DEVELOPMENT AND IMPLEMENTATION OF A “SCIENCE CENTER LEARNING KIT” DESIGNED TO IMPROVE STUDENT OUTCOMES FROM AN INFORMAL SCIENCE SETTING

by

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ABSTRACT

DEVELOPMENT AND IMPLEMENTATION OF A "SCIENCE CENTER LEARNING KIT" DESIGNED TO IMPROVE STUDENT OUTCOMES FROM AN INFORMAL SCIENCE SETTING

This study was conducted to develop, implement and measure the effectiveness of a science center learning kit (SCLK) designed to facilitate learning outcomes from a science center in İstanbul.

The SCLK was developed after careful consideration of the suggestions and cautions raised in the literature. The implementation of SCLK was carried out in Şişli Municipality Science Center in İstanbul. In order to measure the effectiveness of the SCLK the study was implemented in two different kinds of schools (public/private) in İstanbul with two different designs. The effectiveness of SCLK was analyzed by using pre-experimental design (pre-test post-test design) in the public school with the participation of 21 (6^{th} and 7^{th} grade) public school students; and by using quassi-experimental design (pre-test, post-test, control group design) in the private school with the participation of 56 (7^{th} grade) private school students.

Data obtained from the public school sample were analyzed to examine changes in students' conceptual understanding about the concepts in force and motion unit, their personal declarations about their own learning from the visit, and their understanding of the main ideas of selected exhibits. Paired samples t-test analysis indicated no significant differences between pre-test and post-test scores of the students in terms of their conceptual understanding about the concepts in force and motion unit. MOLI scores of the students indicated that they generally had favorable declarations about their own learning.

Data from the private school sample were used to examine the differences between students who conducted a visit to the science center with SCLK (experimental group) and without SCLK (control group) in terms of the changes in their conceptual understanding on force and motion, personal declarations about their own learning from the visit and understanding of the main ideas of selected exhibits. Paired samples t-test analysis indicated no significant differences between pre-test and post-test scores of the students in the experimental group in terms of their conceptual understanding about force and motion unit. Repeated measures ANOVA results showed no significant differences between the experimental and the control groups in terms of the changes in their conceptual understanding about force and motion unit. Students in the experimental and control groups were also similar in terms of their personal declarations about their learning from the visit (MOLI scores). When compared to the data obtained from the public school, private school students declared less favorable views concerning their learning from the visit.

Answers given to the questions in the Understanding of the Big Ideas Questionnaire were similar in both the public and the private school groups. For both groups results indicated that few students could correctly identify the main ideas in selected exhibit. The results also provided evidence on what students considered to be the most interesting and the most meaningful exhibit in the science center.

ÖZET

BİR OKUL DIŞI FEN ORTAMINDA ÖĞRENCİ KAZANIMLARINI ARTTIRMAK İÇİN TASARLANAN "BİLİM MERKEZİ ÖĞRENME PAKETİ"NİN GELİŞTİRİLMESİ VE UYGULANMASI

Bu çalışmada, İstanbul'da bir bilim merkezini ziyaret eden öğrencilerin kazanımlarını artırmak için "Bilim Merkezi Öğrenme Paketi"nin geliştirilmesi, uygulanması ve etkililiğinin ölçülmesi amaçlanmıştır.

Bilim Merkezi Öğrenme Paketi, literatürdeki öneri ve uyarılar temel alınarak geliştirilmiştir. Geliştirilen Bilim Merkezi Öğrenme Paketi İstanbul'da bulunan Şişli Belediyesi Bilim Merkezi'nde uygulanmıştır. Paketin etkililiğinin ölçülmesi için yürütülen bu çalışma biri devlet ve biri özel okul olmak üzere iki farklı okulda ve iki farklı araştırma deseni ile gerçekleştirilmiştir. Paketin etkililiği, devlet okulunda 6. ve 7. sınıf öğrencileri olan 21 kişinin katılımı ile ölçülmüştür ve ön deneysel araştırma deseni (ön test-son test deseni) kullanılmıştır. Paketin etkililiğini ölçmek için özel okulda yürütülen çalışmaya ise 7. sınıf öğrencileri olan 56 kişi katılmış ve bu çalışmada öntest-sontest kontrol gruplu yarı deneysel araştırma deseni kullanılmıştır.

Çalışmanın devlet okulu öğrencilerinden oluşan örnekleminden elde edilen veriler, öğrencilerin kuvvet ve hareket ile ilgili temel kavramları anlama düzeylerindeki değişimi, bilim merkezi ziyaretindeki öğrenme durumları ile ilgili kişisel bildirimlerini ve seçilen deneylerdeki ana fikirleri anlama düzeylerini ölçmek amacıyla analiz edilmiştir. Eşli t-testi analizi sonuçları, öğrencilerin "Kuvvet & Hareket: Temel Kavramlar Testi"nden uygulama öncesi ve uygulama sonrasında aldıkları puanlar arasında anlamlı bir fark olmadığını göstermiştir. "Öğrenme Durumları Ölçeği" puanları öğrencilerin genellikle kendi öğrenme durumları ile ilgili olumlu bildirimde bulunduklarını göstermiştir.

Çalışmanın özel okul öğrencilerinden oluşan örnekleminden elde edilen veriler, bilim merkezi ziyaretini Bilim Merkezi Öğrenme Paketi'ni kullanarak yapan ve bu paketi

kullanmadan yapan gruplardaki öğrencilerin kuvvet ve hareket ile ilgili temel kavramları anlama düzeylerindeki değişimini, bilim merkezi siyaretindeki öğrenme durumları ile ilgili kişisel bildirimlerini ve seçilen deneylerdeki ana fikirleri anlama düzeylerini karşılaştırmak amacıyla kullanılmıştır. Eşli t-test analizi sonuçları deneysel gruptaki öğrencilerin "Kuvvet & Hareket: Temel Kavramlar Testi"nden uygulama öncesi ve uygulama sonrasında aldıkları puanlar arasında anlamlı bir fark olmadığını göstermiştir. İki yönlü tekrarlamalı varyans analizi sonuçları, deneysel grup ve kontrol grupları arasında öğrencilerin kuvvet ve hareket ile ilgili temel kavramları anlama düzeylerindeki değişim açısından istatistiksel olarak anlamlı bir fark olmadığını göstermiştir. Deneysel grup ve kontrol gruplarındaki öğrenciler öğrenme durumları ile ilgili kişisel bildirimleri açısından da farklı bulunmamıştır (MOLI puanları). Devlet okulu öğrencileri ile özel okul öğrencilerinin öğrenme durumları ile ilgili kişisel bildirimleri kıyaslandığında, devlet okulu öğrencilerinin kendi öğrenme durumları ile ilgili daha olumlu bildirimlerde bulundukları tespit edilmiştir.

Özel okul ve devlet okuldaki öğrencilerin "Ana fikirleri Anlama Ölçeği"ndeki sorulara verdikleri cevaplar benzer bulunmuştur. Sonuçlar, her iki gruptaki çok az sayıda öğrencinin seçilen deneylerdeki ana fikirleri anlayabildiklerine işaret etmiştir. Bu çalışma sonucunda öğrencilerin bilim merkezinde en çok ilgi çekici buldukları ve en anlamlı gördükleri deneyler de belirlenmiştir.

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LIST OF SYMBOLS / ABBREVIATIONS

f	Frequency
M	Mean
n	Number
CUQ-Force & Motion	Conceptual Understanding Questionnaire
MOLI	Modes of Learning Inventory
SCLK	Science Center Learning Kit
Sig	Significance
SD	Standard deviation

1. INTRODUCTION

Science is explained as a way of looking at the environment and accordingly developing a store of information about it (Shaw, 1972). It is more than the memorization of facts, and it requires deep understanding about events around the world (Bonner, 2004). As Shaw (1972) defines it “science is an uncompleted jigsaw puzzle, the pieces (large and small) which have been put together being the work of countless observers and investigators” (1972; p.8).

National Research Council in US (1996) stated that the goal of science education is to improve individuals’ scientific literacy. In other words, it helps to raise individuals who have an understanding of the nature of science and its relevance to their lives, and are willing to continue to study science in school or beyond the school walls (as cited in Tuan *et al.*, 2005). Similar definitions are also made in the new primary school science and technology curriculum in Turkey. There is a common understanding in many countries that scientific and technological improvements have special impact on people’s lives, and many countries have become conscious about having scientifically literate citizens. With a similar consciousness, Turkey is also aware that increasing the quality of science and technology courses in the schools is the key to develop scientifically literate citizens. The main vision of the new (2005) science and technology curriculum of the country is stated as to help all students to be scientifically literate individuals regardless of individual differences. This means that all students should develop the abilities of investigation, critical thinking, problem-solving and decision-making (Talim ve Terbiye Kurulu Baskanlığı [TTKB], 2005).

Briefly, science is a crucial factor in the development of countries and science education is critical in the development of scientifically literate individuals. To achieve these aims of science education, different approaches have been developed and supported. Varied points of view, methods and strategies have appeared in the literature regarding how to ensure better learning in science. Innovative approaches have been suggested for instructional designs in order to meet the changing needs of schools (House, 2002).

However, thinking for science learning should not be limited to the experiences of individuals in schools. Science is defined as the field of study which attempts to describe and understand the nature of the universe around us (Siepmann, 1999). Science learning occurs through experiences of individuals. It follows that these learning experiences of students cannot be limited to what happens in schools. Individuals have a chance to construct scientific knowledge, attitudes and understanding while watching television, reading newspaper and books, conversing with friends and family and through interactions with the Internet. In fact, much of what people come to know about science content and process results from real-world experiences in a diversity of physical and social contexts. (Dierking *et al.*, 2003) So, it is clear that individuals may also have valuable learning experiences outside schools.

Worldwide, apart from the schools, there are wide ranges of informal learning environments that are also places for science learning. Science centers, zoos, aquaria, nature centers, and botanical gardens are among the environments listed in the literature. The science in such places outside the schools is often regarded as exciting, challenging, and uplifting (Braund and Reiss, 2006). Currently, there is an ongoing debate about the educational benefits that informal learning environments can offer. Kisiel (2007) points out that these environments are most traditionally used for the class field trips. Connolly *et al.*, 2006) state that field trips has a potential for enriching science classes, bringing textbooks to life, and providing students opportunities for scientific inquiry. In this study, science learning in one particular informal setting will be studied by the researcher. The setting is a science center located in İstanbul. In particular, this study addresses the ways that informal learning environments and schools can work together to support the science learning of the students in the 7th grade age group.

Recently, the challenge to teachers and museum educators has been to realize the potential of museums and improve the quality of learning achieved by pupils (Gilbert and Priest, 1997). In line with the efforts to improve science learning through school collaboration with informal settings, the proposed study attempts to develop and measure the effects of a “Science Center Learning Kit (SCLK)” which was prepared to facilitate science learning in a specific informal setting, a science center. This selected science center seeks to provide an informal environment for science learning to K-12 students from varied schools in İstanbul. The kit seeks to facilitate science learning of 7th grade students on some basic concepts in the “force and motion” unit of the 7th grade science and technology curriculum in Turkey.

2. LITERATURE REVIEW

The literature review begins with a brief overview of how learning is defined in order to provide a general framework for "learning science in informal settings". Then, it continues with an explanation and listing of informal learning environments and information about science learning in informal settings. In addition, cautions about the limitations of science learning in informal settings and some suggested ways to increase the possibility of learning in such settings are discussed. The review ends with some suggestions for crossing the boundaries between schools and informal settings to support better science learning with some actualized project examples.

