, Ayşe'nin 55 dakikalık nabız sayısının grafiğini görmekteyiz. Bu grafiğe göre aşağıdaki sorulara yanıt veriniz?

b) Ayşe' nin nabız sayısı hangi dakikalarda <u>en azdır</u>? Sizce bu dakikalarda Ayşe parçaya göre ne yapıyor olabilir?

b) Ayşe'nin koştuğu dakikaları tahmin edebilir misiniz? Bu dakikalardaki nabız sayısı ve nefes alıp verme sıklığını grafikteki diğer dakikalarla kıyaslarsak ne söyleyebiliriz?

Sonraki sayfaya geçiniz >>>

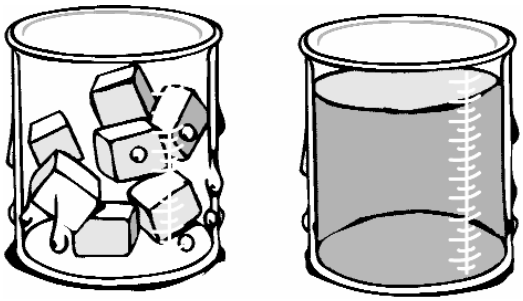
SORU 2) ----------

Bir miktar toprağın miktarını dikkatlice ölçüp, fırına koyup beklettiğimizde, içindeki bazı organik maddeler ayrılır. Toprağın kütlesini ısıttıktan sonra yeniden ölçmek istiyoruz.

a) Dereceli ölçü kabı bu işlem için yeterli olur mu ? Cevabınızı nedeniyle birlikte açıklayınız ?

b) En doğru ölçüm için hangi aleti kullanabiliriz ? Cevabınızı nedeniyle birlikte açıklayınız?

SORU 3) ----------



Ali soldaki iki bardağı eline alıp inceliyor. Bardaklardan bir tanesi buz küpleri, bir tanesi de suyla doldurulmuş. Ali bu iki bardağı incelerken, buz ve suyun birbirinden farklı hangi üç yönünü keşfetmiş olabilir?

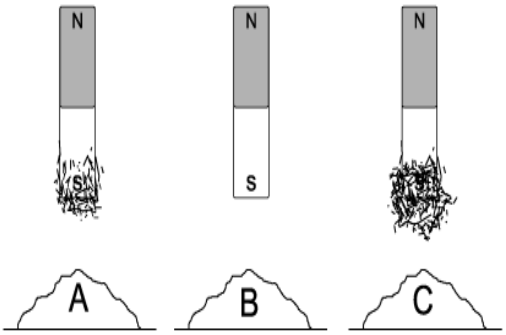
1).....

2).....

3).....

Sonraki sayfaya geçiniz >>>

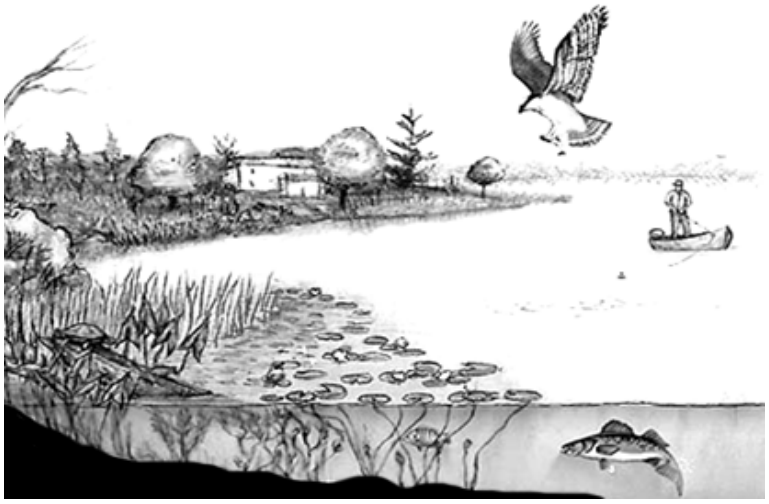
SORU 4) ----------



Herbir mıknatıs aşağısında bulunan maddelere batırılıyor. A, B, C maddelerinin neler olduğu aşağıdaki kutularda verilmiştir. Şekli inceleyip, maddelerin adının altındaki kutulara uygun harfi yazınız.

Demir tozu- kum karışımı	Demir tozu	Un

SORU 5) ----------



Eğer balıkçılar avlanma zamanı dışında ve izinsiz avlanıp, göldeki balık sayısını azaltırsa bundan en çok hangi canlı türü etkilenir ? Nedenini açıklayınız .

Sonraki sayfaya geçiniz >>>

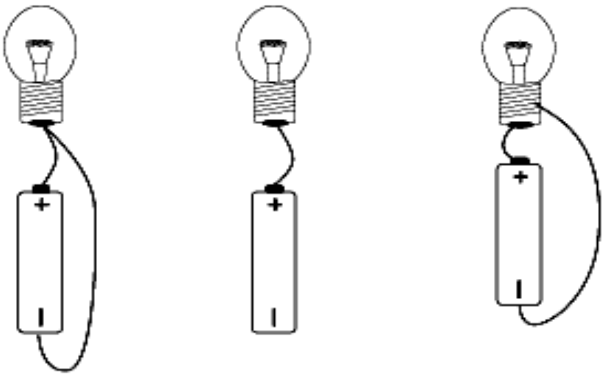
SORU 6) ----------

Aşağıdakilerden hangileri kendi ışığını yapar? Kendi ışığını yapanların numaralarını yuvarlak içine alınız.

1. Ayna **2.** Mum ışığı **3.** Elmas yüzük **4.** Büyüteç camı **5.** Lamba

6. Meşale **7**. Sokak lambası **8.** El feneri **9.** Gözlük camı **10.** Güneş

SORU 7) ----------



Yukarıda kurulan devrelerden hangisinde ampül yanar hangisinde yanmaz. Her bir devre için doğru kutuya X işareti koyarak, nedenini yanına açıklayınız.

A lambası Yanar ☐ Yanmaz ☐ Nedeni:

B lambası Yanar ☐ Yanmaz ☐ Nedeni:

C lambası Yanar ☐ Yanmaz ☐ Nedeni:

Sonraki sayfaya geçiniz >>>

SORU 8) ----------

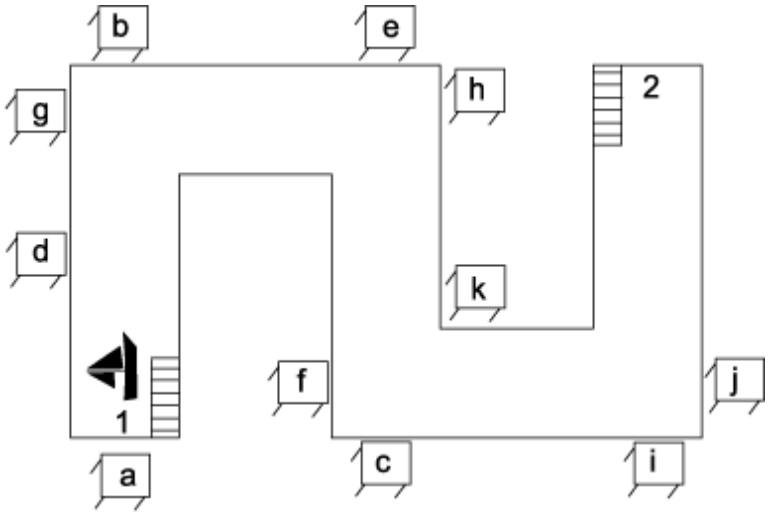
Mehmet Ankara'dan bir uçağa biner. Uçak hiç durmadan ve yönünü değiştirmeden doğuya doğru uçarak yeniden Ankara'ya gelebilir mi ? Neden ?

SORU 9) ----------

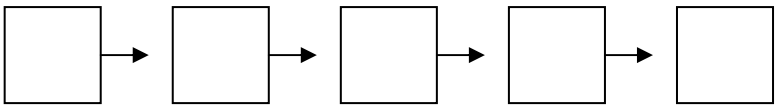
Arzu, bir bardağa bir miktar su doldurup, metal bir tatlı kaşığıyla vurdu ve bir ses duydu. Bardağa vurduğunda daha kalın bir ses duymak için ne yapmalı? Neden ?

Sonraki sayfaya geçiniz >>>

SORU 10) ----------



Yukarıdaki su dolu havuz içerisindeki maket gemimizi harflerle gösterilen masalar üzerine, sadece vantilator koyarak, **1** noktasından **2** noktasına götürmek istiyoruz ve 5 masa kullanma hakkımız var. Vantilatörü koymamız gereken masaların harflerini aşağıdaki kutuların içerisine sırasıyla yazınız .



---------- TEST BİTTİ – Teşekkürler ----------

APPENDIX B

5SATA BOOKLET 5SATB BOOKLET

5. SINIF FEN BİLGİSİ BAŞARI TESTİ – A GRUBU

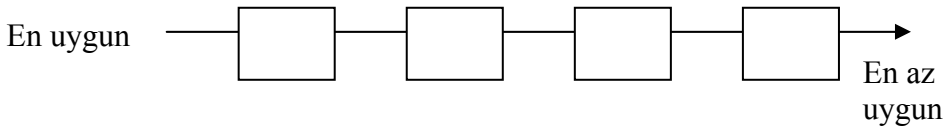
Sevgili öğrenciler, aşağıdaki sorular sizin 1 yıl boyunca fen bilgisi dersinizde öğrendiklerinizi ölçmek için hazırlanmıştır. Cevaplarınızı verirken boş soru bırakmamaya gayret ediniz. Teşekkür ederim.

