THE EFFECTS OF HANDS-ON ACTIVITY ENRICHED INSTRUCTION ON SIXTH GRADE STUDENTS' ACHIEVEMENT AND ATTITUDES TOWARDS SCIENCE

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

BY

ÖZLEM TÜRK

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

MAY 2005

Approval of the Graduate School of Natural and Applied Sciences.

____

Prof. Dr. Canan ÖZGEN
Director

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

____

Prof. Dr. Ömer GEBAN
Head of Department

This is to certify that we 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.

____

Asisst.Prof.Dr. Jale Çakıroğlu
Supervisor

Examining Committee Members

Assoc.Prof.Dr. Ceren Tekkaya (METU, ELE) _______________________

Asisst.Prof.Dr. Jale Çakıroğlu (METU, ELE) _______________________

Asisst.Prof.Dr. Yezdan Boz (METU, SSME) _______________________

Asisst.Prof.Dr. Semra Sungur (METU, ELE) _______________________

Asisst.Prof.Dr. Esen Uzuntiryaki (METU, SSME) _______________________

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

Name, Last name: **Özlem Türk**

Signature:

ABSTRACT

THE EFFECTS OF HANDS-ON ACTIVITY ENRICHED INSTRUCTION ON SIXTH GRADE STUDENTS' ACHIEVEMENT AND ATTITUDES TOWARDS SCIENCE

TÜRK, Özlem

M.Sc., Department of Secondary Science and Mathematics Education
Supervisor: Assist. Prof. Dr. Jale Çakıroğlu

May 2005, 118 pages

This study aimed to investigate the effectiveness of hands-on activity enriched instruction on sixth grade students' achievement (on sense organs) and attitudes towards science. In this study, Science Achievement Test and Science Attitude Scale were used to assess students' achievement on sense organs and students' attitudes towards science, respectively. Also, hands-on activities about sense organs were prepared.

This study was conducted with 2 teachers and 4 classes and total of 140 sixth grade students in the public elementary schools at Keçiören district of Ankara in the fall semester of 2002-2003 academic years. One class of each teacher was assigned as experimental group and treated with hands-on activity enriched instruction and other class was assigned as control group and treated with traditional instruction. At the beginning of the study, both teachers were trained for how to implement hands-on activity enriched instruction in the classrooms. The Science Achievement Test and

The Science Attitude Scale were applied twice as pre-test and after three week treatment period as a post-test to both experimental and control groups to assess and compare the effectiveness of two different types of teaching utilized in science course.

The data obtained from the administration of post-test were analyzed by statistical techniques of Multivariate Analyses of Covariance (MANCOVA). The statistical result indicates that hands-on activity enriched instruction was more effective than traditional instruction. However, the statistical results failed to show a significant difference between the experimental and control groups attitudes toward science.

Keywords: Sense organs, Science achievement, Hands-on activities, Attitudes toward science

ÖZ

BASİT ARAÇLARLA HAZIRLANAN ETKİNLİKLERLE ZENGİNLEŞTİRİLMİŞ YAPARAK ÖĞRENME YÖNTEMİNİN ALTINCI SINIF ÖĞRENCİLERİNİN FEN BİLGİSİ BAŞARISINA VE FEN BİLGİSİ DERSİNE OLAN TUTUMLARINA ETKİSİ

TÜRK, Özlem

Yüksek Lisans, Orta Öğretim Fen ve Matematik Alanları Eğitimi Bölümü
Tez Yöneticisi: Assist. Prof. Dr. Jale ÇAKIROĞLU

Mayıs 2005, 118 sayfa

Bu çalışmanın amacı; basit araçlarla hazırlanan etkinliklerle zenginleştirilmiş yaparak öğrenme yönteminin altıncı sınıf öğrencilerinin fen bilgisi başarısına (duyu organları) ve fen bilgisi dersine yönelik tutumlarına etkisini araştırmaktır. Bu çalışmada öğrencilerin duyu organları konusundaki başarısını ve fen bilgisine yönelik tutumlarını ölçmek için sırasıyla Fen Bilgisi Başarı Testi ve Fen Bilgisi Tutum Ölçeği kullanıldı.

Çalışma, 2002-2003 akademik yılı sonbahar döneminde Ankara'nın Keçiören ilçesinde bir devlet ilköğretim okulundaki 140 altıncı sınıf öğrencisiyle, 2 öğretmen ve 4 sınıfta yapıldı. Her öğretmenin iki sınıfından bir tanesi basit araçlarla hazırlanan etkinliklerle zenginleştirilmiş yaparak öğrenme yönteminin uygulandığı deney grubu ve diğer sınıfı da geleneksel öğretim yönteminin uygulandığı kontrol grubu olarak belirlendi. Çalışmanın başında her iki öğretmen basit araçlarla hazırlanan etkinliklerle

zenginleştirilmiş yaparak öğrenme yöntemini nasıl uygulayacağı hakkında bilgilendirildi. Fen Bilgisi Başatı Testi ve Fen Bilgisi Tutum Ölçeği her iki gruba, iki farklı öğretim yönteminin etkisini karşılaştırmak için ön test ve üç haftalık bir uygulama sonunda da son test olarak uygulandı.

Son test sonuçları MANCOVA istatistiksel tekniği kullanılarak analiz edildi. İstatistiksel sonuçlar, basit araçlarla hazırlanan etkinliklerle zenginleştirilmiş yaparak öğrenme yönteminin geleneksel öğrenme yöntemine göre fen bilgisi başarısı açısından daha etkili olduğunu ama öğrencilerin fen bilgisi dersine yönelik tutumları açısından deney ve control grupları arasında anlamlı bir fark bulunamadığını gösterdi.

Anahtar Kelimeler: Duyu organları, Fen Bilgisi Başarısı, Basit araçlarla hazırlanan etkinlikler, Fen bilgisine yönelik tutum.

To my family…

ACKNOWLEDGEMENTS

I would like to thank to my supervisor Assist. Prof. Dr. Jale Çakıroğlu for her encouraging guidance, incredible patience, and supervision throughout this thesis study. Her lovely attitude was not restricted to this thesis study.

I would like to thank Assist.Prof.Dr. Semra Sungur for her support and advices.

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

I am very grateful to my family for their eternal love, encouragement and trust.

I wish to express my deep appreciation to my fiancée Gökhan Sadi for the extraordinary amount of time and effort he put into to complete this thesis. I want to thank for his support and love.

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

TABLE

LIST OF FIGURES

FIGURE

LIST OF SYMBOLS

SYMBOLS

MANCOVA: Multivariate Analysis of Covariance

ANCOVA: Analyses of Covariance

PREACH: Students’ Science Achievement Pre-Test Scores

PREATT: Students’ Science Attitude Pre-Test Scores

PSTACH: Students’ Science Achievement Post-Test Scores

PSTATT: Students’ Science Attitude Post-Test Scores

PCGPA: Students’ Previous Cumulative Grade Point Average

PSCG: Students’ Previous Science Course Grade

SACT: Science Achievement Test

SATS: Science Attitude Scale

MOT: Methods of Teaching

MRC: Multiple Regression Correlation

IV: Independent Variable

DV: Dependent Variable

ES: Effect Size

df: Degree of Freedom

CHAPTER I

INTRODUCTION

Science is not just a collection of facts. Facts are part of science. Actually, science is much more, it includes observing what's happening, predicting what might happen, testing predictions under controlled conditions to see if they are correct, or trying to make sense of our observations. Also, science involves trial and error, that mean trying failing, and trying again. Science does not provide all the answers. Therefore, children should have scientific information by developing their ideas, making scientific interpretations, and doing experiment. In addition, Rutherford and Ahlgren (1990) pointed that young people can see, touch, manipulate, modify, situations that allow them to figure out what happens in short events and puzzles that they can investigate, which is the very objects of science. Therefore, much of the research findings and literature indicate that students are likely to begin to understand the natural world if they work directly with natural phenomena, using their sense to observe and using instruments to extend the power of their senses (Haury & Rillero, 1994).

The primary goal of science education is to emphasize activities and learning by doing which is indicated almost all the educational reports on the science teaching. It is explained that more active learning for students and less possible direct opportunities to make meaning as a valid way to reach scientific literacy (Schmieder & Dayer, cited in Haury & Rillero, 1994).

The important way of efficient science teaching is to give opportunity to experiment with the natural world around them. Children should make direct concrete experience. According to Bristow (2000), science teaching is the most effective if the instructional program includes learning by doing approach. Haury and Rillero (1994) suggested that the study of natural world in both the elementary school and the high school should be by direct observational study with the specimens in the hands of each student, and especially, in the work below the high school, students should not use only textbook.

All through the last century, educational researchers have done different arrangements and essential renewals in science programs in different countries. Many suggestions related to active participants in science instruction. Since 1960, Bruner's ideas affect instructional strategies in science. Bruner (1966) stressed that effective learning can be done with active process in which learners construct new ideas based upon their framework of prior knowledge. Similarly, Dewey (1980) emphasized the ideas about learning through activity and child-centered instruction. So that, science curriculum studies in 1960s and 1970s affected science learning with hands-on activities (Hodson, 1990).

Current science curricula involved students learning from experiences and observation rather than from the authority of the textbook and the teacher (Rillero, 1993). Therefore, considerable interests focused on what should be thought and how it should be thought. And so, the term hands-on is widely used for good teaching in science and hands-on learning has become a common phrase in science education (Haury & Rillero, 1994).

There are various interpretations of what is meant by "hands-on learning". Hands-on learning is learning by doing. Hands-on learning involves the child in a total learning experience which enhances the child's ability to think critically. Hands-on learning, however, is not simply manipulating things. It is engaging in in-depth investigations with objects, materials, phenomena, and ideas and drawing meaning and understanding from those experiences (Haury & Rillero, 1994). In a program known as hands on science which has been defined as any science laboratory activity that allows the student to handle, manipulate or observe a scientific process (Lumpe

& Oliver, 1991). On the other hand, hands-on teaching can be differentiated from lectures and demonstrations by the central criterion that students interact with materials to make observations, but the approach involves more than mere activity. Moreover, laboratory or experiment is also differing from hands-on activities in two aspects. Firstly, especially in primary and secondary school, students can not do laboratory but perform hands-on science activities in their regular classroom, and secondly, students can carry out hands-on activities that are not careful experiments (Ruby, 2001). Besides, hands-on activities do not need some special materials and special medium.

Moreover, Haury and Rillero (1994) state that hands-on laboratory activities can be defined as students work directly with materials and manipulate physical objects to physically engage in experiencing science phenomena which involves the thinking, reading, writing or research.

Other terms for hands-on activities are material centered activities and manipulate activities (Doran, 1990). Hein (1987) explained that material centered science is related with hands-on science and activity centered science in which students are encouraged to manipulate materials rather that only reading textbooks. Manipulation of equipment provides concrete learning, experiences and designed to be touched or handed by students and by which develop their muscles, perceptual skills and psychomotor skills (Ross & Kurtz, 1993). Then, in practical activities, students can develop their problem solving, experimental design and hypothesizing skills. Inquiry oriented instruction is also related to hands-on learning; however, these terms are not synonymous in assessment aspect (Haury, 1993). Welch, Anderson & Harris (1982) would have agreed with the assessment that instruction in inquiry classrooms reflects a variety of methods, discussions, investigation, laboratories, and student initiated inquiry lectures. On the other hand, in hands-on learning, assessment could be done with performance-based assessment. Actually, hands-on activities and inquiry based approaches are derived from constructivism in which the learner is not passive and students should develop their thinking with experiences (Tobin, 1990).

Therefore, science learning occurs by doing science which is opposed to only reading or hearing science (Ewers, 2001).

Educational researchers continue to show factors that affect students science achievement and students attitudes toward science. Most of the studies were conducted to improve students' science achievement by using hands-on, and inquiry based programs (Freedman, 1997; Stohr-Hunt, 1996) and these studies also are related to students' attitudes toward science that improve positive attitude toward science (Bristow, 2000; Kyle et al., 1988). Some other studies investigated both students' science achievement and students' attitudes toward science together (Simpson & Oliver, 1990). That is, research concerning science activities, attitudes towards science and students' achievement has a significant place in science education

Researches show that science achievement and positive attitudes towards science have a decreasing trend (Hofstein, Mooz, & Rishpon, 1990). According to the result of Third International Mathematics and Science Study (TIMSS) for Turkey, Turkish students have not performed well when they compared to their international counterparts in science (Martin et al., 2000). Because students are not active participant in lesson, they do not make experiments with simple materials. Therefore they lose their interest in science since they can not apply their science knowledge into daily life and think basic concepts with simple life materials. Also, most of students consider that science subjects are learnt by memorization. However, science is in real life; it does not need memorization. Therefore, there is a requirement for new researches to students become more active.

The main purpose of this study is to investigate the effects of hands-on activity enriched instruction on sixth grade students' science achievement and attitudes towards the science as a school subject. This study compared the effectiveness of the hands-on activity enriched instruction related to sense organs with traditionally designed science instruction on sixth grade students' achievement and attitudes towards science.

1.1. The Main Problem

The main problem of this study is “what are the effects of hands-on activities enriched instruction related to sense organs on sixth grade students’ science achievement and attitudes towards science?”

1.2. Hypothesis

The problem stated above was tested with the following hypothesis, which is stated in null form.

Null Hypothesis 1;

H_0 [ACH*, ATT**]: $\mu_{HA}-\mu_{TM}=0$

* Scores on science achievement posttest,

**Scores on science attitude posttest

There will be no significant effects of methods of teaching (hands-on activities enriched instruction versus traditional instruction) on the population means of the collective dependent variables of sixth grade students’ science achievement posttest scores and science attitude posttest scores when previous science course grades, previous cumulative grade point average, science attitude pretest scores are controlled.

Null Hypothesis 2;

H_0 [ACH*]: $\mu_{HA}-\mu_{TM}=0$

There will be no significant effect of methods of teaching (hands-on activities enriched instruction versus traditional instruction) on the population means of sixth grade students’ science achievement posttest scores when students’ previous science course grades and previous cumulative grade point average are controlled.

Null Hypothesis 3;

H_0 [ATT**]: $\mu_{HA}-\mu_{TM}=0$

There will be no significant effects of methods of teaching (hands-on activities enriched instruction versus traditional instruction) on the population means of sixth grade students' science attitude posttest scores when students' previous science course grade, previous cumulative grade point average and science attitude pretest scores are controlled.

1.3. Definition of Important Terms

Students' science achievement pretest scores (PREACH), science attitude pretest scores (PREATT), previous cumulative grade point average (PCGPA), previous science course grade (PSCG), and methods of teaching (MOT; hands-on activity enriched instruction and traditional instruction) are the independent variables (IVs) of the study. Students' science achievement posttest scores (PSTACH) and science attitude posttest scores (PSTATT) are dependent variables (DVs). Following terms are important to understand this study:

PCGPA: Students' previous cumulative grade point averages. They were taken from school administrator and it was used as a covariate in the statistical analysis.

PSCG: Students' previous science course grade in the science course exam taken from school administrator and it was used as a covariate in the statistical analysis.

PREATT: Science attitude pretest scores were handled by Science Attitude Scale (SATS) before the beginning of study. It was used as a covariate in the statistical analysis.

PSTATT: Science attitude posttest scores were taken by using SATS at the end of the treatment.

PREACH: Students' science achievement pretest scores were obtained by Science Achievement Test (SACT) at the beginning of study.

PSTACH: Students' science achievement posttest scores were obtained by SACT at the end of the treatment.

MOT: Methods of Teaching (hands-on activities enriched instruction and traditional instruction): Hands-on learning is learning by doing. It means any activities in classrooms that use materials. However, it is not simply manipulating a thing that is engaging in depth investigations with objects, materials, phenomena, and ideas and drawing meaning and understanding from those experiences (Haury & Rillero, 1994).

A hands-on approach requires students to become active participants instead of passive learners who listen to teachers or watch films, and therefore, students have objects directly available for investigation (Meinhard, 1992). Science educators tend to use term "hands-on science", "materials-based centered science", "inquiry based oriented science" and "activity oriented science" interchangeably to define learning by doing. On the other hand, traditional method is teacher centered of the lecture and students mainly listen, read and take notes. Thus, they are passive learners in the class.

1.4. Significance of the study

Though research has shown that hands-on activities are mostly efficient approach which increase students' achievement and improve students' attitude, there has been no study explaining the effect of hands-on activities related to sense organs on students' achievement and attitude towards science in Turkey so far. This topic is important for students at every part of their life since they can recognize their part of body. Moreover, students should know how we hear the sounds, see environment, feel materials, taste foods and smell something due to having healthy life. Therefore, students should recognize the structure and the functions of sense organs.

The results of this study are important since it gives some important cues to science teachers and science educators in Turkish educational system for several reasons. Firstly, science is important discipline to follow real life. Actually, it is in real life so it is not easy to explain the concepts of science with one sentence. Science is not a set of facts and rules to be memorized. As a substitute, memorization is not a good way to learn scientific concepts because life can not memorize. Unfortunately, today's science instruction in the classroom depends on only reading or listening of scientific facts and taking notes and memorizing in Turkey. Therefore, this study gives information about the hands-on activities which ensure the idea that away from memorization. Secondly, science teachers and researchers can benefits about how to implement hands-on activities enriched instruction in science, and how hands-on activities affect students' science achievement and attitude toward science in the topic of sense organs.

Then, science teachers can have an idea from this study as the use of hands-on activities composing of simple and low-cost daily life materials in their classrooms to attract students' attention and to make science lesson funnier. Besides, students can make connections between science concepts when they carry out different hands-on activities for different subjects of the science.

Finally, this study can assist curriculum developers when they evaluate their science programs to increase student science achievement. They should have an idea about certain teaching method which can be replaced by hands-on activities.

CHAPTER II

REWIEV OF RELATED LITERATURE

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

This chapter consists of eight subchapters. In the first one, importance of the laboratory in science teaching is presented, secondly, history of laboratory teaching and hands-on science, thirdly, studies related to hands-on science, fourths one is benefits of hands-on activities, next teacher preparation for hands-on science, and assessment of hands-on science and finally, summary of findings of the reviewed studies are presented.