2.1. What is Learning?

As Ertmer and Newby (1993) have stated, the way we define learning and what we believe about the way learning occurs will lead us to different strategies and interventions intended to facilitate changes in what people know and do. Therefore, it is important for the purposes of this study, to be aware of how learning is defined while we are aiming to facilitate learning in an informal setting, specifically in a science center. Basically, it is possible to talk about three different approaches on learning; behavioral, cognitive and constructivist (Ertmer and Newby, 1993).

According to the behaviorist approach, learning is defined as change in the form or frequency of observable performance. It is believed that learning has occurred when a proper response is given for a specific environmental stimulus. Therefore, what is important is the consequence of performances (Ertmer and Newby, 1993). As Woolfolk, (2004) points out the behavioral learning theories are the explanations of learning that concentrate on external events as the causes of changes observed in individual's behavior. Gredler (2001) summarizes three basic assumptions of behaviorism as, observable behavior rather than internal mental events; the process of learning is behavioral change; and studying behavior in terms of its simplest elements such as specific stimulus and specific response. It is believed that responses that are followed with reinforcement are more likely to be repeated in the future. Because stimulus-response association is important for this approach, strategies that can strengthen this association are prescribed by the behaviorists. For the behaviorist, the goal of instruction is to acquire the desired response from the learner who is provided with a proper stimulus (Ertmer and Newby, 1993). Originating from the works of B.F. Skinner positive and negative reinforcement and punishment are used for strengthening and weakening a behavior. As Ertmer and Newby, (1993) points out cues, practice, and reinforcement are important for better stimulus-response association in behaviorist approach.

As early as the 1920s the behaviorist approach was criticized due to certain limitations in its explanation of learning. For instance, behaviorists could not explain certain social behaviors (Mergel, 1998). Moreover, behaviorism was mostly based on findings of research conducted on animals' stimulus-response behaviors (Jarvis *et al.*, 1998). As Fosnot and Perry (2005) points out, although behaviorist approach has implications for changing behavior, it offers very little about structural change in understanding. Such critiques resulted in a shift from the behavioral orientation to the cognitive orientation, where there is an emphasis on the role of mental processing. As Woolfolk (2004) summarizes behaviorists and cognitivists differ in their assumptions about what is learned. Cognitivists believe that knowledge is learned whereas behaviorists believe that the new behaviors are learned. As Ertmer and Newby (1993) explain, cognitivists search for understanding the ways that information is received, organized, stored and retrieved by the mind. Knowledge acquisition is perceived as a mental activity and learners are accepted to be active participants in the learning process. According to cognitivists, environmental cues are not sufficient for learning to be actualized. Learners' beliefs, attitudes and values are also accepted to be influential in the learning process. And learning is considered to be actualized when information is stored in memory in an organized and meaningful manner. With these beliefs, cognitivists suggest strategies such as advance organizers, analogies, hierarchical relationships, and matrices for helping learners relate new information with prior knowledge.

Constructivism is different from the behaviorist and cognitivist approaches which accept that the world is real and external to the learner. Existence of the real world is not denied by the constructivists, but they believe that what we know of the world stems from our own interpretations of our experiences. We "create" meaning instead of "acquiring" it. So, it can be said that constructing meaning is learning; each learner individually or socially constructs meaning (Hein, 1991). As Fosnot and Perry (2005) mention, constructivist theory has its roots from the later work of Jean Piaget just before his death in 1980; and works of Lev Vygotsky and his followers, and also Jerome Bruner, Howard Gardner, and Nelson Goodman. According to Glasersfeld (1996), constructivism separated from the other cognitive theories with the influences of Jean Piaget about 60 years ago. With a differing perspective Piaget claimed that knowledge is not the representation of external things, instead "mapping of actions and conceptual operations" (1996; p.4.).

Therefore, as Glasersfeld (1996) states, because "learning is a constructive activity that the students themselves have to carry out" (1996; p.7), educators should not dispense knowledge but provide opportunities that students can build up knowledge by themselves. Moreover, constructivist teachers should manipulate their classroom practices by paying attention to the some suggestions, such as accepting and also encouraging student autonomy, inquire about students' understanding of concepts, encourage student inquiry, provide time for students to construct relationships, and raise students' curiosity (Ishii, 2003). As Julyan and Duckworth (1996) suggests, students should have the opportunities of articulating their ideas to construct an understanding. It is better if those asked to the students are interesting and took their attention; and if they are encouraged to express their feelings. Thus, teachers of constructivist environments have extra responsibilities to ensure students' learning when compared to the teachers preferring traditional ways of teaching and learning. And, informal learning environments are among the major settings where teachers can easily use constructivist practices for ensuring better knowledge construction of the students.

As it can be inferred from the debates and ongoing search for better definitions of learning, there is a need to understand learning in order to design and provide optimal environments to ensure learning. This is also the case specifically for science learning. The best ways to support science learning have been discussed for years and the debates continue. Recently, new and different questions have appeared about learning environments. One of those is about science learning outside the school walls, in the informal arena (Martin, 2004).

2.2. Science Learning in Informal Settings

This part of the review goes over the main points of the literature about science learning in informal settings. It starts with the definitions of informal learning in science education, and different terms preferred to be used by different researchers to address science learning outside the school walls. Then, theories affecting learning in these setting will be explained further. Limitations of science learning in these setting will be reviewed with the suggested ways to increase possibilities of learning in these settings. This part of the literature will be finalized with some suggestions for crossing the boundaries between schools and informal settings.

A selective review of the literature reveals that different researchers use different words to address learning environments outside the school walls. For example, the Center for Informal Learning and Schools (CILS) accepts science centers, zoos, aquaria, nature centers, and botanical gardens as examples for such informal science institutions (ISI). It is stated by CILS that the term "museum" is also used alternatively in the literature to refer to such informal science institutions. But for CILS the term "museum" is more general in that it also covers history museums, art museums, historic sites; because of this CILS suggests use of "informal science institution" when referring to institutions with science-related content area ("What is ISIs?", n.d.). The Center for Informal Learning and Schools (CILS) which is a collaboration of the Exploratorium in San Francisco, the University of California at Santa Cruz and King's College in London (Martin, 2004), is one of the leading institutions in the study of informal science learning and institutions, and their relationships to schools ("The Mission", n.d.). Griffin (1998) uses the term "museums" a generic term; including out of school learning settings such as science museums, science centers, natural history museums, zoos and gardens. Falk (2001) underlines that he and Lynne Dierking prefer to use "free-choice learning" to refer to the type of learning outside the school, type of learning which is facilitated by museums, science centers, a wide range of community-based organizations, and print and electronic media. For them, free choice learning is primarily driven by the unique intrinsic needs and interests of the learner; it is free-choice, nonsequential, self-paced, and voluntary. Eshach (2006) prefers to use the term "non-formal learning". Eshach (2006) believes that it is not enough to take physical differences into consideration while making the distinction for a proper term. According to him informal learning occurs spontaneously in one's day-to-day routine such as at home, in yards, parks, streets, or in break times at school. But non formal learning occurs in places that needs preparation to some extent and visited occasionally. Museums, zoos, aquariums can be given as examples to these informal settings. To summarize, different researchers use different words for learning environments outside the school, they address similar settings to some extent; but among them, there is no common word to use. In this study "informal science learning" has been used to address science learning in settings outside the school, such as science centers, zoos, aquaria, nature centers, and botanical gardens.

In order to discuss further about learning in informal settings it's important to understand what "informal learning" means. "Informal science learning" is defined in the policy statement of the Informal Science Education Ad Hoc committee of the National Association of Research in Science Teaching (NARST). It is stated in their definition that this term refers to science learning that occurs outside the traditional, formal schooling (Dierking *et al.*, 2003). Apart from this, "informal science education" is also defined in the National Science Teachers Association (NSTA) position statement about informal science education. It is defined as the term referring to "programs and experiences developed outside the classroom by institutions and organizations that include children's and natural history museums, science-technology centers, planetaria, zoos and aquaria, botanical gardens and arboreta, parks, nature centers and environmental education centers, and scientific research laboratories" (NSTA Board of Directors, 1999).

As McComas (2006) states it, there is neither a single definition nor a standard list of the domains where informal learning occurs, and it is believed that informal learning settings have the potential to shape one's thinking and teach lessons that can be long lasting. According to Ramey-Gassert, Walberg and Walberg (1994), museums are informal settings where learning is intrinsically motivated and proceeds through curiosity, observation and activity (as cited in Griffin *et al.*, 2005). Personal ownership of the learning is a fundamental component of learning in museums. They are the places for active and reflective learning (Griffin, 1998).

Constructivism is believed to be a learning theory that is more relevant than other learning theories for museums. This theory basically focuses on the learner and personal meanings learners make according to their prior experiences, knowledge and interests (Griffin *et al.*, 2005). Hein (1991) also states that the principles of constructivism can be applied to learning in museums. Hein (1991) explains some learning principles which emerge from the constructivist approach. It is stated in the principles that learning is an active process, a social activity and it occurs in the mind. According to these principles people learn to learn as they learn, and motivation is essential for it. And, previous knowledge effects new learning (as cited in Griffin *et al.*, 2005). Therefore, museum learning is mostly based on constructivist learning practices where learners' prior experiences are being considered, their experiences are crucial, and they are active constructors of meaning from their experiences. Anderson *et al.* (2003) also state that the reasons for referring to constructivist views of learning in science museums can be listed as recognition of the importance of visitors' prior knowledge, their alternative conceptions and the individual nature of construction of meaning from experiences.

If it is the constructivist theory which is more widely accepted nowadays, understanding how the learner constructs meaning gains more significance. Therefore, in order to understand learning, it is important to analyze the actions of the learner rather than probing the nature of the subject to be learned. What is central for this theory is not what is intended to be taught, rather what people learn (Hein, 1995). Therefore, as Hein (1995) points it out, in order to understand learning of the students in an informal learning setting such as a science center, it is important to understand the kind of meaning that students inferred from the exhibit they see, or anything they try in an that setting.

In addition to constructivism, socio-cultural theory is also accepted to be a relevant theory for museum learning (Kelly, 2002). According to (Eshach, 2006) one of the main components of social constructivism is discourse. According to the author, discourse can take place among children, teachers, parents, or science center explainers. Gilbert and Priest (1997) state that in an informal learning setting social construction of knowledge occurs when visitors with varying experiences share their prior and present experiences through conversation.

Affecting by any of these theories, there is a most common belief that informal settings support learning of individuals. In studies conducted by Hood (1995) and Kelly (2000a, 2001) it is revealed that when visitors are asked why they visit places such as museums they often answered “to learn” (as cited in Griffin *et al.*, 2005). Moreover, it is believed that out-of-school experiences have a great potential on learning because they make an impression on students and increase their understanding of science while showing that science is more than a subject studied in school (Kisiel, 2006b). According to Wellington (1990), science centers make cognitive, affective and psychomotor contributions to science education. He asserts that science centers contribute to cognitive domain in terms of knowledge and understanding. They also have an influence on affective domain by developing interest, enthusiasm, motivation, eagerness to learn and excitement. Lastly, in the psychomotor domain, children can develop their manipulative skills, hand-to-eye coordination, etc. Their long-term effects on learning are also investigated. Falk and Dierking (1997) found in their study in which they interviewed one hundred twenty-eight subjects about their recollections of school field trips that even after many years, nearly 100% of the individuals could recall one or more things learned on the trip, and majority of what they recalled are related to content/subject matter. According to their results, Falk and Dierking (1997) suggest that museum field trips are “highly salient and indelible memories” (1997; p.4), and these memories are the indicators of learning about diverse topics.