GÖZDE PEKİNER

SORU 1) ----------

A diyeti ---------- Besin değerleri: Kalori : 180 Yağ: 2 gr Protein : 200 mg	**B diyeti** ---------- Besin değerleri Kalori: 210 Yağ : 4 gr Protein: 220mg
C diyeti ---------- Besin değerleri Kalori:200 Yağ:2 gr Protein: 23 mg	**D diyeti** ---------- Besin değerleri Kalori:280 Yağ: 5gr Protein: 200 mg

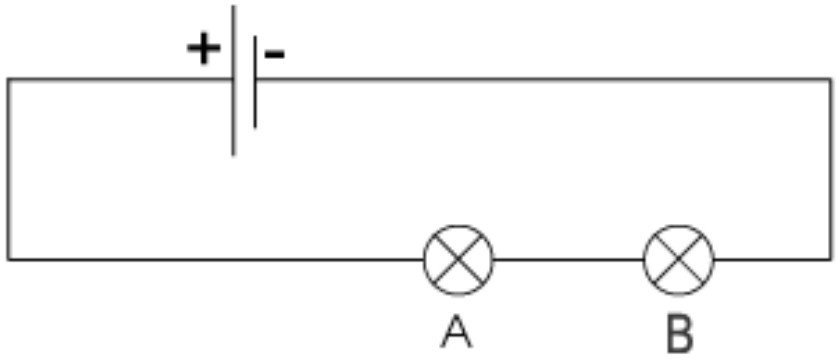
Siz bir diyetisyensiniz ve bir hastanıza yağ ve protein oranı düşük diyet vermeniz gerekiyor. Yukarıdaki seçenekleri en uygun olan diyetten uygun olmayana doğru sıralayınız.



Sonraki sayfaya geçiniz >>>

SORU 2) ----------

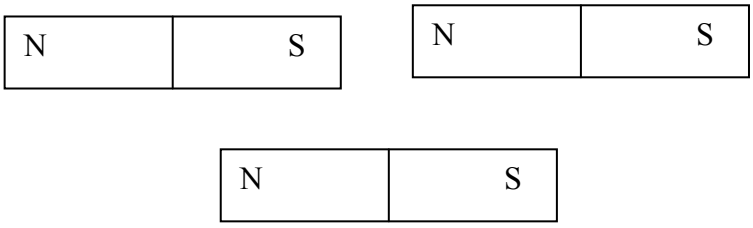
Aşağıdaki devrede A lambasının verdigi ışık şiddetinin artmasını sağlamak için neler yapılmalıdır. İki tanesini yazınız



1) ……

2) ……

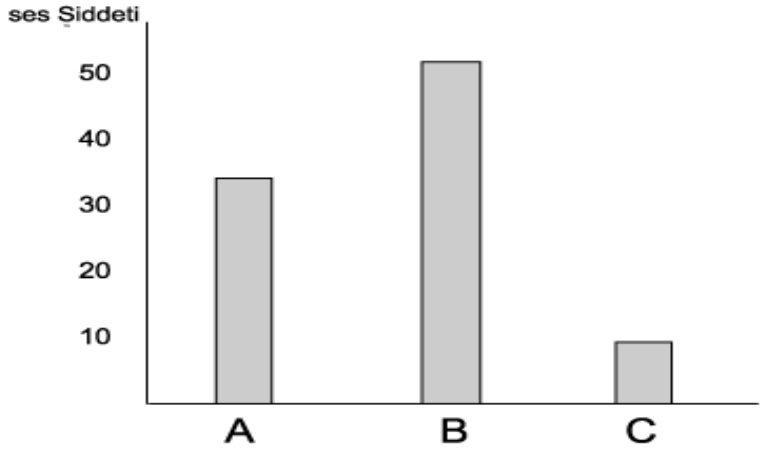
SORU 3) ----------



Yukarıdaki mıknatıs şekline bağlı kalarak üç tane mıknatısı üçgen oluşturacak şekilde öyle bir yerleştirin ki üçgen bozulmadan durabilsin. Çizerek gösteriniz.

Sonraki sayfaya geçiniz >>>

SORU 4) ----------

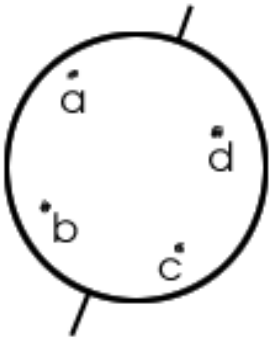


Elimizdeki bir çalar saatin ses yüksekliği grafiği üç ortama göre yukarıda verilmiştir. Bu üç ortamı aşağıdaki verilen ortamlar ile eşleştirerek tabloya A, B, C ortamlarının hangisi olduğunu yazınız.

Hava dolu fanus	Su dolu fanus	Havası boşaltımış fanus

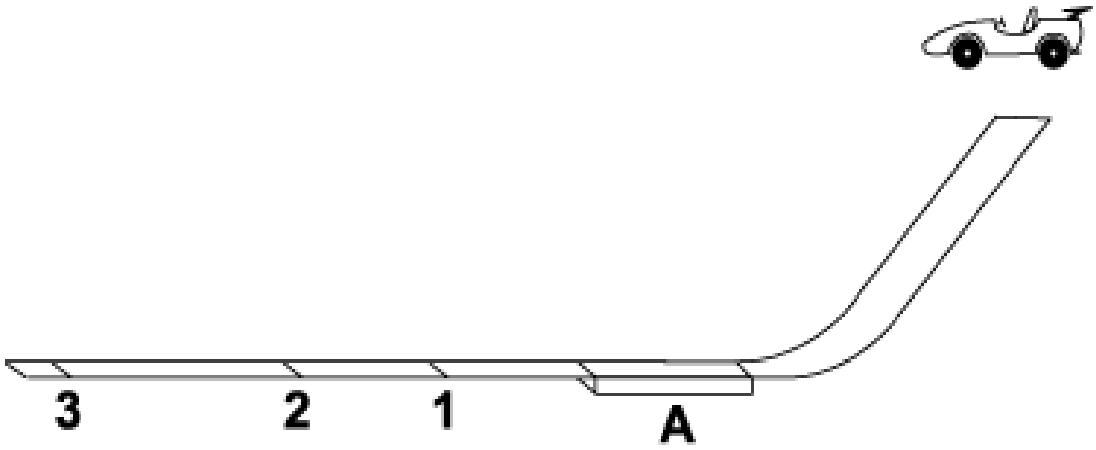
SORU 5) ----------

Aşağıda dünyanın basit bir çizimi ve dünya üzerindeki 4 nokta gösterilmiştir. **b** ve **c** noktalarında **gece** olması icin güneş nerede olmalıdır. Güneşin yerini resim üzerinde basitçe çizerek gösteriniz.



Sonraki sayfaya geçiniz >>>

SORU 6) ----------



Düzenekteki arabayı eğimli yüzeyin yukarısından bırakarak bir deney yapıyorsunuz.
A ile gösterilen bölgeyi **halı , buz** ve **plastik** maddelerinden biri ile kapladığınızda arabanın hangi noktaya kadar gittiğini ölçüyorsunuz. Sizce bu maddeleri kullandığınızda araba hangi noktalara kadar gidebilir ?

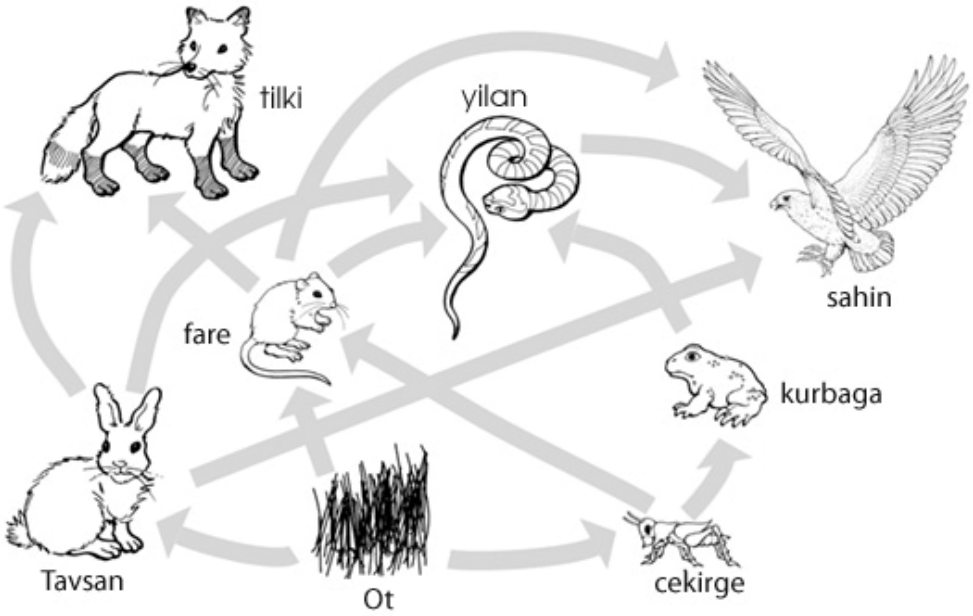
A yüzeyi halı olursa araba ..... noktasına kadar gider.

A yüzeyi buz olursa araba ..... noktasına kadar gider.

A yüzeyi plastik olursa araba ..... noktasına kadar gider.

Sonraki sayfaya geçiniz >>>

SORU 7) ----------



Yukarıda verilen besin zincirinden hangi canlıyı kaldırırsak tüm besin zinciri yok olur? Neden?

