THE RELATION AMONG STUDENTS' GENDER, SOCIO-ECONOMIC STATUS, INTEREST, EXPERIENCE AND MISCONCEPTIONS ABOUT STATIC ELECTRICITY AT NINTH GRADE LEVEL

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

BY

ŞENKOÇ KOÇYİĞİT

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

IN

THE DEPARTMENT OF SECONDARY SCIENCE AND MATHEMATICS EDUCATION

DECEMBER 2003

Approval of the Graduate School of Natural and Applied Sciences.

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ABSTRACT

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December 2003, 95 pages

This study was designed to identify ninth grade students' misconceptions about static electricity concept and to determine relationship among students' gender, socio-economic status, interest, experience with students' misconceptions about static electricity. For this study, Static Electricity Concept Test (SECT) and Socio-Economic Status, Interest and Experience Questionnaire about Static Electricity (SESIEQ) were developed to assess students' misconceptions related to static electricity and their socio-economic status, interest and experience about static electricity, respectively.

This study was carried out during 2002-2003 spring semester with 1260 ninth grade students from 9 Anatolian and regular high schools in Çankaya and Mamak districts of Ankara.

Findings of the concept test indicated that many students had misconceptions about static electricity. Negative and significant relationships among students' gender, socio-economic status, interest, experience and misconception scores were found. The difference between misconception scores of male and female students was significant in favor of males. However, when the data were analyzed using ANCOVA while controlling students' socio-economic status, interest in static electricity and experience about static electricity, no difference was observed between the misconception scores of male and female students.

Keywords: Physics Education, Misconceptions, Static electricity, Electrostatics, Socio Economic Status, Interest, Experience, Gender.

ÖZ

DOKUZUNCU SINIF ÖĞRENCİLERİNİN CİNSİYET, SOSYO EKONOMİK DURUM, İLGİ VE TECRÜBELERİNİN DURGUN ELEKTRİK KONUSUNDAKİ KAVRAM YANILGILARI İLE İLİŞKİLERİ

Koçyiğit, Şenkoç

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Aralık 2003, 95 sayfa

Bu çalışma, dokuzuncu sınıf öğrencilerinin durgun elektrik konusundaki kavram yanılgılarını ve öğrencilerin cinsiyet, sosyo ekonomik durum, ilgi ve tecrübelerinin durgun elektrik konusundaki kavram yanılgıları ile olan ilişkilerini tespit etmek için tasarlandı. Öğrencilerin kavram yanılgılarını ölçmek için Durgun Elektrik Kavram Testi, sosyo ekonomik durum, ilgi ve tecrübelerini ölçmek için ise Sosyo Ekonomik Durum ve Durgun Elektrik Konusuna Karşı İlgi Tecrübe Anketi hazırlandı.

Çalışma, 2002-2003 öğrenim yılı ilkbahar döneminde Ankara ilinin Mamak ve Çankaya ilçelerinde 9 lise ve Anadolu lisesinde 1260 öğrenci ile gerçekleştirildi.

Çalışmanın sonuçları birçok öğrencinin durgun elektrik konusunda kavram yanılgılarına sahip olduklarını gösterdi. Cinsiyet, sosyo ekonomik durum, ilgi, tecrübe ile kavram yanılgısı puanları arasında negatif ve anlamlı ilişkiler bulundu. Kız ve erkek öğrencilerin kavram yanılgısı puanları arasında erkek öğrencilerin lehine anlamlı bir fark bulundu. Fakat veriler ANCOVA ile, öğrencilerin sosyo ekonomik durumları, durgun elektrik konusuna karşı ilgileri ve bu konuya karşı tecrübeleri kontrol edilerek analiz edildiği zaman, kız ve erkek öğrencilerin kavram yanılgısı puanları arasında fark gözlenmedi.

Anahtar Kelimeler: Fizik Eğitimi, Kavram Yanılgıları, Durgun Elektrik, Elektrostatik, Sosyo Ekonomik Durum, İlgi, Tecrübe, Cinsiyet.

To Burcu

ACKNOWLEDGMENTS

My path through this research has been cushioned by many wonderful and cooperative people.

I wish to express my deepest gratitude to my supervisor, Dr. Mehmet Sancar for his guidance and encouragement throughout this study.

I would like to show my appreciation to Assist. Prof. Dr. Ali Eryılmaz for his precious suggestions and support especially about the statistical analyses.

I own my gratitude and thanks to my friends İlker Eryılmaz, Emrah Öztürk, Hakan Harmandar, Burcu Yurdungüzeli, A. Naile Azgın and Gökhan Koç for their support and continuous help.

I express sincere appreciation to my friend Özlem Hardal for her help about the statistical analyses.

I am also grateful to teachers and students that have assisted with different aspects of this study.

A very special thanks to my mom for always being so proud of me and for providing a source of strength for me.

Finally, I thank to Burcu. She pushed when I needed pushing, laughed when I needed humor and questioned when I needed to think harder. Burcu, I will never be more sincere than when I say that I couldn't have done this without you.

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SYMBOLS

ANCOVA:	Analysis of Covariance
MISSCORE:	Misconception Scores
SECT:	Static Electricity Concept Test
SES:	Socio-Economic Status Scores
INTEREST:	Interest Scores
EXP:	Experience Scores
SESIEQ:	Socio-Economic Status, Interest and Experience Questionnaire
MRC:	Multiple Regression Correlation
IV:	Independent Variable
DV:	Dependent Variable
df:	Degrees of Freedom
N:	Sample Size

CHAPTER 1

INTRODUCTION

Science teachers would like their students to know the current scientific explanations for natural phenomena and how scientists have reached these explanations. They want their students to see the power of scientific theories not only in classrooms, but also in everyday life. Beginning with the work of Piaget in the 1920s and coming till today, a great effort has been concentrated on understanding the ways in which learners view the natural world and what teachers need to do to encourage conceptual development in science. To teach science in an effective manner, teachers should understand what their students currently know about the topics they want to teach, how students learn science and which teaching strategies are most appropriate for their conceptual development.

Learning is defined as the result of the interaction between what the student is taught and his current ideas or concepts (Posner, Strike, Hewson & Gertzog, 1982). It is a process in which a student changes conceptions through capturing new ideas and knowledge and replacing the old with the new (Hewson & Hewson, 1991). A widely accepted perspective on the nature of learning is that it is a process of conceptual change (Linder, 1993).

When children are exploring their surroundings, they naturally attempt to explain some of the phenomena they encounter in their own terms and share their explanations (Terry, Jones & Hurford, 1985). When these explanations are inconsistent with scientific conceptions, they are called as misconceptions. Students may have misconceptions about scientific facts, models, laws and theories (Brown & Clement, 1987).

Misconceptions have a variety of labels in the research literature such as alternative conceptions, alternative frameworks, naive conceptions, preconceptions, intuitive or spontaneous concepts or alternative interpretations (Linder, 1993; Mestre & Touger, 1989; Moreira, 1987; Tobias, 1987). In this study the term misconception is used to refer to students' ideas that are incompatible with currently accepted scientific knowledge.

The holding of misconceptions of science has been found to interfere with learning. Nussbaum and Novick (1982) summarize numerous studies concerning the effects of misconceptions by stating that they may play a crucial role in learning by interfering with science comprehension. People who hold misconceptions have difficulty in learning new concepts because their variant conceptions provide a faulty foundation for the formation of new insights. On the other hand, there exists a significant and respectable body of literature that regards science learning as a gradual process involving the child's pre-existing knowledge of everyday physical phenomena gradually being enriched and restructured (Kuhn, Amsel & O'loughlin, 1988; Clement, Brown & Zietsman, 1989; Vosniadou & Ionnides, 1998).

The incorrect ideas that are held by children about the science topics are of considerable importance, and cannot be ignored in the learning process since they are the foundations upon which new knowledge is built. Misconceptions can haunt a student's science learning until the misconception is confronted and overcome

(Brown & Clement, 1987; Hewson & Hewson, 1983) and they will lead to conflict later in the student's academic pursuits if not corrected promptly (Feldsine, 1987; Schultz, Murray, Clement & Brown, 1987). It is very difficult to achieve meaningful conceptual change when deep misconceptions conflict with instruction (Brown & Clement, 1991). If teachers are better informed about the types of misconceptions children are likely to hold, they will be quicker and better at identifying them, at helping children call them to mind and make them explicit and at incorporating them into the process of conceptual change.

Students can become confused in physics and mislearn because of any number of factors. Language usage, everyday experience, teaching methodology, analogies, metaphors, examination papers, textbooks, and teachers (Helm, 1980; Ivowi, 1984; Ivowi & Oludotun, 1987; Johnstone & Mughol, 1976; Pine, Messer & John, 2001) can cause students have difficulty in forming acceptable understanding of physics concepts, theories and laws (Maloney, 1990).

Studies have shown a gender gap favoring boys both for overall science achievement and for achievement at the higher scoring ranks; interestingly, the gap is small or absent at the fourth grade level but grows steadily through secondary school (Jones, Mullis, Raizen, Weiss & Weston, 1992; Mullis, Dossey, Foertsch, Jones & Gentile, 1991). Other studies also have supported a male achievement advantage, although differences generally are small and often related to physical science (Lockheed et al., 1985; Bell, 2001; Tai & Sadler, 2001).

Differences in science-related experiences extend outside the classroom. It has been found that girls as a group have very different out of school experience than boys with many of the kinds of skills and experiences that can later serve to enhance their interest and success in science (Baker, 1990; Farenga & Joyce, 1997; Jones, Howe & Rua, 2000; Kahle & Lakes, 1983; Rennie, 1987). Learning is more likely to be successful if the information is structured and if it links to many aspects of an individual's experience. Increasing the amount of experience for students with low levels of prior experience, interest, and knowledge may lead to more equivalent performance (Burbeles & Linn, 1988). These results are also consistent with the model and results presented by Kahle, Parker, Rennie and Riley (1993). Kahle et al. argued that students' classroom behaviour can influence students' outcomes, attitudes and beliefs. In typical classroom activities, boys often dominate and girls receive less experience. They reviewed interventions demonstrating that when teachers encouraged more equitable participation, girls learned more.

Girls also tend to participate less actively than boys in out of class science activities such as science competitions (Jones, 1991). In many cases differential experiences are not so much the result of a lack of interest as the result of a lack of opportunity (Kahle & Lakes, 1983). As all of these activities provide students with a greater scope of experiences when trying to solve science problems (Erickson & Farkas, 1987; Rennie, 1987), lesser exposure to them could mean lesser success with science in later years. For girls, this can mean lowered academic achievement as well as interest in science.

Since previous experience is essential in interpreting new information, educators should use methods of assessment that acknowledge the effect of previous experience on future learning. Treating all students as if they were the same will only lead to further inequalities. Because young boys and girls are socialized differently, they come to school with vastly different science-related experiences.

Many studies repeatedly indicate that students' interest in physics declines during secondary level and that girls are less interested in physics than boys (Gardner 1985, 1998; Haussler & Hoffmann, 2000; Hoffmann, 2002; Jones, Howe & Rua, 2000; Kahle & Meese, 1994). As interest can be seen as a medium supporting learning processes (Nenniger, 1992; Schiefele, Krapp, & Winteler, 1992; Voss & Schauble, 1992), it is necessary to find out what boys' and girls' interest in physics is and how interest effects students' achievement.

Static electricity is considered core topics in middle level, high school and college level physics courses. Children who have not taken a physics course (and even most of those who have) hold strong misconceptions about this phenomenon that are often not consistent with accepted scientific ideas (Henry, 2000; Otero, 2001).

The purpose of this study is to identify ninth grade students' misconceptions about static electricity concept and to determine relationship among students' gender, socio-economic status, interest, experience and misconceptions about static electricity.

1.1 The Main Problem and Sub-problems

1.1.1 The Main Problem

The main problem of this study is that:

What is the relationship among gender, socio-economic status, interest, experience and ninth grade students' misconceptions about static electricity?

1.1.2 The Sub-problems

The sub-problems (SP) of this study are as follows:

SP1: What is the relationship between gender and ninth grade students' misconceptions about static electricity?

SP2: What is the relationship between socio-economic status and ninth grade students' misconceptions about static electricity?

SP3: What is the relationship between interest and ninth grade students' misconceptions about static electricity?

SP4: What is the relationship between experience and ninth grade students' misconceptions about static electricity?

SP5: What is the effect of gender on ninth grade students' misconception scores when socio-economic status, interest and experience related to static electricity are controlled?

1.2 Hypotheses

The problems stated above will be tested with the following hypotheses stated in the null form.

Null Hypothesis 1:

H_0: $\rho_{(1,2)} = 0$

1: gender; 2: misconception scores

There is no significant relationship between population means of the ninth grade female students' and male students' misconception scores about static electricity.

Null Hypothesis 2:

H_0: $\rho_{(1,2)} = 0$

1: socio-economic status scores; 2: misconception scores

There is no significant relationship between population means of the ninth grade students' socio-economic status scores and the misconception scores about static electricity.

Null Hypothesis 3:

H_0: $\rho_{(1,2)} = 0$

1: interest scores; 2: misconception scores

There is no significant relationship between population means of the ninth grade students' interest scores and the misconception scores about static electricity.

Null Hypothesis 4:

H_0: $\rho_{(1,2)} = 0$

1: experience scores; 2: misconception scores

There is no significant relationship between population means of the ninth grade students' experience scores and the misconception scores about static electricity.

Null Hypothesis 5:

H_0: $\mu_m - \mu_f = 0$

There is no significant difference between population means of the ninth grade female students' and male students' misconception scores about static electricity when the effects of socio-economic status, interest and experience scores are controlled.

1.3 Definition of Important Terms

Some of the important terms related to this study were explained in this section.

Misconceptions about Static Electricity: The ideas that students have about static electricity that are inconsistent with scientific conceptions. It was measured by the Static Electricity Concept Test.

Students' Socio-economic Status: Socio-economic status is a measure of an individual's or a group's standing in the community. Six measures of socio-economic status (father's occupation, father's education, mother's education, mother's occupation, number of brothers/sisters and income of the family) were considered in this study. It was measured by six items in the SESIEQ.

Students' Interest in Static Electricity: If students have interest in static electricity, they want to learn or hear more about it, spend more time on it. The level of students' interest in static electricity was measured by five items in the SESIEQ.

Students' Experience about Static Electricity: Experience is defined as the act of seeing, doing or feeling about something. Students' experiences about static electricity were considered in this study. It was measured by nine items in the SESIEQ.

1.4 Significance of the Study

The static electricity is a basic and important concept in the area of electricity. Static electricity is needed in explaining everyday experiences, for instance the phenomenon that a plastic rod rubbed on fur attracts small pieces of paper. Although there is now a quarter of a century's worth of good research literature on misconceptions in high school science available, few studies concerning students' conceptual understanding of static electricity concept are to be found in the literature on science education. The results of this study will not only give information about ninth grade students' conceptual understanding of static electricity, but also will investigate gender difference, relationship of socio-economic status, interest and experience with misconceptions about static electricity at ninth grade level.