Learning in informal settings is affected by a number of factors. In a study, Storksdieck and Falk (in review; in prep.) found factors influencing museum learning. They list these as prior knowledge, interest, motivation, choice and control, within group social interaction, between group social interaction, orientation, advance organizers, architecture and the quality and quantity of exhibits. According to them all of these factors are important and no single factor can explain visitor learning (as cited in Falk, 2004). Additionally Griffin (1998) states that learning in informal settings is affected by learner’s prior experiences, current conceptual understanding, expectations, and attitudes. Eshach (2006) gathers factors affecting out-of-school learning in the literature together and develops a model for the factors influencing out-of-school learning (Figure 2.1)

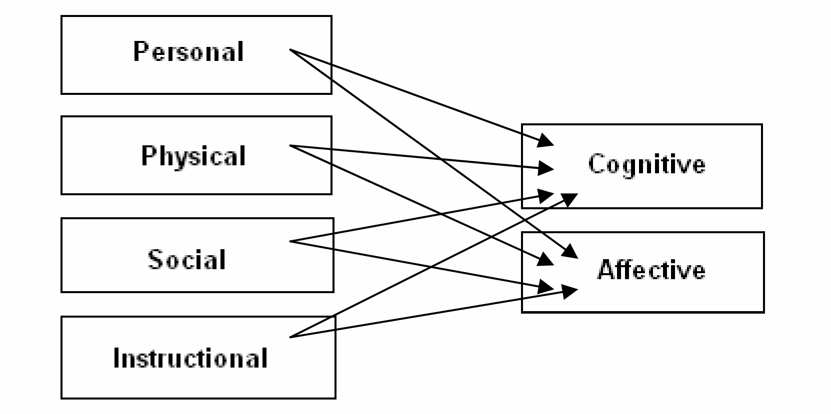


Figure 2.1. Factors influencing out-of-school learning

According to Eshach (2006)'s explanation of the model, there are four factors which influence out-of-school learning; these are personal, physical, social, and instructional. All of these four factors have both cognitive and affective components. For example, personal factors include visitor's prior knowledge, which is a cognitive component. At the same time, it includes visitor's attitude toward science, his/her efficacy beliefs. As a result, there are numerous factors affecting learning in an informal setting.

Therefore, it is not simple to understand learning in museums; each student will gather different information and understanding from the same exhibit. The researchers conducting Museums Actively Researching Visitor Experiences and Learning (MARVEL) project whose aim is to investigate method by which learning in a museum can be uncovered, asserts that looking at how and whether visitors are learning is more valuable than what they have learned (Griffin *et al.*, 2005).

To sum up, learning in informal settings is explained in different ways and it is not easy to understand learning in these settings. There is an argument that visits to science museums do not guarantee learning all the time. There are some possible barriers to learning in a museum (Griffin, 2004). Although there is an agreement that science museums, zoos, planetariums, parks, and aquariums are the environments which provide rich resources for the students, there are still some difficulties about access to such settings (Melber, 2006). As McComas (2006) states it, informal learning environments can support school science instruction but they can also cause some misconceptions that may block science learning. One of the most familiar criticisms about learning science in informal settings is that it is not much possible to talk about true learning in these settings. Instead, in such environments learning is not real, misconceptions are initiated and it is difficult to bring together intentions of visiting a science center, which are entertainment and mastery of scientific concepts and ideas (Braund and Reiss, 2006). Wellington (1990) reported that parents he interviewed have some criticisms about the role of science centers. They question whether their children can learn since they appear to be playing.

Some of the studies conducted to examine learning in out of school environments reveal the factors negatively affecting learning in such places. For instance, according to Gammon (2001), activities that cannot match to the abilities of the audience, or those that do not mean anything to the audience can limit learning in museums (as cited in Griffin, 2004). Moreover, there are also constraints related to the teachers. Carter (2001) states that, teachers usually feel under stress when they take their class to a museum because of curriculum controls, students' wants and needs, and some logistical considerations (as cited in Griffin, 2004). Also, although teachers need to make plan and prepare materials for such museum visits, lack of time is a limiting factor for them. They assert that the availability of curriculum resources and resource people make it easier for them to make field trips (Michie, 1998). In a study conducted by Anderson and Zhang (2003) to understand the issues, determinants and barriers faced by K-7 teachers when planning and implementing field trips, it is revealed that 90% of teachers found field trips as highly valuable educational experiences for their students. However, according to most of the teachers, it was the combined responsibility of the museum and teacher to provide the planning at-venue experiences. One-third of the teachers believed that the planning of at-venue experiences is the responsibility of the museum. Moreover, for post-visit activities again one-third of teachers believe that these should be provided by the museum (Anderson and Zhang, 2003). Then, it can be said that many teachers have an expectation of being provided with prepared learning materials.

Consequently, it can be said that out of school environments cannot guarantee learning all the time; there are some possible barriers that may affect learning in these environments. As Griffin (2004) stated, although the majority of museum visitors (so, students in the school groups visiting museums) enjoy *"just looking around"*, this does not result in learning (p.64). While it is clear that there are factors that may limit learning in out of school environments, it is important to suggest some ways to prevent visitors from simply looking around in a museum without any purpose or meaning. And, studies provide a number of suggestions to foster learning in informal settings.

According to suggestions put fourth by McQuade and Champagne (1995), it is better when a field trip to a museum has a clear purpose. First of all, teachers should know this purpose; by this way they can guide students to achieve this goal. Moreover, teachers want to know the benefits of the time used for the museum visit; because these are the hours lost from their class time. McQuade and Champagne (1995) suggest that clear purposes are actually means for assessment, and after a trip each student can be evaluated. Some follow-up activities can be added according to the effectiveness of the instruction during the museum visit. Students can be expected to ask questions about the exhibits that they see in the museum and try to find answers to them in the classroom, or in the laboratory, or from the library. This might lead students to be curious. And it is expected that these all result in more learning from the trip (McQuade and Champagne, 1995). Apart from these, there are also other suggestions in order to get benefit from the learning opportunities of informal settings. It is recommended for teachers to consider how the museum experiences of the students will fit with their classroom learning; as Kisiel (2006b) suggests trips should be essential, not something auxiliary. Further suggestions by Griffin (2004) emphasize the importance of worksheets. Worksheets are believed to be necessary on field trips. Although most of the students do not prefer to use worksheets; they say at the same time that no learning occurs without using worksheets. Worksheet usage is also recommended by Kisiel (2006b). He states that a worksheet which is prepared carefully may help to facilitate student observation or student thinking during the field trip. Suggestions by Anderson and Zhang (2003) include effective pre-planning/pre-lessons, appropriate curriculum fit, and providing hands-on experiences for the students, and post-visit activities. All are seen as key factors influencing the success of field trips.

For DeWitt and Osborne (2007), there are four features that can help learners construct new knowledge in informal settings. One of them is the reduction of novelty effect which is defined as the effects that unfamiliar settings have on the behaviors and learning of individuals. Therefore, in order to increase the possibilities of learning, students should be oriented to the informal setting before they go there. The other features are listed as the structure, cognitive engagement that will cause students to think actively, and collaboration and discussion which reflect social and mediated nature of learning.

Further suggestions from literature point out the importance of providing guidance to enhance the possibility of learning in museums. This guidance can be provided in different ways as it has been just stated; informing learners about the general aims of the museum and expecting them to achieve this aim; using some learning aids during the visit; making students use what they experience in the museum when they return to the classroom with some evaluation at the end, etc.

Another important concern that emerges from several studies about learning in such places is the importance of attempting to bridge the boundaries between the science museums and the schools. As Braund and Reiss (2006) pointed out, out-of-school contexts such as science museums should accepted to be complementary rather than as in competition with it. National Science Teachers Association (NSTA) shows their support for the development of links between informal institutions and schools. According to the Association, "informal science education complements, supplements, deepens, and enhances classroom science studies" (NSTA Board of Directors, 1999). As Kisiel (2006b) states it, what is tried to be actualized by organizing a school field trip to an informal setting is to bring the structure and order of a formal classroom setting into an unstructured place where learners generally are free to choose what they want to do. In order to address this conflict several strategies are recommended for teachers for organizing effective field trips (Kisiel, 2006b). To start with, research indicates that the value of trips to informal settings increases especially when they are integrated to the school learning. Kisiel (2006b) also makes a similar emphasis. A strong connection between the curriculum and the organized field trip provides an opportunity for students not only to remember what they did but also to understand why they did it. Furthermore, Griffin suggests that museum visits become more meaningful if they are integrated to a unit which is conducted in the classroom. She also asserts that integration is more powerful when a research question or topics developed by the students are used (as cited in Hoban, 2005). According to her, integration provides a purpose for learning from the museum displays. Students know why they are going to the museum and what they will learn about. Then, museum visits becomes purposeful things, and it is understood that they are "more than just to add to students' experience bank" (Griffin, 1999, p.7). It is also found to be important that while making this integration, students' topic questions or those that they are required to investigate should be available in the museum; exhibits should offer experiences and information that allow students to find answers to the questions at hand. Moreover, it is also suggested that a topic should not be too narrow; if so, this decreases students' options for learning in the museum, and it causes students to have only very specific questions (Griffin, 1999).

With the aim of bridging the gap between formal and informal learning environments different studies have been conducted. For example, the School-Museum Integrated Learning Experiences in Science (SMILES)"- led by Griffin (1998), aims to integrate school and museum learning. In SMILES students are encouraged to be involved in planning their own visits, research questions relevant to class topics, and work in groups (as cited in Griffin, 2004). In SMILES, Griffin examines learning in the museum in three ways; by collecting students' personal declaration of knowledge, looking for students' understanding of the big ideas of an exhibit and looking for student behaviors that indicate learning is happening (Griffin, n.d.). Apart from this, in a program led by Mcleod and Kilpatrick an ambassador selected from a school to make connection with a local museum for a year. It is explained that the effectiveness of the program depends on teachers and the other staff in the school. If teachers are the ones who want to develop themselves professionally, schools are willing to provide financial support, centers and schools work together to develop inquiry based learning opportunities which are connected to the curriculum the possibility of making students' learning more meaningful increases (Mcleod & Kilpatrick, 2002, as cited in Griffin, 2004).

Orion (1993) proposes a model for integrating field trip into a curriculum unit. According to Orion, field trips support learning through direct experience with concrete phenomena and materials. This direct experience which is more hands-on helps students construct understanding of abstract concepts and enhance meaningful learning. Orion emphasizes using concrete activities in the field trips that cannot be conducted in the classroom. He suggests that the field trip should not be the first learning activity; before it there should be a preparatory unit. Orion (1993) proposes a three-part model; a learning spiral ranging from concrete to abstract (Figure 2.2).

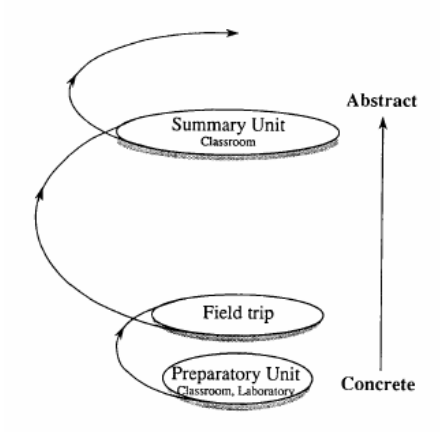


Figure 2.2. Model for integrating field trips into a curriculum unit

The preparatory unit is said to be designed for making students ready for the field experience. According to Orion, students should be prepared for the field trip in such a way that they become ready for the assignment in the trip (cognitive preparation), the area of the field trip (geographical preparation), and the kind of event they will participate in (psychological preparation). During the field trip students are directed through the experiences with some guidance. At the end, a summary unit is implemented to evaluate students' learning (Orion, 1993).