Canlı adı :.....
Nedeni :

SORU 8) ----------

4 ayrı saksıdaki fasulye tohumları farklı koşullar altında yetiştirilmiştir.Her bir saksı için uygulanan ısı / ışık / gübre ve su miktarları aşağıdaki tabloda gösterilmiştir. 1. hafta sonunda bitkilerin boyları ölçüldüğünde bazılarının çok , bazılarının az geliştiği görülmüştür. Sizce en çok gelişen bitki hangi saksıdaki bitkidir? Nedenini açıklayınız

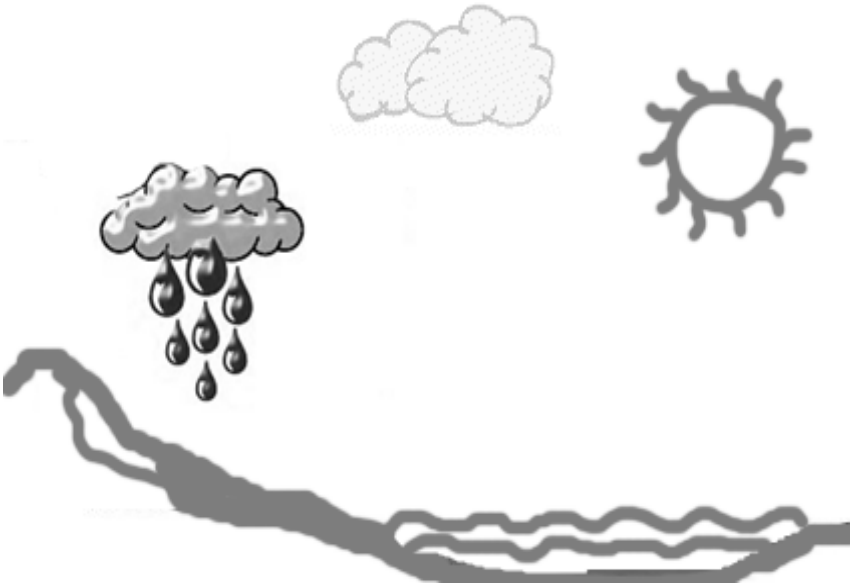
	1. Saksı	**2. Saksı**	**3. Saksı**	**4. Saksı**
ISI	Düşük	Düşük	Düşük	Uygun
IŞIK	Yok	Var	Var	Var
GÜBRE	Yok	Yok	Yok	Var
SU	Az	Uygun	Az	Uygun
SES	Var	Yok	Var	Yok

Hangi saksı ..... Nedeni :

Sonraki sayfaya geçiniz >>>

SORU 9) ----------

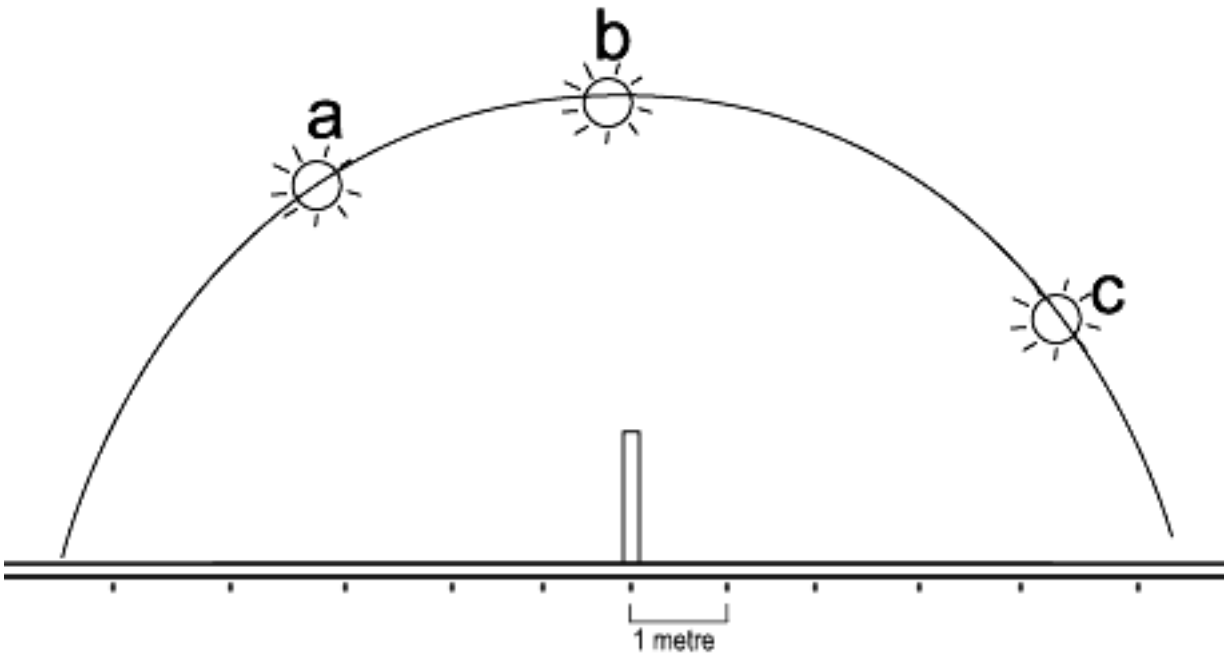
a) Aşağıda gördüğünüz su döngüsünü, oklarla tamamlayınız.
b) Buharlaşma ve yoğuşmanın nerelerde meydana geldiğini şekil üzerine yazarak gösteriniz.



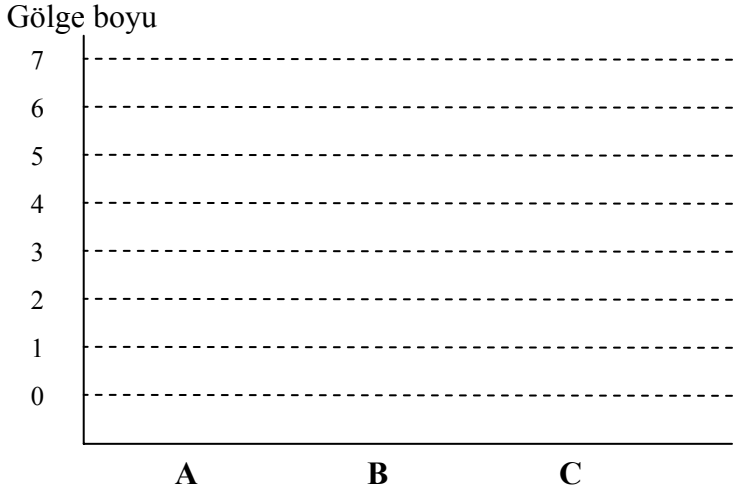
c) Verilen su döngüsünde güneş olmasaydı neler olurdu? Açıklayınız.

Sonraki sayfaya geçiniz >>>

SORU 10) ----------

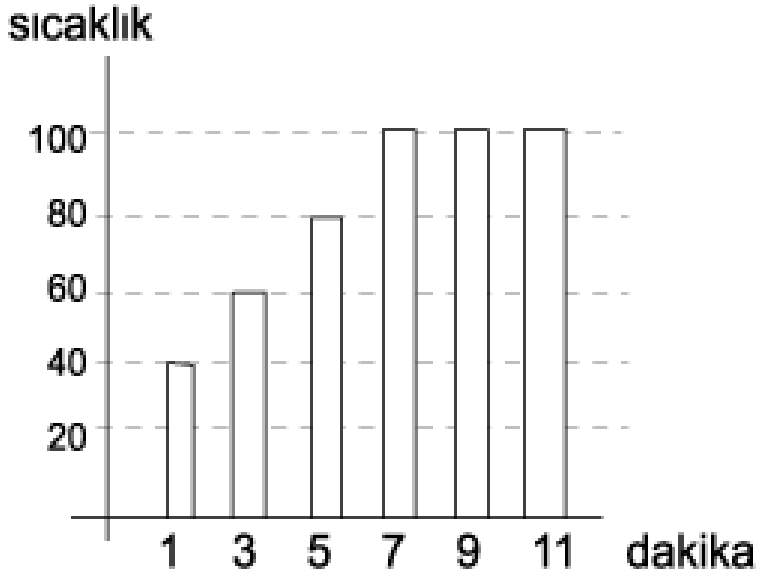


Şekilde güneşin gökyüzündeki üç konumu gösterilmiştir. Güneşin bu üç konumuna göre , çubuğun gölge boyu uzunluğunu, sütun grafiği olarak çiziniz . Birim aralığı 1 metre olarak verilmiştir.



Sonraki sayfaya geçiniz >>>

SORU 11) ----------



Yukarıdaki grafik, ısıtılmakta olan suyun zamana bağlı sıcaklık değişimini gösteriyor. Bu grafiği kullanarak aşağıdaki sorulara cevap veriniz.

a) **4.** dakikada suyun yaklaşık sıcaklığı kaç olabilir?

b) Su hangi dakikada kaynamaya başlamıştır.

c) **7 , 9** ve **11**. dakikalarda sıcaklık neden sabittir?

---------- TEST BİTTİ – Teşekkürler ----------

5. SINIF FEN BİLGİSİ BAŞARI TESTİ – B GRUBU

Sevgili öğrenciler, aşağıdaki sorular sizin 1 yıl boyunca fen bilgisi dersinizde öğrendiklerinizi ölçmek için hazırlanmıştır. Cevaplarınızı verirken boş soru bırakmamaya gayret ediniz. Teşekkür ederim.

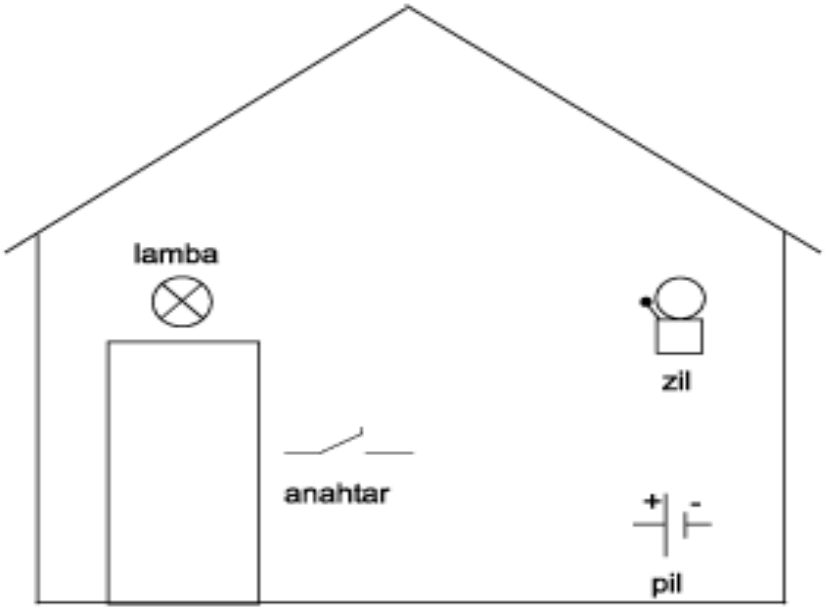
GÖZDE PEKİNER

SORU 1) ----------

Çimen --------→ Çekirge --------→ Küçük Kuşlar --------→ Atmaca

Bu besin zincirinde tek bir canlı türünün sayısının değişmesi bile zincirdeki tüm diğer canlıları etkileyecektir. Bu besin zincirinde küçük kuşlar hastalanıp ölseydi zincirdeki canlılarda meydana gelecek iki değişikliği nedenleriyle yazınız.