CHAPTER 2

REVIEW OF RELATED LITERATURE

This chapter is devoted to the presentation of the theoretical and empirical background for this study.

2.1 Misconception

Research in physics education has exploded over two decades, and today there is a rich collection of research examined how students learn physics (Henry, 2000). Much of this research has concentrated on misconceptions that students hold prior to formal physics instruction (Clement, 1982; Goldberg & McDermott, 1987; Posner, Strick, Hewson, & Gretzog, 1982).

The role of prior misconceptions or misconceptions in learning natural science has been explored extensively. In the science education context, the term misconception refers to ideas that students have about natural phenomena that are inconsistent with scientific conceptions. Many terms have been used to identify such prior conceptions. Wandersee, Mintzes, and Novak (1994) presented an analysis of the subtle distinctions in the usage of these terms. In this study the term “misconception” is used because the goal of effective science instruction is to encourage the student to construct an understanding that is generally consistent with accepted scientific theory. Chambers and Andre (1997) defined accepted scientific theory as understanding constructed by individuals interacting in the culture that defines the discipline, in this case, physical science. The goal of science education is to facilitate entry of the student into the knowledge and language culture of science.

Research on students' conceptual misunderstandings of natural phenomena indicates that new concepts cannot be learned if alternative models that explain a phenomenon already exist in the learner's mind (Tao & Gunstone, 1999). Children do not come to primary science lessons as ‘empty vessels’ but come with rich knowledge about their physical world based on their everyday experience (Pine, Messer & John, 2001) as Vosniadou and Ionnides (1998) proposed, although this rich knowledge is laden with over generalizations, heuristics and misconceptions. And learners’ prior knowledge interacts with knowledge presented in formal instruction, resulting in a diverse set of unintended learning outcomes (Osborne, 1983).

Learners come to formal science instruction with a diverse set of misconceptions concerning natural objects and events (Wandersee, Mintzes & Novak, 1994, Tai & Sadler, 2001). In the Piagetian sense, misconceptions can either result from deficiencies of curricula and methodologies that do not provide the students with suitable experiences to assimilate the new concept or from lack of the reasoning abilities that are necessary to assimilate the new concept (Ivowi & Oludotun, 1987). Others have noted the inconsistencies in students’ solutions to problems (McDermott, 1984; Carey, 1986) and have suggested that the students were proposing alternative hypotheses to answer problems. In the Ausubelian sense, misconceptions can result from either the lack of suitable advanced organizers, or from the presence of preconceptions that are incompatible with scientific conceptions. These ideas are of considerable importance, and cannot be ignored, in the learning process since they are the foundations upon which new knowledge is built. Teachers need to place as much emphasis on children's wrong ideas as on their right ones, if they are to bring about conceptual change in science effectively (Tai & Sadler, 2001).

The misconceptions that learners bring to formal science instruction cut across age, ability, gender, and cultural boundaries and they have their origins in a diverse set of personal experiences including direct observation and perception, peer culture, and language, as well as in teachers' explanations and instructional materials (Wandersee, Mintzes & Novak, 1994).

Johnstone and Mughol (1976) reported three main reasons of difficulty in physics concepts formation in secondary school level. These are teaching, normal language using (which tends to confuse and undo teaching) and everyday experience of the material world.

Teachers serve as the major cause of misconceptions in physics, with textbooks and examination papers contributing their fair share (Dobson, 1985; Helm, 1980; Ivowi, 1984; Schoon, Boone, 1998). Schoon (1995) found that elementary teachers often have the same misconceptions of the earth and space sciences as their prospective students have, and that many teachers have attributed their misconceptions to learning them in school. In some cases, the problem apparently resides in conceptual errors or misinformation held by the teachers themselves and the language that teachers employ in the classroom results in a set of unintended learning outcomes (Wandersee, Mintzes & Novak, 1994).

Osborne, Bell, and Gilbert (1983) noted that science taught in schools is often a mixture of the teachers' own views and textbook quotations. However, textbooks have been found to be the most significant source of misconceptions in the physics classroom (Ivowi & Oludotun, 1987). As an American study showed, there is a huge dependence on the textbook by high school science teachers (Renner, Abraham, Grzybowski & Marek, 1990). Textbooks can mislead students because of poor writing or poor editing.

Misconceptions are found to be tenacious and resistant to extinction by conventional teaching strategies (Brown, 1992; Hewson, 1985; Wandersee, Mintzes & Novak, 1994). The general findings of research studies show that children have misconceptions that are pervasive, stable, and resistant to change (Carey, 1986; Hartel, 1982; Cohen et al. 1983). Some student misconceptions are very resistant to instructional change and traditional instruction has little impact on removing deeply rooted misconceptions (Brown and Clement, 1987). Some students persist in giving answers consistent with their misconceptions even after large amounts of instruction (Driver & Easley, 1978; Fredette & Lockhead, 1980; Osborne, 1983; Schauble, 1996; Wandersee et al., 1994). While some student conceptions might be better conceptualized as simple misunderstanding or misinformation and are more readily changed with instruction (Bell & Barker, 1982), some misconceptions in physics seem more tenacious. The tenaciousness of such misconceptions is not due to the difficulty in acquiring a new concept, but rather the learner's reluctance to relinquish the old familiar misconceptions (Hewson & Hewson, 1991; Terry, Jones & Hurford, 1985). Older children who have had considerable exposure to science teaching hold some misconceptions of the world similar to those held by younger children. Even if teaching is successful in changing children's ideas about certain phenomena, the change can be quite different from what has been really intended. Older children use more sophisticated terminology but demonstrate little understanding of concepts (Stepans, Beisenger, & Dyche, 1986).

Research on instruction designed to change students' misconceptions focused on strategies to promote conceptual change by challenging students' misconceptions, producing dissatisfaction, followed by a correct explanation which is both understandable and plausible to the students.

The conceptual change approach to dealing with students' misconceptions has developed over the past 20 years and based on Piaget's (1964) construct of disequilibrium literature in the philosophy of science. Many specific instructional strategies based on the Posner et al. (1982) conceptual change model have been proposed to help students change their misconceptions (Chambers et al., 1997).

2.2 Gender Difference in Achievement

Tai and Sadler (2001) reported that their examination of nearly 1500 US college students at 16 universities found that gender and preparation both have an impact on success in introductory college physics courses. In terminal, algebra-based physics females perform better than their male classmates. However, in calculus based introductory college physics courses, which are prerequisite to advanced study in many fields, women do significantly worse than their male counterparts with the same background.

The NAEP (National Assessment of Educational Progress) results indicate no difference between boys and girls at the knowledge level (knows everyday science facts), but that boys perform at higher proficiency levels than girls in middle/juinor high, suggesting a relationship between attitude and achievement (Mullis & Jenkins, 1988; Mullis, Dossey, Foertsch, Jones, & Gentile, 1991). Bell (2001) has found gender differences in performance existing in question parts that only involve the retrieval of declarative knowledge and not the use of procedural knowledge. These differences are in favour of boys for physics contexts such as mechanics and earth and space, and in favour of females for human biology. However, in their study Shepardson and Pizzini, (1994) found no significant difference in student achievement by gender at the 7th and 8th grade level.

Hoffman (2002) suggested that both male and female teachers tend to express higher expectations for boys with regard to their achievements in mathematics and science than for girls. Boys are assessed as being more intelligent, more interested, and more creative, while girls are seen as being conscientious, neat, and hard-working. Boys' success in physics and chemistry is attributed to their perceived innate abilities, girls' success to hard work and carefulness (Dweck, Davison, Nelson, & Enna, 1978; Spear 1984). Boys are thought to be capable of solving difficult problems themselves, and are, in fact, encouraged to try to do so on their own. Girls are more likely to be helped. This may contribute to differences in achievement in science and support boys in developing a self-confidence of being able to do well in physics while putting girls on the edge.

Wang and Andre (1991) investigated the relationship between conceptual change approaches and gender. They found an overall gender effect: Men did better than women. However, they proposed that pre-existing differences in experience, knowledge, and motivation accounted for such gender differences. Although, Wang and Andre (1991) reported that the effectiveness of conceptual change text varied with gender, Chambers and Andre (1997) failed to replicate the gender interaction they reported. However, when the covariates of prior knowledge, experience, and interest were not included in the analysis, a significant main effect of gender was found. When these covariates were included in the analysis, the effect of gender disappeared suggesting that differences between the genders in learning about physical science topics can probably be attributed to differences in prior experience, interest, and knowledge.

Sencar (2001) made a study with 1678 ninth grade students to identify and analyse possible gender differences among different categories of students' misconceptions related to simple electric circuits. A gender difference in favor of males was found on some categories of misconceptions. However, when the same data were analysed while controlling students' age and interest-experience scores, this observed difference was disappeared.

At both in the high school and college levels, it often has been found that girls are less likely to enroll in advanced science and mathematics courses or to pursue majors in these areas than are boys (Jones & Wheatley, 1988; Lockheed, Thorpe, Brook-Gunn, Casserly & McAloon, 1985; Shemesh, 1990). Keeves, Kotte (1992) and Jones (1990) found that males, more than females, were more likely to be enrolled in physics and chemistry courses in secondary school. Biology was the only area where the number of female students exceeded the number of male students enrolled. Keeves and Kotte also reported that, at ages 10, 14, and 18, male students had higher achievement in chemistry, earth science, and physics. The differences for biology were not significantly different for males and females.

It has been suggested that, through the interaction of the socialization processes and environmental influences, gender differences in course taking occur in science and mathematics (Joyce & Farenga, 1999). According to Kahle (1990) these differences in the socialization process of young children appear to favor young boys' achievement, interest, and attitude toward science.

Few well-designed studies have examined the incidence of misconceptions among males and females. They generally suggest that males have fewer misconceptions than females, but Wandersee, Mintzes and Novak (1994) realize that this may be a subtle result study focus and design. Examples that seem to support the generalization that males have fewer misconceptions than females include studies in projectile motion (Maloney, 1988), astronomy (Jones at al., 1987), biological classification (Lazarowitz, 1981; Ryman, 1977), natural selection (Jimenez & Fernandez, 1987), geometrical optics (Bouwens, 1987), and pressure, weight, gravity (Mayer, 1987).

2.3 Effect of Interest on Achievement

It has been proposed that the attitude of girls toward science is one of the factors that influences the decision of girls to participate in science, as well as their achievement in science. Important attributes of attitude formation, for girls, appear to be the perceived usefulness of the science being learned, confidence in learning and doing science, interest in people, and a liking of science (Oakes, 1990).

Support for the notion that level of interest affects science achievement was found in several studies. For example, Suchner (1988) suggested that students' attitude toward science, a predictor variable which included interest in science, correlated significantly with science achievement. Furthermore, Benbow and Minor (1986) suggested that even among mathematically gifted youth, gender differences in attitudes toward science relate to science achievement. In their study, the greatest gender differences in science were found in physics; gifted males took more physics courses, had higher physics achievement test scores, had more positive physics attitudes, and more often intended to major in physics than did their gifted female counterparts. Chambers and Andre (1997) also found that the level of prior interest and prior experience did correlate significantly with performance. However, the results suggested that the effects of level of interest and level of experience influence learning indirectly by influencing prior knowledge. Chambers and Andre (1997) and Kahle and Meese (1994) similarly noted that males have a greater interest in physical science than do females. Kahle and Meese (1994) and Simpson et al. (1994) noted that relationships among assessed interest and participation rates and achievement in science are not consistent. Part of the reason for such inconsistency may be inadequacies in the attitude or achievement instruments.

Studies completed in the last three decades have shown that girls and boys have different interests and attitudes toward studying science and different perceptions of scientists and science careers (Jones et al., 2000). Beginning as early as elementary school, boys have typically possessed more interest in studying science than girls (Catsambis, 1995; Clark & Nelson, 1972).

Many interest studies have shown the decline of students' interest in physics during secondary education, particularly among girls (Haussler & Hoffmann, 2002; Hoffmann, 2002). By middle school, girls' attitudes toward science tend to decline and this decline may persist through high school (Sullins, Hernandez, Fuller & Tashiro, 1995).

In the total spectrum of school subjects, physics and chemistry are generally regarded by girls as belonging to the group of the least interesting subjects and by boys to those which are the most interesting. The results also show that what is interesting for girls is also interesting for boys, but not necessarily vice versa (Hoffmann, 2002).

The results of Haussler and Hoffmann (2002) show that a physics curriculum based on girls' and boys' interests results in better in greater and more long-lasting knowledge for both. Introductory physics instruction oriented to girls' and boys' interests instead of the traditional physics lessons leads to significantly better learning achievements for both. For boys, the interest oriented introductory physics lessons also have a positive influence on achievement in the following traditional lessons in the 8th grade. For girls, this positive effect can only be observed when the interest oriented physics lessons are combined with partial single-sex teaching (Hoffmann, 2002).

Hoffmann states that interest oriented physics instruction is especially important for girls. Interest in physics instruction is closely related to the students' physics-related self-concept, i.e. the picture that students have of their own ability and competence in physics. Gender difference in interest in physics seems to be mainly explained by gender differences in physics-related self-concept. Giving girls a better chance in physics means supporting them in developing a positive physics-related self-concept which is one condition for developing general interest in physics as well as for higher physics achievement. Their results showed that girls' self-assessment of their ability and achievement in physics (physics-related self-concept) is not only clearly lower than that of boys, but also decreased markedly from the 7th to the 10th grade, while that of boys increased correspondingly. The girls' limited self-confidence in their own ability to achieve in physics is a reason enough for thought, as one may assume that a low subject-oriented self-concept has a negative influence on the development of interest.

2.4 Effect of Experience on Achievement

Students use pre-existing conceptions constructed from reflection on previous experiences to reason about newly presented science concepts, and to make sense of their instructional science experiences (Driver & Easley, 1978; Zietsman & Hewson, 1986). Such pre-conceptions are often incorrect from a scientific viewpoint and can interfere with students' learning of science (Driver & Easley, 1978; Fredette & Clement, 1981).

Steinkamp's (1984) theory of motivational style and exploratory behavior links early childhood experiences with adult achievement in science. Central to the theory is the idea that the socialization process forms the behavior that affects future achievement. Steinkamp (1984) suggested that socialization process for young girls foster the development of psychological attributes that hinder science achievement.

Researchers and theorists suggest that learning is constructed by a synergistic interaction of prior knowledge and newer learning experiences (Farenga, Joyce, 1997). Children construct their own knowledge by comparing new sensory experiences with previous concepts and using this information to arrive at a new level of understanding (Yager, 1991). Science experiences, both formal and informal, are necessary to foster understanding about the natural world (Joyce, Farenga, 1999). However, in some of the physics concepts there seems to be a lack of basic conceptual understanding even for successful physics students. One common explanation for this is that everyday experience seems to contradict physical principles (Sadanand, 1990). Bell (2001) pointed that previous experience is essential in interpreting new information. However, a gender difference in performance would arise if there were prior differences in experience between male and female candidates even if they received the same teaching experience in science lessons.