What Orion (1993) suggests is in line with what is suggested in many studies for understanding museum learning. According to them, museum learning can be understood by combining information from three time periods. First is information about visitors' pre-museum history, their prior knowledge, interests, experiences, expectations, and motivation. Second is information about in-museum experiences, social interactions in visiting groups, characteristics of the social setting, and presence or absence of advance organizers. Information about visitors' post museum experiences, reinforcing experiences visitors have had after the visit should be examined. (Ellenbogen, 2002, 2003; Falk and Storksdieck, in prep. as cited in Falk, 2004) Studies conducted to examine learning in informal settings reveal varied findings about pre-during-post visit periods. For instance, in the study conducted by Anderson and Zhang (2003), teachers are asked to declare their opinions about pre- and post-visit activities. According to the majority of teachers, pre-visit activities were more desirable. As one of the teachers said, telling kids where they are going, what they are going to do, why they are going, etc is important. However, this finding might also be due to the fact that few teachers reported that they offer post field-trip experiences when they turn back in the classroom. The literature indicates that there is very little implementation of the post visit activities. Few students are provided with the chance of using the learning from the visit when they return to school. Although teachers assert that they plan to do something back at the school, they rarely provide an environment for using information and experiences gathered during the visit (Griffin, 1999).

In a study that questioned teacher concerns while planning field trips, teachers were asked to rank a set of thirteen issues from the highest to the lowest priority importance in terms of their consideration while planning and implementing field-trip visits. Analysis of this study revealed that for teachers the most important issue is the degree to which the field-trip experience fit the school-based curriculum. (Anderson and Zhang, 2003) Parallel with this finding, Xanthoudaki (1998) also has similar results in his study in which he studied the use of visits for art teaching purposes. The results of the study showed that visits to the museum and gallery are more likely to be incorporated into the classroom art practice because of the educational programmes in the informal setting and the school curriculum requirements. Therefore, providing teachers with the programmes or materials which are more related to their classroom instruction encourage them to incorporate the visit experience of the students into the school learning. Another critical assistance to teachers would be to help them find ways to refer to field-trip experiences after students have left the museums (Anderson and Zhang, 2003).

The review of the literature indicates that informal learning environments such as science museums, science centers, botanical gardens, zoos, etc. offer significant opportunities to strengthen learning and fit well with a constructivist approach. It is also emphasized that learning in informal settings can be enhanced with planning of students experiences before, after and during the museum visit. Linking museum learning with the school learning by making clear connections between the museum experiences and school curriculum is also desirable for enhancing the possibility of better learning in informal settings.

3. SIGNIFICANCE OF THE STUDY

As Griffin (2004) states, the valuing of learning in an informal setting can influence approaches to learning in these settings. By this way, new learning opportunities can be created in such places or they can be developed further. This study can be considered as one of these learning opportunities. The aim is to develop a learning kit to facilitate science learning in a science center in İstanbul. By valuing the possibilities of learning in informal settings, the researcher has attempted to connect learning in an informal setting with school learning by integrating it with the 7^{th} grade science and technology curriculum in Turkey.

Falk (2001) explains, in the past a lot of attention has been given to formal education for facilitating learning. But, recently vast array of non-school science education institutions are given a growing appreciation. However, informal learning areas are rarely used for educational purposes in Turkey; specifically science centers are few in number. There are only three science centers in Turkey; one is in Ankara, the other two are in İstanbul. This study specifically addresses one of these three science centers, the "Şişli Municipality Science Center" in İstanbul. Many primary and secondary schools, both public and private, make visits to this center. The learning kit, which was developed specifically for the center is planned to be helpful for the visiting schools. It is predicted that, the learning kit increases students' learning gains from the science center. Moreover, it is also intended that the kit would be a model for other such kits as well. Similar science learning kits about different subjects or for different age groups can be developed in the future. In addition, the kit can be used for other scientific studies as well for different research topics. Furthermore, the results which were obtained from this study add to the literature on learning in informal settings. It is expected that the study report will stimulate further discussion in Turkey on maximizing the usefulness of informal learning settings.

4. STATEMENT OF THE PROBLEM

This study attempts to develop science center learning kit (SCLK) to facilitate learning in a science center in İstanbul and measure its effects through an implementation with and without SCLK. The kit is related to some of the basic concepts in the “force and motion” unit of the seventh grade science and technology curriculum in Turkey.

There are two major goals in this study. The first is concerned with the development of the SCLK. The aim of developing this kit is to guide students’ learning experiences specific to several exhibits at the science center. The development process covers four steps;

1. The first step is the identification of the exhibits which are specifically addressed in the kit.
2. The second step is the identification of the main concepts revealed by the selected exhibits.
3. The third step is the specification of learning objectives from the 7th grade science and technology curriculum that they are found to be associated with the identified concepts.
4. Lastly, the fourth step is the development of the materials and activities to be used by teachers and students prior to the visit, during the visit and following the visit to the science center.

The second major goal of the study is to measure the effects of the Science Center Learning Kit (SCLK) through an implementation in Şişli Municipality Science Center in İstanbul. Its effects were measured by examining the learning outcomes of the 7th grade students who completed the visit, and also by comparing the learning outcomes of the groups who completed the visit with and without the SCLK. In this study “visit” refers to three phases of the science center visit experience. These are pre-visit experiences, during visit experiences and post-visit experiences.

The learning outcomes of the 7th grade students who completed the visit were examined in terms of their level of conceptual understanding, personal declaration of their own learning, and understanding of the big ideas underlying the selected exhibits. The groups of 7th grade students who completed the visit with and without the SCLK were compared in terms of their conceptual understanding, personal declaration of their own learning, and understanding of the big ideas underlying the selected exhibits.

The following research questions and hypotheses are formed on the basis of the second major goal of the study.

4.1. Research Questions and Hypotheses

The study search for the answers of following research questions:

1. Will there be any change in 7th grade students' conceptual understanding about force and motion topic following their visit with SCLK?
2. What is the personal declaration of the 7th grade students who are provided with SCLK for the visit about their own learning as measured by Modes of Learning Inventory?
3. What is the degree of understanding of big ideas of the 7th grade students who are provided with SCLK for the visit?
4. Will the 7th grade students who use the SCLK and students who do not use SCLK during their visit differ in terms of their understanding of the big ideas in the exhibits?
5. Will the 7th grade students who use the SCLK and students who do not use SCLK during their visit differ in terms of their conceptual understanding regarding the selected concepts in the "force and motion" unit?
6. Will the 7th grade students who use the SCLK and students who do not use SCLK during their visit differ in terms of their personal declarations about their own learning as measured by MOLI?

In this study it is hypothesized that,

1. 7th grade students who are provided with the SCLK for their visit will score higher then the 7th grade students who are not provided with SCLK for the visit in terms of their conceptual understanding regarding the concepts force and motion as measured by Conceptual Understanding Questionnaire.
2. 7th grade students who are provided with the SCLK for their visit will score higher than the 7th grade students who are not provided with SCLK for their visit in terms of their personal declaration about their own learning as measured by MOLI.

4.2. Variables and Operational Definitions

4.2.1. Dependent Variables

The dependent variables of the study are the learning outcomes of the students from the science center visit. Learning outcomes of the students from the science center visit refers to students' conceptual understanding regarding the concepts in the "force and motion" unit of the 7th grade science and technology curriculum, personal declaration of their own learning and their understanding of the big ideas in the exhibits. These three dimensions that define learning outcomes were measured with three separate instruments:

1. "Conceptual Understanding Questionnaire-Force & Motion" was used with a pretest-posttest design to assess students' conceptual understanding about selected concepts in the "force and motion" unit prior to and following the visit.

2. "Modes of Learning Inventory (MOLI)" was used to assess personal declaration of students on their own learning. MOLI is one part of the Questionnaire for Exit Surveys. The Questionnaire for Exit Surveys is one of the tools included in the kit developed for Museums Actively Researching Visitor Experiences and Learning (MARVEL) Project.

3. “Understanding of the Big Ideas Questionnaire” was used to assess students’ understanding of the big ideas in the exhibits. Understanding of the Big Ideas Questionnaire is based on the work in MARVEL Project. In this study “big ideas” refers to underlying concepts/theories/explanations of the selected exhibits in the science center.

4.2.2. Independent Variable

The independent variable of the study is the science center learning experience with and without SCLK which was designed to guide learning in the science center. The SCLK was developed by the researcher concerning selected concepts in the “force and motion” unit of the 7th grade science and technology curriculum in Turkey.

The Science Center Learning Kit (SCLK)

The SCLK was developed after careful consideration of the suggestions and cautions raised in the literature. The primary bases of the kit are as follows:

1. The school curriculum should be compatible with the learning experiences of the students in the science center. In other words, learning experiences of students in an informal setting should be integrated into the formal school science learning (Anderson and Zhang, 2003; Bell and Rabkin, 2002; Griffin, 2004).
2. The visit should have a purpose; students should know why they are going to the science center (Griffin, 1999; Kisiel, 2006a; McQuade & Champagne, 1995).
3. Follow-up activities should be provided after a visit; students should be made aware before or during the visit about how they will use their learning experiences in the science center when they return back to school (Anderson & Zhang, 2003; McQuade & Champagne, 1995).
4. The teaching kit should be user friendly for teachers (Hoban, 2005); it should not add significantly to the workload of teachers.
5. Activities which are planned to be conducted in the center should have a meaning for the students and match their abilities (Gammon, 2001 as cited in Griffin, 2004).

6. Because it is generally accepted that learning is enhanced when carefully designed worksheets are used to focus students' attention, worksheets should be provided for the students during the visit (Griffin, 2004; Kisiel, 2006b).
7. Visit experiences should encourage students to observe, make predictions, and confirm or disconfirm their own predictions (Griffin, 1999; Kisiel, 2006a).

By taking these as the primary bases, and considering suggestions made in the literature about designing field trips, the Science Center Learning Kit is composed of support materials and suggested activities for teachers who plan to organize field trip to the science center with their students. Because the kit is about some concepts in the "force and motion" unit of the 7^{th} grade science and technology curriculum, it specifically addresses to the students in this grade level and the science teachers who teach at that level.

5. METHODOLOGY

The study can be separated into two phases;

1. Development of the Science Center Learning Kit (SCLK)
2. Measuring the Effectiveness of the Science Center Learning Kit (SCLK)

5.1. First Phase: Development of the Science Center Learning Kit (SCLK)

Development process of SCLK can be explained in four steps:

5.1.1. Step 1: Specification of the Exhibits Which are Specifically be Addressed in the Kit

The study started with the identification of the exhibits which are addressed in the SCLK. The implied selection includes four exhibits that were seen to be compatible with 7th grade science and technology curriculum requirements (Appendix A):

- *1st Exhibit-The Express Road*: The system includes two inclined planes; one is in the form of a straight path and the other is in the form of a curved path. Each of the two identical balls is taken to the top point of each of the inclined planes, and at the same time they are allowed to roll down the paths. Before leaving the balls visitors are expected to predict which ball reaches to the end of the inclined plane first. Although the road in the shape of a curved path is longer than the other, the ball reaches to the end first on that inclined plane.

- *2nd Exhibit-Transfer of Momentum*: The system of this exhibit composes of five identical balls hanged with very thin strings to the top. All the balls stay in the same height from the ground. When one of the balls is moved away from the other and then released, it strikes to the balls and one ball at the other end goes out. When two balls are moved away and released, two balls go out at the other end. When same thing is made with three balls, three balls go out at the other end. Similar movements are observed when it is made with different number of balls. This movement of the balls is explained in terms of energy conservation and transfer of momentum.

- *3rd Exhibit-Giant Scissor*: This is system of a lever. In one side of the lever there is a spring which is difficult to compress. Visitors are required to compress this spring by applying force from different points in different distances to the pivot. Visitors are asked from which point it is easier for them to compress the spring.

- *4th Exhibit-Your Weight in the Space*: In this system there is a balance put on a ground. And there is a platform on which there are pictures of different planets (the Earth, Jupiter, Mercury, and Mars) and the Moon. Near these pictures there are small screens. Visitors are wanted to stand on it and see their weight on the screens near each planet and the Moon. By this way they see how their weight changes in different planets and the Moon.