2.1 Importance of the Laboratory in Science Teaching

It is known that laboratory work is really important for science teaching. Therfore, most of the studies are interested in the significance of the laboratory in the study of science. It is clear that science is not just a collection of fact. Fact is a part of science (Kyle et al., 1988). Facts, concepts or theories do not get from simple reading. Learning of science is not only the taking in of new science knowledge but also involves learner engaging in experimentation (Driver & Bell, 1986). Science is more than learning information that appears on the printed pages of science texts (Klein et al., 1982). According to Robin and Pearce (2001), science education should be considered as the science laboratory central to activity view of education in contrast to the predominant use of memorization from textbooks. Laboratory must be used not only to verify, but also to find (Remer, 1972). Studies showed that students learn more efficiently through application and experimentation. Shulman and Tamir (1973) proposed a classification of goals for laboratory instruction in science education as to develop creative thinking and problem solving ability, to develop practical abilities. Also Anderson (1976) summarized the importance of laboratory work in science as to help student understand the role of the scientist, to faster science inquiry skills that can transfer to other aspects of problem solving. Moreover, many educators claim that the laboratory is one of the important vehicles for teaching and understanding processes of scientific thinking (Hofstein & Lunetta, 1982).

Manipulating material is a must and fun too, for good science and parents, students, teachers, administrators and community members continue to take an interest in laboratory activities (Fox, 1994). According to Renner et al. (1985), students mostly prefer laboratory activities in science courses because these activities are less confusing and more concrete than other instructional formats and make students think about the phenomenon they are observing. Therefore, laboratory activities can promote positive attitudes and they provide opportunities for student success and fasten the development of skills in cooperation and communication (Hofstein & Lunetta, 1982). The use of laboratory activities in science teaching and learning can promote intellectual development and problem solving skills. Such activities are essential because they provide direct experience with science. Without them, students acquire a distorted and narrow view of science.

2.2 History of Laboratory Teaching

It is believed that children must be active participants in learning process (Klein et al., 1982). The history of laboratory work as a part of school science learning has been started in the nineteenth century. Teaching was rote and drill in that century (Withers, 1983). John Dewey, leader of the progressive education movement, emphasized the ideas about learning through activity and child centered instruction advocated during the 18th and 19th century (Houry & Rillero, 1994). In the years following 1910, the progressive education movement had a major impact on the nature of science teaching in general and outline role of laboratory work in particular. Throughout this period, textbooks and laboratory manuals began to acquire more application. On the other hand, some obstacles were developing about the proper roles of laboratory work such as, secondary schools teachers were not competent to use the laboratory effectively, too much emphasis on laboratory activity leads to a narrow conception of science, too many experiments performed in secondary schools are unimportant and some laboratory works are not related to the capabilities and interests of the children in schools.

In the other aspects, most of the research studies have emphasized that there was no effects of practical working in the laboratory on students' achievement, attitude, critical thinking and the process of science. According to Bates (as cited in Shimuzu, 1998) who reviewed 82 pieces of literature on laboratory activities, laboratory experiences neither enhanced nor reduced students' understanding of the nature. These results may be due to the fact that in that period, laboratory activities could not be done appropriately, they could just include collecting data and confirming concepts (Dana, 2001). This confirmation type laboratory activity resulted in developing the basic process skills but students could not learn the nature of scientific inquiry and improve integrated process skills (Pizzini et al., 1992).

Following World War I, laboratory activities come to be used largely for confirming and illustrating information learned from the teacher or the textbooks. This orientation remained relatively unchanged until the "new" science curricula of the 1960s in the U.S. (Hofstein & Lunetta, 1982). Tamir and Lunetta (1981) indicated that the main purpose of the laboratory in the science curricula of the 1960s was to promote students' inquiry and allow students' undertake investigations. Therefore, during the "golden age" of curriculum development of the 1960s and early 1970s, the idea of science teaching changed as discovery-learning methods were accepted.

With the new science curricula, the laboratory works become more open in terms of inquiry instead of textbook activities (Dana, 2001). For a great many years, laboratory activities have been regarded as an important part of education and by many science educators; the laboratory has been viewed as the essence of science (Tobin, 1990).

For many years, laboratory activities have important space in science education. Most of science educators presented the laboratory as the essence of science (Tobin, 1990). However, during the late 1950s and the early 1960s considerable interest focused on what should be taught and how it should be taught. During the middle late 1950s textbooks were used by most teachers as the principal tool for teaching science. The feeling was that if science for elementary schools was to be improved, there should be more care and emphasis on the selection of content (facts, concepts, principles), reduction of content (sequence, articulation, examples, etc.), more emphasis on processes of science, more 'hands on' science instead of reading about science, and use of a greater variety of media and materials for teaching science (Helgeson, Blosser, & Howe, 1977).

Imitating the work of the scientists in investigating the natural world, usually in the laboratory, is found in all the new curricula. Whether it is called inquiry, scientific process, or problem-solving, each curricula group espoused the virtues of "hands-on" experiences to gain greater insights into the basic concepts of science (Welch, 1971). These curriculum projects were tested and revised and provide a major impetus for current hands-on learning initiatives. For instance, Physical Science Study Committee (PSSC) published its text and laboratory manual in physics, The American Biological Science Curriculum Study (BSCS) in biology and The American Chemical Society developed chemistry course in chemistry (Ruby, 2001). There were three major activity-based elementary science programs in the U.S such as Science-A Process Approach (SAPA), the Elementary Science Study (ESS) and the Science Curriculum Improvement Study (SCIS). These programs have been the most widely used and researched of the National Science Foundation (NSF) supported elementary science programs (Doran, 1990). ESS was developed at the Educational Development Center, Newton, Masschusetts from 1961 through 1971;

SAPA's development was directly by the Commission on Science Education of American Association for the Advancement of Science (AAAS), Washington, D.C. between 1963 and 1974 and SCIS were developed at the Lawrence Hall Science at the University of California at Berkley between 1962 and 1974 (Doran, 1990). These programs were activity-based, frequently using direct experience, experimentation and observation as the self sources of information about the natural world. They were process oriented, putting as much stress on how to gain information and understand it as on the information itself and did not have textbooks for students, but rather teacher' guides and in some cases, laboratory sheets, or manuals (Bredderman, 1983). The overall activity-based programs promote students achievement on all outcome areas. Each of the three programs was the unique in the emphasis on science process and content objectives, the degree of program structure and the advocated instructional approach (Bredderman, 1983). Furthermore, they included separate laboratory manuals, and all three stressed problem-solving, process skills, creativity and positive attitude (Shymansky, 1989; Stohr-Hunt, 1996).

However, the issue of how to use hands-on science in three new curricula is different, for example, SCIS was interested in the learning cycle which began with the exploratory use of hands-on science to raise students questions and ending with students application of the concepts to other situations. Process-oriented curriculum was used in SAPA (Ruby, 2001). ESS had different approach that was the presentation of an event firstly occurred and then open-ended questions came and finally class discussions come to mind. Lastly, from the late 1950s through today, hands-on science has been promoted as a method of science lessons (Kyle et al., 1988).

2.3 Studies related to hands-on science

There are some discussions about the aims of science teaching at the school and most of the studies stressed these aims as an understanding the natural world, and broad concepts, problem solving, and scientific thinking. As Shymansky, Kyle and Albort (1982) cited that several curriculum were carried out to improve appreciation of the nature of the science four decades ago. Studies about those curricula illustrated that students in science programs using hands-on materials, activity-based approaches have much more achievement than do students in traditional text-book oriented science programs (Bredderman, 1982; Kyle et al., 1988; Shymansky et al., 1982).

According to Wideen (1975), students in the Science Process Approach (SAPA) curriculum program had higher on science achievement than students in the traditional curriculum program when the researcher acted upon the study in 25 classrooms. However, students' interest about science was not changed for both experimental and control groups. Similarly, Bredderman (1985) reported the results of a meta analysis of 15 years of research on activity-based science programs. This synthesis of research was based on approximately 57 studies involving 13000 students in 1000 classrooms in this study. All of the studies involved comparing activity-based programs (the Elementary Science Study, Science-A Process Approach, or the Science Curriculum Improvement Study) with comparable classrooms using a traditional or textbook approach to science teaching. A variety of student performance measures were analyzed. The most dramatic differences were found in science process skills where the students in activity-based programs performed 20 percentile units higher than the comparison groups. The students in these programs scored higher than the control groups in the following measures (ranked from largest to smallest differences): creativity, attitude, perception, logic development, language development, science content, and mathematics. Students who were disadvantaged economically or academically gained the most from the activity- based programs (Bredderman, 1985).

Another meta analysis of 105 experimental studies of activity-based science conducted by Shymansky et al. (1983). Researcher categorized students' performance as achievement process skills, and analytical skills. It was found that students were given instruction from activity-based programs had the greatest gains in all categories. When the study was reanalyzed, it showed that students who participated in hands-on programs achieved 9 % points more than their traditional elementary school counterparts on an overall performance assessment.

In accordance with Bredderman (1985) and Shymansky et al., (1983) student in a hands-on, activity-based programs confirmed higher achievement and problem solving skills than student in traditional textbook based programs. Nevertheless, student in inquiry program had more advantage in the area of science process skills as identifying hypothesis, setting up and designing experiments and making predictions than in the area of content skills as basic knowledge of terms, measurement and recitation (Reynolds, 1991; Staver & Small, 1990; Stohr-Hunt, 1996).

The study of Glasson (1989) was related with the relative effect of hands-on and teacher demonstration laboratory methods on declarative knowledge (factual and conceptual) and procedural knowledge (problem solving) achievement. About 54 ninth grade students (27 male and 27 female) contributed in the study. The students in two intact classes were assigned randomly to two treatment classes, one thought by a hands-on laboratory method and the other by a teacher demonstration method. Two instructional methods concluded with declarative knowledge and procedural knowledge. Declarative knowledge was tested with 20 multiple-choice items. Result indicated that students in the hands-on laboratory class performed significantly better on the procedural knowledge test than as student did in the demonstration class.

The relationship between the amount of time that students spent experiencing hands-on science and science achievement was studied by Stohr-Hunt (1996). In the study, analysis of variance (ANOVA) of 24599 eight grade students from 1052 participating school was used. Cognitive test battery was performed to measure student's achievement frequency of hands-on experience was collected through a self-administrated teacher questionnaire. It was found that significant difference present across the hands-on frequency variable with respect to science achievement. Especially, students who take part in hands-on activities every day or once a week scored significantly higher on a standardized test of science achievement than students who participate in hands-on activities once a month, less than once a month, or never. Moreover, Meitchtry (1992) studied in grades six through eight and found that the use of hands-on science activities provided the concrete learning experiences students needed to better understand the presented science concepts.

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

Kyle et al. (1988) compared the attitude toward science of students who had completed one year of the Science Curriculum Improvement Study (SCIS) with students in non-SCIS classes. The students sample was comprised of 228 SCIS students (54% male and 46% female) and 288 non-SCIS students (%52 male and %48 female). Students were selected randomly from second through sixth grade classes. Result of the study indicated that attitude of students who have experienced one year of an inquiry-oriented process approach curriculum were enhanced greatly when compared to students in textbook-oriented science classes. Additionally, Gardner and coworkers (1992) reported that use of hands-on activities advance student attitude toward science. Similarly, results of Powers (1990) showed that students preferred using hands-on instruction in the classroom. The students indicated that they learned more science by doing science and exhibited a better attitude toward science. Besides, Elias (1992) designed a program to bring hands-on science into the local schools where he conducted various science experiments for students demonstrating basic scientific principles. In this study, students are allowed to participate and they left his demonstrations with a renewed interest in science and a better understanding of how science is done.

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

Many researches have shown relationship between attitude toward science and achievement in science knowledge. The quasi-experimental study of Bristow (2000) was completed for 57 sixth grade middle school students to examine effects of hands-on teaching methods on students’ learning science and attitudes towards science. Control groups took traditional approach or textbook instruction; however, experimental groups took hands-on teaching method. Students’ achievement was assessed by multiple-choice test and students’ attitude was assessed by Likert type attitude scale. ANOVA results demonstrated that there was no divergence between students’ achievement for control and experimental groups; however, students who received hands-on activities have more positive attitude toward science than students who received textbook instruction. Similarly, the study of Freedman (1997) with 270

9th grade students proved that hands-on instruction influenced in a positive direction as the students' attitude toward science, and influence their achievement in science knowledge. On the other hand; Turpin (2000) established diverse results of Bristow's research. Over again, students' achievement and attitudes toward science were assessed for hands-on instruction and traditional instruction. About 531 seventh grade students were in experimental group that was applied activity based curriculum and 398 seventh grade students were in control group that was applied traditional curriculum. Iowa Test of Basic Skills (ITBS) science scores was used to measure students achievement and Science Attitude Survey was used to evaluate students' attitude toward science. According to the analyses of covariance (ANCOVA), it was showed that student in activity based curriculum had significantly higher scores for science achievement than that students in traditional curriculum. But, there was no difference in students' attitude toward science for two groups. Besides Hardal (2003) examined the effects of hands-on activities on students' achievement and attitudes towards physics. She conducted her study with 130 ninth grade public school students in Turkey. There were two experimental groups which instructed with hands-on activities and there were two control groups which instructed with textbook. Physics Achievement Test and Physics Attitude Scale were used to both groups to assess and compare the effectiveness of hands-on activities and traditional method in physics course. The result of the study indicated that there was significant difference in the achievement of the experimental and control groups in favor of the experimental group. A similar significant difference was not found between two groups in the attitude towards physics.

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

On the other hand, a series of studies pointed different aspects of hands-on science program. For example, Morey (1990) examined major disadvantages of hands-on science as lack of time, money, and equipment and teacher preparation. Likewise, Bybee (1993) cited that lack of materials could be cause for use of traditional instruction in science classrooms.

2.4 Benefits of hands-on activities

The use of hands-on activities for the teaching of science has been promoted for a number of years. Hands-on materials help to improve students' achievement in science, making them feel science is something that one does rather something that one just learns about (Harty, Kloosterman & Matkin, 1989). According to Lubuffe (1994) and Palmer (1997), hands-on activities are enjoyable and funny, so teachers want to make more activities and students learn more. Students in a hands-on science program will remember the material better, feel a sense of accomplishment when the task is completed, and be able to transfer that experience is easier to other learning situations. When more than one method of learning is accessed as in hands-on learning, the information has a better chance of being stored in the memory for useful retrieval (Haury & Rillero, 1994).

Pearson (1990) defined science as away of investigation or method, science is hands-on activity; an experiment that requires observation, measurement, hypotheses, formulation, and the qualification of empirical observations. The optimal way for students to learn this aspect of science is experimentally, rather than didactically. Similarly, hands-on learning involves the child in a total learning experience which enhances the child's ability to think critically. The child must plan a process to test a hypothesis, put the process into motion using various hands-on materials, see the process to completion, and then be able to explain the attained results. Hands-on learning is the only way students can directly observe and understand science. As students develop effective techniques for observing and testing everything around them, they learn the what, how, when, and why, of things with which they interact. These experiences are necessary if the youngsters of today are to remain "turned-on" to science and become scientifically literate. Also, meaningful learning of concepts is more likely to occur where children are able to experience phenomena directly through the manipulation of objects and materials, and are given the opportunity to think and reflect on what they have done. Millar and Driver (as cited Palmer 1997) stated that it is shared that commitment to a form of science education in which children learn science by doing things, doing them both in the hand and in the head.

According to Keppler (1996), the teacher can develop all the science skills by doing science, trying to activities in their classrooms and so they have greater purpose. They will see why should the students bother to put in the classroom? At this time, they will think that efforts needed to incorporate hands-on science in their curriculum. Then, students will see why and what they are learning in science which can be applied them in their own lives. They will observe, think, experiment, and validate their findings. They will learn to work in teams and communicate their knowledge. They will see for themselves how the world works. Students need to involve their hands as they learn. And when they make the concept life-size, they really see it and come to understand it.

Moreover, certain types of activities can be powerful tools for shaping and reshaping students' cognitive conceptions of the natural world. Experiments provide the means for students to test their own theories about the world similar to the way practicing scientists test scientific theories (Lump & Oliver, 1991). The work of Hofstain and Lunetta (1982) stated that higher order thinking such as problem solving, is the benefit of hands-on activities. As a conclusion, Rutherford (1993) stated that hands-on and learning by experience was powerful ideas, and it is known that engaging students actively and thoughtfully in their studies pays off in better learning.

2.5 Teacher preparation for hands-on science

It is known that good science teaching makes good, creative and interested teachers and students. While such activities play an important role in teaching children about the nature of scientific inquiry and problem solving, they pose management problems for teachers and cognitive problems for students. These types of activities require much planning and hard work. Teachers should be cognizant to the fact that different types of activities can lead to different outcomes. Thus, a multifaceted approach is suggested. Teachers should choose activities that are not just hands-on but also minds-on. Such choices include using activities that engage students as active problem solvers and decision makers (Lumpe & Oliver, 1991). Similar approach was cited by Kyle and coworkers in 1988 that different children have diverse interests and need special science projects. Fortunately, all types of children can find plenty of suitable activities and teachers could encourage them for activities neither too hard nor too easy and consider a child's personality and social habits. For example, some projects were best done alone, but others in a group, some require help, others entail little or no supervision, which means that teachers should select activities appropriate for the child's environment.

Sumrall (1997) showed that the value of hands-on science predisposes teachers to spend more time for teaching science, and the appropriate materials makes it possible for them to carry it out in a classroom of 20-30 students. Finally, Haury and Rillero (1994) said that teachers must continually evaluate and grow their paradigms for learning based on experience as reflective practitioners and review of current learning research. They should recognize that their values enable reform of teaching practice. The good teacher seeks out activities to complement the textbook and more fully illustrate the concepts, to give local examples of the big picture, and to keep students interested in the subject.