Greenfield (1996) assessed science achievement and attitudes for a series of students in grades 3-12 representing the four major ethnic groups in Hawaii. She found that boys of all ethnicities at every grade level expressed more physical science experiences compared to girls. Intermediate school boys also related more science experiences of all kinds than did intermediate schoolgirls. However, the youngest girls expressed more life and general science experiences compared to boys. She found small gender differences in performance on a science achievement test which at the lowest grade level favored girls but at the highest grade level favored boys. She stated that females' science achievement and attitudes frequently equalled those of males, unlike the situations in many studies of other areas.

Young children bring a variety of experiences to the classroom. They generally report having had different experiences with science in and out of school based on gender, males having more early science experiences (Baker, 1990; Farenga & Joyce, 1997; Kahle, 1990; Jones et al., 2000). These differences are important because, although more females than males enroll in post secondary institutions and earn higher grades in science and engineering courses, significantly more males than females major in the natural sciences or engineering (Jones et al., 2000).

Jones et al. (2000) stated that boys continue to have more extracurricular experiences that are related to the physical sciences such as prior use of rifles, batteries, electric toys, fuses, and pulleys, whereas girls have more experiences in biology such as watching birds or planting seeds. The gender differences noted in these extracurricular experiences support the historical supposition that boys tend to have more experiences in the physical sciences and girls tend to have more experiences in the biological sciences. That is, boys tended to favor physical sciences, and girls, life sciences (Farenga & Joyce, 1997; Kahle & Lakes, 1983; Kahle, Parker, Rennie & Riley, 1993). Jones et al. conclude that females’ lack of physical science experiences puts them at a deficit for learning physics concepts.

Constructivist based research suggests that informal science experiences lay the critical foundations for deep conceptual understandings (Strike & Posner, 1992). Additional research suggests that not only will early use of science-related tools and toys affect students’ development of science concepts but that early use of these items influences girls’ development of attitudes toward science (Kelly 1978; Tracy, 1987).

2.5 Effect of Socio-economic Status on Achievement

Carpenter and Hayden (1987) studied eight measures of socio-economic status (father's occupation, father's education, mother's education, sex composition of school, teachers' encouragement, parents' encouragement, peers' plans and science subjects taken). They found a varying degree of correlation between these measures and academic achievement when comparing two Australian states (Victoria and Queensland). In Victoria, all socio-economic status measures correlated less than 0.20 with academic achievement. In Queensland, four socio-economic status measures correlated greater than 0.25 with academic achievement. They suggested that socio-economic status played a greater role in influencing academic achievement in different cultural environments.

O 'Conner and Miranda (2002) made a study with 16498 eighth and twelfth grade students to identify the array of motivational and environmental predictor variables that produce high mathematics achievement. Within the comparison of race, family structure, and gender, prior ability was the strongest influence to mathematics achievement with a negligible influence of socio-economic status. He noted that this finding is inconsistent with previous research, where students from higher socio-economic status were found to complete more mathematics and consequently have higher achievement in mathematics.

Çataloğlu (1996) studied about ninth grade and university level students' misconceptions concerning mechanic concepts. Also, the effect of socio-economic status difference on misconceptions held by students was investigated. He found a significant difference in achievement favoring the students in the upper socio-economic status.

2.6 Misconceptions About Static Electricity

Physics continues to be widely regarded by students as difficult and therefore unattractive. The most obvious feature of physics (and science) education research in the last two decades has been the extraordinary growth of studies of students' misconceptions.

McMillan and Swadener (1991) observed problem solving behaviour of six novice subjects attempting to solve an electrostatics problem in second semester calculus based college physics. The most important result of their study was that introductory physics students (even the "top" students) did not use significant qualitative thinking, or conceptualize a problem situation when solving problems.

To identify students' prior ideas about electrostatic induction, Park et al. (2001) selected 46 ninth grade middle school students of both sexes, whose average age was about 15, from one middle school located in Kwangju, Korea. To compare the differences according to the subjects' ages, 44 second year college students of both sexes, whose average age was 20, also participated in their study. They found that many students showed a lack of understanding about electrostatic induction for a nonconductor, namely, dielectric polarization. When a wood rod was placed between a charged material and an electroscope, many students had misconceptions such as 'the leaves inside the electroscope will not move apart because the wood rod is a nonconductor'. 76% middle school students and 89% collage students predicted the leaves inside the electroscope would move apart for the conductor rod but not for the insulator rod when the rods were placed between a charged material and an electroscope. 37% of middle school students and 75% of collage students explained the reason as: 'because the conductor can allow the electric current to flow but the insulator cannot'. However, among them, 26% of middle school students and 15% of collage students could not correctly identify which rod was a conductor or which was an insulator. Many of the middle school students (69%)

especially believed that the electroscope was an instrument to test whether a material was a conductor or not. Mujir and McInnes (1980) pointed the charging of a gold leaf electroscope or a single conductor by induction as a process which is not well understood by many pupils.

Eylon (1990) stated that students are not able to tie concepts from electrostatics into their description of phenomena occurring in electric circuits. This leads to a number of difficulties. First, the concept of voltage remains vague; its formal definitions are not utilized operationally. Second, most students do not create a consistent picture of the mechanisms, and are therefore unable to explain the phenomena.

Even recent physics texts tend to make the jump from electrostatics to current flow as though they were two separate subjects having only the index and table of contents common. Knowledge of their relation, however, is really needed for a basic understanding of current flow (Parker, 1970).

Henry (2000) made a study about the ideas and mental model of 22 fourth grade students as they experienced and interacted with inquiry activities about static electricity and magnetism. Findings of Henry summarized as follows:

- Students think that static electricity is a substance that is transferred from one object to another. This broad idea of Static as a Substance can be broken down into two camps, those who said static is transferred, and those who thought static is created.

- Students think that both charges are free to move from one object to another.

- Some students used (+) to present extra charge and (-) to represent missing charge.
- Some students predicted that nothing would happen when an un-rubbed object was brought close to a rubbed object.

Otero (2001) studied about understanding of individuals' learning of static electricity and the factors that influenced it. Twenty-nine junior and senior year liberal arts majors who intend to become elementary teachers were enrolled in this study. She identified twelve models for charging insulators by rubbing. These models are as follows:

General condition model: This is a very general model that holds that rubbing materials produce electrical effects. His model may also contain the ideas that different materials produce different effects, and heat and friction cause objects to stick together.

Statically charged or not model: This is a general model that seeks to explain why objects attract or repel each other. In this model, an object is either statically charged or it is not statically charged. Two statically charged objects repel each other and a statically charged object attracts an object that is not statically charged.

Plus and minus condition model: After certain conditions such as heat, friction, or both, are applied to two objects, the positive and negative charges that pre-exist in those objects are able to stick together. The positive charges in one object stick to the negative charges in the other object.

Plus or minus condition model: According to this model, after certain conditions such as heat, friction, or both, are applied to two objects, each object is left with either positive or negative charges only.

Charge creation model: The friction and heat that results from rubbing creates one type of charge on one object and another type of charge on the other object if the materials are different, or the same type of charge on both objects if the materials are the same. The type of material being rubbed, such as plastic or Styrofoam, pre-determines what type of charge will be created on the object.

Charge transformation model: This model defines neutral as an uncharged condition, but neutral is represented by a negative symbol or symbols. The condition of being charged is represented by a positive symbol or symbols.

Dormant charge model: According to this model, positive and/or negative charges pre-exist within an unrubbed object. There is no attention given to the quantity of each. Each object is predestined to become a particular charge but the pre-existing charges are dormant before the objects are rubbed. During rubbing, dormant charges are activated and objects can then have effects on other objects.

Charge Configuration Model: According to this model, positive and negative charges pre-exist within each object before rubbing. There is no attention given to the quantity of each. During rubbing, the positive and negative charges from within the object move to the surface in a certain configuration depending on the material.

Charge rearrangement model: According to this model, positive and negative charges pre-exist within each object before rubbing. During rubbing, one type of charge comes to the surface of one object, leaving the other type of charge in the center of the object. Whether positive or negative charges move to the surface depends both on the material being rubbed and the material to which it is being rubbed.

Atmosphere model: Positive and negative charges pre-exist within each object before rubbing. During rubbing, charges break away from each other and are given off to the atmosphere. When two objects rubbed together, the negatives from one object are given off, leaving it with a net positive charge and the positives from the other object are given off, leaving it with a net negative charge. Each object is predestined to give off either negative or positive charges depending on the material.

Two way transfer model: According to this model, there are an equal number of positive and negative charges in each object before rubbing. During rubbing, positive charges from object S are transferred to object A; negative charges from object A are transferred to object S. After rubbing, object A has an excess of positive charges, or a net positive charge, and object S has an excess of negative charges, or a net negative charge on the surface.

One way transfer model: In this model, there are equal number of positive and negative charges in each object before rubbing. During rubbing, one type of charge is transferred from one object to another.

2.7 Summary of the Literature Review

1. There is a gender difference favoring boys for overall science achievement, although differences generally are small and often related to physical science (Bell, 2001; Greenfield, 1996; Keeves & Kotte, 1992; Lockheed et al., 1985;

Tai & Sadler, 2001). The difference is small or absent at the fourth grade level but grows steadily through secondary school (Jones et al., 1992; Mullis et al., 1991; Mullis & Jenkins, 1988). However, Shepardson and Pizzini, (1994) found no significant difference in student achievement by gender at the 7th and 8th grade level.

2. Girls as a group have very different out of school experience than boys with many of the kinds of skills and experiences that can later serve to enhance their interest and success in science (Baker, 1990; Farenga & Joyce, 1997; Jones, Howe & Rua, 2000; Kahle & Lakes, 1983; Rennie, 1987).
3. Students' interest in physics declines during secondary level and girls are less interested in physics than boys (Gardner 1985; 1998; Haussler & Hoffmann, 2000; Hoffmann, 2002; Jones et al., 2000; Kahle & Meese, 1994).
4. Level of interest affects science achievement (Benbow & Minor, 1986; Chambers & Andre, 1997; Haussler & Hoffmann, 2002; Kahle & Meese, 1994; Suchner, 1988).
5. Experience affects science achievement (Bell, 2001; Chambers & Andre, 1997; Jones et al., 2000; Steinkamp, 1984).
6. Boys tend to have more experiences in the physical sciences and girls tend to have more experiences in the biological sciences (Farenga & Joyce, 1997; Greenfield, 1996; Jones et al., 2000; Kahle & Lakes, 1983; Kahle et al., 1993).
7. Socio-economic status influence academic achievement (Carpenter & Hayden, 1987; Çataloğlu, 1996).
8. Children hold strong misconceptions about static electricity. (Henry, 2000; Otero, 2001, Park et al., 2001).

9. The holding of misconceptions of science interferes with learning (Nussbaum & Novick, 1982; Tao & Gunstone, 1999).
10. Students' experience and interest create gender difference on achievement (Chambers & Andre, 1997; Sencar, 2001)

According to these findings it can be concluded that there is a need for developing a measuring instrument to identify students' misconceptions about static electricity, determining the relation of students' misconceptions with students' gender, socio-economic status, experience and interest and investigating how experience, interest and socio-economic status affect gender difference on students' misconceptions related to static electricity.

CHAPTER 3

METHOD

In this chapter, population and sampling, description of variables, development of measuring tools, procedure, data analysis methods, assumptions and limitations are presented.

3.1 Population and Sample

All ninth grade students in regular and Anatolian high schools in the Çankaya and Mamak districts of Ankara were accepted as the population of this study. While determining the population, socio-economic status of districts and number of students in these districts were considered. The number of students in this population was learnt from the Ministry of National Education as 14675 students. Of this population, 49.6% were males and 50.4% were females. Sample size was determined as 1400 students which is approximately 10% of the population. However, because of some unexpected situations, sample size was limited to 1260 students which is 8.6% of the target population. Stratified cluster random sampling was used to obtain representative sample. Çankaya and Mamak districts of Ankara were determined as strata and schools were thought as clusters. Schools in these districts were obtained from Ministry of National Education and then schools were randomly selected by using table of random numbers. Proportion of schools and students in Çankaya and Mamak districts were taken into account during the sampling process. Table 3.1 presents numbers and percentages of schools and students, numbers and percentages of selected schools and selected students in Mamak and Çankaya districts. An average of 140 students per school participated in this study. Participated classes in each school were selected according to the convenience of administration and teachers.

Table 3.1 Numbers and Percentages of Schools and Students, Numbers and Percentages of Selected Schools and Selected Students in Mamak and Çankaya.

District	# and percentage of schools	# and percentage of selected schools	# and percentage of students	# and percentage of selected students
Çankaya	23 (64%)	6 (67%)	9720 (66%)	787 (63%)
Mamak	13 (36%)	3 (33%)	4885 (34%)	473 (37%)

Number and percentages of male and female students participated in this study are given in Table 3.2.

Table 3.2 Numbers and Percentages of Male and Female Students.

Male	Female	Total
637 (51%)	621 (49%)	1258 (100%)

Figure 3.1 presented distribution of male and female students' preferred lesson. For female students, physics course was the fourth preferred one. It was the second preferred lesson among male students.

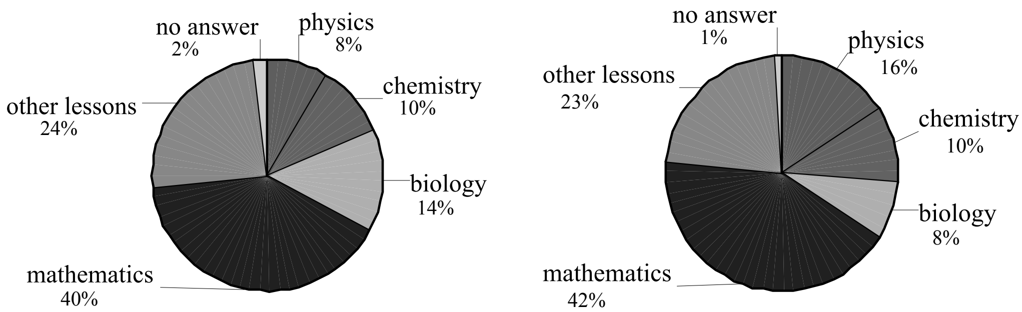


Figure 3.1 Distributions of Students' Most Preferred Lessons for Female and Male Students Respectively.

3.2 Variables

There are one dependent and four independent variables in this study.

3.2.1 Dependent Variables

The dependent variable (DV) in this study was the ninth grade students' misconception scores (MISSCORE) related to static electricity as measured by Static Electricity Concept Test (SECT). The MISSCORE is a continuous variable and measured on interval scales. Students' possible minimum and maximum scores range from 0 to 19 for the MISSCORE.

3.2.2 Independent Variables

The independent variables (IVs) in this study were the ninth grade students' gender, socio-economic status scores (SES), interest scores (INTEREST) in electricity and experience scores (EXP) about electricity as measured by Socio-Economic Status, Interest and Experience Questionnaire (SESIEQ). The SES, INTEREST, EXP were considered as continuous variables and measured on interval scales. The students' gender was determined as a discrete variable and measured on nominal scale.