5.1.2. Step 2: Identification of the Main Concepts Revealed with the Selected Exhibits

After these four exhibits were selected, the main concepts revealed in each were identified. For the identification of the concepts, school visits to the center were observed by the researcher. When school groups come to the science center, each exhibit is explained to the groups of students by the mentors in the center. These explanations of the mentors about the exhibits gave more idea about the main concepts mentioned in each exhibit. Moreover, the researcher discussed all the exhibits with one of the physics professors in the Boğaziçi University and went over the underlying principles and the concepts revealed in each exhibit. With the help of these methods the main concepts and the ideas explained in the exhibits were identified as mass and weight, gravity, force, energy (its conservation and transfer), velocity, and acceleration. These main concepts which are covered in SCLK exist in the second unit of the 7th grade science and technology curriculum, namely "Force and Motion". Some of the selected concepts, such as mass, weight, force, gravity, velocity are introduced and covered in the "Force and Motion" of the 6th grade science and technology curriculum. Thus, the grade level which all of these concepts can be best understood with their relationship with each other is considered to be 7th grade. There is an explanation in the beginning of the 7th grade "Force and Motion" unit in the curriculum. It is stated that;

> Students are provided with knowledge and experience about "speed, measurement of force, showing force with directional line segment, difference between mass and weight, balance of forces". Now the students are in the level of learning the intersection of "force" and "motion", "energy" concept; so transfer and conservation of energy. Moreover, they will learn about springs and simple machines, and they will infer how a frictional force result is energy lost (TTKB, 2005, p. 204).

So, some concepts from 6th grade science and technology curriculum were also used in design of activities and materials that exist in the SCLK.

5.1.3. Step 3: Specification of the objectives addressing the identified concepts from the 7th grade science and technology curriculum

In order to integrate learning experiences of students in science center to school learning, some of the objectives in "Force and Motion" unit of the 6th and the 7th grade science and technology curriculum were linked with the selected exhibits. In Appendix A, the selected exhibits and the objectives they are linked with can be seen. The objectives to be addressed in SCLK are as listed in the following:

Table 5.1 . Objectives to be addressed in SCLK

	6th Grade Objectives
1. Related to a moving along a straight line with constant velocity students,	
	calculate speed of an object by using distance traveled and elapsed time,
	show the graphical representation of the relationship between distance traveled and elapsed time, and interpret this graphic,
	explain the relationship among distance traveled, elapsed time and speed and apply it for different situations.
2. Related to the direction and measurement of force students,	
	state unit of force as "Newton" and use it,
	state the direction of force applying on an object and show it by drawing.
3. Related to weight students,	
	observe the existence of force between masses in the Earth from events around them,
	name the force between masses in the earth and the Earth as gravitational force,
	name gravitational force acting on a mass as weight,
	explain how weight of an object with the same mass will be different in different planets
	differentiate mass and weight.
7th Grade Objectives	
1. Related to force, work and energy students,	
	realize moving objects having kinetic energy,
	discover relation of kinetic energy with speed and mass,
	state that objects have gravitational potential energy due to their positions,
	discover that gravitational potential energy depends on weight and height of an object,
	explain with examples that kinetic energy and potential energy can be transferred into one another,
	from transfer of energy, reach at a conclusion that energy is conserved.
2. Related to the simple machines students,	
	name kits which are used to change a force's direction and/or magnitude as simple machines,
	realize that it is possible to obtain exit force larger than entrance force by using simple machines,
	state that while doing work using simple machine will not cause energy saving but it will simplify the work being done.
3. Related to frictional force's resulting in energy loss students,	
	realize that frictional force cause decrease in kinetic energy,
	explain decrease in kinetic energy with transfer of energy,
	make a generalization that air and water resistance result in decrease in kinetic energy.

5.1.4. Step 4: Development of the Materials and Activities

Development step also includes the production of materials and activities which were used prior to, during and after the visit to the science center. SCLK therefore includes the following materials:

5.1.4.1. Materials developed for 1st part of the visit: Preparatory materials. Preparatory materials developed for the kit are "guiding booklet for teachers" and "Presentation for advance organization of the visit". They are explained in the detail in the following paragraphs:

- *Guiding booklet for teachers*: The aim of preparing this booklet is to guide science and technology teachers' of 7th graders to conduct visits to the science center with their students. Because the concepts covered in the SCLK are from the "Force and Motion" unit, students' experiences in the science center can be integrated to their school learning, specifically in this unit.

Introduction section for the "Guiding Booklet for Teachers" is given in Appendix B. The guiding booklet also includes appendices on exhibits selected for SCLK and the objectives associated with the main ideas underlying the selected exhibits (presented in Appendix A), presentation for prior organization of the visit (presented in Appendix C), worksheet (Appendix D), enjoy & learn cards (Appendix E), authentic tasks (Appendix F).

As Kisiel (2003), pointed out, organizing field trips is actually not an easy task for teachers. There are many variables, such as getting parental permission, funding for transportation, scheduling that may affect teacher's goals for the visit. Therefore, it is important to provide teachers ready and easy-to-use materials that they can benefit in a field trip. By taking such suggestions and cautions raised in the literature, the guiding booklet covered in SCLK was prepared in a way that it can simplify teacher's work while organizing field trip to the science center. With the simple directions and explanations in the booklet the teacher can easily use SCLK. The booklet starts with general information about SCLK and its components. It covers detailed information about the selected exhibits, and how they are connected with the objectives of the “force and motion” unit in the 7th grade science and technology curriculum. Photographs of the selected exhibits are included in the booklet. All the other materials of the SCLK are also covered in the booklet in order to help teachers reach them easily, whenever they need.

- *Presentation for prior organization of the visit:* Students may feel anxious when they enter an unfamiliar location; this may cause students’ involving in off-task activities. This is known as “novelty effect” in the literature. Because of decreasing anxiety levels of the students when they are exposed to an unfamiliar setting, teachers are suggested to prepare students for the visit beforehand (Eshach, 2006). In order to prevent this situation, a preparatory PowerPoint presentation is included in SCLK (Appendix C).

The PowerPoint presentation was prepared to be used in class by teachers, before going to the science center. The presentation starts with the general information about Şişli Municipality Science Center. Some photographs of science centers from other countries are also covered in the presentation. It provides answers for the following questions that can be raised by some students:

- ✓ Why shall we visit the science center?
- ✓ What shall we see in the center?
- ✓ What shall we do in the science center?
- ✓ How shall we use our science center experiences when we turn back to school?

Also, information about the follow-up activity is covered in the presentation, because students may not be accustomed to implement activities related to their science center experience when they turn back to school. Students are also reminded in the presentation that they are required to study in group. Moreover, “study plan” is included in the presentation. It is thought that these can help students to be ready for different during and after visit experiences.

5.1.4.2. Materials developed for the 2nd part of the visit: During-visit materials. In SCLK during-visit materials are "worksheet" and "Enjoy & Learn cards". Both of these materials are explained in detail in the following paragraphs:

- *Worksheet:* As Ausubel (1977) mentioned, worksheets, as advance organizers, help students organize their visit and provide support for the acquisition of new knowledge (as cited in Kisiel, 2003). Taking its availability as one of the requirements of science center visit, worksheet is also included in the SCLK (Appendix D).

In the worksheet there is one question about each of the four exhibits selected for SCLK. It is planned by the researcher that questions in the worksheet help students to observe the exhibits in detail. In each question students are asked to give an answer to a question and write which exhibit they use to answer this question. They also asked to tell the concepts/principles that are revealed by the exhibit by trying to remember what they have learned in school. Students' going back to what they have learned in the school is very important because this helps them to remember their pre-existing knowledge and their experiences that they consider to be related with the exhibits in the center. According to Ferguson (1998), when visitor can connect exhibits to their previous experiences, they gain meaning for the visitor.

Apart from these, Connolly *et al.* (2006) mentioned that having fill-in-the-blank questions in the worksheets does not promote learning in an informal setting. When this is the case, students start to search for the correct word that they can find in an exhibit label. On the other hand, students should be encouraged for inquiry and exploration with the open-ended questions covered in the worksheets. Therefore, the questions covered in the worksheet in SCLK were prepared in a way that they did not directly ask what happens in an exhibit. Instead there is a question that students can answer by using one of the exhibits in the center; then students were asked to write by using which exhibit they can answer this question. Moreover, in order to make further thinking about the concepts revealed in the exhibit students are asked to write the concepts and principles revealed in that exhibit by trying to remember what they have learned about these concepts/principles in the school. Worksheet should be provided for each student before their visit started; and they should be collected before leaving the science center.

- *Enjoy & Learn Cards:* These are small colorful cards which give information about the underlying principles of the selected exhibits. They cover pictures, drawings, tables and formulas about the underlying principles of the exhibits. Enjoy and learn cards (Appendix E) should be distributed to the students while they are explained the exhibit about it.

5.1.4.3. Materials developed for 3rd part of the visit: Follow-up activities. Lastly, follow-up activities covered in SCLK are four authentic tasks which are described in detail in the following paragraphs:

- *Authentic Tasks:* Authenticity is one of the critical terms in science education. As Braund and Reiss (2006) explained, in an authentic school science environments, students should be provided with experiences that are more in line with the activities that scientists and technologists do in real world. And, such experiences can be student-directed tasks and open-ended enquiries. When compared to the classrooms, museums provide contexts which are very similar to the environments experienced by scientists (Gilbert and Priest, 1997). Parallel with what is suggested in the literature; in this study authentic learning environments were provided for the students. First of all, integrating science center visit is an authentic experience in its nature. Additionally, as a follow-up activity four different authentic tasks, each of which is specific for one of the exhibits selected for SCLK were prepared for the students.

All of the four tasks are serving to a common assignment which is building up a playground in İstanbul. Each group will be responsible for a task related to one part of the playground. In some of the tasks students are required to propose scientific solutions to the problems that architects of the playground could not handle. In some of the tasks students are required to design a poster for advertisement of some parts of the playground; and what is special for this poster is to make explanations made for that part of the playground by basing them on scientific principles. In the following, each of the four tasks is summarized and they can be found in Appendix F in detail:

Taks-1: Slide in a Pool. Architects of the playground had a difficulty while designing a slide coming into a large pool. They had to decide either of the top of which slides a ball can slide faster. Architects are expecting scientific explanations for their problems that they can decide on one of these two designs.

Task-2: Seesaw. There are different characters in this park that will entertain visitors of the playground in the opening ceremony. One of them is cute little mouse and the other is the lovely monkey. In the opening ceremony these two should stay in balance on a long seesaw. Owners of the playground want to have a special design of a seesaw, which is supported with scientific explanations. They tell that the best design will be used while building up the seesaw in the playground.

Task-3: Cheerful Seal's Balls. The other area which is being designed for the playground is the place where another character of the playground "Cheerful Seal" can play balls with the visitors. While designing this area, architects of the playground faced with a problem; they need a solution for that problem supported with scientific problems.

Task-4: Planet Area. Planet area in the playground was completed; now poster for advertising this area is being prepared. An advertisement author started to prepare a poster but he left it without completing. Owners of the playground are searching for someone who can complete this poster. While completing it, what is critical is requiring answers for the questions held by "Curious Squirrel" in the poster.

Each task should be assigned to one of the groups after students complete their science center visit. Then students should be expected to study for their task in group and on the day of presentation each group should be ready for presenting their work to other groups. While groups presenting their works, it is important to create a discussion environment among the students. Each task can be solved by using one of the four exhibits covered in SCLK. At the end of the presentations, all of the four exhibits seen in the science center, underlying principles of these exhibits and their connection to what they learned in the school should be repeated.