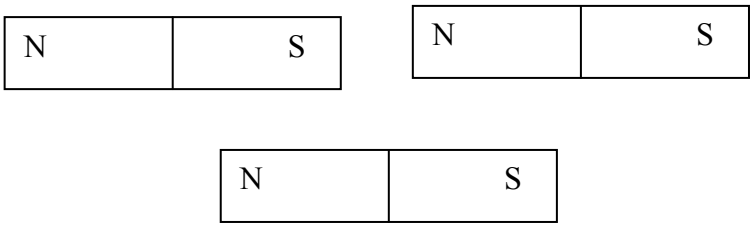
SORU 2) ----------



Yukarıdaki çizimde ziyaretçi anahtara bastığında, hem lambanın yanması hem de zilin çalması için gerekli devre çizimini şekil üzerinde yapınız.

Sonraki sayfaya geçiniz >>>

SORU 3) ----------



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SORU 4) ----------

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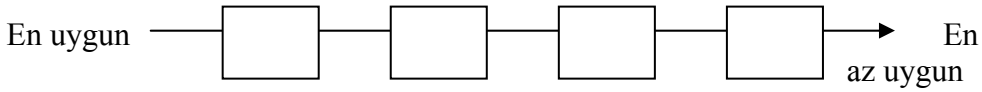
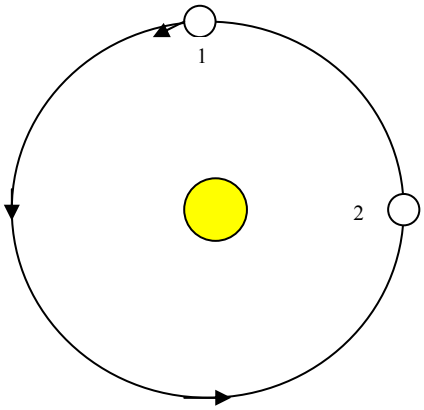


Sonraki sayfaya geçiniz >>>

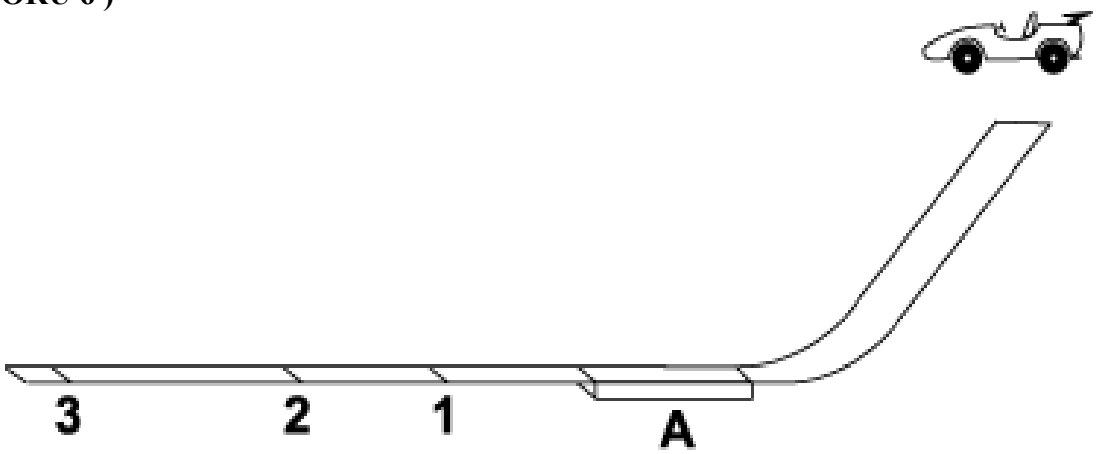
SORU 5) ----------



Dünyanın güneş etrafındaki yörüngesindeki iki durumunu görüyorsunuz.

Dünya 1. noktadan 2. noktaya , ok ile gösterilen yönde hareket eder .Bu hareket kaç gün sürmüştür?

SORU 6) ----------



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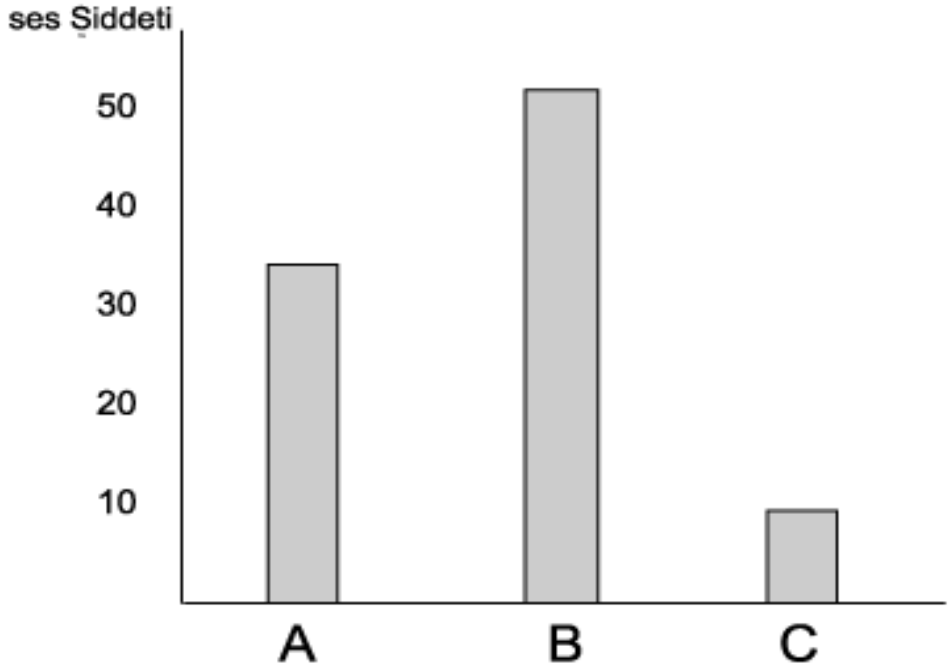
Sonraki sayfaya geçiniz >>>

SORU 7) ----------



Elimizdeki bir çalar saatin ses yüksekliği grafiği üç ortama göre yukarıda verilmiştir. Bu üç ortamı aşağıdaki verilen ortamlar ile eşleştirerek tabloya A, B, C ortamlarının hangisi olduğunu yazınız.

Hava dolu fanus	Su dolu fanus	Havası bir miktar boşaltımış fanus

Sonraki sayfaya geçiniz >>>

SORU 8) ----------

4 ayrı saksıdaki fasulye tohumları farklı koşullar altında yetiştirilmiştir.Her bir saksı için uygulanan **ısı** / **ışık** / **gübre** ve **su** miktarları aşağıdaki tabloda gösterilmiştir. 1. hafta sonunda bitkilerin boyları ölçüldüğünde bazılarının çok , bazılarının az geliştiği görülmüştür. Sizce en çok gelişen bitki hangi saksıdaki bitkidir? Nedenini açıklayınız

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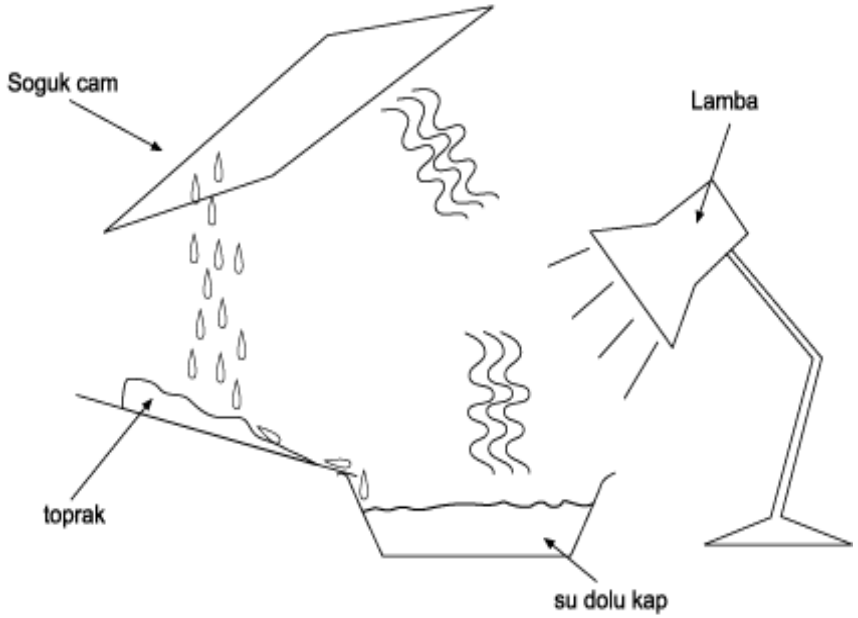
IŞIK	Yok	Var	Var	Var
GÜBRE	Yok	Yok	Yok	Var
SU	Az	Uygun	Az	Uygun
SES	Var	Yok	Var	Yok

Hangi saksı ..... Nedeni :

Sonraki sayfaya geçiniz >>>

SORU 9) ----------



Yukarıda çeşitli cisimler kullanılarak hazırlanmış doğadaki su döngüsüne benzer bir düzenek görmekteyiz.
Buna göre:

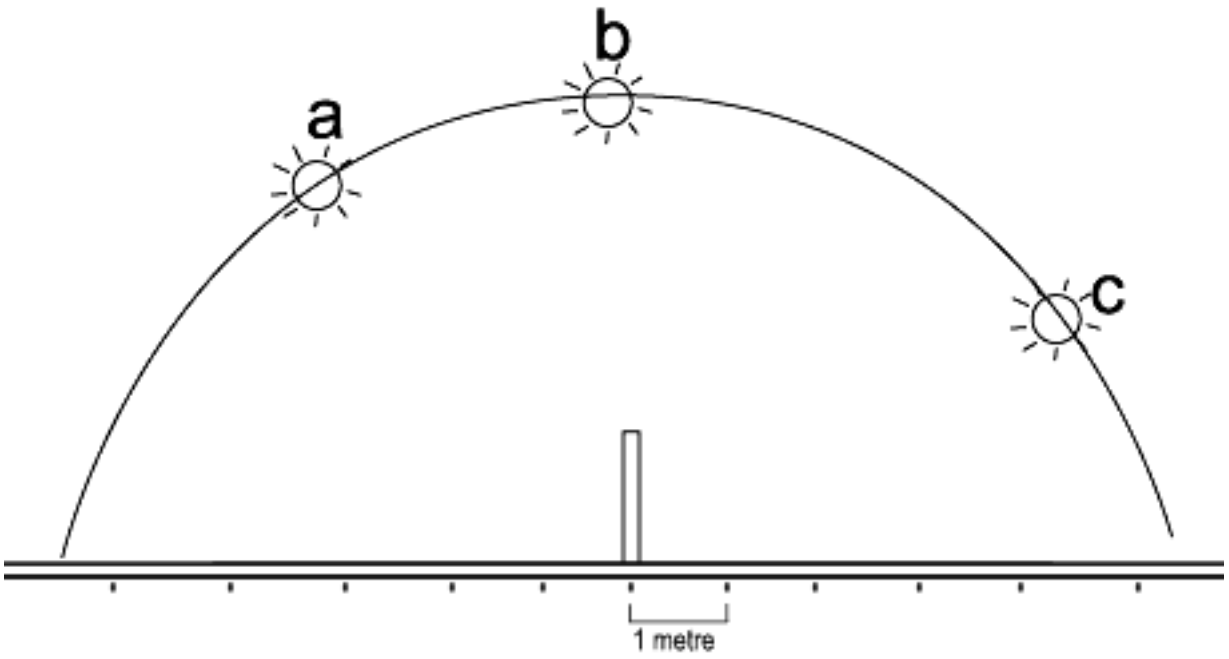
a) Bu düzenekteki cisimler ile doğadaki karşılıklarını oklarla eşleştiriniz

Su dolu kap ☐	☐ Soğuk hava tabakası
Lamba ☐	☐ Göl
Cam ☐	☐ Güneş

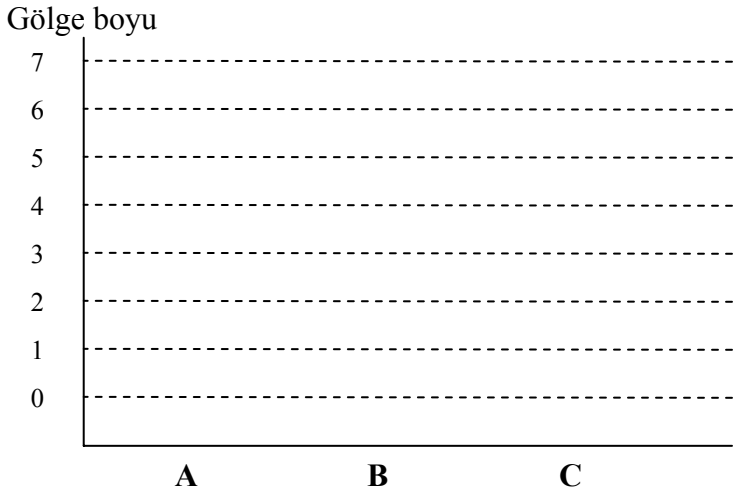
b) Bu düzenekte soğuk cam olmasaydı düzenekteki değişiklikler neler olurdu ?

Sonraki sayfaya geçiniz >>>

SORU 10) ----------



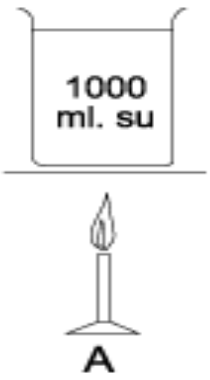
Şekilde güneşin gökyüzündeki üç konumu gösterilmiştir. Güneşin bu üç konumuna göre , çubuğun gölge boyu uzunluğunu, sütun grafiği olarak çiziniz . Birim aralığı 1 metre olarak verilmiştir.

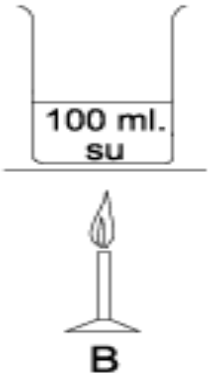


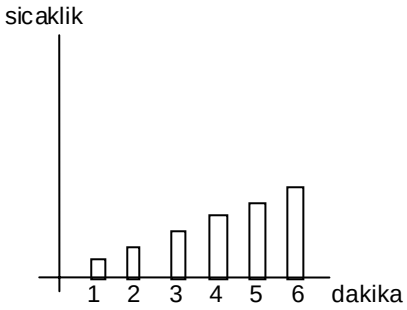
Sonraki sayfaya geçiniz >>

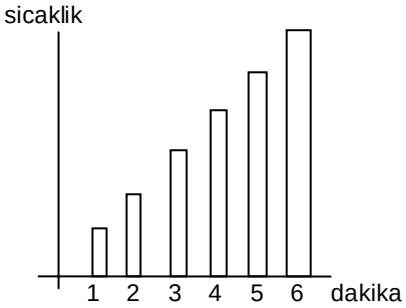
SORU 11) ----------

Aşağıdaki deney düzeneğinde farklı miktarlardaki su, aynı şiddette ve aynı sürede ısıtılmaktadır. Verilen grafikleri inceleyerek , grafiğin altına , uygun olan düzeneğin adını yazınız.









_____ _____

---------- TEST BİTTİ – Teşekkürler ----------

APPENDIX C

TEACHERS' CLASSROOM ACTIVITIES SCALE

Fen Bilgisi Öğrenci Anketi

Sevgili öğrenciler, aşağıda 72 adet soru verilmiştir. Bu soruların amacı sizinle ilgili olarak bazı kişisel bilgiler toplamak ve Fen Bilgisi derslerinin nasıl yapıldığına dair görüşlerinizi almaktır. Elde edilen bilgiler, Fen Bilgisi derslerinin geliştirilmesi amacı ile kullanılacaktır. Bu nedenle vereceğiniz yanıtların doğruluğu son derece önemlidir. Her bir soruyu dikkatle okuyarak size uygun gelen yalnız bir seçeneği işaretleyiniz. Verdiğiniz yanıtlar kesinlikle gizli tutulacaktır.

Gözde Pekiner

1. Cinsiyetiniz ,
   a. Erkek
   b. Kız

2. Okula devamsızlığım,
   a. Hiç yok
   b. 1-10 gün arası
   c. 11 gün ve üzeri

3. Fen bilgisi dersine çalışmak için haftada ortalama kaç saat ayırırsınız?

   a) Hiç b) 1 satten az c) 1-3 saat arası d) 3 saatten fazla

4. Annenizin ve babanızın öğrenim durumu nedir?

	Anne	Baba
Okula gitmemiş	A	A
İlkokul mezunu	B	B
Ortaokul mezunu	C	C
Lise mezunu	D	D
Üniversite mezunu	E	E
Yüksek lisans yapmış	F	F
Doktora yapmış	G	G
Bilmiyorum	H	H

5. Evinizde yaklaşık olarak kaç tane kitap vardır?

Hiç ya da çok az (0-10 tane)	A
Bir rafı dolduracak kadar (11-25 tane)	B
Bir kitaplığı dolduracak kadar (26- 100 tane)	C
İki kitaplığı dolduracak kadar (101 – 200 tane)	D
İkiden fazla kitaplığı dolduracak kadar (200 den fazla)	E

6. Aşağıdakilerden hangileri evinizde bulunur ?

	Evet	Hayır
a) Hesap makinesi	A	B
b) Bilgisayar	A	B
c) İnternet bağlantısı	A	B
d) Kendime ait odam	A	B
e) Kendime ait çalışma masam	A	B
f) Sözlük	A	B
g) Ansiklopedi	A	B
h) Deney setleri	A	B
i) Çamaşır makinası	A	B
j) Bulaşık Makinası	A	B

---

7. Evinizde sizinle beraber kaç kişi yaşamakta?

3 kişi	A
4 kişi	B
5 kişi	C
6 kişi	D
7 kişi	E
7'den fazla	F

Sevgili öğrenciler, aşağıda fen bilgisi derslerini yaptığınız öğretmenlerinize yönelik bazı ifadeler verilmektedir. Bu ifadeleri okuyarak size uygun gelen tek bir seçeneğe işaret koyunuz.

	Hemen her gün	Haftada **1-2** kez	Ayda **1-2** kez	Dönem boyunca **1-2** kez	Hiçbir Zaman
1. Öğretmenim fen bilgisi dersinde benimle ilgilenir.					
2. Öğretmenim benim fen bilgisini nasıl öğrendiğimi bilir.					
3. Öğretmenim fen bilgisi dersinde yaptıklarımın ve söylediklerimin doğruluğu konusunda bana yol gösterir.					
4. Öğretmenim fen bilgisi dersinde ders araç ve gereçlerinden yararlanır.					
5. Öğretmenim fen bilgisinde anlamadığım konuları tekrar açıklar.					
6. Öğretmenim beni dinler ve bana değer verir.					
7. Öğretmenim fen bilgisi dersinde bilgileri anlayacağım bir sıra içinde sunar.					
8. Fen bilgisini eğlenerek öğrenirim.					
9. Öğretmenim fen bilgisi dersinde derse katılmamı sağlar.					
10. Öğretmenim fen bilgisi dersi ile ilgili araştırma yapmama yardımcı olur.					
11. Fen bilgisi dersinde öğretmenin yaptıklarını ve anlattıklarını sessizce takip ederiz.					
12. Fen bilgisi dersinde çalışma kağıtları dağıtılır.					
13. Öğretmenim fen bilgisi konularını bizimle birlikte tartışır.					
14. Öğretmenim fen bilgisi ile ilgili soru ve problemlerin çözümünde bana yardımcı olur.					
15. Öğretmenim fen bilgisi derslerinde VCD, tepegöz, bilgisayar gibi araçları kullanır.					
16. Öğretmenim fen bilgisi anlatırken VCD, tepegöz, bilgisayar gibi araçları kullandığında daha iyi öğreniyorum.					
17. Öğretmenim fen bilgisi derslerinde boya kalemleri, resimler, renkli kartonlar kullanmamıza izin verir.					