The students' possible minimum and maximum scores range from 6 to 31 for the SES, 5 to 20 for the INTEREST, 9 to 27 for the EXP. The students' gender was coded as 1 for female and 2 for male. Table 3.3 shows all the characteristics of dependent and independent variables.

Table 3.3 Characteristics of Variables.

Type of Variable	Name	Type of Value	Type of Scale
DV	MISSCORE	Continuous	Interval
IV	SES	Continuous	Interval
IV	INTEREST	Continuous	Interval
IV	EXP	Continuous	Interval
IV	GENDER	Discrete	Nominal

3.3 Measuring Tools

Two measuring tools to determine students' characteristics were used in this study. One of them is the SECT and the other is the SESIEQ.

3.3.1 Static Electricity Concept Test (SECT)

This measuring instrument was developed to assess students' misconceptions about static electricity. It consists of nineteen two-tier multiple choice questions (see Appendix A for the SECT). Two-tier multiple choice tests were used because they allow to not only understand students' scientifically incorrect ideas, but also explore students' reasoning behind these ideas (Tsai & Chou, 2002). Moreover, it facilitates assessment of misconceptions of a larger sample of students in a more efficient and relatively straightforward manner (Christianson & Fisher, 1999; Voska & Heikkinen, 2000) and scoring is very objective. In two-tier questions each alternative includes two parts. The first tier assesses students' descriptive knowledge about the phenomenon, the second tier explores students' reasons for their choice made in the first tier. Hence, the second tier investigates students' explanatory knowledge or their misconceptions. Since the two-tier questions are in a multiple-choice format, it is much easier to score or to interpret students' responses. By this way, even with numerous students, their misconceptions can be efficiently diagnosed.

All of the questions in the concept test were developed by the researcher, using various articles, dissertations, text books, university entrance exam preparation books, university entrance exam questions (Champion, 2001; Henry, 2000; Hewitt, 2002; Landsberg, 1988; Mujir & McInnes, 1980; Otero, 2001; Park et al., 2001; Rogers, 1960). The concept test covers the physics content about static electricity taught in the ninth grade curriculum, which is same in all schools due to the settings of Ministry of National Education.

While the test items were developed, firstly the misconceptions that were diagnosed selected according to the review of literature survey. Some of the misconceptions were not included in the concept test because of the difficulties of preparing two tier multiple choice questions for these misconceptions. Also, the 12th, 13th, 14th, and 15th misconceptions, which are presented in Table 3.4, were added to the misconceptions that will be diagnosed and measured by the concept test after the teachers and students checked the concept test during the development period. Table 3.4 shows these misconceptions and the questions in which misconceptions are measured. Related literature was searched and measuring instruments developed by other researchers were collected and examined. There was no instrument that assessed students' misconceptions using two-tier multiple choice questions. Then, the questions were developed making use of different sources. In the concept test, each misconception was diagnosed with at least two alternatives. Each alternative in the test questions corresponds to a misconception or the correct answer. After each question, students were asked to indicate their confidence level by choosing between the alternatives "sure", "not sure", and "no idea about the question". To calculate the MISSCORE, firstly scores for each of the fifteen misconceptions that were measured in this study were calculated for a student. When the student selected an alternative that was not the correct one and selected the alternative "sure" from the question that asked his/her confidence level, the misconception that was measured by this selected alternative was determined. 1 point was added to the score of this misconception. However, no point was added when the student selected the alternative "not sure" or "no idea about the question" from the question that asked his/her confidence level. Therefore, fifteen scores were obtained for each student at the end. The sum of these fifteen scores constituted his/her MISSCORE. Since there are nineteen items in the SECT, the MISSCORE was ranged from 0 to 19. Higher scores indicated having more misconceptions about static electricity.

During the development of questions, following criteria were considered:

- Questions should be verbally comprehensible and clear.

- Questions should be suitable for the level of students' physics knowledge.
- Questions should not require mathematical skills to be solved.
- Figures should be clear enough to understand the questions.

Table 3.4 Misconceptions about Static Electricity, Questions and Alternatives that Measure These Misconceptions.

Misconceptions	Questions and Alternatives
1. Students think that both charges are free to move from one object to another.	1 d; 5 a, c; 11 a; 13 d; 15 a; 21 e; 25 a; 29 d
2. Students think that charge is created.	1 a; 3 a; 11 b; 21 a; 37 a
3. Students use (+) to present extra charge and (-) to present missing charge.	13 a; 17 a, d; 27 d; 29 a; 31 c
4. Students represent neutral by a negative symbol and the condition of being charged by a positive symbol.	13 b; 17 b; 29 b; 31 b, d
5. Students think that two statically charged objects repel or attract each other.	7 a, b; 9 a; 23 a, c; 35 a, d
6. Students think that each object is predestined to become a particular charge but the pre-existing charges are dormant before the objects are rubbed. During rubbing, dormant charges are activated.	1 b; 21 b
7. Students think that each object contains either positive or negative charges only.	19 a, c; 27 a, c; 33 a
8. Students think that during statically charging, one type of charge comes to the surface of one object, leaving the other type of charge in the center of the object.	11 c; 37 b

Table 3.4 Continued

9. Students think that static electricity is caused by friction.	5 d; 11 d; 15 e; 19 e; 25 c; 33 d; 37 c
10. Students think that during statically charging, positive charges from one object and negative charges from the other object are exchanged.	1 f; 3 b; 21 f
11. Students think that nothing would happen when an un-rubbed object was brought close to a rubbed object.	9 c; 15 d
12. Students think that when a charged object is brought close to an uncharged object, charges from the charged object are transferred to the uncharged one.	9 b; 15 c; 25 d
13. Students think that during charging by contact, the uncharged object is statically charged with the opposite charge of the charged object.	19 d; 33 c
14. Students think that during rubbing, two objects are statically charged with the same kind of charge.	1 c; 21 c
15. Students think that oppositely charged objects repel, the same charged objects attract each other.	7 d; 23 b; 35 b

3.3.2 Socio-Economic Status, Interest and Experience Questionnaire about Static Electricity (SESIEQ)

This instrument was developed to collect information about students' socio-economic status, interest in electricity and experience with electricity (see Appendix B for the questionnaire). It consists of 23 questions. The instrument was adopted from the study conducted by Sencar (2001) except the socio-economic status part. Three items collect data about students' gender, age and favorite lesson. Six items constitute the socio-economic status part of the instrument. This part has been adopted from a test used by Çataloğlu (1996). Some items have been removed from the original socio-economic status questionnaire and two new items asking students' brother/sister number and monthly income of the family have been added. Scores of items in this part have been calculated by giving a point to each alternative. The sum of these scores formed total socio-economic status score of a student. Mother and father's occupational scores have been obtained referring the Turkish occupational index from the study of Cingi and Kasnakoğlu (1980). Higher scores indicated being in a high socio-economic status.

Interest part of the instrument consisted of five items and it was designed to be rated on a 4-point likert type response format (very interested, interested, uninterested, very interested). Higher scores indicated more interest in static electricity. In this part, one item was modified from the original questionnaire used by Sencar.

Experience part of the instrument consisted of nine items and designed to be rated on a 3-point likert type response format (never, sometimes, frequently). Higher scores indicated more experience about static electricity. Three items were taken from the original questionnaire and the others were modified.

3.3.3 Validity and Reliability of Measuring Tools

Static electricity concept test and Socio-Economic Status, Interest and Experience Questionnaire about Static Electricity were checked by two professors from the department of physics at METU, two instructors and one research assistant from the department of Secondary Science and Mathematics Education at METU, four high school physics teachers from different schools and five high school students from Ayaş Çok Programlı Lisesi according to the content and format of the instruments. All high school teachers and students who checked the instruments were interviewed. Questions were discussed one by one. They evaluated appropriateness of questions to the ninth grade students' physics knowledge level, comprehensiveness of items, representativeness of content by the developed concept test, appropriateness of the format (font size, quality of printing, clarity of language, figures, directions etc). Mostly, they found mistakes about language usage and figures. According to the suggestions from these people, mistakes in the questions were corrected, some of the alternatives that leaded wrong understanding were changed or removed completely, clearer figures were drawn. The teachers interviewed stated some misconceptions that they were identified during their physics lessons. Therefore, four new misconceptions were added to the list according to the teachers' ideas (see 12th, 13th, 14th, 15th misconceptions in Table 3.4).

After the study completed, the internal reliability coefficients were calculated as .89 for the SECT, .81 for socio-economic status part of the SESIEQ, .75 for interest part of the SESIEQ and .65 for experience part of the SESIEQ using Cronbach alpha coefficient. The validity evidence and reliability results for the SECT and the SESIEQ show that they are reliable and valid measuring tools.

3.4 Procedure

Design of this study was both survey and causal comparative because ninth grade students' misconceptions about static electricity, the gender difference, and the factors that lead to gender difference on misconceptions related to static electricity were investigated. Firstly, a keyword list was prepared. After that, the databases EbscoHost, Elsevier Science Direct, Web Of Science, Kluwer Online, Wiley InterScience, ProQuest Digital Dissertations and internet search engines were scanned. MS and PhD theses made in Turkey were searched from YÖK, Hacettepe Eğitim Dergisi, Eğitim ve Bilim, and Çağdaş Eğitim Dergisi. Photocopies of documents were taken from METU Library, Library of Bilkent University and TUBITAK Ulakbim. Besides, various physics textbooks from METU Library, university entrance exam preparation books were checked and necessary parts were copied. All of these documents were examined and categorized according to their content. By the help of these documents, the measuring instruments were developed. Then, measuring tools were checked and revised according to the interview results and suggestions from specialists. They took the final form in April 2003. Necessary permission was taken for administration of the instruments to all classes of the selected schools (see Appendix C for correspondence). Finally, the measuring tools were given to 1260 ninth grade students in nine selected schools during May 2003. The administration of measuring tools took five weeks. It started in the first week of May and finished in the first week of June. Most of the instruments administrated by the researcher but some of them were given by the teachers. Before the administration of instruments, directions were read, explanations were made and questions of students were answered. Instruments were given during physics classes and students were provided with one class hour to complete all items. No problems were encountered during the administration of the instruments.

3.5 Data Analysis

The statistical analysis of this study was done using Excel and SPSS. Firstly, a data file containing all of the answers of students was created using Excel. A fortran program was developed by researcher and his friend to calculate the MISSCORE of the students. This program calculated a score for each of the measured fifteen misconceptions for every student (see Table 3.4 for measured misconceptions) and summed these misconception scores constituting the MISSCORE of a student. The SES, INTEREST and EXP were calculated using Excel. A data list that consists of students' MISSCORE, GENDER, SES, INTEREST, EXP were prepared with Excel in which columns show variables and rows show the students participating in the study. The statistical analyses were done using SPSS.

3.5.1 Descriptive and Inferential Statistics

The mean, median, standard deviation, minimum, maximum, range, skewness, kurtosis values of the variables were presented. In order to test the first, second, third and fourth hypotheses, the statistical technique called bivariate correlation was used because it describes the strength and direction of the linear relationship between two variables. To test the fifth null hypotheses, the statistical technique named analysis of covariance (ANCOVA) was used since it explores differences between groups while statistically controlling for an additional (continuous) variable. This additional variable (called a covariate) is a variable that may be influencing scores on the dependent variable. According to the review of literature, the variables SES, INTEREST and EXP were determined as variables that may be influencing the gender difference on the MISSCORE. Table 3.5 shows variables and the variable set entry order that were used in the statistical analysis of the fifth null hypotheses with analysis of covariance.

Table 3.5 ANCOVA Variable Set Composition and Statistical Model Entry Order

Variable set	Entry order	Variable name
A (covariates)	1st	X1 = SES X2 = INTEREST X3 = EXP
B (group membership)	2nd	X4 = GENDER
AxB (covariates * group interactions)	3rd	X5 = X1*X4 X6 = X2*X4 X7 = X3*X4

Block A (covariates) was entered first in the ANCOVA model so that variance due to students' SES, INTEREST and EXP can be removed before entry of the GENDER. Block B (group membership) was entered second in the analysis and Block AxB (covariate*group interactions) was entered third to determine covariate-group membership interactions. Block AxB must be statistically non-significant for the ANCOVA model to be valid.

The significance level, that is the probability of rejecting true null hypothesis was set to .05, which is most used value in educational studies, as a priori to hypothesis testing. Power of the study was set to 0.99. Hence, the probability of failing to reject the false null hypothesis, that is probability of making Type 2-error was set as 0.01. According to the results of previous studies, effect size was considered as medium or large. Sample size was calculated using the statistics program MINITAB as 148 for medium effect size and 59 for large effect size.

3.6 Assumptions and Limitations

The assumptions and the limitations of the study are as follows;

- The administration of the test and questionnaire were completed under standard conditions.
- All the subjects answered the questions in the measuring instruments accurately and sincerely.
- This study was limited to 1260 ninth grade students in Çankaya and Mamak districts of Ankara in May 2003.

CHAPTER 4

RESULTS

The results of this study are explored in four sections. In the first section, the descriptive statistics of dependent and independent variables are presented. The second section presents the inferential statistics of five null hypotheses. In the third section, descriptive comparison of male and female students' misconceptions concerning simple electricity is done. Finally, in the last section, the findings of this study are summarized.

4.1. Descriptive Statistics

Descriptive statistics related to the students' MISSCORE that were grouped according to the students' gender were presented in Table 4.1. As seen in Table 4.1, although the possible scores for the MISSCORE range between 0 and 19, students' MISSCORE ranged from 0 to 18 in which higher scores indicated having more misconceptions about static electricity. The female students had more misconceptions related to static electricity (M = 7.73, SD = 5.31) than male students (M = 6.93, SD = 5.23). The median number of errors for male students was 7, compared to a median of 8 for female students. For female students, the value of skewness for the MISSCORE was -0.009 and the value of kurtosis for the MISSCORE was -1.356. For male students, the value for skewness was 0.228 and the value for kurtosis was -1.264. Kunnan states that to be able to assume a distribution as approximately normal, the skewness and kurtosis values should be between -2 and +2 (cited in Ağazade, 2001). Therefore, the skewness and kurtosis values for the MISSCORE could be accepted as approximately normal.

Table 4.1 Descriptive Statistics for Misconception Scores According to Students' Gender

	MISSCORE								
Gender	N	Mean	Median	S D	Min.	Max.	Range	Skewness	Kurtosis
Male	637	6.93	7	5.23	0	18	18	0.228	-1.264
Female	621	7.73	8	5.31	0	18	18	-0.009	-1.356
Total	1258	7.28	7	5.27	0	18	18	0.111	-1.327

Descriptive statistics for the SES, INTEREST and EXP that were measured by the SESIEQ were presented in Table 4.2 according to the students' gender.

Although the possible scores for the SES range between 6 and 31, students' SES ranged from 8 to 30 in which higher scores indicated being in a high socio-economic status. The mean of the SES for female students was slightly higher (M = 17.84, SD = 4.74) than male students (M = 17.61, SD = 4.51) indicating that there was no much more difference between male and female students' socio-economic status. The median for both male and female students was 7. For female students, the value of skewness for the SES was 0.262 and the value of kurtosis was -0.837. For male students, the value for skewness was 0.350 and the value for kurtosis was -0.681. The values of skewness and kurtosis were between +2 and –2. Therefore, the SES distribution could be assumed as approximately normal.