It is planned that these tasks as follow-up activities will provide students an opportunity to connect what they experienced in the science center with daily life. The idea of connecting real life with science center experience is consistent with what George Hein (2004) points out in a figure explaining Dewey-inspired educational model applied to museum (Figure 5.1). According to him, it is important to connect museum experience with the life outside the museum.

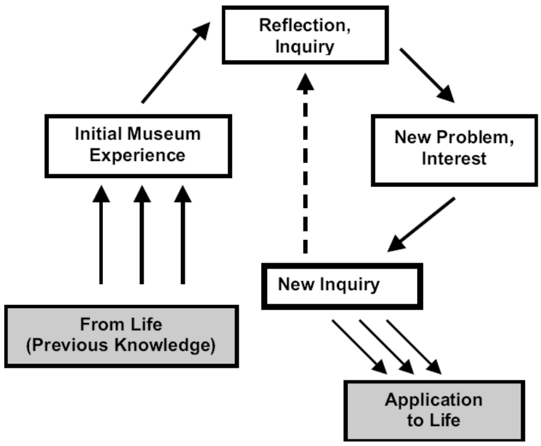


Figure 5.1. Dewey-inspired education model applied to museums

5.2. Second Phase: Measuring the Effectiveness of the Science Center Learning Kit (SCLK)

5.2.1. Sample

This study was implemented in two different kinds of schools in İstanbul. One of the schools was a public school that functions within a joint protocol with Boğaziçi University Faculty of Education. The other is a private school. Both of the schools were selected due to its convenience for the researcher.

The sample of the study consisted of 21 students (6^{th} and 7^{th} graders) from the public school, and 56 students (7^{th} graders) from the private school. However the actual number of students who participated in this study extends beyond the specified number (24 students from the public school and 74 students from the private school). Three students from the public school and 18 students from the private school were excluded from analysis due to missing data. The details for the missing cases are explained in the following paragraphs.

The sample from the public school included student from three different grade levels (12 students from 6th grade, 9 students from 7th grade and 3 students from 8th grade), who were selected by their teachers and the administrator of the school. Although the selection was expected to include only the 7th grade students, (the grade level that matches the content and objectives specified for the exhibits selected for the SCLK), the selection was made among the most hardworking and volunteering students. In its final form the sample included only 21 students (12 students from 6th grade and 9 students from 7th grade formed the sample of the study), because 8th graders were reported to be missing during major parts of the implementation process. There was no control group. Therefore, all of the students selected for the study completed the field trip to the Science Center with SCLK. The visit was carried out by the researcher.

The sample from the private school consisted of 56 students from the seventh grade. Although six classes of seventh graders were initially involved in the study, the actual number is much lower due to large amount of absentee during the science center visit. The private school included both the experimental and the control groups. Table 5.1 summarizes the number of the students in each class.

Table 5.2. Sample of the study (private school)

	Experimental vs Control	**Teacher**	**Number of the students**
Class-1	Experimental	Teacher-A	17
Class-2	Control	Teacher-A	21
Class-3	Control	Teacher-B	18

5.2.2. Design

The study aims to determine the effectiveness of SCLK by 1) examining the learning outcomes of students who were provided with the SCLK during their visit and 2) comparing the learning outcomes of students who made their visit with SCLK with the students who made their visit without SCLK.

The learning outcomes of students who were provided with the SCLK during their visit were examined using data from both the public and the private school. However, comparisons between students who made their visit with SCLK with the students who made their visit without SCLK were only based on the data from the private school. Therefore the effectiveness of SCLK was analyzed using pre-experimental design (pre-test post-test design) and quassi-experimental design (pre-test, post-test, control group design) for the public and private school respectively.

Table 5.3. Design of the Study

		PRE-MEASUREMENT	INTERVENTION			POST-MEASUREMENTS		
PUBLIC SCHOOL	Experimental Group (n=21)	CUQ	Preparation for the visit as suggested in SCLK	Visit to the science center as suggested in SCLK	Follow-up as suggested in SCLK	CUQ	MOLI	Understanding of Big Ideas Questionnaire
PRIVATE SCHOOL	Experimental Group (n=17)	CUQ	Preparation for the visit as suggested in SCLK	Visit to the science center as suggested in SCLK	Follow-up as suggested in SCLK	CUQ	MOLI	Understanding of Big Ideas Questionnaire
	Control Group-1 (n=21)	CUQ		Visit to science center without SCLK		CUQ	MOLI	Understanding of Big Ideas Questionnaire
	Control Group-2 (n=18)	CUQ		Visit to science center without SCLK		CUQ	MOLI	Understanding of Big Ideas Questionnaire

5.2.3. Instruments

The instruments which were used in the study were designed to assess students learning outcomes from the science center visit in terms of students' conceptual understanding about force and motion topic, personal declaration of their own learning and their understanding of the big ideas underlying the selected exhibits.

5.2.3.1. Conceptual Understanding Questionnaire-Force & Motion (CUQ-Force & Motion). The Conceptual Understanding Questionnaire-Force & Motion (CUQ-Force & Motion) (Appendix G) was designed in a selected response assessment format by the researcher. It was used to assess conceptual understanding of 7^{th} grade students about mass, weight, gravity, force, energy (its conservation and transfer), velocity, acceleration concepts which are covered in "Force and Motion" unit of the 6^{th} and 7^{th} grade science and technology curriculum.

CUQ-Force & Motion is composed of four parts. There are eight fill-in the blank questions in the first part and nine binary choice questions in the second part. Third part of the CUQ-Force & Motion consists of five matching items, forth part consists of fourteen multiple choice questions. Totally 36 questions of the questionnaire were in "knowledge" and "application" levels.

The questionnaire was given to the whole sample as a pre-test in the beginning of the study before students had no experience related to the science center visit. Questionnaire was also administered to the students at the end of their field trip experience.

Validity and Reliability Analysis of the CUQ-Force & Motion Questionnaire

For the content validity of the questionnaire all the questions were prepared according to the objectives selected from the "force and motion" unit in the 6^{th} and 7^{th} grade science and technology curriculum. The objectives which are addressed in the SCLK and aimed to be measured with the CUQ-Force & Motion were listed previously in "First Phase: Development of Science Center Learning Kit" part. In order to cover questions which address all the objectives from each level proportionally a test plan (Appendix H) was developed by the researcher firstly. For each objective in the test plan there are questions either in "knowledge" or in "application" or in both levels. Then, the questions were developed according to this test plan. This is also an evidence for the content validity of the instrument.

Reliability analysis of the questionnaire was conducted with the data obtained from that original study. Cronbach's alpha and item-total correlation coefficients were computed in order to find the internal consistency of CUQ-Force & Motion. Reliability analysis was conducted with both the pre-test and the post-test scores of the students participating to the study from the public and the private school. Firstly, alpha coefficient was found to be 0.779 with the pre-test scores and 0.731 with the post-test scores. Item-total statistics were also analyzed. Items with item-total correlation coefficients lower than 0.15 were reviewed. It was found that items 6, 10, 17, 23, 24 and 27 have item-total correlation coefficient lower than 0.15. In order to come up with a more reliable questionnaire, these items were removed from the questionnaire and second reliability analysis was carried out. After removing these 6 items from the questionnaire, Cronbach's alpha was found to be 0.818 with the pre-test scores and 0.786 with the post-test scores. Again, item-total statistics were analyzed. It was found that items 11 and 26 have lower item-total correlation coefficients according to analysis made with the post-test scores. 26^{th} item's item-total correlation coefficient is very close to 0.15. Therefore only 11^{th} item was removed and another reliability analysis was carried out with the remaining 29 items. At the end, Alpha coefficient was found to be 0.810 with the pre-test scores and 0.789 with the post-test scores (Table 5.3).

Table 5.4. Reliability Analysis of CUQ-Force & Motion

	Cronbach's Alpha	**Cronbach's Alpha Based on Standardized Items**	**N of Items**
Reliability Statistics (with pre-test scores)	0.810	0.877	29
Reliability Statistics (with post-test scores)	0.789	0.864	29

Table 5.5. Item-total statistics of CUQ-Force & Motion

Statistics based on pre-test scores

	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Q1	0.245	0.808
Q2	0.420	0.807
Q3	0.644	0.798
Q4	0.329	0.806
Q5	0.556	0.799
Q7	0.662	0.787
Q8	0.594	0.799
Q9	0.124	0.811
Q12	0.328	0.805
Q13	0.285	0.807
Q14	0.422	0.803
Q15	0.134	0.811
Q16	0.283	0.807
Q18	0.252	0.809
Q19	0.539	0.805
Q20	0.632	0.803
Q21	0.360	0.807
Q22	0.235	0.809
Q25	0.435	0.803
Q26	0.312	0.806
Q28	0.445	0.804
Q29	0.167	0.823
Q30	0.473	0.802
Q31	0.243	0.820
Q32	0.451	0.802
Q33	0.453	0.802
Q34	0.397	0.807
Q35	0.517	0.801
Q36	0.563	0.792

Statistics based on post-test scores

	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Q1	0.446	0.780
Q2	0.535	0.784
Q3	0.509	0.779
Q4	0.186	0.788
Q5	0.472	0.778
Q7	0.644	0.762
Q8	0.478	0.780
Q9	0.197	0.787
Q12	0.342	0.783
Q13	0.174	0.788
Q14	0.164	0.788
Q15	0.239	0.786
Q16	0.301	0.784
Q18	0.397	0.785
Q19	0.657	0.780
Q20	0.399	0.785
Q21	0.364	0.785
Q22	0.256	0.787
Q25	0.487	0.778
Q26	0.137	0.789
Q28	0.314	0.792
Q29	0.414	0.782
Q30	0.620	0.774
Q31	0.298	0.795
Q32	0.225	0.786
Q33	0.390	0.782
Q34	0.219	0.797
Q35	0.602	0.775
Q36	0.385	0.779

As Table 5.4 shows, according to pre-test scores items with lower item-total correlation coefficient are items 9 and 15. However, when item-total statistics were carried out with the post-test scores, it was found that item-total correlation coefficient of these items increased. According to the item-total statistics based on post-test scores, the only item whose item-total correlation coefficient low is 26th item; since it is very close to 0.15 this item was not removed from the questionnaire. At the end of these analyses, CUQ-Force & Motion took its final version.

5.2.3.2. Modes of Learning Inventory (MOLI). Modes of Learning Inventory (MOLI), is one part of the Questionnaire for Exit Interviews. It measures personal declaration of visitors' own learning. Although questions are interview questions in that questionnaire, they were used in written format rather than as interview questions in this study.

Questionnaire for Exit Interviews is one of the tools in a kit developed in Museums Actively Researching Visitor Experiences and Learning (MARVEL) Project. The aim of that project is developing a set of "tools" for measuring aspects of learning. MARVEL Project is a collaboration between the University of Technology, Sydney (UTS); the Australian Museum, Sydney; the Royal Botanic Gardens, Sydney; and Environmetrics Pty Ltd. The project team is composed of Janette Griffin, Linda Kelly, Janelle Hatherly and Gillian Savage (Griffin *et al.*, 2005). The kit contains three tools; "Observation Study", "Listening Study" and "Exit Interviews". In this study, parts of "Exit Interviews" were translated into Turkish and adapted according to the design of the study.

Exit Interviews were suggested to be used when there is a need to,

- ✓ to measure the main messages visitors are getting
- ✓ to measure how visitors view their own learning
- ✓ quantitative measures reported as percentages
- ✓ data reported by demographic category (with children/without children, first time visitors/repeat visitors etc.)