2.6 Instructional approach for hands-on science

Science educators like generally to define and classify hands-on activities into different categories. One dimension addressed by numerous science educators is inquiry. Prominent educators and psychologists have stated for years that science is an inquiry based subject and therefore should be thought in a similar fashion (Dewey et al., 1990 cited in Watson & Konicek, 1990). An ideal activity for hands-on and inquiry-based instruction focuses on the science content that students are learning and can be introduced with an observation (Deal, 1994). When used in this manner, science activities not only capture students' attention and stimulate interest, but also create Piagetian cognitive dissonance, and motivate students to challenge their existing mental constructs and misconceptions (Martin, 2000 & Science Media Group, 1995). However, hands-on did not always guarantee inquiry (Huber & Moore, 2001). Many seemingly limited hands-on activities can be extended into the realm of inquiry using a model that involves (a) discrepant events to engage students and direct inquiry; (b) teacher-supported brainstorming activities to guide students in planning investigations; (c) suitable written job performance aids to provide structure and support; and (d) the requirement that students provide a product of their research, which typically includes a class presentation and a graph. Houry and Rillero (1994) cited that hands-on science, when defined as inquiry, cannot easily fit into a textbook-centered science program. At best, textbook programs incorporate some activities with materials as supplements to or illustrations of material covered in a particular chapter. These activities tend to be much directed, "cookbook" in nature, and children do them to confirm what they've been told, not inquire into the materials or phenomena. Textbooks also cover a great deal of content, leaving little time for in-depth hands-on experiences.

Another dimension is a structure dimension that one needs to consider when evaluating hands-on science activities. This dimension centers on the involvement of students in making decisions concerning the design and planning of an activity's procedures. Within this dimension, hands-on activities can be highly structured to provide detailed procedures and guidelines for students to follow. In uninstructed activity, students are given freedom to choose their own methods and procedures. Science educators have argued that students should be allowed freedom in making important decisions concerning an activity if higher level problem solving skills are to be achieved (Tamir & Lunetta 1981; Tobin, cited in Lumpe & Oliver, 1984).

There is another dimension which can be used to delineate the types of manipulation involved and the conclusions that can be drawn from the results of hands-on activity. Tobin (1984) categorized activities into groups based on how variables are treated.

1. Descriptive: The student describes or determines the status of what is observed without establishing connections or causal relationships.
2. Correlation: The student uses data to determine or show connections or associations, not causal relationships. Variables are not manipulated.
3. Experimental: A design is incorporated in which variables are manipulated to infer cause and affect relationships.

It has been shown that hands-on laboratory activities can be categorized within three distinct dimensions. The outcomes of the different types of activities are very distinct from one another.

2.7 Assessment of hands-on learning

Several researchers addressed the issue of how to assess hands-on learning. It was clear that the traditional paper and pencil, multiple-choices approach to testing can not be used alone to adequately assess the full range of learning outcomes typically associated with hands-on learning in science (Houry & Rillero, 1994). A similar idea was cited by Stohr and Hunt (1996) that traditional assessment methods could be useful in measuring content knowledge or science concepts covered by the students, however, they were not suitable for process skills.

In all modes of instruction evaluation has important roles in efforts to assess student learning, to discover misconceptions among students, and to determine the effectiveness of programs (Doran, Boorman, Chan, & Hejaily 1993). There is considerable evidence to suggest that assessment can focus on learning activities in science classrooms. Doran et al. (1993) suggested that performance tasks for skills should not be paper-and-pencil items, but should involve students in doing activities. During assessment, the directions must be clear and concise; diagrams can help with clarity. Questions should be based on the process skills identified.

According to Kauffman (1993), the director of Wisconsin's Department of Public Instruction prepared hands-on performance assessment tasks which are on the cutting edge of what is going on in schools as far as assessment. Moreover, New York State developed a mandated test called the Elementary Science Program Evaluation Test (ESPET), which was first administered to 211,000 fourth grade students. The manipulative skills section of this test has attracted national and international attention. According to Agruso (1993), the Project Director, the ESPET manipulative skills section consists of five hands-on stations with a total of 15 questions designed to evaluate student ability to measure physical properties, predict an event, create a classification system, make generalizations, and draw an inference. This assessment program has had a profound effect on science education in elementary schools. Students are especially excited about the manipulative portion, enjoying the opportunity to engage in problem-solving activities that require their handling equipment and taking data.

As educators move toward more performance-based assessment, the potential advantages offered by portfolios must be considered. Growing out of authentic classroom practices, portfolios provide a holistic view of student performance. They allow for the alignment of instruction and assessment and provide the opportunity for students to be more closely involved in reflecting upon and assessing their own growth. They also offer a vehicle for increased communication among teachers and between home and school. Although the implementation of portfolios is laborintensive and time consuming, the gains in terms of improved education seem to warrant their consideration as part of the assessment process (Markham & Smolen, 1991).

Concept maps may be another effective way to assess learning from hands-on science. Markham, Mintzes, and Jones (1994) concluded from a study of college biology students that concept maps are a powerful and psychometrically sound tool for evaluation in science education.

Hein (1987) recommends a variety of approaches be used in assessing hands-on learning, including observing students at work, examining the things they manipulate, and evaluating science related drawing and writing. Other assessment techniques include group discussion, journaling, and student interviews (Gaffney, 1992; Tippens & Dana, 1992). Some assessment tasks should be done by student teams to help build group skills (Small & Petrek, 1992). It is often beneficial to have students score their peers' group work (Culp & Malone, 1992).

Finally, the teacher's evaluation of such activities is also likely to be informal, relying mostly on unobtrusive observations. Teachers may find it useful to observe systematically individual students, small groups, or even the class as a whole. The teacher's observations should be recorded in writing, either immediately or at the end of the day, noting the time, date, and activity. These remarks may be quite brief, even cryptic, but should specify in some way what was seen, not just the teacher's judgment of its quality. If the comments are recorded on index cards, they can be filed easily by student name, can serve as a record of progress and attainment to be used in planning further instruction, shared with parents, used in grading, and perhaps even shared with the students themselves (Haertel, 1991).

It is acknowledged that these enriched forms of assessment require a greater investment of time to develop, administer, and interpret, but there is also a great need to more carefully align student assessment with curricular aims, instructional practices, and performance standards.

2.8 Summary of Findings of the Reviewed Studies

One can summarize the results of these studies as follows:

1. In science teaching, laboratory work is the essential subject to gain scientific education (Haury & Rillero, 1994).
2. Researches were done to verify the efficiency and the role of the laboratory. Researches explained that laboratory activities caused measurable advantage over the other type of instruction in the development of students' science achievement (Dana, 2001; Hofstein & Lunetta, 1982).
3. At 1960s and early 1970s, science curriculum was developed under the concept of hands-on, activity-based instruction or inquiry (Tamir & Lunetta, 1981).
4. Instructional approaches known as hands on science which has been defined as any science laboratory activity that allows the student to handle manipulate or observe a scientific process (Lumpe & Oliver, 1991).
5. Students, who engage hands-on, activity-based approaches, have higher science achievement than students who engage in traditional, textbook-based programs (Shymansky, 1982; Bredderman, 1985; Glasson, 1989; Stohr-Hunt, 1996; Freedman, 1997; Turpin, 2000; Hardal, 2003).
6. Even though many studies confirmed increasing in attitudes for students who engage hands-on, activity-based instruction, some others could not showed improvement in students' attitude towards science (Bredderman, 1982; Bristow, 2000; Freedman, 1997).
7. Science lesson become more enjoyable, meaningful and funnier with hands-on activities (Haury & Rillero, 1994).
8. Researchers stressed that there are different assessment strategies including performance task, portfolios of student work, scoring schemes, observational checklist should be used to assess students' hands-on learning (Bristow, 2000; Haury & Rillero, 1994).

These findings propose that there were not lots of studies about effects of hands-on activities on student's achievement and attitudes towards science in Turkey. In addition, there was no study concentrated on sense organs in Turkey although the subject is important for elementary school students to learn the basic concepts of science. Sense organs are the sixth grade subject which is very suitable to prepare variety of hands-on activities. Therefore, the aim of this study is to examine the effect of hands-on activities enriched instruction on sixth grade students' science achievement and attitudes towards science in the topic of sense organs. Science achievement test and hands-on activities which are related to sense organs are developed to achieve this goal.

CHAPTER III

METHODS

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

3.1 Population and Sample

The target population of this study is all sixth grade regular elementary schools students in the Keçiören, Ankara. According to Ministry of Education (MEB) documents, there are 85 regular elementary schools in this area. The accessible population of the study is selected as all sixth grade elementary school students in one elementary school. There are 6 sixth grade classes in this school. The results of this study are generalized for this population.

Convenience sampling was used to choose study sample from the accessible population. A convenience sample is a group of individuals who (conveniently) are available for the study. One-hundred forty 6^{th} grade students from four classes of two teachers were involved in this quasi-experimental study. One of the science teachers had two classes that one of the classes was experimental group and other was control group. Again, second science teacher had two classes and one of them was experimental group and another class was control group. Therefore, each teacher had one experimental group (instructed by hands-on activities) and one control group (instructed by traditional method). Fortunately, both teachers allowed observing their classes by the researcher. There were 72 students in the experimental group and 68 students in control group (Table 3.1)

Student's socio-economic status and their family income can be assumed as near to each other. Most of the students' ages are 12 in this study. There are 71 female students and 69 male students; numbers of female students are slightly greater than that of male students (Table 3.1).

Table 3.1 Characteristics of the Sample

Gender	**Experimental Group**	**Control Group**
Female	41	30
Male	31	38
Total	72	68

3.2 Variables

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

Table 3.2 Identification of variables

Type of Variable	**Name**	**Type of Value**	**Type of Scale**
DV	PSTACH	Continuous	Interval
DV	PSTATT	Continuous	Interval
IV	PREACH	Continuous	Interval
IV	PREATT	Continuous	Interval
IV	PCGPA	Continuous	Interval
IV	PSCG	Continuous	Interval
IV	MOT	Discrete	Nominal

3.2.1 Dependent Variables

The dependent variables (DV's) are Student's Science Achievement Posttest Scores (PSTACH) and Student's Science Attitude Posttest Scores (PSTATT) that was measured by Science Achievement Test (SACT) related with the subject of sense organs and Science Attitude Scale (SATS), respectively. PSTACH and PSTATT are continuous variables and measured on interval scales. Minimum and maximum scores for PSTACH are 0-25 scores and minimum and maximum scores for PSTATT are 24-120 scores.

3.2.2 Independent Variables

There are five independent variables (IV's) that are Previous Science Course Grades (PSCG), Previous Cumulative Grade Point Averages (PCGPA) and Students' Science Achievement Pretest Scores (PREACH), Studemts' Science Attitude Pretest Scores (PREATT) and Methods of Teaching (MOT). PSCG, PCGPA and PREATT are continuous variables and measured on interval scales. However; MOT is discrete variable and measured on nominal scale.

The students' minimum and maximum scores of both PSCG and PCGPA are 0-5, and the students' minimum and maximum scores of PREACH and PREATT are 0-25 and 24-120 scores, respectively.

3.3 Measuring Tools

Three measuring tools were used for this study that was Science Achievement Test (SACT) about sense organs, Science Attitude Scale (SATS) about science and observation checklist.

3.3.1 Science Achievement Test

The instrument Science Achievement test (SACT) used in this study was consisted of LGS questions that were obtained from LGS Question Books and some of them were developed by the researcher to assess students' achievement about sense organs. The SACT covers the science content present in the sixth grade curriculum. It consists of 25 multiple choice questions related with all of five sense organs such as eye, ear, nose, tongue and skin. Possible SACT scores range from 0 to 25, with higher scores showing greater achievement in sense organs topic.

Before developing the test, the objective list (See Appendix A) of the sense organs was arranged. Then, each question was examined in detail and the table of specification (See Appendix B) was organized. In the table of specification, the objectives and the questions were defined according to cognitive domain of Bloom's Taxonomy.

Twenty-five multiple choice questions (SACT) (See Appendix C) were administered as a pretest and posttest to both control and experimental groups to assess students' science achievement about sense organs (Table 3.3). The researcher preferred multiple choice questions as a test questions, because it is easy to apply and scored objectively.

3.3.2 Science Attitude Scale

The instrument SATS (See Appendix D) used in this study was developed by Geban et al. (1994). This scale consists of 15 items and designed to be rated on a 5-point likert type response format (strongly disagree, disagree, neutral, agree, strongly agree). SATS were administered as a pretest and posttest to both control and experimental groups to assess students' attitudes towards science (Table 3.3). Possible SATS scores range from 24 to 120, with higher scores demonstrating positive attitude towards science and lower scores demonstrating negative attitudes towards scienc

Table 3.3 Science Achievement Test and Science Attitude Test

	Pretest	Treatment	Posttest
Experimental Group	SACT, SATS	Hands-on activity Enriched instruction	SACT,SATS
Control Group	SACT, SATS	Traditional Instruction	SACT,SATS

3.3.3 Observation Checklist

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

3.3.4 Validity and Reliability of the Measuring Tools

Face and content validity was used to show the tests’ validity, which is the appropriateness of the interpretations obtained from test results. For this reason one instructor, two research assistants and one biology teachers from both the Department of Secondary School Science and Biology at METU examined in accordance with content and the format of the instrument. At the beginning, all of them knew the main purpose of the test and then they started to check the measuring tools with respect to given criteria of suitability of items to the grade level, suitability of content by the selected items. Their suggestions were very important for the revision of the instrument. Finally, it should be mentioned that content and format of the instrument will be used as an evidence of validity. There was a direct relationship between the test items and objectives. Content of the test shows what it is wanted to measure from the students' knowledge. Level of the questions should be appropriate with the sample of subjects to be measured. To obtain this characteristic of validity, it was prepared a table of specification. Therefore, it was ensured that prepared test items were suitable for content and instructional objectives.

During the pilot study, the SACT was administered to 36 sixth grade students. According to reliability analyses, reliability coefficient of cronbach alpha was found to be .68. The cronbach alpha coefficient of SATS was found to be .82 for this study. The validity and reliability estimates for the SACT and SATS mean that scores obtained on these test are reliable and valid measure of the students' achievement on sense organs and attitudes towards science.

3.4 Teaching and Learning Materials

Various materials were used in this study; objective list, table of test specification, hands-on activities, objective-activity table, and handout.

The objective list was used to prepare hands-on activities. By this way 14 hands-on activities (See Appendix F) were prepared to employ students actively involved in the sense organs by making use of wide range of sources (Bosak, 1991; Lien, 1981; Tolman, 1996; Güngör et al., 2002). As Table 3.4 displays, the titles of the activities are the structure of the eye, the effect of the light, why we have two eyes, how we understand the different colors, color blindness, finding of blind spot, what is vibration?, vibration in the eye dice, different smells, spread of the smells, sweet, salty, bitter, smell and taste, heat or cold and do we feel materials same in all skin? Every activity consists of purpose, materials and procedure parts. All the activities are made with simple materials such as plastic water bottle, balloon, ancestral, hot water, cold water, different color pencils, papers, scissors, lemon juice, potato, onion.

Table 3.4 Hands-on Activities about sense organs

Content	**Name of activities**
Eye	1. The structure of the eye 2. The effects of the light 3. Why do we have two eyes? 4. How do we understand the different colors? 5. Color blindness 6. Finding of blind spot
Ear	1. What is vibration? 2. Vibration in the eye dice
Nose	1. Different smells 2. Spread of the smells
Tongue	1. Sweet, salty bitter 2. Smell and taste
Skin	1. Heat or cold 2. Do we feel materials same in all part of skin?

Moreover, objective-activity table (See Appendix G) was constructed to prepare proper and useful hands-on activities. It indicates which hands-on activity matches with which objectives.

Finally, one handout (See Appendix H) was prepared for both students and teachers. Some of sense organs information, pictures and explanations about the subject were given in this handout. This handout was also delivered to control group students.

3.5 Procedure

At the beginning, the researcher searched a detailed literature. First, the keywords were determined. By the help of these key terms, Educational Resources Information Center (ERIC), Ebscohost, Science Direct and Internet (Goggle) were systematically searched. Previous studies which were done in Turkey were also searched from YOK. These entire tasks took about two months. Photocopies of accessible document were taken from the METU library, library of Bilkent University, and TUBITAK, Ulakbim. All of the papers were read and results of the studies were compared with each other. Also, hands-on activities were prepared by use of such books as “Science is…A Source of Book Fascinating Facts, Projects and Activities” (Bosak, 1991); “Investigations to Science Inquiry” (Lien, 1981); “Hands-on Science Life Activities For Grades K-8” (Tolman, 1996); “The Best of Wonder Science Elementary Science Activities” (American Chemical Society, 2001); “MEB Secondary Course Book, Science 6” (Güngör et al., 2002).

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

Experimental research as a research methodology was used in this study since it is the best way to establish cause and affect relationships between variables. The effect of hands-on activities on student’s science achievement was examined in this study. A quasi-experimental study design was preferred as an experimental model since it does not include random assignment. At the beginning of the study, the teachers were trained by the researchers. A teacher handout which mentioned about what they did during hands-on activities step by step was prepared and this handout was given to the teachers. By this way, teachers could know how to teach sense organs in both experimental group and control group. Moreover, the teachers allowed researcher to observe their classes.

Two measuring tools were used in this study (SACT and SATS). One was used to assess students' achievement about sense organs and the other was used to assess students' attitudes toward science. SACT and SATS were applied for both groups as a pretest one week before the treatment started. At the top of the test papers some information were wanted from the students as students' age, gender, mother education, and father education. Test application took approximately one class hour for pre-test and post-test separately. Time was adequate to complete the instruments.