Table 4.2 Descriptive Statistics for Socio-Economic Status, Interest and Experience Scores Categorized According to the Gender.

SES									
Gender	N	Mean	Median	S D	Min.	Max.	Range	Skewness	Kurtosis
Male	637	17.61	17	4.51	8	30	22	0.350	-0.681
Female	620	17.84	17	4.74	9	29	20	0.262	-0.972
Total	1259	17.72	17	4.63	8	30	22	0.305	-0.837
INTEREST									
Gender	N	Mean	Median	S D	Min.	Max.	Range	Skewness	Kurtosis
Male	637	15.46	16	2.93	5	20	15	-1.006	1.016
Female	621	12.64	13	3.16	5	20	15	-0.097	-0.560
Total	1258	14.07	14	3.36	5	20	15	-0.461	-0.463
EXP									
Gender	N	Mean	Median	S D	Min.	Max.	Range	Skewness	Kurtosis
Male	637	18.61	18	3.08	9	27	18	0.115	0.167
Female	620	17.85	18	3.03	9	26	17	0.158	-0.251
Total	1259	18.24	18	3.08	9	27	18	0.139	-0.049

As Table 4.2 indicated, students' INTEREST ranged from 5 to 20 in which higher scores meant more interest in static electricity. Male students were more interested in static electricity (M = 15.46, SD = 2.93) than female students (M = 12.64, SD = 3.16). The median number of errors for male students was 16, compared to a median of 13 for female students. For female students, the value of skewness for the INTEREST was -0.097, it was –1.006 for male students. The value of kurtosis was -0.560 for female students and 1.016 for male students. The values of skewness and kurtosis for female and male students could be accepted as approximately normal.

Figure 4.1 shows the histograms with normal curves related to the MISSCORE for males and females respectively.

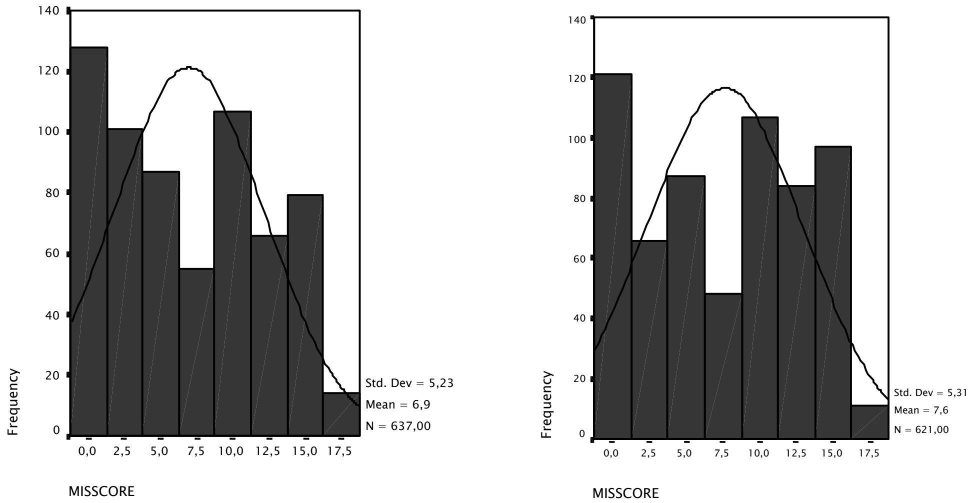


Figure 4.1 Histograms of Students' MISSCORE for Males and Females.

As for the EXP, they ranged from 9 to 27 with high scores meaning more experience about static electricity. Male students had more experience about static electricity (M = 18.61, SD = 3.08) than female students (M = 17.85, SD = 3.03). The median number of errors for both male and female students was 18. Whereas the skewness value for male students was 0.115, it was 0.158 for female students. The kurtosis value was 0.167 for male students and –0.251 for female students. Again, the skewness and kurtosis values could be assumed as approximately normal.

4.2. Inferential Statistics

This section consisted of nine subsections dealing with the missing data analysis, assumptions of correlation, analyses of the first four hypotheses, determination of the covariates, assumptions of analysis of covariance and finally analysis of the fifth hypothesis.

4.2.1 Missing Items and Data Analysis

Before starting the inferential statistics, total number of missing items in the socio-economic status, interest and experience parts of the SESIEQ were determined. It was observed that number of the missing items was below 10% of the total number of the items in each part. Any missing item caused the students' SES, INTEREST or EXP scores to be seen quite different than their real scores. Therefore, these missing item scores were replaced with the middle scores of the items. Although the SES, INTEREST and EXP were continuous variables, the nature of the scores of items in the socio-economic status, interest and experience parts of the SESIEQ were discrete. The SES, INTEREST and EXP were constituted from the total of these discrete scores. Because of that, middle scores of missing items were preferred for the replacement.

Table 4.3 shows number of missing items, with what these values were replaced, number of excluded students and number of valid cases for each variable. A total of 43 (3%) items in the socio-economic status part of the SESIEQ were missing. The missing item scores of the 3rd, 4th, 5th, 6th, 7th items in the SESIEQ were replaced with 3 and the missing item scores of the 8th item were replaced with 2. Seventeen (1%) items in the interest part and thirtysix (3%) items in the experience part were missing. They were replaced with 2.

As for the missing data of the variables, the followings were done. Two students who did not complete the gender part of the SESIEQ were not included in the statistical analyses related to the gender. One student did not answer all questions of the socio-economic status part of the SESIEQ. Therefore, this student excluded from the statistical analyses related to the SES. One student, who did not answer all questions of experience part, was excluded from the statistical analyses related to the EXP.

Table 4.3 Number of Missing Items and Excluded Students versus Variables.

Variable	# of Missing Items	Replaced with	# of Excluded Students	Valid Cases
Gender	2	-	2	1258
SES	43	Middle Scores	1	1259
INTEREST	17	2	0	1260
EXP	36	2	1	1259

4.2.2 Assumptions of Bivariate Correlation

Bivariate correlation has six assumptions. These are level of measurement, related pairs, independence of observations, normality, linearity and homoscedasticity. All the variables were tested for all the assumptions.

The scale of measurement for the variables should be interval (continuous) or one discrete independent variable and one continuous dependent variable. In this study, the MISSCORE, SES, INTEREST and EXP were continuous variables and GENDER was a discrete variable. Therefore, the requirements of the level of measurement assumption were supplied.

Each subjects provided a score on both variables and both pieces of information were from the same subject. So, there were no violations for the related pairs assumption.

Independence of observations assumption requires that observations should be independent of one another. Although the smallest unit during the administration of test was a class not an individual, this assumption was met with the observations of the researcher. It was observed that all participants did their test by themselves.

Normality assumption states that scores on each variable should be normally distributed. Skewness and kurtosis values were used for this assumption. The values for skewness and kurtosis of the MISSCORE, SES, INTEREST and EXP were given in Table 4.1 and Table 4.2. These values were in approximately acceptable range for a normal distribution.

The linearity assumption requires that the relation between two variables should be linear. This assumption was checked with the scatterplots of the variables. There was no violation for the linearity assumption. The homoscedasticity assumption states that the variability in scores for dependent variable should be similar at all values of independent variable. This assumption again checked with the scatterplots. Although the scatterplots started off narrow and then got fatter in the middle, they supplied the requirements of the homoscedasticity assumption.

4.2.3 Null Hypothesis 1

The first null hypothesis was 'There is no significant relationship between population means of the ninth grade female students' and male students' misconception scores about static electricity.'

Bivariate correlation was conducted to determine the strength and the direction of the relationship between gender and the misconception scores.

Table 4.4 Results of Bivariate Correlation for Null Hypothesis 1.

Variables	r	Sig.	N
MISSCORE and GENDER	-0.067	0.018	1258

The correlation for the data revealed that gender and misconception scores were significantly related, $r = -0.067$, $n = 1258$, $p < 0.05$, two tails. The significance value indicated that there was a significant difference between male and female students' misconception scores. Female students (M= 7.73) had more misconceptions compared to male students (M= 6.93) as presented in Table 4.1.

4.2.4 Null Hypothesis 2

The second null hypothesis was 'There is no significant relationship between population means of the ninth grade students' socio-economic status scores and the misconception scores about static electricity.'

Bivariate correlation was conducted to determine the strength and the direction of the relationship between socio-economic status scores and the misconception scores.

Table 4.5 Results of Bivariate Correlation for Null Hypothesis 2.

Variables	r	Sig.	N
MISSCORE and SES	-0.375	0.000	1259

There was a medium, negative and significant correlation between misconception scores and socio-economic status scores ($r = -0.375$, $n = 1259$, $p <$

0.01, two tails). Students in low socio-economic status had more misconceptions compared to those in high socio-economic status.

4.2.5 Null Hypothesis 3

The third null hypothesis was ‘There is no significant relationship between population means of the ninth grade students’ interest scores and the misconception scores about static electricity.’

Bivariate correlation was conducted to determine the strength and the direction of the relationship between interest scores and the misconception scores.

Table 4.6 Results of Bivariate Correlation for Null Hypothesis 3.

Variables	r	Sig.	N
MISSCORE and INTEREST	-0.195	0.000	1260

The correlation for the data revealed that interest scores and misconception scores were significantly related, r = -0.195, n = 1260, $p < 0.01$, two tails. Students who were more interested in static electricity had low misconception scores than students who were less interested.

4.2.6 Null Hypothesis 4

The fourth null hypothesis was ‘There is no significant relationship between population means of the ninth grade students’ experience scores and the misconception scores about static electricity.’

Bivariate correlation was conducted to determine the strength and the direction of the relationship between experience scores and the misconception scores.

Table 4.7 Results of Bivariate Correlation for Null Hypothesis 4.

Variables	r	Sig.	N
MISSCORE and EXP	-0.170	0.000	1259

The correlation for the data revealed that experience scores and misconception scores were significantly related, $r = -0.170$, $n = 1259$, $p < 0.01$, two tails. Although a positive correlation was expected according to literature survey (Chambers & Andre, 1997), a negative correlation found indicating that students who had more experience about static electricity had fewer misconceptions. This could be resulted from the items used to measure experience about static electricity.

4.2.7 Determination of Covariates

The independent variables SES, INTEREST and EXP were determined as variables that could be influencing the gender difference on the MISSCORE. As seen in Table 4.8, all these variables had significant correlations with the MISSCORE. To statistically equalize the differences between male and female students, these variables were included in Block A as covariates.

Table 4.8 Correlations among the MISSCORE, GENDER, SES, INTEREST and EXP.

Variables	MISSCORE	GENDER	SES	INTEREST
MISSCORE				
GENDER	-0.067*			
SES	-0.375**	-0.025		
INTEREST	-0.195**	0.421**	0.043	
EXP	-0.170**	0.122**	0.185**	0.403**

* $p < 0.05$, two tails

** $p < 0.01$, two tails

4.2.8 Assumptions of Analysis of Covariance (ANCOVA)

There are a number of issues and assumptions associated with the ANCOVA. These are normality, reliability of covariates, multicollinearity, linear relationship between dependent variable and covariates, homogeneity of regression slopes, equality of variances and independency of observations. All the variables were tested for all the assumptions.

To check the normality assumption, skewness and kurtosis values were used. The values for skewness and kurtosis of the MISSCORE were given in Table 4.1. As seen in Table 4.1, males' and females' MISSCORE were normally distributed.

The reliabilities of scales were checked by calculating the Cronbach alpha coefficients for socio-economic status, interest and experience part of the SESIEQ. They were found as 0.81, 0.75 and 0.65, respectively. Therefore, all of these scales could be considered as reliable.

To check the multicollinearity assumption, correlations among the covariates were examined. As seen in Table 4.8, the correlation coefficients among covariates were not greater than 0.80. So there was no violation for this assumption.

Scatterplots were used to test for linearity. Scatterplots for male and female students were checked separately. The relationships among dependent variable of the MISSCORE and covariates were linear for each of the groups (for males and females).

Homogeneity of regression assumption requires that the relationship between the covariate and the dependent variable for each of the group membership is the same. The results of Multivariate Regression Correlation (MRC) analysis of homogeneity of regression were presented in Table 4.9. For this analysis, three new interaction terms were produced. These interaction terms were prepared by multiplying the group membership with the covariates of SES, INTEREST and EXP separately. Then, three different blocks were produced. Covariate variables were set to Block A, group membership was set to Block B and interaction terms were set to Block C. Then MRC was performed to test the significance of R^2 change using enter method for each dependent variable. As shown in Table 4.9, contribution of Block C was not significant ($F(3,1248) = 2.272$, $p = 0.079$) for the MISSCORE. Hence, the interaction set (Block C) could be dropped. In other words, there was no significant interaction between the covariates and the group membership meaning that the homogeneity of regression assumption was validated.

Table 4.9 Results of the MRC Analysis of Homogeneity of Regression

Model	Change Statistics				
MISSCORE	R^2 Change	F Change	df1	df2	Sig. F Change
Block A	0.174	87.947	3	1252	0.000
Block B	0.174	0.004	1	1251	0.948
Block C	0.179	2.272	3	1248	0.079

Levene's Test of Equality was used to check the equality of variance assumption. The significance value greater than .05 meant that the error variance of the MISSCORE across groups was equal, as indicated in Table 4.10. Therefore, this assumption was not violated.

Table 4.10 Levene's Test of Equality of Error Variances.

	F	df1	df2	Sig.
MISSCORE	1.028	1	1254	0.311

Independence of observations assumption states that observations should be independent of one another. This assumption was met with the observations of the researcher. It was observed that all participants did their test by themselves.

4.2.9 Null Hypothesis 5

The fourth null hypothesis was 'There is no significant difference between population means of the ninth grade female students' and male students' misconception scores about static electricity when the effects of socio-economic status, interest and experience scores are controlled.'

A one-way analysis of covariance (ANCOVA) was conducted to compare the mean difference of male and female students' misconception scores related to static electricity. The results of ANCOVA were presented in Table 4.11.

Table 4.11 ANCOVA Results for Null Hypothesis 5.

Dependent Variable: MISSCORE

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Eta Squared	Obs. Power
Corrected Model	6080.74	4	1520.185	65.909	.000	0.174	1.000
Intercept	9328.36	1	9328.367	404.437	.000	0.244	1.000
SES	4390.23	1	4390.234	190.341	.000	0.132	1.000
INTEREST	646.63	1	646.639	28.035	.000	0.022	1.000
EXP	41.92	1	41.929	1.818	.178	0.001	0.270
GENDER	.098	1	.098	.004	.948	0.000	0.050
Error	28854.39	1251	23.065				
Total	101433.00	1256					
Corrected Total	34935.13	1255					

As indicated in Table 4.11, after adjusting for the SES, INTEREST and EXP scores, there was no significant difference between male and female students on the MISSCORE ($F(1, 1251) = 0.004$, $p = 0.948$).