	Hemen her gün	Haftada **1-2** kez	Ayda **1-2** kez	Dönem boyunca **1-2** kez	Hiçbir Zaman
18. Fen bilgisi dersinde boya kalemleri, resimler, renkli kartonlar kullanıldığında daha çok eğleniyorum.					
19. Fen bilgisi dersinde arkadaşlarımızla grup çalışması yaparız.					
20. Fen bilgisinde grup çalışması yaptığımızda konuyu daha iyi anlıyorum.					
21. Öğretmenim fen bilgisi dersinde proje çalışmaları verir.					
22. Hazırladığımız fen projelerini sınıfta sunarız.					
23. Fen bilgisinde, proje çalışmalarını kağıda yazıp öğretmenimize veririz.					
24. Fen bilgisinde proje ödevlerini yapmakta zorlanıyorum.					
25. Fen bilgisinde proje ödevlerini yaparken konuyu daha iyi anlıyorum					
26. Öğretmenim projelerimizi bitene kadar projelerimizle ilgilenir.					
27. Proje çalışmamız bittiğinde öğretmenim eksiklerimizi anlatır.					
28. Fen bilgisi dersinde ürün seçki dosyası hazırlarız.					
29. Fen bilgisinde ürün seçki dosyası hazırlarken zorlanırım.					
30. Fen bilgisinde ürün seçki dosyası hazırlarken konuyu daha iyi öğreniyorum.					
31. Fen dersini deneyler yaparak öğreniriz.					
32. Fen dersinde deneyleri öğretmenimiz yapar, biz seyrederiz.					
33. Fen bilgisi dersinde deneyleri gruplar halinde yaparız.					
34. Fen dersinde deney yaptığımızda konuyu daha iyi anlıyorum.					

35. Fen bilgisi dersinde çeşitli oyunlar oynarız.					
36. Fen bilgisi derslerini oyunlarla işlediğimizde hangi konuyu işlediğimizi karıştırıyorum.					
37. Fen bilgisi derslerinde oynadığımız oyunlar, işlediğimiz konuya uygun olur.					
38. Öğretmenim fen bilgisi dersini tahtada anlatır.					
39. Öğretmenim fen bilgisi dersini tahtada anlattığında konuyu daha iyi anlıyorum.					
40. Öğretmenim günlük olaylardan örnekler verir					
41. Öğretmenim fen bilgisi dersini benim eğlendiğim ve anladığım biçimde işler.					
42. Öğretmenim fen araştırmalarımızda bilgisayar kullanmamız için destekler.					
43. Öğretmenim fen bilgisinde yeni konuya başlarken o konu ile ilgili sorular sorar.					
44. Öğretmenim fen bilgisiyle ilgili soru sorduktan sonra düşünmemiz için yeterli zaman verir.					
45. Öğretmenim bizi sözlü yapar.					

APPENDIX D

SCIENCE ATTITUDE SCALE

Fen Bilgisi Tutum Ölçeği

Sevgili öğrenci, bu ölçek sizin Fen bilgisi dersine yönelik düşüncelerinizi öğrenmek için hazırlanmıştır. Ölçekte belirtilen ifadelerden hiçbirinin kesin cevabı yoktur. Her ifadeyle ilgili görüş, kişiden kişiye değişebilir. Bunun için vereceğiniz yanıtlar kendi görüşünüzü yansıtmalıdır. Her ifadeyle ilgili düşüncenizi yazmadan önce, o ifadeyi dikkatlice okuyunuz, sonra ifadede belirtilen düşüncenin, sizin düşünce ve duygunuza ne derecede uygun olduğuna aşağıda belirtilen derecelendirmeyi düşünerek karar veriniz.

Hiç katılmıyorsanız,	Hiç Uygun Değildir
Katılmıyorsanız,	Uygun Değildir,
Kararsız iseniz,	Kararsızım
Kısmen katılıyorsanız,	Uygundur
Tamamen katılıyorsanız,	Tamamen Uygundur

Seçeneğini işaretleyiniz.

	Tamamen Uygundur	Uygundur	Kararsızım	Uygun Değildir	Hiç uygun Değildir
1. Fen bilgisi sevdiğim bir derstir.					
2. Fen bilgisi dersine girerken büyük bir sıkıntı duyarım.					
3. Fen bilgisi dersi olmasa öğrencilik hayatı daha zevkli olurdu.					
4. Arkadaşlarımla Fen bilgisi tartışmaktan zevk alırım.					
5. Fen bilgisine ayrılan ders saatlerinin fazla olmasını dilerim.					
6. Fen bilgisi dersine çalışırken canım sıkılır.					
7. Fen bilgisi dersi bence gereksizdir.					
8. Fen bilgisi dersinden hoşlanırım.					
9. Fen bilgisi dersleri bana çok uzun geliyor.					
10. Fen bilgisi benim için ilgi çekicidir.					
11. Fen bilgisi bütün dersler içinde en korktuğum derstir.					
12. Yıllarca Fen bilgisi okusam bıkmam.					
13. Fen bilgisi derslerinde eğleniyorum.					
14. Fen bilgisi sınavları beni korkutur.					

15. Kendimi Fen bilgisi derslerinde başarılı hissederim.					
16. Fen bilgisi sorularını çözmekten keyif alırım.					
17. Fen bilgisi dersinde başarılı olamıyorum.					
18. Fen bilgisi dersine ne kadar çalışırsam çalışayım sınavlarda iyi not alamıyorum.					
19. Fen bilgisi benim için diğer sınıf arkadaşlarım için olduğundan daha zordur.					
20. Fen bilgisi dersini diğer derslerimden daha yavaş öğreniyorum					

APPENDIX E

Dördüncü Sınıf Fen Bilgisi Başarı Testi A ve B Grup Soruları Kazanımları

A_1= B_3

Ünite adı: Maddeyi Tanıyalım
Öğrenme Alanı: Madde ve Değişim

Kazanımlar:

Katıların, sıvıların ve gazların temel özellikleriyle ilgili olarak öğrenciler;
Katıların belirli bir şekli olduğunu fark eder ,

Bilimsel Süreç Becerisi Kazanımları:

- Gözlem;

Nesneleri (cisim, varlık) veya olayları çeşitli yollarla bir veya daha çok duyu organını kullanarak gözlemler.

Bir cismin, şekil, renk, büyüklük ve yüzey özellikleri gibi çeşitli özelliklerini belirler.

- Karşılaştırma-Sınıflama;

Gözlemlere dayanarak bir veya birden fazla özelliğe göre karşılaştırmalar yapar.

A_2= B_2

Ünite adı: Maddeyi Tanıyalım
Öğrenme Alanı: Madde ve Değişim

Kazanımlar:

1) Katıların hacmini ölçmek için yöntem önerir; bu yöntemle bir katının hacmini ölçer .

Bilimsel Süreç Becerisi Kazanımları:

- Deney Tasarlama;

- Bir tahminin doğruluğunun nasıl test edilebileceğine yönelik basit bir deney önerir.

- Deney Malzemelerini ve Araç-Gereçlerini Tanıma ve Kullanma;

- Basit araştırmalarda gerekli malzeme ve araç gereçleri seçer; becerikli, emniyetli ve etkin bir şeklide kullanır.

- Ölçme;

- Cetvel, termometre, tartı aleti ve zaman ölçer gibi basit ölçüm araçlarını tanır.
-Büyüklükleri uygun ölçme araçları kullanarak belirler.

2) Katıların, sıvıların ve gazların temel özellikleriyle ilgili olarak öğrenciler;
Katıların belirli bir şekli olduğunu fark eder

Bilimsel Süreç Becerisi Kazanımları:

- Gözlem;

Nesneleri (cisim, varlık) veya olayları çeşitli yollarla bir veya daha çok duyu organını kullanarak gözlemler.

Bir cismin, şekil, renk, büyüklük ve yüzey özellikleri gibi çeşitli özelliklerini belirler.

- Karşılaştırma-Sınıflama;

Gözlemlere dayanarak bir veya birden fazla özelliğe göre karşılaştırmalar yapar.

3) Hacim ve kütle kavramları ve birimleri ile ilgili olarak öğrenciler;
Katı ve sıvı maddelerin kütlelerini ölçer; g ve kg cinsinden ifade eder.

Bilimsel Süreç Becerisi Kazanımları:

- Ölçme;

- Cetvel, termometre, tartı aleti ve zaman ölçer gibi basit ölçüm araçlarını tanır.
-Büyüklükleri uygun ölçme araçları kullanarak belirler.
- Büyüklükleri birimleri ile ifade eder.

- Verileri Kaydetme;

- Gözlem ve ölçüm sonucunda elde edilen araştırmanın amacına uygun verileri yazılı ifade, resim, tablo ve çizim gibi çeşitli yöntemlerle kaydeder.

A_3= B_5

Ünite adı: Canlılar Dünyasını Gezelim, Tanıyalım
Öğrenme Alanı: Canlılar ve Hayat

Kazanımlar:

1) Bir yaşam alanında bulunabilecek canlıları tahmin eder .

Bilimsel Süreç Becerisi Kazanımları:

- Çıkarım Yapma;
  -Olmuş olayların sebepleri hakkında gözlemlere dayanarak açıklamalar önerir.

- Tahmin;
  -Gözlem, çıkarım veya deneylere dayanarak geleceğe yönelik olası sonuçlar hakkında fikir öne sürer.