Modes of Learning Inventory (MOLI) was developed by Environmetrics Pty Ltd (Gillian Savage) which is an independent social and market research consultancy in North Sydney ("Market Intelligence", n.d.). MOLI measures visitors' own impressions and expressions of their learning from a particular exhibit. In other words, this tool gives information about "whether the visitors themselves consider that they have been learning and how they have been learning. MOLI measures the process of learning rather than the content" (Griffin *et al.*, 2005).

In the adaptation process of MOLI, firstly items were translated into Turkish by an expert in English Teaching Department, and then items written in Turkish were translated into English by another expert in the same department. Then these items in English were compared with the items in the original inventory.

MOLI comprises of 10 items which are all five-point Likert type. While adapting into Turkish one of the items in the original scale was separated into two items. Because of this, Turkish version of MOLI comprises of eleven items. Moreover, in the Turkish version of MOLI items are all four-point Likert type. They are scored as 1 point for "no, never", 2 points for "just a very little", 3 points for "some, but not a lot", 4 points for "yes, a lot". The scale includes items such as:

"I discovered things that I didn't know"

"I was reminded of the importance of some issues"

Reliability Analysis of MOLI

Reliability analysis of MOLI was conducted with the current study. In order to find the internal consistency of MOLI Cronbach's Alpha and item-total correlation coefficients were computed. The reliability analysis results indicated a reasonable internal consistency for the scale.

Table 5.6. Reliability Analysis of MOLI

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.887	0.888	11

As Table 5.5 shows an alpha coefficient was found to be 0.887. Item-total statistics were also analyzed. Items with item-total correlation coefficients lower than 0.15 were reviewed.

Table 5.7. Item-total statistics of MOLI

	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
item1	0.692	0.874
item2	0.724	0.871
item3	0.512	0.883
item4	0.578	0.879
item5	0.585	0.879
item6	0.741	0.869
item7	0.527	0.882
item8	0.783	0.865
item9	0.741	0.868
item10	0.066	0.908
item11	0.792	0.865

As Table 5.6 shows the only item with item-total correlation coefficients lower than 0.15 is item 10. When the item was examined closely, although it seemed to show some divergence from the other items this item was not removed from the inventory, primarily because the divergence was not considered to extend beyond the overall nature of the scale, and secondly because the lower correlation might be in part due to the reverse nature of the item.

5.2.3.3. Understanding of the Big Ideas Questionnaire. Understanding of the Big Ideas Questionnaire contains two open-ended questions which are in the Questionnaire for Exit Interviews; they measure visitors' understanding of the big ideas in the selected exhibits in the science center. In other words, these two questions were used to directly tap visitors' views of the important ideas in the exhibits (Griffin *et al.*, 2005).

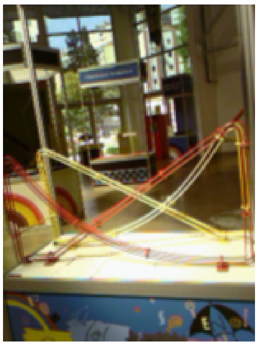
These two open-ended questions are as in the following:

1. "What do you think are the main messages that the < name of the exhibit > is trying to communicate?"
2. "What was the most interesting thing you saw in the < name of the exhibit>? What made it interesting for you?"

The present study uses the two open-ended questions included in the "Questionnaire for Exit Interviews" after being adapted in a number of ways. In the "Questionnaire for Exit Interviews" these two open ended questions were interview questions. However, in this study, students were required to answer them in written format.

"Understanding of the Big Ideas Questionnaire" which was used in this study includes additional items to elaborate the two questions covered in "Questionnaire for Exit Interviews". In addition to the second question students were also required to specify the most meaningful exhibit for them by giving their reasoning. Moreover, the first open ended question was asked for each of the four exhibits selected for SCLK with an additional multiple choice question. In this multiple choice question, students were required to answer how much they observed each of the four exhibits. In the original form, the first open ended question is stated as, "What do you think are the main messages that the < name of the exhibit > is trying to communicate?". This statement was repeated for the exhibits on "the express road", "giant scissors", "transfer of momentum" and "your weight in the space". For example, when questioning the exhibit on "the express road", the item was reformulated as indicated in Figure 5.2. The main ideas in the remaining three exhibits were questioned in a similar way.

1. Aşağıdaki soruları altta resmi verilen Bilim Merkezi'ndeki "Ekspres Yol" adlı deney ünitesini dikkate alarak cevaplandırınız.



a. Aşağıdakilerden hangisi sana en uygun? (Yalnızca birini işaretleyin.)

☐ Deney ünitesine şöyle bir göz attım.

☐ Deney ünitesini dikkatlice inceledim.

☐ Deney ünitesini kendim de yaparak denedim

b. Sence bu deney ünitesinin vermek istediği esas mesajlar nedir?

....

....

Figure 5.2. An example for a question in Understanding of the Big Ideas Questionnaire

5.2.3.4. Questions on Prior Science Center Experiences. Before the MOLI and Understanding of the Big Ideas Questionnaire, participants were also required to answer four questions for getting information about their previous science center visit experiences (Appendix K). These four questions are dependent to one another. Because of this, participants were not required to answer all the questions. For instance, if the participant's answer is "no" for the first question, he/she is not required to answer the following questions.

5.2.4. Procedure

As it was mentioned previously, the study was implemented in two different kinds of schools. In this section the implementation of the study in these two schools is explained.

5.2.4.1. Study Implementation in the Public School. In the public school 21 6th and 7th grade students participated in the study. Although the intended sample was limited to 7th graders both 6th and 7th grade students were included in the study, because the researcher had to meet the terms desired by the school administration.

The implementation process in the public school was conducted by the researcher. The science teacher did not want to participate in the implementation process although initially a meeting was organized in an attempt to include the science teacher within the research procedure. The school had only one science teacher and during the meeting she was informed about the study, the SCLK and how it is used for the science center visit. All the steps that are carried out by the researcher during the implementation process are given in the following action flow:

- Pre-Measurement (*May 17, 2007*)

CUQ-Force & Motion was administered to 18 students by the researcher as a pre-test of the study

- Intervention

May 21, 2007: The power-point presentation was made by the researcher to the students, on the day of the science center visit, before the visit. This presentation can be regarded as an orientation for the visit. Follow-up tasks were also distributed to the students while they were informed about the follow-up activity. They decided on the groups by their own.

May 21, 2007: 24 students visited the science center as suggested in SCLK. Worksheets were distributed to the students; each student had one worksheet while touring the exhibits. Then, they were separated into groups by the museum staff who explained the exhibits to the students in these small groups. “Enjoy & Learn Cards” about four exhibits covered in SCLK were given to the museum staff guiding the groups in the center and they distributed the cards to the students while they were explaining the four exhibits. After tour was completed, students were given extra time to complete their worksheets and the worksheets were collected by the researcher before leaving the center.

May 24, 2007: A discussion was made with the students about their visit to the science center; their feelings, likes and dislikes, opinions about the pre-visit activity and using worksheets were taken by the researcher. Their presentation day was identified as 4th of June, 2008; they told that they would prepare their tasks until this date.

June 4, 2007: Although this date was specified as the presentation date with the students, since they did not complete their tasks, the presentation date was postponed to 5th of June.

June 5, 2007: The follow-up activity was implemented with some limitations. Only one group became ready on this day. All the others completed their tasks on the time that we specified for their presentations. The group who had taken 3rd task was not at school. Therefore, the 3rd task was given to one of the students who was actually in another group but took no responsibility in that group. One group declared that they had completed their task but forgotten at home. Because of this they did their task at school. Another had worked on their task before, but hadn't answered the questions in their task; this group also completed their task at school. Groups made their presentations after they completed their tasks.

- Post-Measurements

June 8, 2007: Conceptual Understanding Questionnaire-Force & Motion, Modes of Learning Inventory and Understanding of the Big Ideas Questionnaire were administered to 13 students by the researcher. Students were requested to write their opinions about this implementation.

June 13, 2007: For the missing students another data collection date was organized by the researcher. On this date, Conceptual Understanding Questionnaire-Force & Motion, Modes of Learning Inventory and Understanding of the Big Ideas Questionnaire were administered to 3 students again by the researcher.

To summarize, one control group composing of 21 students formed the public school sample of the study. CUQ-Force & Motion was firstly implemented to the students. Then, they completed the visit to the science center by using SCLK. After the implementation process completed students were administered CUQ-Force & Motion again. They also completed two additional questionnaires; MOLI and Understanding of the Big Ideas Questionnaire. Apart from these, the researcher requested students who are willing to write their positive and/or negative comments about their science center visit experience.

5.2.4.2. Study Implementation in the Private School. 56 students participated in the study in the private school. The implementation process in the private school was conducted by the researcher, because the science teachers did not volunteer to take part in the study. They only administered the questionnaires to the students but all the other implementation was conducted by the researcher. The following action flow summarizes the steps in the implementation process in the private school:

- Pre-Measurement

CUQ-Force & Motion was administered to the 7th grade students in six classes by their science teachers as a pre-test of the study.

- Intervention

May 29, 2007: On the day of the science center visit, the power-point presentation was made as a pre-visit activity by the researcher to the group of students in the experimental group; the group who would make their visit to the science center with SCLK. This presentation can be regarded as an orientation for the visit.

May 29, 2007: In the morning, students in the experimental group visited the science center as suggested in SCLK. There were totally 21 students; 2 students from class-1, 2 students from class-2 and 17 students from class-3. Worksheets were distributed to the students; each student had one worksheet while touring the exhibits. Then, they were separated into groups by the museum staff who explained the exhibits to the students in these small groups. "Enjoy & Learn Cards" about four exhibits covered in SCLK were given to the museum staff guiding the groups in the center and they distributed the cards to the students while they were explaining each of these four exhibits. After they completed their tour students were given extra time to complete their worksheets and then the worksheets were collected by their teacher and the researcher together. While turning back to school, group tasks were given to the groups of students. Groups were formed by their science teacher.

In the afternoon, students in control group visited the science center as they usually did. There were totally 53 students; 14 students from class-4, 21 students from class-5 and 18 students from class-6.

June 11, 2007: The follow-up activity was implemented with some limitations. There were many students who were absent on this date; two groups were not at school so could not present their tasks. Except one student the others were not ready enough for the presentation. Five groups made a presentation; presentation of the 1st, 2nd and 4th tasks were made.

- Post-Measurements

CUQ-Force and Motion, MOLI, and Understanding of the Big Ideas Questionnaires were administered to the students by their teachers.

To summarize, CUQ-Force & Motion was administered to the whole group by their teachers. Then, on the day of the visit the researcher made the presentation to the students in the experimental group before going to the center. One group visited the science center with SCLK and the other two groups visited the center without SCLK. At the end of the implementation CUQ-Force & Motion was administered to the students for the second time. In addition to CUQ-Force & Motion, MOLI and Understanding of the Big Ideas Questionnaire were also administered to the students in three groups.

6. DATA ANALYSIS AND RESULTS

6.1. Analysis Done on the Research Questions and Hypothesis

The evaluation of SCLK was carried out using both quantitative and qualitative data. Quantitative data were obtained from Conceptual Understanding Questionnaire-Force & Motion and Modes of Learning Inventory. Qualitative data were obtained as a result of Understanding of the Big Ideas Questionnaire and the four questions about participants' prior science center experiences.

Data obtained from public school are based on within group comparisons. On the other hand, data obtained from private school are based on both within-group and between-group comparisons. The way of analyzing data and results for each hypothesis and research question will be given separately for both public and private school respectively. It is important to emphasize that the study does not aim to make comparison between the public and the private school data. However, for some cases comparisons were made when it was necessary to get information about the difference between the public and private school data.

Research Question-1: Will there be any change in 7th grade students' conceptual understanding about force and motion topic following their visit with SCLK?

The difference between pre and post test scores obtained from Conceptual Understanding Questionnaire-Force & Motion was analyzed using paired samples t-test.