Adjusted means (i.e. means when the effect of the covariates had been removed) and unadjusted means of the MISSCORE for males and females were presented in Table 4.12. As seen in the table, the covariates decreased the mean difference between male and female students. According to the ANCOVA results, the effect size was calculated as 0.003 (small) and observed power calculated as 0.05 using MINITAB indicating that there was no difference between male and female students' MISSCORE.

Table 4.12 Estimated Means of the MISSCORE According to Gender.

GENDER	Unadjusted Mean	S. D.	Adjusted Mean	Std. Error
Female	7.73	5.31	7.29	0.204
Male	6.93	5.23	7.27	0.200

4.3 Exploration of Students' Misconceptions About Static Electricity.

One of the purposes of this study was to identify ninth grade students' misconceptions about static electricity. This study showed that most of the students held the misconceptions about static electricity measured by the SECT.

Figure 4.2 gives number of students that held each misconception according to gender. Figure 4.3 presents percentages of students that held each misconception by gender. Numbers in the horizontal axis represents misconceptions mentioned in Table 3.4.

73% of the female students and 69% of the male students at ninth grade level thought that positive charges could move from one object to another. The number of the students held this misconception was relatively high compared to others.

36% of males and 42% of females believed that neutral objects were signed with a negative symbol and charged objects (negatively or positively) were signed with a positive symbol.

35% of male students and 36% of female students thought that two statically charged objects (no concern about their sign) repel or attract each other. Being positively or negatively charged was enough for two objects to repel or attract each other. However, the students' ideas about this situation were not known in detail. For example, what changes if both objects have the same charge or opposite charges? What happens when one of the objects is charged and the other is neutral.

32% of males and 35% of females used the sign (+) to show an object with extra charge and (-) to present an object that had missing charge.

40% of males and 42% of females did not know the fact that if one object is positively or negatively charged, it has both two kinds of charges. They thought that if one object was positively charged, it contained only positive charges and similarly, if one object was negatively charged it contained only negative charges.

39% of male students and 41% of female students believed that friction was necessary for one object to become charged.

Although during their school life students do the famous experiment with a comb and pieces of paper and see that comb attracts pieces of paper when it rubbed with hair or fur, 33% of males and 32% of females said that charged objects could not attract uncharged objects. This showed students' lack of understanding about electrostatic induction.

22% of males and 26% of females thought that during rubbing, the dormant charges in the objects were activated and charged the objects with those predestined charges.

27% of males and 28% of females said that charge was created during the charging process.

25% of male and 31% of female students thought that during statically charging, one type of charge comes to the surface of the object, leaving the other type in the center.

30% of males and 31% of females believed that during charging, positive charges from one object and negative charges from the other object were exchanged.

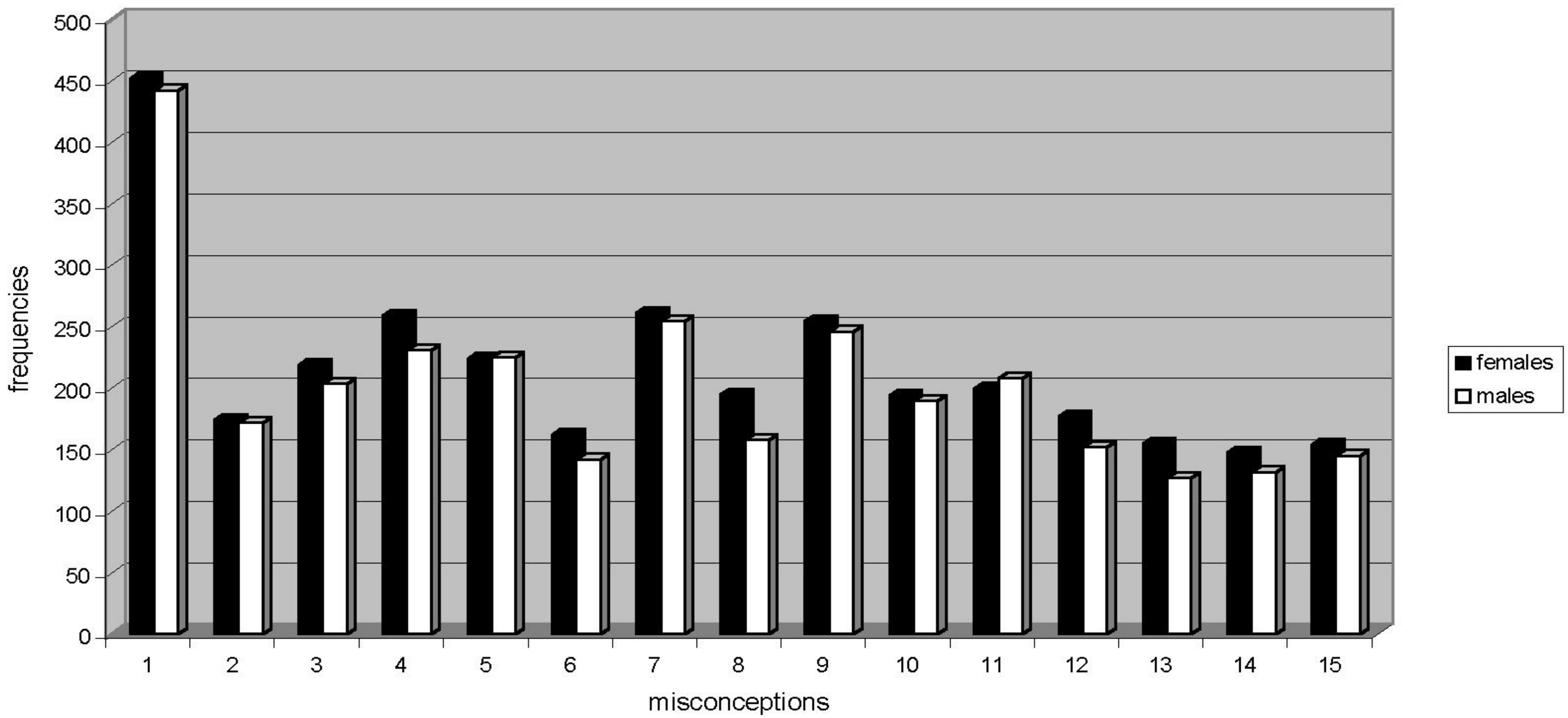
24% of males and 29% of females thought that charges from the charged object were transferred to the uncharged one when a charged object was brought close to an uncharged object.

20% of male and 25% of female students believed that during charging by contact, the uncharged object was statically charged with the opposite charge of the charged object.

21% of males and 24% of females said that two objects were charged with the same kind of charge during rubbing.

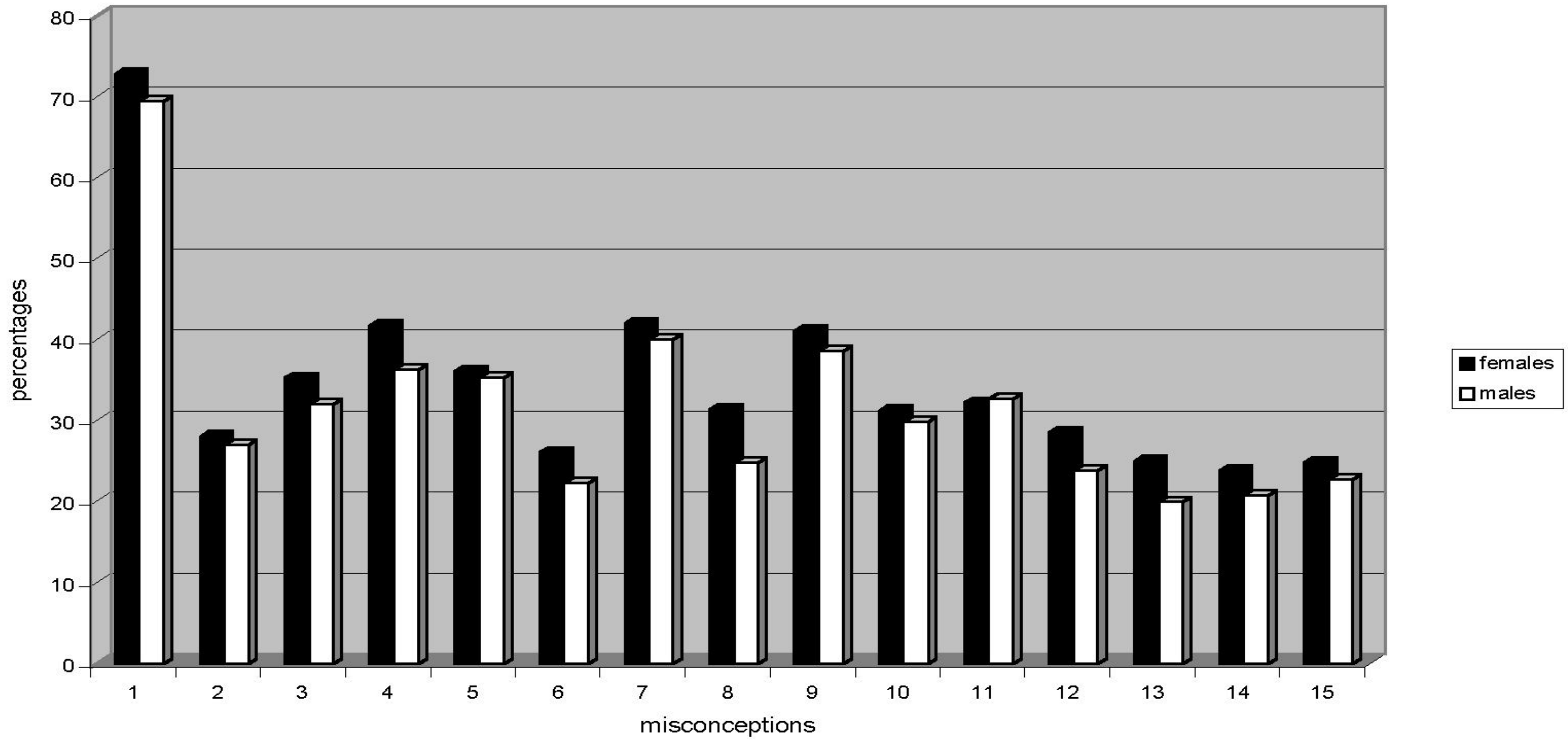
23% of male and 25% of female students thought that oppositely charged objects repelled, the same charged objects attracted each other.

Although the differences were small, female students at ninth grade level held more misconceptions compared to males for most of the misconceptions measured in this study.



Misconceptions	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Males	442	172	204	231	225	142	255	158	246	190	208	152	127	132	145
Females	452	174	219	259	224	162	261	195	255	194	200	177	155	148	154

Figure 4.2 Frequencies of Misconceptions for Males and Females.



Misconceptions	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Males	69	27	32	36	35	22	40	25	39	30	33	24	20	21	23
Females	73	28	35	42	36	26	42	31	41	31	32	29	25	24	25

Figure 4.3 Percentages of Misconceptions for Males and Females.

4.4 Summary of the Results

1. Students have misconceptions about static electricity. When the percentages of misconceptions held by students are examined, it is seen that female students have slightly more misconceptions than males.
2. There is a significant difference between male and female students' misconception scores. Female students have more misconceptions about static electricity compared to male students.
3. There is a significant, negative correlation between misconception scores and socio-economic status scores. Students in low socio-economic status have more misconceptions related to static electricity compared to those in high socio-economic status.
4. There is a significant, negative correlation between misconception scores and interest scores. Students who are more interested in static electricity have fewer misconceptions than students who are less interested.
5. There is a significant, negative correlation between misconception scores and experience scores. Students who have more experience about static electricity hold fewer misconceptions.
6. There is no significant difference between male and female students' misconception scores when socio-economic status, experience and interest scores are controlled.

CHAPTER 5

CONCLUSIONS, DISCUSSION AND IMPLICATIONS

This chapter consists of six sections. In the first section, conclusions are presented. The results are discussed in the second section. Internal validity of the study is given in third section and external validity is presented in the fourth section. The fifth section discusses implications for practice. The last section presents recommendations for further studies.

5.1 Conclusions

There is no limitation about the generalizability of this research to the target population because the sample of this study was a large randomized and stratified one. Therefore, the conclusions of this study can be applied to the defined target population.

The statistical analyses showed that there were significant and negative relationships among students' socio-economic status, interest, experience and misconceptions. The difference between male and female students' misconceptions was significant. Female students held slightly more misconceptions compared to male students. However, no significant difference between male and female students' misconceptions found when the effects of socio-economic status, interest and experience were removed, indicating that these factors create a gender difference on students' misconceptions about static electricity.

5.2 Discussion of the Results

This study supports the findings of the previous research. Henry (2000) made a study about the ideas and mental model of 22 fourth grade students as they experienced and interacted with inquiry activities about static electricity and magnetism. He identified some of the misconceptions about static electricity. Similarly, Otero (2001) studied about understanding of individuals' learning of static electricity and the factors that influenced it. Twenty-nine junior and senior year liberal arts majors who intend to become elementary teachers were enrolled in this study. She identified twelve models for charging insulators by rubbing. Park et al. (2001) studied with 46 9th grade middle school students and 44 2nd year college students of both sexes to identify students' prior ideas about electrostatic induction. They found that many students showed a lack of understanding about electrostatic induction for a non-conductor. In this study, it was observed that students held the misconceptions identified in these researches. The findings of this study were in agreement with these of Henry (2000), Otero (2001) and Park et al. (2001).

Chambers and Andre (1997) made a study with 206 college students of both sexes investigating relationships between gender, interest and experience in electricity, and conceptual change text manipulations on learning fundamental direct current concepts. They found that when the covariates of prior knowledge, experience, and interest were not included in the analysis, a significant main effect of gender was found. When these covariates were included in the analysis, the effect of gender disappeared suggesting that differences between the genders in learning about physical science topics can probably be attributed to differences in prior experience, interest, and knowledge.

Similarly, Sencar (2001) made a study with 1678 ninth grade students to identify and analyse possible gender differences among different categories of students' misconceptions concerning simple electric circuits. She stated that when the data were analysed using MANOVA, gender difference was observed in favor of males. However, when the same data were analysed while controlling students' age and interest-experience scores, this observed difference was disappeared.

In this study, different from the studies of Chambers and Andre (1997), and Sencar (2001), socio-economic status was added as a factor influencing the gender difference. Firstly, a gender difference favoring males is found and this difference disappeared when socio-economic status, interest and experience of students were controlled showing that socio-economic status, interest and experience create a gender difference. The findings of this study were in agreement with these of Chambers and Andre (1997), and Sencar (2001).

Significant and positive correlation was found between experience and misconception in the previous studies. It is expected that out of school experiences affect science achievement negatively and cause holding more misconceptions by the students. However, there was a negative correlation in this study. The students who had more experience about static electricity had fewer misconceptions. This could be resulted from the items used to measure experience about static electricity because half of the questions in the SESIEQ were about the experiences in schools.

Since the purpose of experiences gained in schools is to remove misconceptions of students, the items in questionnaire can cause such a negative correletion.