The students in control groups and the experimental groups treated with different methods of teaching. In control group, traditional method was given. Teacher-centered instruction was applied and students were generally taught with note taking strategy. The teacher gave some important concepts about sense organs and the students wrote the teachers' explanations in the classroom. The teacher did not use demonstration or any activities. On the other hand, in experimental group, hands-on activity enriched instruction was given. Student-centered instruction was applied and students got the information by doing hands-on activities individually or pairs. Activity sheets helped them to perform the eye, ear, nose, tongue and skin activities, respectively. For example, activity one; how can we see? Firstly, students followed the procedures of the activity and then answered the questions about this activity. They used handout about the subject during answering these questions. At this time, teachers became a guide for students. After that, all students discussed each questions of activity one in the classroom before performing next activity. Finally, the teacher explained some important terms of the activity and they gave information about critical points of sense organs (eye for first activity) at the end of each activity. It should be said that activity sheet were examined by researcher to control students' attention during instruction.

Observation checklist was used for both groups during the study to confirm proper treatment implementation. The checklist showed the degree to which the course was taught with hands-on activities. Finally, SACT and SATS were applied as a posttest after three weeks treatment for control and experimental groups. Test scoring was done and computed.

3.6 Analyses of Data

All data were entered to the computer. The variables were formed and given in raw data form. The statistical analyses were done by using SPSS. The data obtained in this study were analyzed in two parts; descriptive statistics and inferential statistics.

3.6.1 Descriptive and Inferential Statistics

The mean, standard deviation, skewness, kurtosis, range, minimum, maximum values and the histograms were offered for the control and experimental groups.

In order to test hypotheses, statistical technique named MANCOVA was used since it incorporates two or more dependent variables. All statistical computations were done by using statistical package program (SPSS). Table 3.2 shows all variables and the variable set entry order that were used in the statistical analyses.

Set 1 (covariates) was entered firstly in the MANCOVA model. Therefore, variance because of PREATT, PSCG and PCGPA can be removed before the entry of the treatment. Set 2 (group membership) was entered secondly, and Set 1*2 (covariates* group interactions) was entered finally to decide covariate- group membership interactions.

For inferential statistical analyses, α was set to 0.05 (probability of making Type-1 error) that is mostly used value in educational studies. The study performed 140 secondary school students and the number of variables was seven. Effect size was set to small in this study (f^2= 0.3 for mean difference and 0.08 for variance).

3.7 Assumptions and Limitations

1. The application of treatment and the administration of the SACT and SATS were under standard condition.
2. All subjects of the study responded sincerely to the items on the SACT and SATS.
3. The teachers followed our instruction.
4. Students in control and experimental groups did not interact and shared questions of the SACT and SATS before and during the administration of the tests.
5. Student's performance in hands-on activities assessed with a paper and pencil test in this study. However, it is considered that a paper and pencil test is not appropriate measure of performance for the students occupied in hands-on activities.
6. Generalizations of the study are limited because the participants of this quasi-experimental study were not selected randomly.

CHAPTER IV

RESULTS

The results are divided into three sections. The first section presents the descriptive statistics associated with the data collected from the administration of the science achievement posttest and science attitude posttests. The second section of this chapter presents the inferential statistical data yielded from testing three null hypotheses outlined in Chapter 1. The third section explains the findings of the study.

4.1 Descriptive Statistics

Descriptive statistics related to scores which were measured by the students' Science Achievement Pretest Scores (PREACH) Science Achievement Posttest Scores (PSTACH), Science Attitude Pretest Scores (PREATT) and Science Attitude Posttest Scores (PSTATT) for both experimental and control groups are presented in Table 4.1. Students achievement scores could range from 0 to 25 in which higher scores mean greater science achievement and students' attitude scores range from 24 to 120 in which higher scores mean greater attitude toward science.

As presented in Table 4.1, the experimental groups showed mean increase ranging from 6.64 to 15.25 in their level of science achievement from the pretest to posttest. However, the control group showed mean increase ranging from 7.32 to 11.57 in their level of science achievement from the pretest to posttest. Therefore, experimental group shows a mean increase of 8.61 whereas the change of control group is 4.25 points on the Science Achievement Test (SACT). It can be said that the experimental group students have gained more science achievement than the control group students.

Table 4.1 also showed the pretest and posttest attitude scores towards science of all students who participated in the study according to experimental and control group. Higher attitude scores mean more positive attitude towards science and lower attitude scores mean negative attitude towards science. Although the experimental group showed mean increase of about 2.12 points in their science attitude scores from pretest to posttest, the control groups' scores showed mean increase of about 0.86 points from pretest to posttest scores.

Some other basic descriptive statistics like standard deviation (SD), skewness, kurtosis, minimum and maximum points were also indicated in Table 4.1. For the experimental group, the values for skewness on the pretest and posttest science achievement scores were 0.147 and -0.506, respectively which could be accepted as approximately normal. In a similar manner, for the control group students' skewness values were -0.101 and 0.647 which could also be accepted as normal.

Table 4.1 Descriptive Statistics for the Science Achievement Scores and Science Attitude Scores

	Experimental Group		Control Group	
	Pretest	Posttest	Pretest	Posttest
Scores on Science Achievement Test				
N	72	72	68	68
Mean	6.64	15.25	7.32	11.57
Standart Deviation	2.53	3.39	2.57	3.87
Skewness	0.147	-0.506	-0.101	0.647
Kurtosis	-0.441	-0.583	-0.374	0.114
Range	11	14	11	17
Minimum	1	7	2	5
Maximum	12	21	13	22
Scores on Science Attitude Scale				
Mean	56.57	58.69	57.94	58.80
Standart Deviation	8.92	8.64	7.95	8.24
Skewness	0.283	-0.208	-0.306	-0.379
Kurtosis	1.78	-0.71	0.59	-0.453
Range	56	36	36	38
Minimum	33	36	39	37
Maximum	89	75	82	85

Skewness values for both the experimental and control groups on the SATS before and after treatment were 0.283, -0.208, -0.306 and -0.379, respectively. These values were also accepted as approximately normal.

When the kurtosis values were explained in Table 4.1, values for the experimental and control students' achievement scores were -0.441, -0.583,-0.374 and 0.114 on the pretest and posttest, respectively. Kurtosis values for the experimental and control students' attitude scores were 1.78, -0.71, 0.59 and -0.453 on the pretest and posttest, respectively.

Figure 4.1 and 4.2 indicate the histogram with normal curves related to the PSTACH and PSTATT for the control and experimental groups. These are also evidence for approximately normal distribution of these four variables.

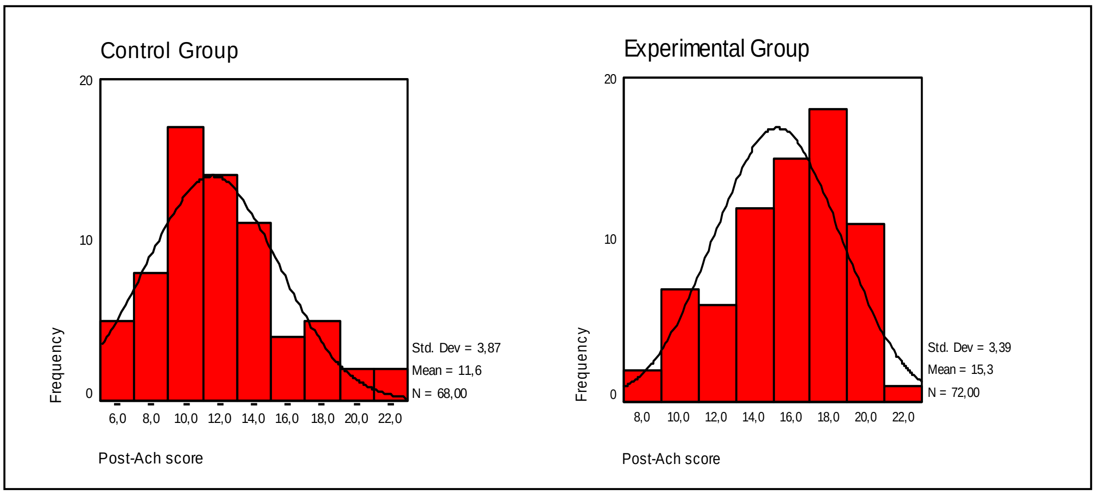


Figure 4.1 Histograms with normal curves of the control and experimental groups for the PSTACH

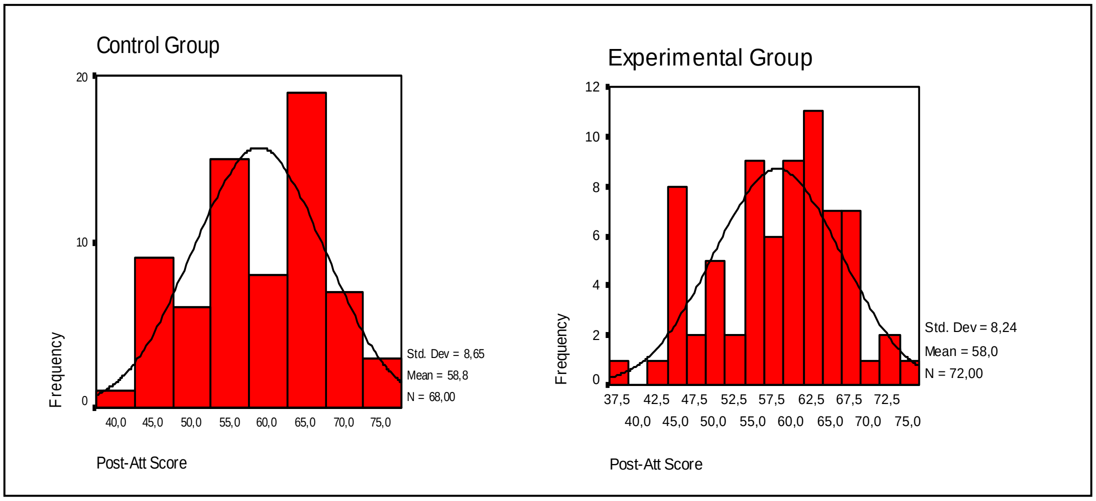


Figure 4.2 Histograms with normal curves of the control and experimental groups for the PSTATT

4.2 Inferential Statistics

Determination of the covariates, verification of MANCOVA assumptions, the statistical model of MANCOVA and the analyses of hypothesis are given in this chapter.

4.2.1 Determination of Covariates

Three independent variables (Previous Science Course Grades (PSCG), Previous Cumulative Grade Point Averages (PCGPA) and Science Attitude Pretest Scores (PREATT)) were pre-determined as potential extraneous factors of the study. Therefore, these variables were included in Set 1 as covariates to statistically equalize the differences between experimental and control groups. All pre-determined independent variables in Set 1 have been correlated with the two dependent variables (students' science achievement posttest scores (PSTACH) and science attitude posttest scores (PSTATT)). The results of these correlations are presented in Table

4.2. As shown in the table, all independent variables in Set 1 have significant correlation with one of the dependent variables.

Table 4.2 Significance Test of Correlations between dependent variables and covariates

Variables	**Correlation Coefficient**	
	PSTACH	**PSTATT**
PSCG	.369*	.395
PCGPA	.460*	.233
PREATT	.138	.572*

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

Also as seen in Table 4.3, correlations among independent variables are less than, 8. Therefore, PSCG, PCGPA and PREATT can be used as covariates for the inferential statistics.

Table 4.3 Significance Test of Correlations among the Covariates

Variables	**PSCG**	**PCGPA**	**PREATT**
PSCG		. 60*	.384*
PCGPA			.237*

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

4.2.2 Assumptions of Multivariate Analysis of Covariance

Assumptions of MANCOVA are as follows; normality, homogeneity of regression, equality of variances, multicollinearity and independency of observations. All the variables were rested for all the assumptions.

For the normality assumption, skewness and kurtosis values which were given in section 4.1 were used. The skewness and kurtosis values for the PSTACH and PSTATT were in suitable range for normal distribution.

Homogeneity of regression assumption means that the slope of the regression of a dependent variable on covariates (Set 1) on a dependent variable must be constant over different values of group membership (Set 2). Table 4.4 shows the results of Multivariate Regression Correlation (MRC) analysis of homogeneity of regression. As seen from the table, interaction term (Set 3) did not result in significant change (F (2,134) =1.969, p= 0.145). So, the interaction term (Set 3) was dropped. That means there is no significant interaction effect. Therefore, homogeneity of regression assumption for dependent variables of the PSTACH and PSTATT was validated.

Table 4.4 Results of the MRC Analysis of Homogeneity of Regression for the PSTACH and PSTATT

Model Change Statistics

PSTACH	**R^2 Change**	**F Change**	**df1**	**df2**	**Sig. F Change**
Set 1	.212	18.436	2	137	.000
Set 2	.042	15.214	1	136	.000
Set 3	.025	1.969	2	134	.145
PSTATT					
Set 1	.180	15.072	2	137	.000
Set 2	.083	1.505	1	136	.478
Set 3	.047	.110	2	134	.832

Levene's Test of Equality was used to determine the equality of variance assumption. As table 4.5 shows, the error variances of the selected DV's across groups were equal.

Table 4.5 Levene's Test of Equality of Error Variances

	F	df1	df2	Sig.
PSTACH	4.441	1	138	.220
PSTATT	.728	1	138	.810

For the testing of multicollinearity assumption correlation among covariates were examined. As Table 4.3 shows, there was correlation among covariates. However, correlations among covariates are smaller than 0.80. Therefore, the assumption of multicollinearity was also supplied.

As a last assumption independency of observation was examined. To meet this assumption the researcher was made observations in the experimental and control groups. It was observed that all the participants did their test by themselves.

4.2.3 Multivariate Analysis of Covariance Model

MANCOVA model was used to test the hypothesis of this study. The dependent variables of this study are the posttest scores of the PSTACH and PSTATT. The variables of the PSCG, PCGPA and PREATT are covariates of the study. Table 4.6 indicates the results of MANCOVA. As seen from the table, methods of teaching (MOT) explain 25.0 % variance of model for the collection DV's of the PSTACH and PSTATT.

Table 4.6 MANCOVA Test Results

Effect	**Wilks' Lambda**	**F**	**Hypothesis df**	**Error df**	**Sig.**	**Eta Squared**	**Observed Power**
Intercept	.758	6.39	2.0	134	.000	.080	.923
PSCG	.918	5.96	2.0	134	.003	.082	.873
PCGPA	.960	2.781	2.0	134	.002	.040	.540
PREATT	.759	21.242	2.0	134	.000	.241	1.000
MOT	.750	10.336	2.0	134	.000	.250	.968

4.2.4 Null Hypothesis 1

The first null hypothesis was " there will be no significant effect of methods of teaching (hands-on activities enriched instruction versus traditional method) on the population means of the collective dependent variables of sixth grade students' science achievement posttest scores and science attitude posttest scores when previous science course grades, previous cumulative grade point average, science attitude pretest scores are controlled". MANCOVA was conducted to determine the effect of methods of teaching on the PSTACH and PSTATT when previous science course grades, previous cumulative grade point average, science attitude pretest scores were controlled. Significance differences were found between hands-on activities enriched instruction and traditional method on the collective dependent variables. As indicated Table 4.6, the first null hypothesis was rejected ($\lambda = 0.750$, $p = 0.000$).

An analysis of covariance (ANCOVA) was conducted to determine the effect of independent variables of the methods of teaching on each dependent variable of PSTACH and PSTATT. Table 4.7 shows the result of the statistical analysis of ANCOVA.

4.2.5 Null Hypothesis 2

The second null hypothesis was "there will be no significant effect of methods of teaching (hands-on activities enriched instruction versus traditional method) on the population means of sixth grade students' science achievement posttest scores when students' previous science course grades and previous cumulative grade point average are controlled". Table 4.7 indicates the result of the statistical analysis of ANCOVA.

As seen from the table, the second null hypothesis was rejected ($F(1,135) = 23.444$, $p = 0.000$). So that, hands-on activities enriched instruction were effective to increase the PSTACH.

4.2.6 Null Hypothesis 3

The third null hypothesis was "there will be no significant effect of methods of teaching (hands-on activities enriched instruction versus traditional method) on the population means of sixth grade students' science attitude posttest scores when students' previous science course grade, previous cumulative grade point average and science attitude pretest score are controlled".

As indicated Table 4.7, the third hypothesis was failed to be rejected ($F_{(1,135)} = 1.133$, $p = 0.289$). That is, there is no significant difference in the means of the PSTATT between the experimental and control groups when the effects of students' previous science course grade, previous cumulative grade point average and science attitude pretest score have been controlled.

4.2.7 Classroom Observation

All through the study, the researcher observed lessons to compare the experimental group with the control group in terms of the treatment implemented. A total of 12 classroom observations have been done for the purpose of the treatment verification. Eight observations were conducted by the researcher and four observations conducted by the researcher and another observer together.

Table 4.7 Test of Between Subjects Effect

Source	**DV**	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Eta Squared**	**Observed Power**
Corrected Model	PSTACH	929.089	4	232.272	22.960	.000	.405	1.000
	PSTATT	712.857	4	928.214	20.388	.000	.377	1.000
Intercept	PSTACH	57.837	1	57.837	5.717	.018	.041	.661
	PSTATT	1664.057	1	1664.057	36.551	.000	.213	1.000
PSCG	PSTACH	31.564	1	31.564	3.120	.080	.023	.418
	PSTATT	391.261	1	391.261	8.594	.004	.060	.829
PCGPA	PSTACH	31.722	1	31.722	3.136	.079	.023	.420
	PSTATT	119.474	1	119.474	2.624	.108	.019	.363
PREATT	PSTACH	6.441	1	6.441	.637	.426	.005	.124
	PSTATT	1904.873	1	1904.873	41.841	.000	.237	1.000
MOT	PSTACH	439.507	1	439.507	23.444	.000	.243	1.000
	PSTATT	51.583	1	51.583	1.133	.289	.008	.600
Error	PSTACH	1365.733	135	10.117				
	PSTATT	6146.079	135	45.527				
Total	PSTACH	27675.000	140					
	PSTATT	486987.000	140					
Corrected Total	PSTACH	2294.821	139					
	PSTATT	9858.936	139					

4.3 Summary of the Results

The statistical analyses show that there were significant correlations between some variables of independent variables and dependent variables. Such as, independent variables of the PSCG, PCGPA and PREATT have significant correlations with at least one of the dependent variables of the PSTACH and PSTATT.