2) Çevresinde bir yaşam alanında canlıları ve bu canlıların içinde bulunduğu şartları gözlemler ve kaydeder .

Bilimsel Süreç Becerisi Kazanımları:

- Verileri Kaydetme;
  -Gözlem ve ölçüm sonucunda elde edilen araştırmanın amacına uygun verileri yazılı ifade, resim, tablo ve çizim gibi çeşitli yöntemlerle kaydeder.

3) Yaşam alanlarının insan faaliyetlerinin olumsuz etkisinden korunması gerektiği çıkarımını yapar .

Bilimsel Süreç Becerisi Kazanımları:

- Çıkarım Yapma;
  -Olmuş olayların sebepleri hakkında gözlemlere dayanarak açıklamalar önerir.
- Fen-Teknoloji-Toplum-Çevre Kazanımları:

- İnsanların ve toplumun çevreyi nasıl etkilediğini bilir.

A_4= B_4

Ünite adı: Maddeyi Tanıyalım
Öğrenme Alanı: Madde ve Değişim

Kazanımlar:
1) Mıknatıslar tarafından çekilen ve çekilmeyen maddeleri ayırt eder

Bilimsel Süreç Becerisi Kazanımları:

- Karşılaştırma Sınıflama;

- Gözlemlere dayanarak bir veya birden fazla özelliğe göre karşılaştırmalar yapar.
- Benzerlik ve farklılıklara göre grup ve alt-gruplara ayırma şeklinde sınıflamalar yapar.
- Deney Malzemelerini ve Araç-Gereçlerini Tanıma ve Kullanma;
- Basit araştırmalarda gerekli malzeme ve araç gereçleri seçecekler; becerikli, emniyetli ve etkin bir şekilde kullanır.

A_5= B_1

Ünite adı: Vücudumuz Bilmecesini Çözelim
Öğrenme Alanı: Canlılar ve Hayat

Kazanımlar:
1) Egzersizin nabza ve soluk alıp vermeye etkisi ile ilgili olarak öğrenciler; Gözlemleri sonucunda egzersizin nabza etkisini fark eder

Bilimsel Süreç Becerisi Kazanımları:

- Gözlem;

- Nesneleri (cisim, varlık) veya olayları çeşitli yollarla bir veya daha çok duyu organını kullanarak gözlemler.

2) Egzersiz sonucu nabız ile ilgili elde ettiği verileri kaydeder ve yorumlar.

Bilimsel Süreç Becerisi Kazanımları:

- Bilgi ve Veri Toplama:

-Değişik kaynaklardan yararlanarak bilgi ve veri toplar (örneğin çevrede gözlem, sınıfta gözlem ve deney, fotoğrafla, kitaplar, haritalar veya bilgi ve iletişim teknolojileri.

- Verileri Kaydetme;

-Gözlem ve ölçüm sonucunda elde edilen araştırmanını 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.

- Fen-Teknoloji-Toplum-Çevre Kazanımları

-Doğal olayların betimlenmesinde sayısal verilere ihtiyaç olduğunu anlar.

3) Gözlemleri sonucunda egzersizin soluk alıp verme sıklığına etkisini fark eder.

Bilimsel Süreç Becerisi Kazanımları:

- Gözlem;
- - Nesneleri (cisim, varlık) veya olayları çeşitli yollarla bir veya daha çok duyu organını kullanarak gözlemler.

4) Gözlem ve araştırmaları sonucunda egzersiz, soluk alıp verme ve nabız arasında ilişki kurar Bilimsel Süreç Becerisi Kazanımları:

- Gözlem;

- Nesneleri (cisim, varlık) veya olayları çeşitli yollarla bir veya daha çok duyu organını kullanarak gözlemler.

- Yorumlama ve Sonuç Çıkarma;

-Elde edilen bulgulardan desen ve ilişkilere ulaşır.
-Egzersiz dışında nabız ve soluk alıp verme hızına etki eden etkenleri belirtir.

A_6 = B_6

Ünite adı: Işık ve Ses
Öğrenme Alanı: Fiziksel Olaylar

Kazanımlar:
1) Çevredeki ışık kaynaklarıyla ilgili olarak öğrenciler;
Bazı cisimlerin çevrelerine ışık yaydıklarını gözlemler.

2) Farklı ışık kaynaklarına örnekler verir.
3) Işık kaynaklarını, doğal/yapay oluşları ve parlaklıkları bakımından sınıflandırır. Bilimsel Süreç Becerisi Kazanımları:

- Karşılaştırma Sınıflama;

- Gözlemlere dayanarak bir veya birden fazla özelliğe göre karşılaştırmalar yapar.
- Benzerlik ve farklılıklara göre grup ve alt-gruplara ayırma şeklinde sınıflamalar yapar.

- Fen-Teknoloji-Toplum-Çevre Kazanımları:

- Bazı ürün ve sistemlerin doğal, bazılarının ise yapay (insanlar tarafından yapılmış) olduğunu fark eder.
4) Bazı cisimlerin, ortamda bulunan başka ışık kaynaklarının varlığında ışık yayıyormuş gibi göründüklerini fark eder.

A_7=B_7

Ünite adı: Yaşamımızdaki Elektrik
Öğrenme Alanı: Fiziksel Olaylar

Kazanımlar:
Basit elektrik devreleri oluşturma ile ilgili olarak öğrenciler;
1) Basit bir elektrik devresinin, temel devre elemanlarını (pil, ampul, duy, anahtar, kablo, pil yatağı) tanır ve kullanır.
2) Basit bir elektrik devresi kurar ve çalıştırır .
3) Bir elektrik devresinin hangi durumlarda çalışmayacağını fark eder.
4) Verilen çeşitli devre resimlerinin çalışıp çalışmayacağını tahmin eder ve sebebini açıklar.

Bilimsel Süreç Becerisi Kazanımları:

- Tahmin;

- Gözlem, çıkarım veya deneylere dayanarak geleceğe yönelik olası sonuçlar hakkında fikir öne sürer.

A_8=B_9

Ünite adı: Işık ve ses
Öğrenme Alanı: Fiziksel Olaylar

Kazanımlar:

1) Titreşim ve ses oluşumu ilişkisiyle ilgili olarak öğrenciler;
Çeşitli cisimler kullanarak farklı sesler üretir.

Bilimsel Süreç Becerisi Kazanımları:

- Deney Tasarlama;

Bir tahminin doğruluğunun nasıl test edilebileceğine yönelik basit bir deney önerir.

2) Ses üreten cisimlerin titreştiğini fark eder.

3)Titreşen her cismin ses üretebileceğini ifade eder.

4) Ses şiddetini değiştirmeye ve işitme yetimizi geliştirmeye yarayan araçlara örnekler verir.

A_9= B_10

Ünite adı: Kuvvet ve Hareket
Öğrenme Alanı: Fiziksel Olaylar

Kazanımlar:

1. Hareket eden varlıkların hareket özelliklerini hızlı, yavaş, dönen ve sallanan gibi kelimelerle ifade eder
2. Varlıkları hareket özelliklerine (yön değiştirme, hızlanma, yavaşlamalarına) göre karşılaştırarak sınıflandırır.
3. Cisimleri hareket ettirme ve durdurma ile ilgili olarak öğrenciler;

4. Cisimleri iterek veya çekerek nasıl hareket ettirebileceğini gösteren bir deney önerir. Bilimsel Süreç Becerisi Kazanımları:

- Deney Tasarlama;

-Bir tahminin doğruluğunun nasıl test edilebileceğine yönelik basit bir deney önerir.

5) Cisimleri iterek veya çekerek hareket ettirebileceğini gösteren bir deney yapar.

6) Bir cismi iterek veya çekerek harekete geçirebileceği sonucunu çıkarır.

7) Hareket eden bir cismi iterek veya çekerek yavaşlatabileceği ya da durdurabileceği sonucunu çıkarır.

Kuvvetin cisimler üzerindeki çeşitli etkilerini anlamak amacıyla öğrenciler;

8) Gözlemlerine dayanarak bir cisim eğer hızlanıyor, yavaşlıyor veya yön değiştiriyorsa ona bir kuvvet uygulandığı çıkarımını yapar.

9) Kuvvetin cisimlerin hareket ve şekilleri üzerindeki etkilerini örneklerle açıklar.

A_10-B_8

Ünite adı: Gezegenimiz Dünya
Öğrenme Alanı: Dünya ve Evren

Kazanımlar:

Dünya'mızın şekli ile ilgili olarak öğrenciler;

1) Dünya'nın şeklinin küreye benzediğini ifade eder.

Dünya'nın şeklinin küreye benzediğini gösteren örnekler verir.

Bilimsel Süreç Becerisi Kazanımları:

- Çıkarım Yapma;

-Olmuş olayların sebepleri hakkında gözlemlere dayanarak açıklamalar önerir.

*Kazanımlar, 4. sınıf Fen ve Teknoloji Programındaki orjinal hali ile konulmuştur.

APPENDIX F

Beşinci Sınıf Fen Bilgisi Başarı Testi A ve B Grup Soruları Kazanımları

A_1= B_4

Ünite adı: Vücudumuz Bilmecesini Çözelim
Öğrenme Alanı: Canlılar ve Hayat

Kazanımlar:

1) Besinleri içerdikleri karbonhidrat, protein ve yağ açısından deney yaparak test eder.
2) Günlük enerji ihtiyacının beslenme ile ilişkisini kavrar.
3) Besinlerin içerikleri ile ilgili tablolar hazırlar.
4) Temel besin gruplarını belirtir.
5) Dengeli beslenmeye örnek biröğün hazırlar
6) Kendisi ve ailesi için günlük mönü düzenler.