Our study supports the findings of Carpenter and Hayden (1987), Çataloğlu (1996). They suggested that socio-economic status played a greater role in influencing academic achievement. Similarly, in this study significant and negative correlations between misconceptions and socio-economic status found supporting the previous research done.

Although significant relationships among students' gender, SES, INTEREST, EXP and the MISSCORE were found, the effect sizes were calculated as 0.005 (small) for the relationship between students' gender and the MISSCORE, 0.16 (large) for the relationship between the SES and the MISSCORE, 0.04 (small) for the relationship between the INTEREST and the MISSCORE and 0.03 (small) for the relationship between the EXP and the MISSCORE using the formula $f^2 = R^2/(1-R^2)$. In large samples, very small correlations may be statistically significant. Probably, the significant relationships in this study were found because of the large sample size (N=1260 in this research).

5.3 Internal Validity of the Study

Internal validity of the study is the degree to which observed differences on the dependent variable are directly related to the independent variable, not to some other extraneous variable. Possible threats to internal validity and the methods used to cope with them were discussed in this section.

Lack of randomisation and inability to manipulate independent variable are sources of weakness in a causal comparative research. The randomization of subjects to groups is not possible in causal comparative studies because the groups already exist. Therefore, subject characteristics threat is an important menace for the internal validity of causal comparative studies. Many subject characteristics (interest and experience of students about static electricity, students' previous knowledge about static electricity, their socio-economic status) might affect results of the study. Therefore, the variables experience, interest and socio-economic status were included in the covariate set to statistically match subjects on these factors. Students' previous knowledge was assumed to be equal for all students.

Maturation could not be a threat for the study because most of the students were the same age. Location and instrumentation could not be threat to this study because the tests were administrated to all groups in similar conditions and by the researcher.

Mortality could not be threat to this study because all the percentages of the missing values were below 3%. Therefore, they were changed with the appropriate values for these variables.

Confidentiality could not be a threat for this study because names of the students were not used anywhere. Their names were just taken for the sake of the statistical analyses.

5.4 External Validity

All ninth grade students in regular and Anatolian high schools in the Çankaya and Mamak districts of Ankara were the target population of this study. The subjects of the study were 1260 ninth grade students from Çankaya and Mamak districts of Ankara and they were randomly selected from the target population.

Because of that, generalization of this study's findings has not any limitation. The results and conclusions of this study can be applied to target population.

Because all testing procedure took place in ordinary classrooms during regular class time, the environmental conditions were same for all subjects. The external effects were sufficiently controlled by the settings in this study.

5.5 Implications

According to the findings of this research and the previous studies done, following suggestions can be offered.

1. Because students' socio-economic status, interests and out of school experiences affect their physics achievement, teachers should be more interested in students' background. They should try to supply teaching environment considering these factors.
2. Since students come to school with different misconceptions and teachers serve as a main cause of misconceptions, they should be aware of the misconceptions that held by the students before starting to teach a new concept. They should search ways to remove these misconceptions and plan instruction with these misconceptions in mind.
3. Curriculum developers should prepare programs according to students' interest.
4. Textbooks were found to be the most significant source of misconceptions. Therefore, they should be checked carefully and revised to remove possible causes of misconceptions.

5. Universities should develop teacher preparation programs to prepare teacher candidates to help their students overcome misconceptions.

5.6 Recommendations for Further Research

This research has suggested some topics for future studies like mentioned below:

1. Future research could investigate the relationship of different variables with students' misconceptions in static electricity concept.
2. For different grade levels, students' misconceptions related to static electricity can be investigated using similar design of this study.
3. There may be some other factors that influence gender difference on student's misconceptions about static electricity. Hence, future research could investigate gender difference on students' misconceptions by controlling different variables.
4. Future research could perform a replication of this study with different physics concepts.
5. Future research could investigate the effectiveness of a teaching method aimed to remove misconceptions about static electricity that were identified in this study.

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APPENDIX A

DURGUN ELEKTRİK KAVRAM TESTİ

Elinizdeki soru kitapçığı; 5 sayfa ve 38 sorudan oluşan kavram testi ve 2 sayfada 23 soru içeren bir ilgi ve tecrübe anketinden oluşmaktadır. Testin amacı Madde ve Özellikleri ünitesindeki Elektriklenme ve Elektrik Yükü konusu ile ilgili olarak bulunduğunuz düzeyi tespit etmektir. Testin sonuçları sizlere daha iyi ve anlaşılır bir fizik dersi dizayn edilmesinde kullanılacaktır. Testteki her soruyu cevaplayıp, cevabınızla birlikte açıklamanızı belirten seçeneği daire içine alınız. Eğer şıklardan hiçbiri size uygun değilse, kendi cevap ve açıklamanızı sorunu altında bırakılan boşluğa yazınız. Ayrıca, her sorudan sonra, vermiş olduğunuz cevaptan ne kadar emin olduğunuzu ölçmek amacıyla hazırlanan sorudan sizin için en uygun seçeneği mutlaka daire içine alınız. Araştırmanın geçerliliği açısından cevaplarınızın eksiksiz olması zorunludur. Lütfen atlanmış soru bırakmamaya ve tüm soruları eksiksiz cevaplamaya özen gösteriniz. Katkılarınızdan dolayı teşekkür ederim.

ADI SOYADI:

1. Yüksüz plastik bir çubuk yüksüz yünlü kumaşa sürtüldüğünde, kumaşın pozitif elektrikle yüklendiği görülüyor.

Plastik çubuğun yük durumu için ne söylenebilir?

a) Pozitif elektrikle yüklenir çünkü sürtme esnasında çubukta ve kumaşta kendiliğinden pozitif elektrik yükleri oluşur.

b) Pozitif elektrikle yüklenir çünkü yüksüz çubukta bulunan ve başlangıçta etkisiz olan yükler, sürtmenin etkisiyle aktifleşir ve pozitif elektrik yüklerine dönüşür.

c) Pozitif elektrikle yüklenir çünkü birbirine sürtülen cisimler ayrıldıklarında aynı cins elektrik yüküne sahip olurlar.

d) Negatif elektrikle yüklenir çünkü sürtme esnasında çubuktaki pozitif yükler kumaşa geçer.

e) Negatif elektrikle yüklenir çünkü sürtme esnasında kumaştaki negatif yükler çubuğa geçer.

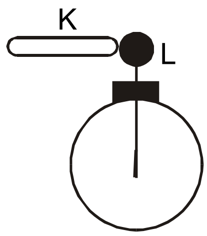
f) Negatif elektrikle yüklenir çünkü sürtme esnasında kumaştaki negatif yükler çubuğa, çubuktaki pozitif yükler ise kumaşa geçer.

g) ....

2. Yukarıdaki soruya verdiğiniz cevaptan ne kadar eminsiniz?

a) Eminim b) Emin değilim c) Soru hakkında hiçbir fikrim yok

3. Yüksüz K cismi, yüksüz L elektroskobunun topuzuna değdirilirse, elektroskobun yapraklarında aşağıdakilerden hangisi gözlenir?



a) Açılır çünkü yüksüz iki cisim birbirine dokundurulduğunda kendiliğinden elektrik yükleri oluşur.

b) Açılır çünkü cisimden elektroskoba bir miktar elektron ve elektroskoptan cisme aynı sayıda proton geçmiştir.

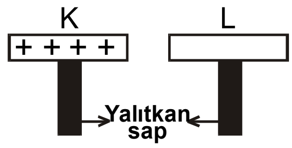
c) Değişmez çünkü yüksüz iki cisim birbirine dokundurulduğunda yine yüksüz olurlar.

d) ....

4. Yukarıdaki soruya verdiğiniz cevaptan ne kadar eminsiniz?

a) Eminim b) Emin değilim c) Soru hakkında hiçbir fikrim yok

5. Pozitif yüklü K iletkeni, yüksüz L iletkenine dokundurulup çekilirse, L'nin yük durumu hakkında ne söylenebilir?



a) Pozitif elektrikle yüklenir çünkü L'ye pozitif yük geçişi olur.

b) Pozitif elektrikle yüklenir çünkü L iletkenindeki elektronların bir kısım K iletkenine geçer.

c) Negatif elektrikle yüklenir çünkü L iletkenindeki protonların bir kısım K iletkenine geçer.

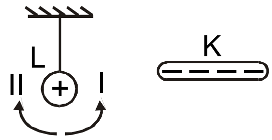
d) Yüksüz kalır çünkü K cisminin elektrikle yüklenebilmesi için L cismine sürtülmesi gerekir.

e) ....

6. Yukarıdaki soruya verdiğiniz cevaptan ne kadar eminsiniz?

a) Eminim b) Emin değilim c) Soru hakkında hiçbir fikrim yok

7. Negatif yüklü K çubuğu, yalıtkan iplikle düşey olarak asılmış pozitif yüklü iletken L küreciğine dokundurulmadan yaklaştırılırsa, L küreciği hangi yönde hareket eder?



a) I yönünde çünkü elektrik yüklü iki cisim birbirini her zaman çeker.

b) II yönünde çünkü elektrik yüklü iki cismi birbirini her zaman iter.

c) I yönünde çünkü zıt yüklü iki cisim birbirini her zaman çeker.

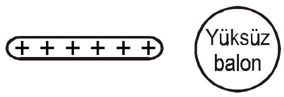
d) II yönünde çünkü zıt yüklü iki cisim birbirini her zaman iter.

e) ....

8. Yukarıdaki soruya verdiğiniz cevaptan ne kadar eminsiniz?

a) Eminim b) Emin değilim c) Soru hakkında hiçbir fikrim yok

9. Pozitif yüklü bir çubuk, yüksüz küçük bir balona yaklaştırılırsa, balonu nasıl etkiler?



a) Çeker çünkü pozitif yüklü çubuk yalnız yüklü cisimleri iter.

b) İter çünkü çubuktaki pozitif yükler balona geçer.

c) Etkilemez çünkü yüksüz balonda elektrik yükleri yoktur.

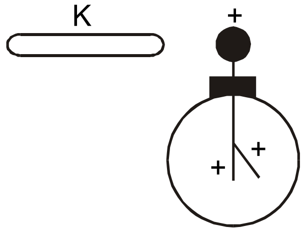
d) Çeker çünkü yüklü çubuk balon içerisindeki elektronları kendisine doğru yaklaştırır.

e) ....

10. Yukarıdaki soruya verdiğiniz cevaptan ne kadar eminsiniz?

a) Eminim b) Emin değilim c) Soru hakkında hiçbir fikrim yok

11. Yüksüz iletken K çubuğu, pozitif yüklü elektroskobun topuzuna dokundurulup uzaklaştırılırsa, K çubuğunun yükü ne olur?



a) Pozitif elektrikle yüklenir çünkü elektroskoptaki pozitif yüklerin bir kısım çubuğa geçer.

b) Pozitif elektrikle yüklenir çünkü dokunma esnasında K çubuğunda kendiliğinden pozitif elektrik yükleri oluşur.

c) Pozitif elektrikle yüklenir çünkü başlangıçta çubuğun merkezinde olan pozitif yükler dokunma esnasında çubuğun yüzeyine doğru hareket ederken, negatif yükler çubuğun merkezinde kalır.

d) Yüksüz kalır çünkü K çubuğunun elektrikle yüklenebilmesi için elektroskobun topuzuna sürtülmesi gerekir.

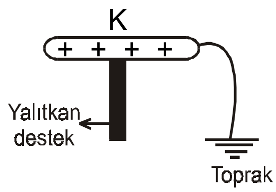
e) Pozitif elektrikle yüklenir çünkü çubuktaki elektronların bir kısmı elektroskoba geçer.

f) ....

12. Yukarıdaki soruya verdiğiniz cevaptan ne kadar eminsiniz?

a) Eminim b) Emin değilim c) Soru hakkında hiçbir fikrim yok

13. Yalıtkan destek üzerindeki pozitif elektrikle yüklü K iletkeni şekilde görüldüğü gibi bir süre topraklandıktan sonra toprak bağlantısı kesilirse, K cisminin elektrik yük işareti ne olur?



a) (+) olur çünkü topraktan elektron alır ve elektron sayısı proton sayısından fazla olur.

b) (–) olur çünkü topraktan elektron alır ve elektron sayısı proton sayısına eşit olur.

c) (0) olur çünkü topraktan elektron alır ve elektron sayısı proton sayısına eşit olur.

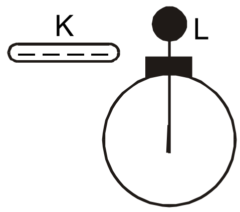
d) (0) olur çünkü pozitif elektrik yüklerini toprağa verir.

g) ....

14. Yukarıdaki soruya verdiğiniz cevaptan ne kadar eminsiniz?

a) Eminim b) Emin değilim c) Soru hakkında hiçbir fikrim yok

15. Negatif yüklü iletken K çubuğu, yüksüz L elektroskobunun topuzuna değmeyecek şekilde yaklaştırılırsa, elektroskobun yapraklarında aşağıdakilerden hangisi gözlenir?



a) Açılır çünkü elektroskoptaki pozitif elektrik yükleri topuza doğru hareket ederken, negatif elektrik yükleri ise yapraklara doğru hareket eder.
b) Açılır çünkü elektroskoptaki negatif elektrik yükleri yapraklara doğru hareket eder.
c) Açılır çünkü K çubuğundaki negatif elektrik yükleri elektroskoba geçer.
d) Değişmez çünkü elektroskop herhangi bir elektrik yüküne sahip değildir.
e) Değişmez çünkü K çubuğu, L elektroskobunun topuzuna sürtülmemiştir.
h) ....

16. Yukarıdaki soruya verdiğiniz cevaptan ne kadar eminsiniz?

a) Eminim b) Emin değilim c) Soru hakkında hiçbir fikrim yok

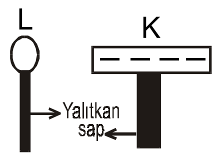
17. Yüksüz bir cisim herhangi bir yöntemle elektron kazanırsa, bu cismin elektrik yükünün işareti ne olur?

a) (+) olur çünkü elektron sayısı proton sayısından fazladır.
b) (+) olur çünkü elektrikle yüklenmiştir.
c) (–) olur çünkü elektron sayısı proton sayısından fazladır.
d) (–) olur çünkü proton sayısı elektron sayısından fazladır.
e) ....

18. Yukarıdaki soruya verdiğiniz cevaptan ne kadar eminsiniz?

a) Eminim b) Emin değilim c) Soru hakkında hiçbir fikrim yok

19. Negatif elektrikle yüklü K iletkeni, yüksüz ve iletken L küresine dokundurulup çekilirse, L küresinin elektrik yükü ne olur?



a) Negatif elektrikle yüklenir ve sadece negatif elektrik yüklerine sahip olur.
b) Negatif elektrikle yüklenir ve negatif elektrik yük sayısı, pozitif elektrik yük sayısından fazla olur.
c) Pozitif elektrikle yüklenir ve sadece pozitif elektrik yüklerine sahip olur.
d) Pozitif elektrikle yüklenir çünkü dokunma ile elektriklenmede yüksüz cisim yüklü cismin zıt elektrik yükü ile yüklenir.
e) Yüksüz kalır çünkü K iletkenine sürtülmemiştir.
f) ....