The statistical analysis of ANCOVA indicates that the students instructed by hands-on activities enriched instruction gained more science achievement about sense organs than the students instructed by traditional method. However, statistical results do not provide to the same result between the hands-on activities enriched instruction and students' attitude towards science. The hands-on activities enriched instruction did not increase the students' positive attitudes towards science more than the traditional method did.

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

1. There was a positive significant correlation between the PSCG and PSTACH. Similarly, positive significant correlation was found between the PCGPA and PSTACH about sense organs in science.
2. Statistical results showed that there were positive significant correlations between the PSCG and PSTATT. Similarly, positive significant correlation was found between the PCGPA and PSTATT about science.
3. Contrary to the expectations, there was no significant correlation between PREACH and PSTACH. However, the correlation between PREATT and PSTATT was significant and positive. On the other hand, there was no significant correlation between the PREACH and PSTATT. Similarly, no significant correlation was found between the PREATT and PSTACH.

4. The hands-on activities were efficient to improve the students' science achievement about sense organs. Hands-on activities enriched instruction increased the students' achievement more than the traditional method did.
5. There was no significant difference between the experimental and control groups' attitude towards science that means hands-on activities enriched instruction did not increase the students' attitude towards science more than the traditional method did.

CHAPTER V

CONCLUSIONS
DISCUSSION AND IMPLICATIONS

The purpose of the study was to investigate the effect of hands-on activities enriched instruction on students’ achievement and attitudes towards science. To finalize this goal, this chapter consists of six sections. First section presents the conclusions obtained from the results. Discussion of the results is given in the second section. The third and fourth sections present internal and external validities of the study, respectively. The fifth one is implication of the study. The final section is recommendations for further studies.

5.1 Conclusions

The accessible population of the study was all 6^{th} grade students in Keçiören district in Ankara. The sample of the study chosen from this accessible population was a sample of convenience. Therefore, there is a limitation about the generalizability of the study. On the other hand, conclusions of this research can be used to a broader population of similar sixth grade students.

The hands-on activity increased students’ achievement in science more than the traditional instruction did. However, the effect of the hands-on activities compared to traditional method on the students’ attitudes toward science was not significant.

5.2 Discussion of the Results

In comparing the results of this research with those of the previous ones, this research supports the findings of previous studies mainly in the area of science achievement. The results of this study indicated that students instructed by hands-on activities enriched instruction gained more science achievement than that of instructed by the traditional method. However, there was not significant difference between the experimental and control groups' attitude toward science.

Findings of this study are in agreement with those of Stohr-Hunt (1996), Turpin (2000), and Freedman (1997). For example, Stohr-Hunt (1996) investigated the effect of frequency of hands-on activities (daily, once a week and once a month) on student's science achievement. It was used showed that students who performed hands-on activities frequently had significant higher scores of science achievement than the students who performed hands-on science infrequently.

Turpin (2000) studied with 929 seventh grade students to investigate the effect of an activity-based science curriculum program on science achievement, science process skills and attitude towards science. In this quasi-experimental design, ANCOVA results showed that science achievement and science process skills of students who involved activity-based program, had significantly higher scores when compared to science achievement and science process skills of students who involved the traditional program had. On the other hand, there was no significant differences between experimental and control group in respect to students' attitude towards science.

Freedman (1997) investigated the effect hands-on laboratory instruction on science achievement and attitudes towards science. Students who received a hands-on laboratory experience one period each week for 36 weeks and other ones received no hands-on laboratory experiences. ANOVA data analysis showed that in the areas of science achievement, students using hands-on laboratory instruction had significant higher scores. However, there was no significantly a difference between the experimental and control groups' attitude towards science.

The results of Wideen (1975) showed that the students who instructed with Science-A Process Approach (SAPA) have higher science achievement test than the students who instructed with the traditional program. It was also found that there was no significant differences between experimental and control groups in terms of students' attitude towards science.

Theoreis that have been developed in educational areas, such as constructivism, put forward the active participation of students and guidance of instructors in science lessons. In present study, students who had hands-on activity enriched instruction had significant effect on student's achievement. The students who instructed with hands-on activities enriched instruction learned sense organs by both hands-on and minds-on. Students were active participant during all lessons and instructors guide them. They performed all hands-on activities and disscused all critical questions to get the important points of the subject at the end of activities. Therefore, students learned sense organs actively. Since they tried and observed those consepts in lessons, students might remember important concepts after years. For these activities, hands-out was prepared about the sense organs which could be benefical for them, while they both observe the results of activities and read and check their conclusions. Besides, they do science lessons funny, more enjoyable and efficient. However, students who instructed with traditional method learned sense organs only by listening their teacher and taking notes**.** They could not observe and feel what happen in our body during hearing, tasting, smelling, touching and seeing mechanisims. Based upon observation checklist results, these students got bored during instruction. These factors may be reason of such a result.

In addition to importance of hands-on enriched instruction for students, it has some other important aspects for the teachers during science lessons. For example, hands activities were inexpensive since simple life materials easy to obtain, easy and practical to perform in class, adaptable for most of the lessons and science subjects.

That is so, theacher could use hands-on enriched instruction to teach science and to motivate students.

Kyle et al. (1988), and Bristow (2000) findings are not in agreement with the present study in respect to attitude towards science. Kyle et al. (1988) found that sixth grade students who involved inquiry-oriented had significantly higher scores in attitude towards science.

The study of Bristow (2000) was conducted with 57 sixth grade students. This study has presented science concepts learned better when using hands-on teaching methods versus a traditional method and also, the effect of teaching methods on students' attitudes towards science. Researcher used a quasi-experimental study. Results indicate that there was no significant difference between experimental and control groups in respect to their science achievement. However, it was realized that students received hands-on instruction have more positive attitude towards science than the students received traditional textbook instruction.

The results of present study show that there were no significant differences between the experimental and control groups' attitudes toward science. One possible explanation of such a result is that the unit of the study, sense organs, was given to students in three weeks, which may not have been a long enough time period to show a difference in attitude of students between the two teaching methods. To show the ideals of one teaching method over the other, a longer time period may be needed.

In this study, another result was obtained about confounding variables that, gender difference did not have significant effect on both students' science achievement and attitude toward science. The subject of the studies can cause such result. It is known that some subjects of science attract only male student's attention or only female student's attention. Therefore, gender differences could be obtained. However, sense organs of this study have not such property. Both male and female students were interested with the subject. So that gender differences was not significant on dependent variables of this study.

5.3 Internal Validity

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

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

In this study the groups were randomly assigned to the treatment conditions. Since many subject characteristics (students' previous science knowledge, previous grade point average, science attitude pretest scores) might affect students' science achievement posttest scores (PSTACH) and science attitude posttest scores (PSTATT). These characteristics could be defined as potential extraneous variables to this study. As indicated in Table 3.2, variables were included in the covariate set to statistically match subjects on these factors. The statistical analyses showed that PSCG, PCGPA, and PREATT were covariates. And also, students' cognitive development was assumed to be equal for all students.

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

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

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

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

5.4 External Validity

Population Generalizability: The population generalizibality refers to the degree to which a sample of a study represents the population of interest (Fraenkel & Wallen, 1996). In this study the accessible population was all sixth grade students in public school at Keçiören district. The subjects of the study were 140 sixth grade students of two teachers from one public elementary school. Subjects of the study were not randomly selected from accessible population. Generalization according to the results of the study is limited because of nonrandom sampling. But generalizations to similar populations of public primary school students might be possible.

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

5.5 Implications

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

1. Science teachers should prepare hands-on activities in their science lessons. They should ensure their students become active and so science lesson should be student-centered but not to be teacher-centered.
2. Science teachers should be aware of how to set up hands-on activities since these activities should not be as cookbook style; however, hands-on activities should be both hands-on and minds-on.
3. Hands-on activity books should be written for science teachers as a source.
4. Science teachers should be supported in their lessons by administrators of schools about performing hands-on activities by obtaining them those hands-on activity booklets for science.
5. Curriculum developers should plan some hands-on activities in science curricula.
6. Universities should educate preservice science teachers about what is the meaning and importance of hands-on activities, and how it can be applied in science classrooms.
7. Science teachers and students should realize the significance of hands-on activities on science learning. They should understand that they do not need special laboratory equipments to learn science better.

5.6 Recommendations for Further Research

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

1. Future study could examine the effects of hands-on activities enriched instruction on increasing students' achievement and attitude in different science topics, and different grade levels.
2. This study was about public primary school students in Ankara. Future study could investigate the effect of hands-on activities on students' science achievement and attitude towards science in private primary schools.
3. Sample size could be larger for obtain more accurate results.
4. Further research could examine the effect of the hands-on activities enriched instruction on students' science achievement and attitudes toward science for a longer time which is integrated in the flow of normal science course.
5. Not only PSCG, PCGPA and PREATT but also many other variables may affect students' science achievement and attitudes towards science. Future study could examine the effect of teaching methods on students' science achievement and attitudes towards science by controlling different variables.

REFERENCES

Anderson, R.O. (1976). The Experience of Science: A New Perspective for Laboratory Teaching. New York: Columbia University. Teachers College Press.

Bates, G.C. (1978). The Role of Laboratory in Secondary School Science Programs. *What Research Says to Teacher, 1*, 55-57.

Bredderman, T. (1982). What Research Says: Activity Science the vidence Shows It Matters. *Science and Children, 20(1),* 39-41.

Bredderman, T. (1983). Effects of activity-based elementary science on students outcomes: A Quantitative Synthesis. *Review of Educational Research*, 53(4),499-518.

Bredderman, T. (1985). Laboratory programs for elementary school science: A Meta Analysis of Effects of Learning. *Science Education, 69(4),* 577-591.

Bristow, B.R. (2000). The Effects of Hands-on Instruction on Sıxth Grade students' Understanding of Electricity and Magnetizm. *Dissertation Abstracts International, 39(11)*,30A. (University Microfilms No. AAT1400301).

Bruner, J.S.,(1996). Toward a Theory of Instruction. Massachusetts: The Belknap Press of Harvard University Press.

Bybee, R.W.(1983). The Effectiveness of an individualized approach to a general Education Earth Science Laboratory. *Science Education, 54,* 157-161.

Culp, L., & Malone, V.(1992). Peer Scores for Group Work. *Science Scope, 15(6),* 35-36,59.

Dana, L.A.(2001). The Effects of the Level of Inquiry of Situated Secondary science Laboratory Activities on Students' Understanding of Concepts and the nature of Science, Ability to Use Process Skills and Attitudes Toward Problem Solving. *Dissertation Abstracts International, 62 (01),* 119A. (University Microfilms No. AAT3001676).

Deal, D. (1994). A look at Project AIMS. *School Science and Mathematics, 94(1),* 11-17

Dewey, J. (1980).The Scholl and Society. Chicago& London: The University of Chicago Press.

Doran, R.L. (1990). What Research Says...About Assesment. *Science and Children, 27(8)*, 26-27.

Doran, R.L., Boorman, J., Chan, F., & HejailY, N. (1993). Alternative Assessment of High School Laboratory Skills. *Journal of Research in Science Teaching, 30(9)*, 1121-1131.

Driver, R.& Bell, B.(1986). Students' Thinking and the Learning of Science: A Contructivist View. *The School Science Review, 67(240)*,443-456.

Elias, I. (1992). On Bringing Physics into the Elementary- School Classrooms. *The Physics Teacher, 30(7)*, 430-433.

Ewers, T.G.(2001). Teacher-Directed versus Learning Cycles Methods: Effects on Science Process Skills Mastery and Teacher Efficacy Among Elementary Education Students. *Dissertation Abstracts International, 62(07),* 2387A.

Fox, P. (1994). Creating a Laboratory: It's Elementary. *Science and Children, 361(4*), 20-22.

Freedman, M.P. (1997). Relationships Among Laboratory Instruction, Attitude toward Science, and Achievement in Science Knowledge. *Journal of Research in Science Teaching, 34(4)*,343-357.

Gaffney, K.E. (1992). Multiple Assessments for Multiple Learning Styşes. *Science Scope, 15(6)*, 54-55.

Gardner, C.M., Simmons, P.E., & Simpson, B.D. (1992). The Effects of CAI and Hands-on Activities on Elementary Students Attitudes and Weather Knowledge. *School Science and Mathematics, 92(6),* 334-336.

Glasson, G.E. (1989). The Effects of Hands-on Teacher Demonstrations Laboratory Methods on Science Achievement in Relations to Reasoning Ability and Prior Knowledge. *Journal of Research in Science Teaching, 26(2),*121-131.

Haertel, E. H. (1991). Form and function in assessing science education. In Kulm G. and Malcom, S. M. (Eds.) Science assessment in the service of reform. Washington, DC, American Association for the Advancement of Science.

Hardal, Ö.(2003). The Effects of Hands-on Activiites on 9th Grade Students Achievement and Attitudes Towards Physics, METU.

Harty, H.K., Kloosterman, P., & Matkin, J. (1989). Science Hands-on Teaching-Learning Activities of Elementary SchoolTeachers. *School Science and Mathematics, 89(6),* 456-467.

Haury, D.L. (1993). Teaching Science Through Inquiry. East Lansing, MI (ERIC Document Reproduction Service No. ED 359048).

Haury, D.L., & Rillero, P. (1994). Perspectives of Hands-on Science Teaching, (On-Line). http://www.ncrel.org/sdrs/areas/issues/content/cntareas/science/eric/eric-toc.htm#aut

Hedgeson, S.L., Blosser, P.E., & Howe, R.W. (1977). The Status of Pre-college Science, Mathematics and social Sciences Education: 1955-1975. Volume I. Science Education. Columbus, Oh. ERIC Clearinghouse for Science, Mathematics and Environmental Education. (ERIC Document Reproduction Service No. ED 153876).

Hein, G.E.(1987). The Right Test for Hands-on Learning. *Science and Children,25(2),*8-12.

Hodson, D. (1990). A Critical Look at Practical Work in School Science. *School Science Review, 71(256),*33-43.

Hofstein, A., & Lunetta, V.N. (1982). The Role of the Laboratory in Science Teaching. *Review of Educational Research, 52,* 201-247.

Hofstein, A., Mooz, N., & Rishpon, M.(1990). Attitudes Toward School Science: A Comparison of Participants and Non-participants in Extracurricular Science Activities. *School Science and Mathematics, 90 (1),* 13-22.

Huber, R.A., & Moore, C.J. (2001). A Model for Extending Hands-on Science to be Inquiry Based. *School Science and Mathematics, 101(1),* 32-41.

Jaus, H.H.(1977). Activity Oriented Science: Is It Really That Good? *Science and Children, 14(7)*, 26-27.

Kauffman, J. M. (1993). How we might achieve the radical reform of special education. *Exceptional Children, 60*, 6-16.

Keppler, L. (1996). How to make Hands-on Science Work for You. *Instructor, 52,* p46-48,

Klein, S.E., Yager, R.E., & McCurdy, D.W. (1982). The Laboratory is Vital in Science Instruction in the Secondary School. *Science Teacher, 49(2*),20-23.

Kyle, W.C., & Bonnstetter, R.J., & Godsten, T.(1988). An Implementation Study: An Analysis of Elementary Students' and Teachers' Attitudes Toward Science in Process-Approach vs. Traditional Science Classes. *Journal of Research in Science Teaching, 25(2),* 103-120.

Kyle, W.C., & Bonnstetter, R.J., McCloskey, J. & Frults, B.A.(1985). What Research Says: Science Through Discovery: Students Love It. *Science and Children, 23(2)*, 39-41.

Lebuffe, J.R.(1994). Hands-on Science in the Elementary School. East Lansing, MI: National Center for Research on Teacher Learning (ERIC Document reproduction Service No. ED 375003).

Lumpe, A. T., & Oliver, J.S.(1991). Dimensions of Hands-on Science. *The American Biology Teacher, 53(6),* 345-348.

Markham,C., & Smolen,L.(1991). Portfolio Assessment in Our Schools: *Implementation Advantages and Concerns Mild-Western Educational Researcher, 61(1),* 28-32.

Martin, D.J. (2000). Elementary Science Methods: SA Contructivist Approach. Albany: Delmar Publishers.

Martin, M.O., Mullis, I.V.S., Gonzales, E.J., Gregary, K.D., Smith, T.A., Chrostowski, S.J.,Garden, R.A., & O'Conner, K.M.(2000). Tımms 1999 International Science Report. (On-Line). Available: http://isc.bc.edu./timss 1999/pdf/ T99: sci Alll.pdf

Meinhard, R.(1992). Concept/Process-based Sience in the Elementary School. Salem, OR: Oregon Department of Education.

Meitchtry, Y.J(1992). Influencing Student Understanding of the Nature of Science: Data from a Case of Curriculum Development. *Journal of Research in Science Teaching, 29(4),* 389-407.

Millar, R., & Driver, R.(1987). Beyond Processe. *Studies in Science Education, 14*, 33-62.

Milner, N., Ben Zevi., & Hofstein, A.(1986). Variables that Affect Students Enrollment in Science Courses. Paper Presentd at the Meeting of the National Association for Research in Science Teaching. (NARST), San Francisco.

Morey, M.K. (1990). Status of Science Education in IIIinois elementary Schools, *Journal of Research in Science Teaching, 90(4)*, 387-397.

Palmer, D. (1997). Linking Theory and Practice: A Strategy for Presenting Primary Science Activities. *School Science Review, 79(286)*,73-80.

Pearson, E. (1990). Scientific Literacy: What is the Role of the Science Teacher? *Journal of Negro Education, 59(3),* 316-319.

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

Pizzini, E., Shepardson, D., & Abell, S. (1992). The Inquiry Level of Junior High Activities: Implications to Science Teaching. *Journal of Research in Science Teaching, 28 (2)*,111-112.

Powers, D.T. (1990). The Effects of Hands-on Instruction on Students Cognitive Structures as Measured by Concepts Maps. Dissertation Abstracts International, 51 (6), 1895.