A_2= B_2

Ünite adı: Yaşamımızdaki Elektrik
Öğrenme Alanı: Fiziksel Olaylar

Kazanımlar:

1) Basit bir elektrik devresinde ampullerin parlaklığının değiştirilmesi ile ilgili olarak öğrenciler;
1.1 Basit bir elektrik devresindeki ampulün parlaklığını nasıl değiştirebileceği hakkında tahminlerde bulunur .
1.2 Bir ampulün parlaklığını nasıl değiştirebileceği hakkındaki tahminlerini test eder .
1.3 Bir ampulün parlaklığını etkileyen değişkenleri listeler .
1.4 Elektrik devresinde sadece ampul sayısının değiştirilmesinde bağımlı, bağımsız değişkeni ve kontrol edilen değişkenleri belirler .
1.5. Elektrik devresinde sadece pil sayısının değiştirilmesi olayındaki bağımlı, bağımsız değişkeni ve kontrol edilen değişkenleri belirler.
1.6. Devrede pil sayısı aynı kalırken, ampul sayısının artması veya azalması ile ampullerin parlaklığının nasıl değiştiğini ifade eder.

1.7. Devrede ampul sayısı aynı kalırken pil sayısının artması veya azalması ile ampulün parlaklığının nasıl değiştiğini ifade eder.
1.8. Evde ve okulda odalardaki elektrik düğmelerinin birer devre anahtarı olduğunu farkeder.
1.9. Evde ve okulda odalardaki elektrik düğmelerinin ile lambalar arasında duvar içinden geçen bağlantı kablosu olduğu çıkarımını yapar.

2)Basit bir elektrik devresindeki elemanların sembolik gösterimi ve devre şemalarının çizimi ile ilgili olarak öğrenciler;
2.1. Basit bir elektrik devresindeki pil, ampul, bağlantı kablosu ve anahtarı sembolik olarak gösterir.
2.2. Devre elemanlarının sembolik gösterimlerinin, devre şeması çizimlerinde kullanıldığını fark eder.
2.3. Çalışan bir elektrik devresi şeması çizer.
2.4. Basit bir elektrik devre şemasından yararlanarak devreyi kurar ve çalıştırır.

A_3= B_3

Ünite adı: Kuvvet ve Hareket
Öğrenme Alanı: Fiziksel Olaylar
Kazanımlar:
1) Mıknatısların özellikleriyle ilgili olarak öğrenciler;
1.1.Mıknatısların birbirini çektiğini veya ittiğini gözlemler.
1.2.Mıknatısların farklı iki kutbu olduğunu fark eder.
1.3.Mıknatısların farklı kutuplarından birinin N ve diğerinin S olarak isimlendirildiğini ifade eder.
1.4.Mıknatısların aynı kutuplarının birbirini ittiği, zıt kutupların ise birbirini çektiği sonucuna ulaşır .

A_4= B_7

Ünite adı: Işık ve Ses
Öğrenme Alanı: Fiziksel Olaylar

Kazanımlar:
1) Sesin yayılmasıyla ilgili olarak öğrenciler;
1.1.Sesin boşlukta yayılamayacağını ifade eder.
1.2.Sesin katı, sıvı ve gaz ortamlarda yayılabileceğini deneylerle gösterir.
1.3.Sesin hangi ortamda yayılılıp yayılamayacağını tahmin eder.
1.4.Sesin farklı ortamlarda farklı duyulmasıyla ilgili olarak öğrenciler;
1.5.Aynı ses kaynağından üretilen sesin, farklı maddesel ortamlarda farklı işitileceğini fark eder. .

2) Ses yalıtımı ile ilgili olarak öğrenciler;
2.1.Hangi malzemelerin sesin yayılmasını daha iyi önleyeceğini tahmin eder.

2.2.Sesin yayılmasını önlemeyle ilgili tahminlerini, teknolojik tasarımın aşamalarını uygulayarak yaptığı bir model ile test eder.
2.3.Farklı maddesel ortamların sesin kulağımıza ulaşmasını farklı engellediği sonucunu çıkarır.
2.4.Farklı ortamları, sesin yayılmasını önleyebilme dereceleri bakımından karşılaştırır.

A_5= B_5

Ünite adı: Dünya, güneş ve ay
Öğrenme Alanı: Dünya ve Evren

Kazanımlar:

1) Dünya'nın hareketleri ile ilgili olarak öğrenciler;
1.1. Dünya'nın kendi etrafında döndüğünü ifade eder.
1.2. Dünya'nın kendi etrafında bir tam dönüşünü tamamladığı sürenin, bir gün olarak kabul edildiğini ifade eder.
1.3. Gece-gündüz oluşumunu, Dünya'nın kendi etrafındaki dönme hareketiyle açıklar.
1.4. Güneş'in gökyüzünde gün boyunca hareket ediyor gözükmesini, Dünya'nın kendi etrafındaki dönme hareketiyle açıklar (BSB-23).
1.5. Dünya'nın kendi etrafında dönerken aynı zamanda Güneş etrafında da dolandığını ifade eder.
1.6 Dünya'nın Güneş etrafında bir tam dönüşünü tamamladığı sürenin, bir yıl olarak kabul edildiğini belirtir.

A_6 = B_6

Ünite adı: Işık ve Ses
Öğrenme Alanı: Fiziksel Olaylar

Kazanımlar:

1. Sürtünme kuvvetini ve hayatımızdaki önemini anlamak amacıyla öğrenciler;
1.1. Çeşitli yüzeylerin (halı, beton, buz vb.), cisimlerin hareketlerine etkilerini karşılaştırır .
1.2. Bir cismin kaygan bir yüzeyde daha kolay, pürüzlü bir yüzeyde ise daha zor hareket ettirilebileceğini gözlemler.
1.3. Bir cismin kaygan bir yüzeyde daha kolay, pürüzlü bir yüzeyde ise daha zor hareket ettirilmesinin sebebini, sürtünen yüzeylerin farklılığı ile açıklar .

A_7=B_1

Ünite adı: Canlılar Dünyasını Gezelim, Tanıyalım
Öğrenme Alanı: Canlılar ve Hayat

Kazanımlar:

1. Çevredeki yaşam alanları ve burada yaşayan canlılar ile ilgili olarak öğrenciler;
1.1. Gözlemlediği bir yaşam alanındaki canlıların beslenmelerindeki benzerlik ve farklılıklarını karşılaştırır .
1.2 Bir yaşam alanındaki canlılar arasındaki beslenme ilişkilerini gösteren besin zinciri modeli oluşturur.
1.3. İnsan etkisi ile besin zincirindeki bir halkanın yok olması ile ortaya çıkabilecek sonuçları tartışır.

A_9=B_9

Ünite adı: Maddenin Değişimi ve Tanınması
Öğrenme Alanı: Madde ve Değişim

1) Yağmur ve karın oluşumu ve yer yüzünde suyun uğradığı değişimlerle ilgili olarak öğrenciler;
1.1 Yağmur, kar, buz, sis ve bulutun su olduğunu fark eder.
1.2 Suyun ısınınca buharlaştığını, buharın da soğuyunca yoğuştuğunu gösteren deney tasarlar.
1.3 Buharlaşma ile suyun havaya döndüğü ve yağışlarla buharlaşmanın birbirini dengelediği çıkarımında bulunur.
1.4 Su döngüsü ile yağış–buharlaşma dengesi arasında ilişki kurar.
1.5 Su döngüsünün gerçekleşmesi için enerji kaynağı gerektiği çıkarımında bulunur.

A_10=B_10

Ünite adı: Işık ve Ses
Öğrenme Alanı: Fiziksel Olaylar
Kazanımlar:
1) Işığın yayılmasıyla ilgili olarak öğrenciler;
1.1. Bir kaynaktan çıkan ışığın, doğrular boyunca yayıldığını fark eder.
1.3. Işığın iki nokta arasında izlediği yolu, ışınlar çizerek gösterir .
2) Gölge oluşumu ile ilgili olarak öğrenciler;
2.1. Gölgenin nasıl oluştuğunu keşfeder.
2.2. Işık kaynağının, cismin veya ekranın yeri değiştirildiğinde; cismin gölgesinin büyüklüğünün, yerinin ve/veya şeklinin değişebileceğini fark eder.
2.3. Gölgenin, cismin büyüklüğü ve şekline göre değişeceğini gösterir.
2.4. Gölge oluşumunu basit ışın çizimleri ile gösterir.

A_11-B_11

1) Isının madde üzerindeki etkileri ile ilgili olarak öğrenciler;
Isı-sıcaklık ilişkisi deneyimlerinden, ısının maddeler üzerindeki en belirgin etkisinin ısınma-soğuma olduğu çıkarımını yapar.

2) Bir sıvı kaynarken gözlemlerini ifade eder.

3)Saf maddelerin kaynama sıcaklıkları ile ilgili olarak öğrenciler;
Saf maddelerin kaynama sıcaklıklarının sabit olduğunu gösteren deney tasarlar.

*Kazanımlar, 5. sınıf Fen ve Teknoloji Programındaki orjinal hali ile konulmuştur.

APPENDIX G

TABLE OF SPECIFICATION OF 4th GRADE SCIENCE ACHIVEMENT TEST

Content/ objective Level	*KUL*	*HOTS*
Solve the puzzle of our body		A_5=B_1
Identify the matter	A_1=B_3, A_4=B_4	A_2=B_2
Force and motion		A_9=B_10
Light and Sound	A_6=B_6	A_8=B_9
Our planet : World	A_10=B_8	
Recognize the livings' world		A_3=B_5
Electricity in daily life		A_7=B_7

KUL (Knowledge and Understanding level) covers Knowledge, Comprehension, Application levels.

HOTS (Higher order thinking skills cover the levels: Analysis, Synthesis, Evaluation)

APPENDIX H

TABLE OF SPECIFICATION OF 5th GRADE SCIENCE ACHIVEMENT TEST

Content/ Objective Level	*KUL*	*HOTS*
Solve the puzzle of our body		A_1=B_4
Identify the matter and phases	A_11=B_11	A_9=B_9
Force and motion	A_3=B_3, A_6=B_6	
Electricity in daily life		A_2=B_2
World, sun and moon	A_5=B_5	
Recognize the livings'world		A_7=B_1, A_8=B_8
Light and Sound	A_4=B_7	A_10=B_10

KUL (Knowledge and Understanding level) covers Knowledge, Comprehension, Application levels.

HOTS (Higher order thinking skills cover the levels: Analysis, Synthesis, Evaluation)