20. Yukarıdaki soruya verdiğiniz cevaptan ne kadar eminsiniz?

a) Eminim b) Emin değilim c) Soru hakkında hiçbir fikrim yok

21. Yüksüz cam çubuk yüksüz ipek kumaşa sürtüldüğü zaman ipek kumaşın negatif elektrikle yüklendiği gözleniyor.

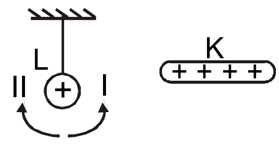
Cam çubuğun elektrik yükü ne olur?

a) Negatif elektrikle yüklenir çünkü sürtme esnasında çubukta ve kumaşta kendiliğinden negatif elektrik yükleri oluşur.
b) Negatif elektrikle yüklenir çünkü yüksüz çubukta bulunan ve başlangıçta etkisiz olan yükler, sürtmenin etkisiyle aktifleşir ve negatif elektrik yüklerine dönüşür.
c) Negatif elektrikle yüklenir çünkü birbirine sürtülen cisimler ayrıldıklarında aynı cins elektrik yüküne sahip olurlar.
d) Pozitif elektrikle yüklenir çünkü sürtme esnasında çubuktaki negatif yükler kumaşa geçer.
e) Pozitif elektrikle yüklenir çünkü sürtme esnasında kumaştaki pozitif yükler çubuğa geçer.
f) Pozitif elektrikle yüklenir çünkü sürtme esnasında kumaştaki pozitif yükler çubuğa, çubuktaki negatif yükler ise kumaşa geçer.
g) ....

22. Yukarıdaki soruya verdiğiniz cevaptan ne kadar eminsiniz?

a) Eminim b) Emin değilim c) Soru hakkında hiçbir fikrim yok

23. Pozitif elektrikle yüklü K çubuğu, yalıtkan iplikle düşey olarak asılmış pozitif yüklü iletken L küreciğine dokundurulmadan yaklaştırılırsa, L küreciği hangi yönde hareket eder?



a) I yönünde çünkü elektrikle yüklü cismiler birbirini çeker.

b) I yönünde çünkü aynı tür elektrikle yüklü cisimler birbirini çeker.

c) II yönünde çünkü elektrikle yüklü cisimler birbirini iter.

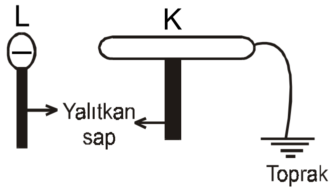
d) II yönünde çünkü aynı tür elektrikle yüklü cisimler birbirini iter.

e) ....

24. Yukarıdaki soruya verdiğiniz cevaptan ne kadar eminsiniz?

a) Eminim b) Emin değilim c) Soru hakkında hiçbir fikrim yok

25. Yalıtkan destek üzerindeki iletken K cisminin bir ucu topraklanmıştır. K cisminin diğer ucuna negatif yüklü L cismi şekildeki gibi değmeyecek şekilde yaklaştırılıyor.



Düzenek bu durumdayken, önce toprak bağlantısı kesilir, sonra L cismi uzaklaştırılırsa K cismi için aşağıdakilerden hangisi söylenebilir?

a) Pozitif elektrikle yüklenir çünkü topraktan pozitif yükler alır.

b) Pozitif elektrikle yüklenir çünkü toprağa negatif yükler verir.

c) Yüklenmez çünkü L cismi K cismine sürtülmemiştir.

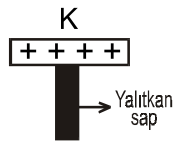
d) Negatif elektrikle yüklenir çünkü L cismindeki negatif yükler çubuğa geçer.

e) ....

26. Yukarıdaki soruya verdiğiniz cevaptan ne kadar eminsiniz?

a) Eminim b) Emin değilim c) Soru hakkında hiçbir fikrim yok

27. Pozitif elektrikle yüklü K iletkeni elektronlara sahip midir?

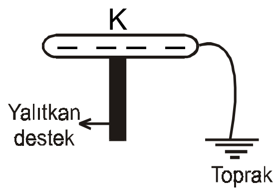


a) Hayır çünkü pozitif elektrikle yüklü cisimler sadece protonlara sahiptir.
b) Evet çünkü pozitif elektrikle yüklü cisimler de elektronlara sahiptir ve proton sayısı elektron sayısından fazladır.
c) Evet çünkü pozitif elektrikle yüklü cismiler sadece elektronlara sahiptir.
d) Evet çünkü pozitif elektrikle yüklü cisimler de elektronlara sahiptir ve elektron sayısı proton sayısından fazladır.
e) ....

28. Yukarıdaki soruya verdiğiniz cevaptan ne kadar eminsiniz?

a) Eminim b) Emin değilim c) Soru hakkında hiçbir fikrim yok

29. Yalıtkan destek üzerindeki negatif elektrikle yüklü K iletkeni bir süre topraklandıktan sonra toprak bağlantısı kesilirse, K cisminin elektrik yük işareti ne olur?



a) (–) olur çünkü toprağa elektron verir ve proton sayısı elektron sayısından fazla olur.
b) (–) olur çünkü toprağa elektron verir ve elektron sayısı proton sayısına eşit olur.
c) (0) olur çünkü toprağa elektron verir ve elektron sayısı proton sayısına eşit olur.
d) (0) olur çünkü topraktan pozitif elektrik yükleri alır.
e) ....

30. Yukarıdaki soruya verdiğiniz cevaptan ne kadar eminsiniz?

a) Eminim b) Emin değilim c) Soru hakkında hiçbir fikrim yok

31. Yüksüz bir cisim herhangi bir yöntemle elektron kaybederse, bu cismin elektrik yükünün işareti ne olur?

a) (+) olur çünkü proton sayısı elektron sayısından fazladır.

b) (+) olur çünkü elektrikle yüklenmiştir.

c) (–) olur çünkü proton sayısı elektron sayısından fazladır.

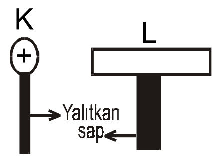
d) (–) olur çünkü elektron sayısı proton sayısına eşittir.

e) ....

32. Yukarıdaki soruya verdiğiniz cevaptan ne kadar eminsiniz?

a) Eminim b) Emin değilim c) Soru hakkında hiçbir fikrim yok

33. Pozitif elektrikle yüklü iletken K küresi, yüksüz L iletkenine dokundurulup çekilirse, L iletkeninin elektrik yükü ne olur?



a) Pozitif elektrikle yüklenir ve sadece pozitif elektrik yüklerine sahip olur.

b) Pozitif elektrikle yüklenir ve pozitif elektrik yük sayısı, negatif elektrik yük sayısından fazla olur.

c) Negatif elektrikle yüklenir çünkü dokunma ile elektriklenmede yüksüz cisim yüklü cismin zıt elektrik yükü ile yüklenir.

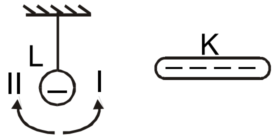
d) Yüksüz kalır çünkü K küresine sürtülmemiştir.

e) ....

34. Yukarıdaki soruya verdiğiniz cevaptan ne kadar eminsiniz?

a) Eminim b) Emin değilim c) Soru hakkında hiçbir fikrim yok

35. Negatif elektrikle yüklü K çubuğu, yalıtkan iplikle düşey olarak asılmış negatif yüklü L küreciğine dokundurulmadan yaklaştırılırsa, L küreciği hangi yönde hareket eder?



a) I yönünde çünkü elektrikle yüklü cisimler birbirini çeker.

b) I yönünde çünkü aynı tür elektrikle yüklü cisimler birbirini çeker.

c) II yönünde çünkü aynı tür elektrikle yüklü cisimler birbirini iter.

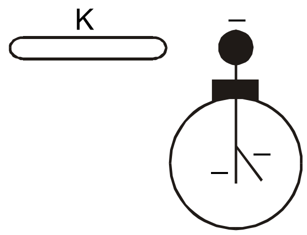
d) II yönünde çünkü elektrikle yüklü cisimler birbirini iter.

e) ....

36. Yukarıdaki soruya verdiğiniz cevaptan ne kadar eminsiniz?

a) Eminim b) Emin değilim c) Soru hakkında hiçbir fikrim yok

37. Yüksüz iletken K çubuğu, negatif elektrikle yüklü elektroskobun topuzuna dokundurulup uzaklaştırılırsa, K çubuğunun yükü ne olur?



a) Negatif elektrikle yüklenir çünkü dokunma esnasında K çubuğunda kendiliğinden negatif elektrik yükleri oluşur.

b) Negatif elektrikle yüklenir çünkü başlangıçta çubuğun merkezinde olan negatif yükler dokunma esnasında çubuğun yüzeyine doğru hareket ederken, pozitif yükler çubuğun merkezinde kalır.

c) Yüksüz kalır çünkü K çubuğunun elektrikle yüklenebilmesi için elektroskobun topuzuna sürtülmesi gerekir.

d) Negatif elekrikle yüklenir çünkü elektroskoptaki elektronların bir kısmı çubuğa geçer.

e) ....

38. Yukarıdaki soruya verdiğiniz cevaptan ne kadar eminsiniz?

a) Eminim b) Emin değilim c) Soru hakkında hiçbir fikrim yok

Correct Alternatives	1 e, 3 c, 5 b, 7 c, 9 d, 11 e, 13 c, 15 b, 17 c, 19 b, 21 d, 23 d, 25 b, 27 b, 29 c, 31 a, 33 b, 35 c, 37 d

APPENDIX B

SOSYO EKONOMİK DURUM VE ELEKTRİK KONUSUNA KARŞI İLGİ TECRÜBE ANKETİ

Bu anket elektrik konusuna karşı ilginizi ve bu alandaki tecrübenizi ortaya çıkarmak üzere hazırlanmıştır. İlk bölümde kişisel bilgiler, ikinci bölümde elektrik konusuna karşı ilgi ve tecrübe soruları yer almaktadır. Ankette verdiğiniz bilgiler yalnızca araştırma amaçlı kullanılacak olup, kesinlikle gizli tutulacaktır. **Anketi doldururken lütfen atlanmış soru bırakmamaya ve tüm soruları eksiksiz cevaplandırmaya özen gösteriniz.** Katkılarınızdan dolayı şimdiden teşekkür ederim.

1. Cinsiyetiniz:

   Kız ( ) Erkek ( )
2. Doğum tarihiniz: .... (yıl)
3. Annenizin mesleği:
4. Babanızın mesleği:
5. Babanızın eğitim düzeyi nedir?

   a) Okur yazar değil b) İlkokul c) Ortaokul d) Lise

   e) Üniversite f) Yüksek lisans / Doktora
6. Annenizin eğitim düzeyi nedir?

   a) Okur yazar değil b) İlkokul c) Ortaokul d) Lise

   e) Üniversite f) Yüksek lisans / Doktora
7. Siz hariç kaç kardeşsiniz? (Sizden büyük ve küçük olanlar dahil)

   a) Kardeşim yok b) 1 c) 2-3 d) 4-5 e) 6 ve üstü
8. Ailenizin aylık geliri ne kadardır?

   a) 500 milyondan az b) 500 milyon – 1 milyar

   c) 1 milyar – 2 milyar d) 2 milyardan fazla
9. En fazla ilgi duydugunuz ders hangisidir?

   a) Fizik b) Kimya c) Biyoloji d) Matematik e) Diğer

Lütfen her soruyu dikkatle okuyup size en uygun seçeneği çarpı (X) işareti ile belirtiniz.

	Çok İlgiliyim	İlgiliyim	İlgisizim	Çok İlgisizim
10. Fizik dersine ne kadar ilgilisiniz?	☐	☐	☐	☐
11. Fizik dersindeki elektrostatik konusuna ne kadar ilgilisiniz?	☐	☐	☐	☐
12. Çocukken elektrikli oyuncak ve aletlerle ne kadar ilgiliydiniz?	☐	☐	☐	☐
13. Şu anda elektrikli oyuncak ve aletler ile ne kadar ilgilisiniz?	☐	☐	☐	☐
14. Çocukken elektrikli oyuncak tamiri ve alet tamiri işleri ile ne kadar ilgiliydiniz?	☐	☐	☐	☐

	Hiç	Nadiren	Sık Sık
15. Ne kadar sıklıkla bilgisayar kullanırsınız?	☐	☐	☐
16. Daha önce ilköğretim okulu veya lisede elektrostatik ile ilgili deney yaptınız mı?	☐	☐	☐
17. Elektrostatik ile ilgili deney setlerini kullanarak bir maddeyi elektrik ile yükleme şansınız oldu mu?	☐	☐	☐
18. Eve yeni alınan elektrikli ev aletlerini kullanmayı öğrenmek için çaba gösterir misiniz?	☐	☐	☐
19. Daha önce hiç elektrikli alet tamir etmeyi denediniz mi?	☐	☐	☐
20. Hiç laboratuvarda elektroskop kullandınız mı?	☐	☐	☐
21. Elektroskop kullanarak bir maddenin yüklü olup olmadığını ölçtünüz mü?	☐	☐	☐
22. Hiç plastik kalem veya tarağı elektrikle yüklediniz mi?	☐	☐	☐
23. Yüklü cisimlerin birbirine etkisini gözlemlediniz mi?	☐	☐	☐

APPENDIX C

CORRESPONDENCE

T.C.
ANKARA VALİLİĞİ
Milli Eğitim Müdürlüğü

BÖLÜM : Kültür
SAYI : B.08.4.MEM.4.06.00.11.070/ 1925 07.05.200
KONU : Anket

VALİLİK MAKAMINA
ANKARA

İLGİ: ODTÜ Öğrenci İşleri Dairesi Başkanlığı'nın 28.04.2003 tarih ve 3106 sayılı yazısı.

ORTA-Doğu Teknik Üniversitesi Öğrenci İşleri Dairesi Başkanlığından alınan ilgide kayıtlı yazıda, Ortaöğretim Fen ve Matematik Alanları Eğitimi EABD yüksek lisans öğrencilerinden Şenkoç KOÇYİĞİT'in, "Elektrostatik Konusuna İlişkin Kavram Yanılgıları" konulu tezi ile ilgili anketini ekli listede isimleri belirtilen ilimiz okullarında yapabilmesi için ilgi yazı ile izin istenmektedir.

Kamu kurum ve kuruluşlarında uygulanan Devlet Memurları Kılık Kıyafet Yönetmeliği ve Okullarda uyulması gereken usul ve esaslara özen gösterilmesi ve sonucundan bilgi verilmesi kaydıyla söz konusu istek Müdürlüğümüzce uygun görülmektedir.

Makamlarınızca da uygun görüldüğü takdirde, olurlarınıza arz ederim.

Murat Bey BALTA
Milli Eğitim Müdür V.

OLUR
06/05/2003

Murat YILDIRIM
Vali a.
Vali Yardımcısı