Renner, J.M. (1972). The Laboratory and Science Teaching. Reprinted in Renner, J.W., & Stafford, D.G. *Science Teacher, 28*, 20-31

Renner, J.W., & Abraham, M.R., & Birnie, H.H. (1985). Secondary School Students' Beliefs about the Physics Laboratory. *Science Education, 69(5)*, 649-663.

Reynolds, A.J. (1991). Effects of Experiment-Based Physical Science Program on Cognitive Outcomes. *Journal of Educational Research, 84(5)*, 296-302.

Rillero, P. (1993). The Enlightenment Revolution: A Historical Study of Positive change Through Science Teacher Education. *Journal of Science Teacher Education, 4(2),* 37-43.

Robin, S., & Pearce, K. (2001). Learning Student Attitudes Toward Chemistry. *The Science Teacher, 68(2)*, 30-32.

Ross, R., & Kurtz, R. (1993). Making manipulatives work: A strategy for success. *Arithmetic Teacher, 40(5),* 254-57.

Rowland, P.M. (1990). Using Science Activities to Internalize Locus of Control and Influence Attitudes Towards Science. Paper Presented at the Annual Meeting of the National Association for Research in Science Teaching (63rd. Atlanta, GA, April 8-11, 1990). (ERIC Document Reproduction Service No. ED 325333).

Ruby, A.M. (2001). Hands-on Science and Student Achievement. Dissertation Abstracts International, 61(10), 3946A. (University Microfilms No. AAT9991730): Retrieved, January 02, 2003, from Digital Dissertations Database.

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

Schmieder, A.A., & Michael-Dayer,G. (1991). State of the Scene of Science Education in the Ration. Paper presented at the Public Health Service National Conference, Washington, DC.

Science Media Group. (1995). Minds of Our Own. South Burlington, VT: Public Broadcasting Service. Secondary Schools, New York: Harper& Row.

Shimuzu, K. (1998). The Effect of Inquiry Science Activity in Educational productivity. Dissertation Abstracts Internatıonal, 59(12), 453 4A.(Uniiversity Microfilms No. AAT9915008). Retrieved, Journay 02,2003, from Digital Dissertations Database.

Shulman, L.S., Tamir, P. (1973). Research on Teaching in the Natural Sciences. In R.M.W. Travers (Ed.), *Second Handbook of Research Teaching*, 1098-1140. Chicago: Rend Mc Nally.

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

Shymansky, J.A. (1989). What Research Says About ESS, SCIS, AND, SAPA. *Science and Children, 26(7)*,33-35.

Shymansky, J.A., Kyle, W.C., & Albort, J.M., (1982). How Effective were the Hands-on Science Programs of Yesterday. *Science and Children, 20(3),* 14-15.

Shymansky, J.A., Kyle, W.C., & Albort, J.M., (1983). The Effects of New Science Curricula on Student Performance. *Journal of Research in Science Teaching, 20(5),* 387-404.

Simpson, R.D.,& Oliver, J.S. (1990). A Summary of Major Influences on Attitude Toward and Achievement in Science Among Adolescent Students. *Science Education, 74(1),* 1-18.

Small, L., & Petrek, J. (1992). Teamwork Testing. *Science Scope, 15(6)*, 29-30.

Stever, J.R., & Small, L. (1990). Toward a Clearer Presentation of the Crisis in Science Education*. Journal of Research in Science Teaching, 27(1),* 79-89.

Stohr-Hunt, P.M. (1996). An Analysis of Frequency of Hands-on Experience and Science Achievement. *Journal of Research in Science Teaching, 33(1),*101-109.

Sumrall, W.J. (1997). Why Avoid Hands-on Science. *Science Scope, 20(4),*16-19.

Tamir, P., & Lunetta, V.N. (1981). Inquiry Related Tools in High School Science Laboratory Handbooks. *Science Education, 65(5),* 477-484.

Tippens, D.J., & Dana, N.F. (1992). Culturally Relevant Alternative Assessment. *Science Scope*, *15(6),*50-53.

Tobin, K. (1990). Research on Science Laboratory Activities: In Pursuit of Better Questions and Answers to Improve Learning: *School Science and Mathematics, 30(5),* 403-418.

Watson, B.& Konicek, R. (1990). Teaching for Conceptual Change: Confronting Childrens' Experience. *Kappan, 71(9)*, 680-685.

Welch, W.W. (1971). Science Education Information Report Research Review Series Science Paper 7: A Summary of Research in Science Education for the Years 1968-1969. Secondary School Level. Colombus, Ohio: ERIC Science Mathematics and Environmental Education Clearinghouse, Ohio State University.

Welch, W.W., Anderson, R.E., & Harris, L.J. (1982). The Effects of Schooling on Mathematichs Achievement.*American Educational Research Journal,19*,145-153.

Wideen, M.F. (1975): Comparison of Students Outcomes for Science. A Process Approach and Traditional Science Teaching for tHird, Fourt, Fifth, and Sixth Grade Classes: A Product Evaluation. *Journal of Research in Science Teaching, 12(1)*, 31-39.

Withers, C. (1983). Introduction to Dover Issue. In C. Johnson, Old-Time Schools and School books. (Reprint of 1904 edition). New York: Daver Publications.

Yager, R.E., & Yager, S.O. (1985). Changes in Perceptions of Science for Third, Seventh, and Eleventh Grade Students. *Journal of Research in Science Teaching, 20(4)*, 347-358.

APPENDIX A

OBJECTIVE LIST

Students will be able to;

1. list the structures of an human eye. (Knowledge (K))
2. design an eye model with given materials. (Synthesizing (S))
3. define the functions of the structures in a human eye. (K)
4. identify that different amount of light effects the pupil. (Analyzing (A))
5. explain the importance of eye accommodation (Comprehension (C))
6. discriminate if two eyes let you tell distance better than one eye (A)
7. describe how to see different colors. (K)
8. explain which colors can not be differentiate by the color blind people. (C)
9. explain how people become a color blind.(C)
10. explain why people can't see if image is on the blind point of human eye. (C)
11. state that difference of eye deficiency in respect to image effectiveness. (C)
12. predict the relationships between the vibration ad the sound.(Applying (Ap))
13. design an ear model with given materials. (S)
14. list the structures of an human ear. (K)
15. define the functions of the structures in a human ear. (K)
16. state that the procedures of how people can hear the sounds. (K)
17. identify the materials by their odor but without seeing them. (K)
18. explain the diffusion of perfume in air. (C)
19. predict that which region of the tongue feel which taste.(Ap)
20. explain why the tongue feels different taste in different regions. (C)
21. state that how to taste foods. (K)
22. predict the relationships between the smell and taste.(Ap)
23. relate that why people can not taste foods when they catch cold.(Ap)

24. describe how right and left fingers feel lukewarm water.(K)
25. explain that what is the concept of feelings of materials with skin.(C)
26. predict which part of the body feel better than other. (Ap)
27. define the sense receptors in the skin.(K)
28. list the structures of an human skin.(K)
29. define the functions of the structures in human skin.(K)

APPENDIX B

TABLE OF TEST SPECIFICATION

Obj.level / Content	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation
İnsan gözünün yapısı	**1,3,5,15, 19** 1,2	**11,3**		6		
Nasıl Görürüz?	**23** 3,7	**18** 5,10			4	
Göz Kusurları ve Etkileri	**13,21**	**25** 8,9,11				
İnsan kulağının yapısı	**15,17** 14	**1,6,11,24**			13	
Kulak zarındaki titreşimler		**16**				
Nasıl İşitiriz?	**20** 15,16		12			
Burnun yapısı	**4,15**	**11**	23,24			
Nasıl koku alırız?	**17**	**18,19**				
Dilimizle nasıl tat alırız?		**11,8** 21,22				
İnsan dilin yapısı	**12,15**		19,23,24			
Derimizle nasıl algılarız?	25*	**7** 26				
İnsan derisinin yapısı	**14,22** 28,29,30	**9**	27			

APPENDIX C

SCIENCE ACHIEVEMENT TEST

1.İsim:___________

2. Cinsiyet: ❑ Kız ❑ Erkek

3. Annenizin mesleği ___________________

4. Babanızın mesleği___________________

5. Annenizin Eğitim Durumu

❑ Hiç okula gitmemiş ❑ İlkokul

❑ Ortaokul

❑ Lise ❑Üniversite

❑ Yüksek lisans (Mastır/Doktora)

6. Babanızın Eğitim Durumu:

❑ Hiç okula gitmemiş ❑ İlkokul

❑ Ortaokul

❑ Lise ❑Üniversite

❑ Yüksek lisans (Mastır/Doktora)

1. Refleksel olarak, yüksek ve düşük ışık şiddetinde göze girecek olan ışık miktarını ayarlayan göz yapısı hangisidir?
   A) Kornea
   B) İris
   C) Mercek
   D) Göz bebeği

2. Göz uyumunun tanımı aşağıdaki verilenlerden hangisidir?
   A) Merceğin ışığı geçirmesidir
   B) Uzak ve yakın cisimlerin net olarak görülmesi faaliyetidir
   C) Göze giren ışık miktarının ayarlanmasıdır
   D) Yorulunca gözün dinlendirilmesidir
3. Gözümüz görme duyuları olup, cisimlerin görüntüsünü alarak beyne iletir. Aşağıda bir cismin görüntüsünün algılanmasında kullanılan yapılar ve kullanılma sıraları verilmiştir.

   Cisim → ışık → kornea → ....I........

   .III...... ← sinirler ← ..II..... ← mercek

   Boş olan numaralı yerlere hangileri gelmelidir

	I ________	II ________	III ________
A)	Göz bebeği	Ön oda	Retina
B)	İris	Camsı cisim	Kör nokta
C)	Göz bebeği	Sarı benek	Beyin
D)	İris	Arka oda	Retina

4. Koku almakla görevli almaçların bulunduğu yer aşağıdakilerden hangisidir?
   A) Burun boşluğunun alt kısmı
   B) Mukoza tabakası
   C) Sarı bölge
   D) Sarı benek
5. Aşağıdakilerden hangisi göze özgü bir yapı <u>değildir?</u>
   A) Salyangoz
   B) İris
   C) Sarı benek
   D) Saydam tabaka

6. Sesin dış ortamdan beyine iletimi sırasında kulakta kullanılan organlar ve kullanılma sırası verilenlerden hangisi gibi olur?

   A) Kulak yolu, kulak zarı, salyangoz, çekiç

   B) Kulak kepçesi, örs, oval pencere, dalız, salyangoz

   C) Kulak yolu, üzengi, salyangoz, oval pencere

   D) Kulak zarı, çekiç, örs, sinirler, dalız

7. Aşağıda verilen bölgelerden hangisinde algılama hissi en fazladır?

   A) Kollar

   B) Parmak uçları

   C) Avuç içleri

   D) Omuzlar

8. Dilin farklı kısımlarında aynı tadların daha çok algılamasının sebebi aşağıdaki verilenlerden hangisidir?

   A) Tad maddelerinin dilin farklı kısımlarına dokunması

   B) Farklı duyu hücrelerini taşımaları

   C) Farklı tad maddelerini eritebilmeleri

   D) Tad maddeleri ile etkileşimlerinin farklı olması

9. Güneşten gelen zararlı ultraviyole ışınlarını emerek deri altı organlarını koruyan deri kısmı aşağıda verilenlerden hangisidir?

   A) Ölü tabaka

   B) Üst deri

   C) Alt deri

   D) Yağ tabakası

10. Hangisi iç kulakta <u>bulunmaz</u>?

   A) Salyangoz

   B) Yarım daire kanalı

   C) Oval pencere

   D) Ağ tabaka

11. Aşağıda belirtilen duyulardan hangisi beyinde birbiriyle bağlantılı sinirler tarafından yorumlanır?

A) Koku ve tat alma

B) İşitme ve görme

C) İşitme ve tat alma

D) Görme ve koku alma

12. Dilde tad alma tomurcukları belirli yerlerde yoğunlaşmıştır. Bunlarla ilgili verilenlerden hangisi yanlıştır?

A) Tatlı- dilin ucunda

B) Acı- dilin arkasında

C) Ekşi- dilin kenarında

D) Tuzlu- dilin ortasında

13. Uzağı görmeyen göz hastalığına ne ad verilir?

A) Miyop

B) Hipermetrop

C) Astigmat

D) Renk körlüğü

14. Dokunma hissini almakla görevli duyu almaçlarının bulunduğu yer aşağıdakilerden hangisidir?

A) Üst deri

B) Yağ doku tabakası

C) Ter bezleri

D) Alt deri

15. Duyu organlarındaki duyu sinirlerinin bulunduğu yerlerden hangisi yanlıştır?

A) Göz- Ağ tabaka

B) Dil-Tad tomurcukları

C) Burun- sarı bölge

D) Kulak- Dalız

16. Kulağa gelen ses titreşimleri hangi yapıdaki duyu hücreleri tarafından algılanır?

A) Kulak zarı

B) Östaki borusu

C) Yarım daire kanalları

D) Salyangoz

17. İşitme sinirleri aşağıdaki yapılardan hangisinde bulunur?

A) Dalız

B) Oval pencere

C) Salyangoz

D) Yarım daire kanalları

18. Gözde görüntünün oluşması ve algılanması ile ilgili verilenlerden hangisi yanlıştır?

A) Işık, kornea ve mercekte kırılır

B) Görüntü retinaya ters olarak düşer

C) Kör noktada göz sinirleri bulunmaz

D) Sarı benekteki görüntü net olarak algılanır

19. Işığı algılayan duyu hücrelerinin bulunduğu yer aşağıdakilerden hangisidir?

A) Ağ tabaka

B) İris

C) Kornea

D) Kör nokta

20. Ses dalgaları ile meydana gelen titreşimlerin kulak zarından sonra ilk olarak iletildiği yer neresidir?

A) Dalız

B) Korti organı

C) Çekiç kemiği

D) Üzengi kemiği

21. Renk körlüğünde aşağıdaki renklerden hangileri ayırt edilemez?

A) Kırmızı-mavi

B) Kırmızı-sarı

C) Mavi-sarı

D) Sarı-yeşil

22. Aşağıdakilerden hangisi derinin görevi değildir?

A) Dışarıdan gelen uyarılara cevap verir

B) Vücuda mikropların girmesini önler

C) Vücudun su kaybetmesini önler

23. Aşağıdaki göze ait yapılardan hangisi renkleri algılamamızı sağlayan yapıdır?

A) Kornea

B) Saydam tabaka

C) Kör nokta

D) Retina

24. I-Çekiç

II-Örs

III-Östaki borusu

Yukarıdakilerden hangisi ses dalgalarının iletilmesinde görevli değildir?

A) Yalnız I

B) Yalnız II

C) Yalnız III

D) I ve I

25. Aşağıdaki verilen göz bozukluklarından hangisi düzeltilemez?

A) Şaşılık

B) Renk körlüğü

C) Astigmatizm

D) Hipermetrop

APPENDIX D

SCIENCE ATTITUDE SCALE

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

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

APPENDIX E

OBSERVATION CHECKLIST

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

APPENDIX F

HANDS-ON ACTIVITIES

1. **Nasıl Görürüz?**

Aktivite 1: Gözümüzün Yapısı

Amaç: Çevrenizi görmenizi sağlayan gözünüzde hangi yapıların olduğunu göz modeli yaparak anlamaya çalışmak.

Araç ve Gereçler:

- Yuvarlak cam top, siyah ve beyaz karton, su, makas, ve ışık kaynağı (el feneri, masa lambası vs.).

Yöntem:

1) Bu aktiviteyi aynı sırada oturduğunuz arkadaşınızla birlikte yapınız. Siyah kartonunuzun ortasından küçük bir delik açınız. Sınıfınızda bulunan göz modeline bakarak açtığınız bu deliğin gözdeki hangi yapı olduğunu tahmin ediniz.

....

2) Yuvarlak cam topunuzu su ile doldurunuz.

3) Siyah kartonunuzu cam topun bir tarafına sarınız.

4) Beyaz kağıdınızı da topun diğer tarafına sarınız. Bu sardığınız beyaz kağıdın gözdeki hangi yapı olduğunu yazınız.

....

5) Işık kaynağınızı topunuzun bir tarafında sarılı olan siyah kağıdınızda açtığınız deliğe doğru tutunuz.

6) Sınıfınızın çok fazla ışık almasını engelleyiniz. Lambanızı beyaz kağıtta görecek şekilde hareket ettiriniz. Yaptığınız <u>bu model ile gözünüz</u> arasındaki benzerlikleri ve farklılıkları yazınız.

<u>Benzerlikler</u>	**<u>Farklar</u>**
1)	1)
2)	2)
3)	3)
4)	4)

7) Bulduğunuz göz yapılarının gözünüzde hangi görevleri üstlendiklerini arkadaşlarınızla tartışınız ve maddeler halinde yazınız.

Gözdeki Yapı	**Görevi**
1)	1)
2)	2)
3)	3)
4)	4)
5)	5)

Aktivite 2: Işığın göz bebeğine etkisi

Amaç: Göz bebeğinin farklı ışık şiddetinde nasıl değiştiğinin algılanması.

Araç ve Gereçler:

- Işık kaynağı (el feneri v.s.).

Yöntem:

1) İkişer kişilik gruplar oluşturunuz. Gruptaki bir arkadaşınız diğer arkadaşınızın gözüne dikkatlice bakarak, iris ve göz bebeğini çizsin.

Şekil 1

2) Sınıftaki perdeleri çekiniz, ışıkları kapatınız. Şimdi arkadaşınızın göz bebeğini ve irisini yeniden gözlemleyiniz ve çiziniz.

Şekil 2

3) Şekil 1 ve şekil 2 arasında fark var mı?Açıklayınız.

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

4) Elinizdeki el fenerini gözlemlediğiniz arkadaşınızın **direk olarak gözüne gelmeyecek** şekilde gözlerinin yan tarafından gözüne doğru tutunuz. Şimdi arkadaşınızın iris ve göz bebeğini yeniden çiziniz.

Şekil 3

5)Bu çizdiğiniz üç şekli karşılaştırınız. Arkadaşınızın göz bebeğinde nasıl bir değişiklik oldu yazınız.

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

6) Göze girecek olan ışık miktarını ayarlayan göz yapısı hangisidir?

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

Aktivite 3: Neden İki Gözümüz Var?

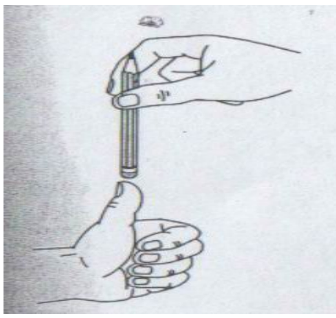
Amaç: İki göze sahip olmanın tek göze göre uzaktaki cisimleri algılamamızdaki üstünlüğünün fark edilmesi.

Araç ve Gereçler:

- Arkası silgili kurşun kalem

Yöntem:

3) Bu aktiviteyi aynı sırada oturduğunuz arkadaşınızla birlikte yapınız. Gruptaki bir arkadaşınız başparmağını şekildeki gibi sizin göz seviyenizde tutsun. İki gözünüzde açık iken kalemin silgisini arkadaşınızın başparmağına dokundurmaya çalışınız. Arkadaşınızın başparmağını bulmakta zorlandınız mı? Yazınız.



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

2) Kalemi tutan arkadaşınız gözlerini kapatsın. Diğer arkadaşınız başparmağını size doğru biraz daha yaklaştırsın. Arkadaşınızın aç komutuyla yalnızca tek gözünüzü açınız ve hızlı bir şekilde kaleminizin silgisini arkadaşınızın başparmağına dokundurmaya çalışınız. Tek gözünüz açık iken mi yoksa iki gözünüz açık iken mi arkadaşınızın başparmağına kalemi daha kolay dokundurdunuz? Arkadaşlarınızla tartışınız.

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

3) Yukarıda yaptığınız aktivitede arkadaşınız başparmağını size doğru biraz daha yaklaştırdığında arkadaşınızın başparmağını daha kolay mı algıladınız? Gözünüz her uzaklıktaki cisimleri aynı nitelikte mi görür? Nedenlerini arkadaşlarınızla tartışınız ve yazınız.

....

....

....

....

....

....

<u>Aktivite 4</u>: Renkleri nasıl algılıyoruz?

Amaç: Gözümüzde renkleri algılamamızı sağlayan yapının anlaşılması.

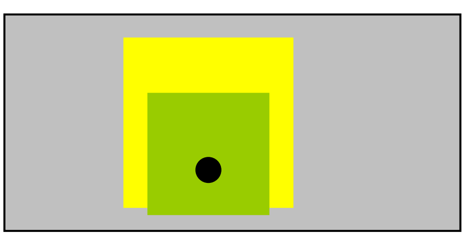
Araç ve Gereçler:

- Renkli kalemler.

Yöntem:

1) Kağıdınızın arka sayfasına şekil 1.1'deki gibi önce sarı kaleminizle bir kare şekli çiziniz. Çizdiğiniz karenin içine yeşil kaleminizle bir kare daha çiziniz. Ve karenizin orta yerine siyah kaleminizle bir tane nokta koyunuz.

<u>Şekil 1.1</u>



2) Çizdiğiniz siyah noktaya gözünüzü kırpmadan 40 saniye dikkatlice bakınız. 40 saniye sonra hızlı bir şekilde beyaz kağıdınızın kenarlarında bulunan boş bir yerine bakınız. Şimdi kenar çizgilerini ve karenizin içini hangi rengi görüyorsunuz? Neden? Açıklayınız.

....

....

....

....

....

....

....

....

3) Gözümüze ait yapılardan hangisi renkleri algılamamızı sağlayan yapıdır? Araştırınız.

....

....

....

....

....

....

Aktivite 5: Renk Körlüğü

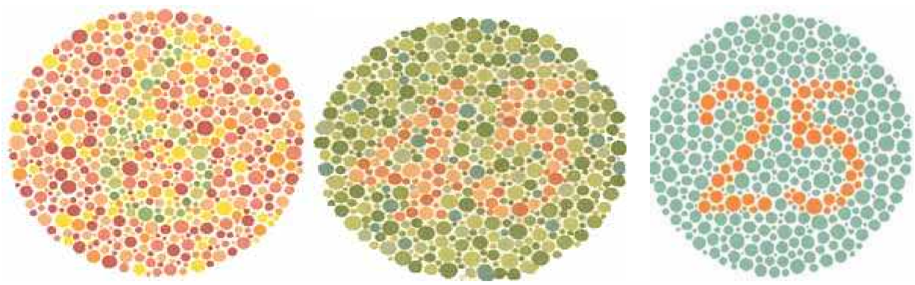
Amaç: Renk körlüğü kavramının algılanması ve renk körlüğünün belirlenmesi.

Araç ve Gereçler:

- Renkli yuvarlak karton kart.

Yöntem:

1) Siz şekildeki rakamları okuyabiliyor musunuz?



....

....

....

....

....

....

3) Yukarıdaki şekiller renk körlüğünün tespitinde kullanılır. Renk körlüğü, şekillerinizi de düşünerek, ne demektir?Yazınız.

....

....

....

....

....

....

....

....

3) Renk körlüğü tedavi edilirmi? Araştırınız.

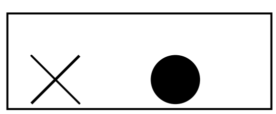
....
....
....
....
....

Aktivite 6: Kör noktanın bulunması

Amaç: Görüntü kör nokta üzerinde oluşsaydı görüntü gerçekleşirimiydi sorusunun yanıtını bulmak.

Araç ve Gereçler:

- 5 x 7 cm büyüklüğünde kağıt (çarpı ve yuvarlak işaretli)



Yöntem:

1) Bu aktivite için kağıdınızın arka sayfasında çizili olan şekli kullanınız.

2) Sol gözünüzü elinizle kapatınız. Kağıdınızı kendinizden 30 cm kadar uzaklaştırınız ve çarpı işaretine dikkatlice bakınız. Daha sonra kağıdınızı yavaşça sağ gözünüze doğru yaklaştırınız. Aynı işlemi birkaç kez deneyiniz.

Yuvarlak işaretini görebiliyor musunuz yazınız. Arkadaşlarınızla sonucu tartışınız.

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

3) Kör nokta nedir? Ve göz sinirleri var mıdır?Yukarıdaki aktivitenizden yola çıkarak görme olayının gerçekleşmesi için görüntünün nerede oluşması gerektiğini tartışınız ve yazınız.

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

4) Sınıfınızda gözlük kullanan arkadaşlarınız var mı? Arkadaşlarınızın göz kusurlarının neler olduğunu öğreniniz ve aşağıdaki tabloyu doldurunuz.

Göz Kusurları	**Etkileri**
1)	1)
2)	2)
3)	3)
4)	4)
5)	5)

2. Nasıl İşitiriz?

Aktivite 1: Titreşim nedir?

Amaç: Titreşim ve ses arasındaki ilişkiyi kavramak.

Araç ve Gereçler:

- Paket lastiği.

Yöntem:

1) Bu aktiviteyi aynı sırada oturduğunuz arkadaşınızla birlikte yapınız. İçinizden bir arkadaşınız paket lastiğini uçlarından tutarak çok fazla olmamak şartı ile gerdirsin. Diğer arkadaşınız lastiğin ortasından tutup aşağıya doğru çekip bıraksın.

2) Lastiğinizin hareketi ile birlikte ne gözlemlediğinizi yazınız. Bu gözlemleriniz lastiğinizi hareket ettirmeden önce de var mıydı? Yazınız.

....

....

....

....

3) Titreşim ve ses arasında nasıl bir ilişki var? Tartışınız.

....

....

....

....

....

....

<u>Aktivite 2</u>: Kulak zarındaki titreşimler.

Amaç: Ses dalgalarının kulak zarı üzerindeki etkisinin gözlemlenmesi.

Araç ve Gereçler:

- Büyük pet şişe, balon, makas, paket lastiği.

Yöntem:

1) Pet şişenin dibini kesiniz. Buraya kestiğiniz balon parçasının gerdirerek paket lastiğiyle tutturunuz.
2) Şişenin açık olan ağız bölümünden elinizle vurarak balon parçasında ne gözlemlediğinizi yazınız.

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

3) Vurma şiddetini arttırarak balon hareketinin nasıl değiştiğini yazınız.

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

4) Kulak ile ilgili daha önce edindiğiniz bilgileri düşünerek, etkinliğinizdeki hangi bölümü kulak zarına benzetirsiniz?

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

5)Sınıfınızdaki kulak modeline bakarak kulak zarı, kulağın hangi bölümündedir yazınız. Ve kulağımızdaki diğer bölümleri de sırayla ayrıntılı olarak yazınız.

Kulaktaki Bölümler	**Görevleri**
1)	
2)	
3**)**	
4)	

6) Titreşimlerin ses olarak algılanmasına kadar olan sürede kulakta neler olduğunu arkadaşlarınızla tartışınız ve maddeler halinde yazınız.

1)
2)
3)

3. **Nasıl Koku Alırız?**

Aktivite 1: Değişik Kokular

Amaç: Bazı maddeleri görmeden de kokularından ayırt edilebileceğinin farkına varılması.

Araç ve Gereçler:

- Baharatlar (kimyon, nane, kekik, ada çayı)
  Kolonyalar (limon, tütün)
  Meyveler (muz, portakal)
  Siyah kumaş bant

Yöntem:

1) Dörder kişilik gruplar oluşturunuz. Gruptaki bir arkadaşınız diğer kişilere maddeleri koklatmakla görevli olsun. Diğer üç kişi gözlerini siyah kumaş bantla bağlayarak kapatsın.
2) Görevli arkadaşınız gruptaki birinci kişiye baharatları, ikinci kişiye kolonyaları ve üçüncü kişiye ise meyveleri koklatıp kokuların hangi maddelere özgü olduklarını sorarak not etsin.

Arkadaşınızın ismi	**Ne koklattın?**	**Ne söyledi?**
1)		
2)		
3)		

3) Kokuları karıştırmadan tanıyabildiniz mi?

....

....

....

4) Kokuların nelere özgü olduğunu anlamada hangi olayların gerçekleştiğini söyleyebilir misiniz? Kokuları nasıl algılıyoruz arkadaşlarınızla tartışınız ve yazınız.

....

....

....

....

....

....

....

Aktivite 2: Kokuların Yayılması

Amaç: Havada kokunun nasıl yayıldığının ve koku hissinin kişiden kişiye nasıl farklılık gösterdiğinin algılanması.

Araç ve Gereçler:

- Çay tabağı, parfüm yada kolonya, ve saniyeli saat

Yöntem:

1) Bulunduğunuz yerde başınızı sıranıza koyup gözlerinizi kapatınız.
2) Parfüm kokusunu aldığınız anda başınızı ve elinizi gözlerinizi açmadan kaldırınız.

3) Birinci, ikinci, üçüncü ve son sıralarda kaçıncı saniyede kokunun ulaştığını kaydediniz. Tahtaya aşağıdaki gibi bir tablo çizerek, sonuçları yazınız.

Sıralar	**Zaman (saniye)**
1.	
2.	
3.	
Son sıralar	

4) Her sıra aynı zamanda mı kokuyu hissetti yazınız. Tahtadaki tablonuza bakarak sonuçları tartışınız.

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

4. Nasıl Tat Alırız?

Aktivite 1: Tatlı, tuzlu, ekşi ve acı

Amaç: Farklı tatların dilin hangi bölgelerinde algılandığının incelenmesi.

Araç ve Gereçler:

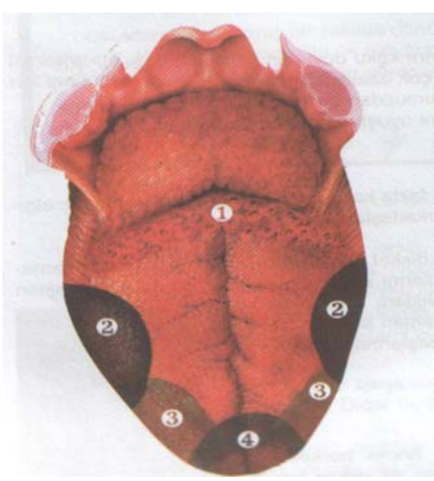
- Limon suyu, sulandırılmış acı biber salçası, tuzlu su, sulandırılmış reçel, su, plastik kaşık (4 adet), plastik bardak (4 adet), 4 farklı renkli kalem, kağıt.

Yöntem:

1) Beş kişilik gruplar oluşturunuz.

2) Bardaklara sırayla limon suyu, sulandırılmış acı biber salçası, tuzlu su, ve sulandırılmış reçel koyunuz.

3) Dilimizin haritasını oluşturmak için aşağıdaki şekli kullanınız.



Dört arkadaşınızın birinin diline tatlı, birininkine tuzlu, birininkine acı ve birininkine de ekşi maddelerden damlatınız.

Bu işlemi arkadaşlarınızın dillerinin değişik bölgelerine uygulayınız. Maddenin tadının hangi bölgelerinde en iyi algılandığını arkadaşlarınıza sorunuz ve dil haritanızda bu tadları renkli kalemlerinizle işaretleyiniz. Aşağıdaki boşlukları doldurunuz.

İsim	**Tadlar**	**Bölge**

....

....

....

....

....

4) Tüm tatları dilinizin her tarafında aynı ölçüde mi algıladınız yazınız.

....

....

....

....

....

5) Tat alma olayının nasıl gerçekleştiğini tartışınız.

....

....

....

....

....

....

....

<u>Aktivite 2</u>: Koku ve Tat Alma

Amaç: Koku ve tat alma duyularının birlikte çalışmasının farkına varılması.

Araç ve Gereçler:

- Küçük patates, elma ve soğan parçaları, siyah kumaş bant, renkli kalem.

Yöntem:

1) Dörder kişilik gruplar oluşturunuz. Gruptaki üç kişinin gözlerini siyah kumaş bant ile kapatınız ve bu üç kişiyi altı adımlık uzaklıkta oturtunuz.

2) Küçük patates, elma ve soğan parçacıklarından birini gözleri kapalı arkadaşlarınızdan bir tanesinin ağzına veriniz. Diğer iki yiyecek parçacıklarından birini de burnunun altına tutunuz. Daha sonra arkadaşınıza ağzındaki yiyeceğin ne olduğunu sorunuz ve not alınız. Aynı işlemi değişik kombinasyonlardaki yiyeceklerle tekrar ediniz. Diğer iki arkadaşınız içinde bu aktiviteyi uygulayınız.

<u>İsim</u>	**<u>Tadı alınan yiyecek</u>**	**<u>Kokusu alınanyiyecek</u>**

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

3) Arkadaşlarınız her kombinasyonda yiyecekleri doğru tanımladı mı? Sonuçları arkadaşlarınızla tartışınız.

....

....

....

....

....

....

....

....

4) Yukarıda yaptığınız aktiviteyi de düşünerek nezle olup burnunuz tıkandığında yediklerinizin tadını neden alamazsınız? Yazınız.

....

....

....

....

....

....

....

5. Derimizle Nasıl Algılarız?

Aktivite 1: Sıcak mı soğuk mu?

Amaç: Deriniz maddelerin sıcaklığını nasıl algılar sorusunun yanıtını bulmak.

Araç ve Gereçler:

- Soğuk su, sıcak su, ılık su, su bardağı (üç adet).

Yöntem:

1) Bardaklardan birine soğuk su, diğerine ılık su, üçüncüsüne de sıcak su (elinizi yakmayacak şekilde) koyunuz. Ve sağ işaret parmağınızı soğuk suya, sol işaret parmağınızı sıcak suya aynı anda batırınız. Parmaklarınızı 30 saniye beklettikten sonra çekerek, iki parmağınızı da ılık suya batırınız.

2) Sağ eliniz ılık suyu nasıl algıladı yazınız.

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

3) Sol eliniz ılık suyu nasıl algıladı yazınız.

....

....

....

....

4) Ilık suyun sıcaklığı her iki parmağınıza aynı hissi verdi mi? Hangisinde sıcak hangisinde soğuk hissettiniz?Yazınız.

....

....

....

....

Aktivite 2: Derimizin her yerinde maddeleri aynı şekilde mi algılarız?

Amaç: Vücudumuzun farklı bölgelerinde algılama hissimizin farklı olabileceğinin kavranması.

Araç ve Gereçler:

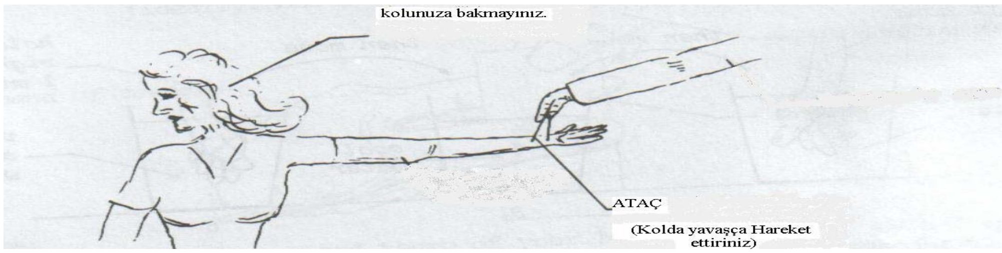
- Ataç ve siyah kumaş bant

Yöntem:

1) Bu aktiviteyi aynı sırada oturduğunuz arkadaşınızla birlikte yapınız. İçinizden bir arkadaşınızın gözlerini siyah kumaş bant ile kapatınız.

2) Elinizdeki atacınızın uçlarını açınız. Atacınızı arkadaşınızın parmağında, elinde ve kolunda yavaşça hareket ettirerek arkadaşınızın koluna doğru

çıkınız. Rasgele olarak atacınızın bazen tek ucunu bazen de iki ucunu dokundurunuz. Bu işlemi yaparken atacınızın kaç ucunu dokundurduğunuzu ve nerelerde bunun daha iyi algılandığını arkadaşınıza sorunuz ve cevaplarını aşağıdaki tabloya yazınız.



Tek uç	**Bölümler**	**Tek Uç**	**İki Uç**
	Parmak		
	El		
	Kol		
İki uç	**Bölümler**	**Tek Uç**	**İki Uç**
	Parmak		
	El		
	Kol		

3) En kolay hangi bölgede atacınızın kaç ucunun dokunduğunu doğru hissettiniz?

....

....

....

....

....

4) Dokunma hissinizi sağlayan duyu almaçları derinizin hangi bölgesinde bulunur? Yazınız. Derinizde bulunan diğer bölümleri ve bu bölümlerin görevlerini yazınız.

Derimizdeki Bölümler	**Görevleri**
1)	
2)	
3)	
4)	
5)	

APPENDIX G

OBJECTIVE ACTIVITY TABLE

OBJECTIVE-ACTIVITY TABLE

Activity / Objective	A.1	A.2	A.3	A.4	A.5	A.6	A.7	A.8	A.9	A.10	A.11	A.12	A.13	A.14
1	*													
2	*													
3	*													
4		*												
5			*											
6			*											
7				*										
8					*									
9					*									
10						*								
11						*								
12							*							
13								*						
14								*						
15								*						
16								*	*					
17									*					
18										*				
19											*			
20											*			
21											*	*		
22												*		
23												*		
24													*	
25													*	
26														*
27														*
28														*
29														*

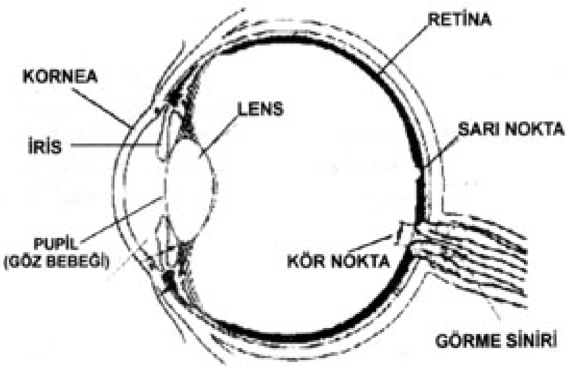
APPENDIX H

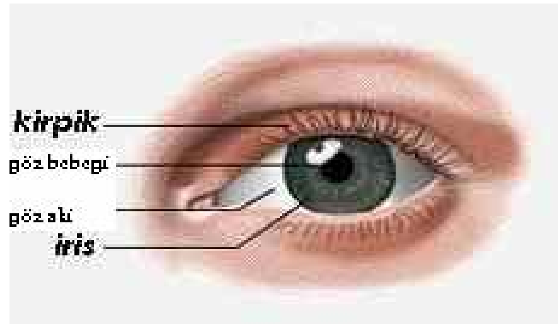
HANDOUT

ÇEVREMİZİ NASIL ALGILIYORUZ?

1. **Nasıl Görürüz?**

GÖZÜN YAPISI	GÖREVLERİ
Sert Tabaka	1. Gözü dıştan saran ve koruyan beyaz tabakadır. 2. Saydam tabakayı (kornea) oluşturur.
Damar Tabaka	1. Sert tabaka ve ağ tabaka arasında bulunur. 2. Damarlarca zengindir ve gözü besler.
İris	1. Damar tabakanın oluşturduğu gözün renkli bölümüdür. 2. Ortasında göz bebeği bulunur. 3. Göz bebeğinin büyüklüğünü ayarlar.
Göz merceği	1. Işığın sarı beneğe düşmesini sağlar.
Ağ Tabaka	1. Gözün en iç tabakasıdır. 2. Duyu almaçları bulunur. 3. Görüntü burada bulunan sarı benek üzerinde oluşur.



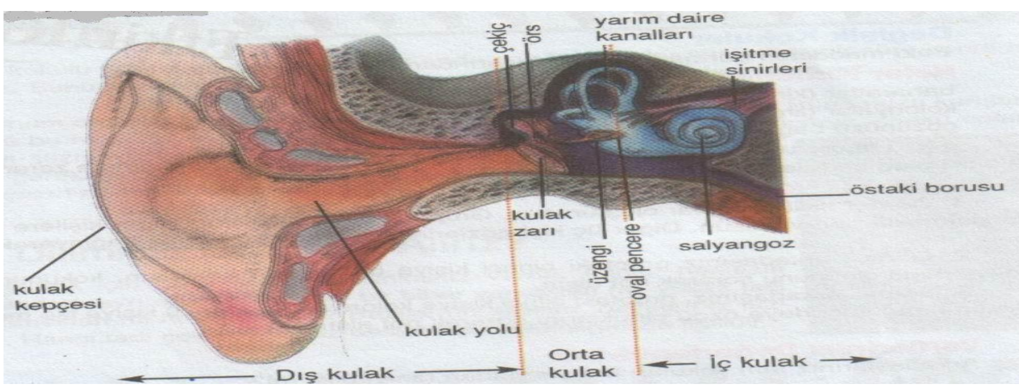


Görme Olayı; Cisimden gelen ışık ışını —»-kornea------Göz bebeği------ Göz merceği------Camsı cisim----Sarı leke —>Görme sinirleri—»-Beyindeki Görme merkezi

GÖZ KUSURLARI	ETKİLERİ
Miyopluk	• Yakını görüp uzağı net görememe durumudur.
Hipermetropluk	• Uzağı görüp yakını net görememe durumudur
Astigmatlık	• Gözdeki saydam kısımların düzgün simetriye sahip olmama durumudur. • Cisimler bulanık görülür.
Şaşılık	• Gözü hareket ettiren kasların uyumsuzluğu durumudur. • Ameliyatla tedavi edilir.
Katarakt	• Göz merceğinin saydamlığını yitirme durumudur. • Ameliyatla tedavi edilir.
Renk Körlüğü	• Kalıtımsal bir hastalıktır. • Bazı renkleri ayırt edememe durumudur. • Tedavisi yoktur.

2. Nasıl İşitiriz?

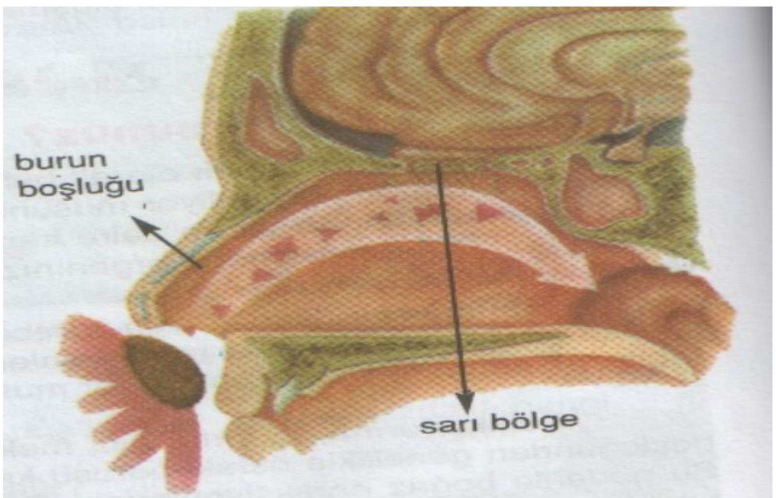
KULAĞIN YAPISI	GÖREVLERİ
Dış Kulak	1. Kulak kepçesi ve kulak yolundan oluşur. 2. Ses dalgalarını orta kulak başlangıcındaki kulak zarına iletir.
Orta kulak	1. Kulak zarındaki titreşimler çekiç, örs ve üzengi kemiklerini harekete geçirir. 2. Bu üç kemiğin titreşimleri iç kulağa aktarılır.
İç Kulak	1. Titreşimler salyangozda bulunan duyu almaçları tarafından algılanır. 2. İşitme sinirlerinde uyartı oluşur ve beyne iletilir.



İşitme Olayı: Kulak kepçesi —»• Kulak yolu —»-Kulak zarı---Örs, çekiç,Üzengi-----Oval pencere----- Dalız------Salyangoz-------İşitme sinirleri —--- Beyindeki işitme merkezi

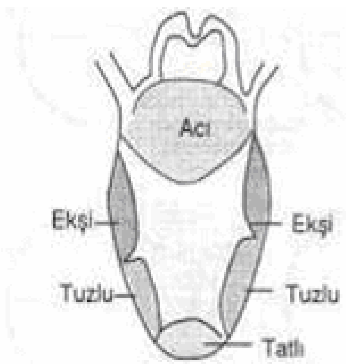
3. Nasıl Koku Alırız?

- Burun kemik ve kıkırdakla desteklenen bir organdır.
- Burun boşluğu bir bölmeyle ikiye ayrılmıştır.
- Burun boşluğunun duvarı epitel doku hücreleriyle kaplıdır. **Mukus salgısı** üreten bu tabakaya **mukoza** denir.
- Mukoza burnun nemli kalmasını sağlar.
- Burun boşluğunun üst kısmındaki bölgeye sarı bölge denir.
- Duyu almaçları(koku almakla görevli almaçlar) sarı bölgede mukus içinde gömülü olarak bulunur.
- Kokulu cisimler sarı bölgede mukus içinde çözülür ve duyu almaçları tarafından uyartı oluşturulur. Uyartılar duyu sinirleri ile beyne iletilir.



4. Dilimizle Nasıl Tat Alırız?

- Yediğimiz ve içtiğimiz maddeler dil ve damaktaki ıslak yüzeyde çözülürler.
- Çözünen maddeler dilimizdeki tat cisimciklerini uyarırlar.
- Uyarılan almaç hücreler, bu uyartıları sinir hücrelerine iletir.
- Sinir hücreleri bu uyartıları beyne iletir.
- Dilimizin her bölgesi her tadı alır. Ama bazı tatları alan tat tomurcukları bazı bölgelerde daha fazladır. Dilin ucu tatlı, orta kenarları tuzlu, arka kenarları ekşi ve arkası acı tatları algılamamızı sağlar.



Dilde farklı lezetlerin algılanma bölgeleri

5. Derimizle Nasıl Algılarız?

DERİNİN YAPISI	GÖREVLERİ
Üst Deri	1. Derinin alt bölümlerini koruyan tabakadır. 2. Deriye rengini veren özel renk hücreleri bulunur.
Alt Deri	1. Kan damarları, bağ doku lifleri, kıl kökleri, yağ ve ter bezleriyle bazı duyu almaçlarının bulunduğu tabakadır. 2. Duyu almaçlarıyla alınan uyartılar sinirlerle beyne iletilir. 3. Derinin her yerine aynı oranda duyu almaçları yoktur ve bunun için hissetme her yerde aynı değildir.
Ter Bezleri	1. Alt deride bulunur 2. Salgı kanallarıyla üst deriyi geçerek dışarı açılır. (Boşaltıma yardımcı olur)
Yağ Doku Tabakası	1. Alt derinin en alt tabakasında bulunur. 2. Vücudu çarpma ve basınç sonucu oluşacak ezilme, zedelenme gibi durumlara karşı korur. 3. Isı kaybını önleyerek vücut sıcaklığının korunmasını sağlar.

1) Üst Deri

2) Alt Deri

3) Duyu Almaçları

4) Ter Bezleri

5) Yağ Doku Tabakası

APPENDIX I

RAW DATA

Student	Gender	PSCG	PCGPA	PST ACH	PST ATT	GROUP	PRE ACH	PRE ATT
1	1	3	3,92	11	49	11	9	47
2	1	5	4,84	12	58	12	8	52
3	1	1	3,15	5	49	5	8	50
4	2	2	3,38	12	50	12	8	52
5	1	4	4,46	13	54	13	5	52
6	2	4	4,38	12	49	12	7	51
7	1	3	4,61	13	46	13	8	48
8	2	5	5	11	43	11	11	47
9	2	3	4,23	11	51	11	7	50
10	1	5	5	9	52	9	13	50
11	1	2	3,23	10	52	10	7	52
12	2	2	3,15	9	42	9	7	42
13	1	5	4,61	12	45	12	7	49
14	2	2	3,46	10	50	10	9	50
15	2	5	4,3	9	52	9	7	46
16	1	1	2,92	12	53	12	3	57
17	2	2	3,38	9	48	9	7	47
18	1	4	4,46	10	49	10	11	47
19	2	2	3,15	6	42	6	8	44
20	1	1	2,84	8	46	8	8	56
21	2	2	3,84	7	52	7	6	52
22	1	3	4,38	10	47	10	5	53

23	1	1	2,53	7	52	7	8	52
24	2	3	3,76	10	56	10	2	55
25	1	2	3	6	45	6	7	46
26	2	1	3,15	7	49	7	7	50
27	1	3	3,15	7	45	7	10	50
28	1	3	4,3	10	43	10	8	47
29	1	1	2,84	9	51	9	4	55
30	2	2	3,38	8	49	8	4	49
31	1	1	3,38	14	55	14	7	52
32	2	4	4,53	9	46	9	6	45
33	2	4	3,3	5	53	5	8	58
34	2	2	3,3	7	47	7	5	50
35	2	4	4,61	14	45	14	12	49
36	1	3	3,38	13	56	13	12	39
37	2	5	3,76	21	54	21	10	56
38	2	1	3,07	6	57	6	10	51
39	2	5	4,46	10	50	10	2	45
40	2	1	3,15	8	59	8	6	55
41	2	2	2,76	17	55	17	8	55
42	1	4	4,46	15	47	15	8	52
43	2	5	4,76	17	55	17	10	55
44	1	5	4,84	16	55	16	8	50
45	2	5	4,69	20	51	20	9	54
46	1	4	4,3	13	51	13	8	51
47	2	1	3,07	9	53	9	6	49
48	2	2	3,61	11	41	11	7	48
49	1	2	3	13	45	13	6	53
50	1	1	2,38	11	44	11	7	50

51	1	2	3,15	9	50	9	3	47
52	2	5	4,46	22	55	22	10	55
53	2	2	3,61	11	40	11	10	43
54	1	1	3,15	11	51	11	5	45
55	1	3	4,23	15	52	15	3	49
56	1	3	3,76	12	52	12	9	55
57	2	5	4,38	18	54	18	11	49
58	2	3	3,38	17	53	17	10	47
59	2	3	3,15	16	48	16	8	52
60	2	2	3,69	11	46	11	5	46
61	2	1	2,07	14	31	14	4	33
62	1	5	4,92	19	48	19	10	50
63	2	1	2,15	18	44	18	3	48
64	2	3	3,07	10	53	10	12	53
65	2	5	3,76	14	54	14	7	51
66	2	1	2,3	14	65	14	4	51
67	1	1	2,69	13	45	13	7	48
68	2	1	2,23	9	71	9	3	50
69	1	1	2,46	12	55	12	9	52
70	1	1	2,84	7	53	7	4	47
71	2	5	4,92	18	56	18	9	53
72	1	1	2,53	8	57	8	7	57
73	1	4	4,53	20	42	20	10	47
74	1	1	4	14	53	14	7	56
75	1	1	4,3	17	45	17	10	52
76	2	5	4,53	11	44	11	4	49
77	2	1	2	10	59	10	4	54
78	1	2	4,07	18	43	18	4	45

79	2	4	4,69	19	48	19	12	53
80	1	1	2,69	13	47	13	7	50
81	1	2	3,92	18	46	18	4	48
82	1	2	4,46	18	42	18	9	45
83	2	5	5	19	47	19	12	48
84	1	2	3,76	15	52	15	9	51
85	1	2	3,69	17	45	17	5	48
86	1	3	4,46	19	45	19	4	43
87	1	3	4,61	20	42	20	9	51
88	2	1	2,53	10	44	10	6	38
89	1	2	3,61	15	41	15	5	47
90	1	2	3,92	18	49	18	6	43
91	2	1	2,3	16	54	16	8	32
92	1	2	3,53	16	44	16	4	48
93	2	1	2,07	9	50	9	5	58
94	1	2	4	19	47	19	7	47
95	2	4	4,76	15	46	15	3	45
96	2	3	3,84	16	52	16	1	45
97	1	3	4	15	41	15	8	47
98	1	2	4,07	17	44	17	2	53
99	1	1	3,76	15	42	15	7	49
100	2	2	4,23	14	45	14	8	51
101	2	1	2,69	17	51	17	5	59
102	2	1	2,15	14	44	14	5	43
103	2	1	2,46	10	53	10	9	58
104	2	2	3,46	12	52	12	4	45
105	2	1	3,38	13	46	13	5	55
106	1	5	4,61	20	53	20	5	53

107	2	1	2,92	11	56	11	7	56
108	1	3	4,15	16	58	16	4	61
109	2	2	3,92	16	55	16	9	49
110	1	5	5	20	50	20	6	47
111	2	4	4,76	21	51	21	9	54
112	1	3	4,07	18	55	18	8	58
113	1	3	4,3	16	53	16	5	50
114	1	4	4,61	13	55	13	6	59
115	1	2	3,92	12	61	12	9	55
116	1	3	4,15	18	55	18	8	54
117	1	3	4,38	16	54	16	6	51
118	1	5	5	20	48	20	8	52
119	2	4	4,61	13	52	13	7	54
120	2	2	3,3	14	57	14	5	55
121	1	2	4	18	56	18	7	55
122	2	3	3,84	17	61	17	6	49
123	2	1	3,07	13	56	13	4	53
124	1	4	4,53	9	51	9	10	50
125	2	2	3,76	15	51	15	6	53
126	1	1	2,23	9	38	9	5	45
127	2	3	4,38	18	57	18	7	48
128	2	4	4,76	18	51	18	6	56
129	2	4	4,76	17	53	17	2	46
130	1	1	2,61	13	56	13	2	54
131	2	1	2,76	10	57	10	5	46
132	1	3	2,61	14	50	14	8	57
133	1	4	4,76	19	49	19	5	54
134	2	4	4,76	16	55	16	9	56

135	2	1	3,69	11	60	11	7	50
136	2	1	3,23	16	43	16	10	52
137	1	4	4,53	17	54	17	11	56
138	1	4	4,69	19	47	19	11	48
139	1	1	3	18	57	18	12	58
140	1	1	3,38	13	52	13	6	61