Results for the data obtained from the public school are summarized in the following paragraphs. The public school sample of the study consists of 21 students. They all made their visit to the science center by using the materials and the guidelines provided with SCLK. Among those 21 students some students could not take pre-test and post-test. The missing cases in either one or both of the pre and post measures were excluded from analysis. Descriptive statistics were carried out in order to get information about the students' CUQ-Force & Motion pre and post test scores.

Table 6.1. Descriptive statistics about CUQ-Force & Motion scores of participants who are provided with SCLK for their visit (Public School Group)

	Mean	n	Std. Deviation
CUQ-Force & Motion Pre-test	9.5000	13	6.15765
CUQ-Force & Motion Post-test	10.8846	13	5.69047

As shown in Table 6.1, the mean of scores of the students in the pre-test is M=9.5 and the standard deviation of the scores is SD=6.2. The mean of scores of the students makes a little shift in the post-test; it was found to be M=10.9 and SD=5.7. In order to determine whether the difference between the means of pre and post-test scores is significant or not, paired samples t-test was used.

Table 6.2. Differences between the pre-post tests mean scores in terms of CUQ-Force & Motion (Public School Group)

	Mean	Std. Deviation	Std. Error Mean	T	df	Sig. (2-tailed)
CUQ (pre-test) – CUQ (post-test)	-1.38462	2.93083	0.81286	-1.703	12	0.114

As a result of the analysis, it was found that there is no statistically significant difference between pre-test scores (M=9.5, SD=6.2) and post-test scores (M=10.9 and SD=5.7) of the students who are provided with SCLK for the science center visit, t (12) =-1.703, p=0.114 (Table 6.2).

About the first research question, results for the data obtained from the private school are given in the following paragraphs:

The private school sample of the study consists of 56 students. 17 of those 56 students made their visit to the science center by using the materials and the guidelines provided with SCLK. Among these 17 students some students could not take pre or post-test. The missing cases in either one or both of the pre and post measures were excluded from analysis. Table 6.3 shows the details of descriptive statistics about the scores of the participants in the experimental group.

Table 6.3. Descriptive Statistics about CUQ-Force & Motion scores of participants who are provided with SCLK for their visit (Private School Group)

	Mean	**n**	**Std. Deviation**
CUQ-Force & Motion Pre-test	21.7083	12	4.97475
CUQ-Force & Motion Post-test	23.0417	12	5.43331

As Table 6.3 shows, the mean of scores taken from the pre-test is M=21.7 and standard deviation is SD=4.9. In the post-test the mean of scores increased to M=23.04 and the standard deviation SD=5.4. There is not much difference between the pre and post test mean scores of the students who are provided with SCLK for their science center visit. In order to test this statistically, paired samples t-test was used.

Table 6.4. Differences between the pre-post tests mean scores in terms of CUQ-Force & Motion (Private School Group)

	Mean	**Std. Deviation**	**Std. Error Mean**	**t**	**df**	**Sig. (2-tailed)**
CUQ (pre-test) – CUQ (post-test)	-1.33333	5.90583	1.70487	-0.782	11	0.451

Paired samples t-test analysis showed that there is no statistically significant difference between pre-test results (M=21.7, SD=4.9) and post test results (M=23.04, SD=5.4) of the students in the experimental group, t(11)=-0.782, p=0.451 (Table 6.4).

Research Question-2: What is the personal declaration of the 7th grade students who are provided with SCLK for the visit about their own learning as measured by Modes of Learning Inventory?

Scores obtained from Modes of Learning Inventory indicate students' personal declaration of their own learning. It was implemented to the participants at the end of the study. MOLI consists of 11 questions, among which 10th is a reverse item. Possible scores that can be taken from MOLI ranges from 11 to 44.

MOLI was administered to 16 among 21 students in public school. There are 15 valid scores whose mean score and standard deviation were computed. In the following paragraphs, results obtained from the public school are summarized:

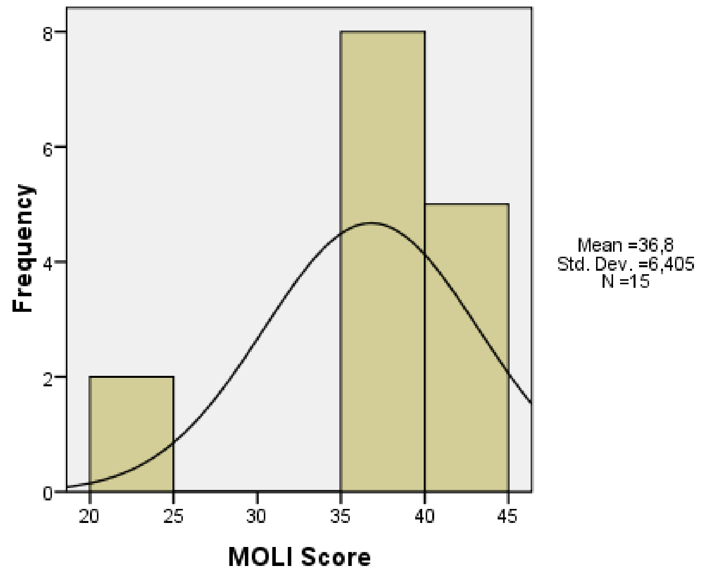
Table 6.5. Descriptive Statistics about the MOLI scores of participants who were provided with SCLK for their visit (Pubic School)

	n	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
MOLI Score	15	20	43	36.80	6.405

The mean of the scores was found to be M=36.80 and the standard deviation SD=6.405. The minimum score taken from MOLI is 15 and the maximum score is 43 out of 44 (Table 6.5).

For each item of MOLI there are four possible answer choices. In order to find the frequency of answers given for each item by the students, frequencies of answers were calculated.

Table 6.6. Frequency Distribution of the MOLI scores of participants who were provided with SCLK for their visit (Public School)



MOLI Score	Frequency	Valid Percent
20	1	6.7
24	1	6.7
36	1	6.7
37	3	20.0
38	3	20.0
39	1	6.7
41	3	20.0
42	1	6.7
43	1	6.7
Total	15	100.0

As Table 6.6 indicates frequency distribution of the MOLI scores of the students in the public school is skewed right; all the scores taken from MOLI is equal and more than 20. The possible maximum score which can be taken from MOLI is 44 and there is one student who took 43 which is very close to the possible maximum score. Moreover there are five students whose scores are more than 40 (Table 6.6).

In order to get further information about students' personal declaration about their own learning, analysis was done for each item separately.

Item-1: "I discovered things that I didn't know"

Table 6.7. Frequency distribution for item-1 (public school)

ITEM-1	**"no, never"**	**"no, not at all"**	**"yes but very little"**	**"yes, a lot"**
Frequency	0	0	5	11
Percent	0 %	0 %	31.2 %	68.8 %

The result for the first item indicates that all of the students think that they discovered new things. Among them about 70 per cent of the students stated they discovered a lot of things and about 30 per cent discovered very little.

Item 2: “I learnt more about things I already knew”

Table 6.8. Frequency distribution for item-2 (public school)

ITEM-2	“no, never”	“no, not at all”	“yes but very little”	“yes, a lot”
Frequency	0	1	4	11
Percent	0 %	6.2 %	25 %	68.8 %

Frequency distribution of the answers given to the second item indicates that except one student, all the other students (93.8%) think that they learnt more about things they already knew.

Item-3: “I remembered things I hadn’t thought of for a while”

Table 6.9. Frequency distribution for item-3 (public school)

ITEM-3	“no, never”	“no, not at all”	“yes but very little”	“yes, a lot”
Frequency	1	3	5	7
Percent	6.2 %	18.8 %	31.2 %	43.8 %

According to answers given to the third item students who remembered things they hadn’t thought of for a while (25%) are more than the percentage (75%) of students who indicated that the visit did not help them to remember things they hadn’t thought of for a while.

Item-4: “I shared some of my knowledge with other people”

Table 6.10. Frequency distribution for item-4 (public school)

ITEM-4	“no, never”	“no, not at all”	“yes but very little”	“yes, a lot”
Frequency	2	2	8	4
Percent	12.5 %	12.5 %	50 %	25 %

Frequency distribution of answers given to the 4th item indicates that sharing of knowledge existed between students in large proportion; 75 per cent of students declared that they shared some of their knowledge with other people.

Item-5: "I got curious about finding out more about some things"

Table 6.11. Frequency distribution for item-5 (public school)

ITEM-5	"no, never"	"no, not at all"	"yes but very little"	"yes, a lot"
Frequency	0	2	2	12
Percent	0 %	12.5 %	12.5 %	75 %

Answers given to the 5th item indicates that 87.5 per cent of the students became curious about finding out more about some things. On the other hand, there are also students who did not become curious about anything as a result of the visit.

Item-6: "I was reminded of the importance of some issues"

Table 6.12. Frequency distribution for item-6 (public school)

ITEM-6	"no, never"	"no, not at all"	"yes but very little"	"yes, a lot"
Frequency	0	1	5	10
Percent	0 %	6.2 %	31.2 %	62.5 %

Frequency distribution of the answers given to item-6 shows that except one student, all the other students (n=15) were reminded of the importance of some issues.

Item-7: "I got a real buzz out of what I learnt"

Table 6.13. Frequency distribution for item-7 (public school)

ITEM-7	"no, never"	"no, not at all"	"yes but very little"	"yes, a lot"
Frequency	0	2	2	11
Percent	0 %	13.3 %	13.3 %	73.3 %

According to the frequency distributions of the answers given to the 7th item, majority (13 students) stated that they got an excitement out of what they learnt. Only two students (13.3%) declared that what they learnt did not create an excitement on them.

Item-8: “It was pleasant to be reminded”

Table 6.14. Frequency distribution for item-8 (public school)

ITEM-8	“no, never”	“no, not at all”	“yes but very little”	“yes, a lot”
Frequency	2	0	5	9
Percent	12.5 %	0 %	31.2 %	56.2 %

Frequency distribution of the answers given to the 8th question was also computed. According to this distribution except one student, all other 14 students thought that it was pleasant to be reminded of their prior understanding related to what they experience in the science center.

Item-9: “It was pleasant to learn more”

Table 6.15. Frequency distribution for item-9 (public school)

ITEM-9	“no, never”	“no, not at all”	“yes but very little”	“yes, a lot”
Frequency	1	0	2	13
Percent	6.2 %	0 %	12.5 %	81.2 %

Again according to the frequency distribution of the answers given to the 9th item, except one student all the other students (n=15) stated that they enjoyed learning more.

Item-10: “It was all very familiar to me”

Table 6.16. Frequency distribution for item-10 (public school)

ITEM-10	“no, never”	“no, not at all”	“yes but very little”	“yes, a lot”
Frequency	1	6	6	3
Percent	6.2 %	37.5 %	37.5 %	18.8 %

Number of the students who found things very familiar is nearly the same as the number of the students who did not. For 56.3 per cent of the students the visit contained stuff that was familiar and for 43.7 per cent of the students the contents of the visit did not seem to be familiar.

Item-11: “Some of the things I learnt will be very useful to me”

Table 6.17. Frequency distribution for item-11 (public school)

ITEM-11	“no, never”	“no, not at all”	“yes but very little”	“yes, a lot”
Frequency	1	0	3	12
Percent	2.9 %	0 %	18.8 %	75 %

According to the frequency distribution of the answers in the last item, there is only one student who thought that the things he/she learnt would not be very useful for him/her. On the other hand, all the other students (n=15) stated that some of the things they learn would be very useful for them.

All in all, frequency distribution of the answers given to 11 items of MOLI indicates that students generally have favorable declarations about their own learning. The percentages of the answers marked as “3” and “4” are more than the percentages of answers marked as “1” and “2” in these 11 items.

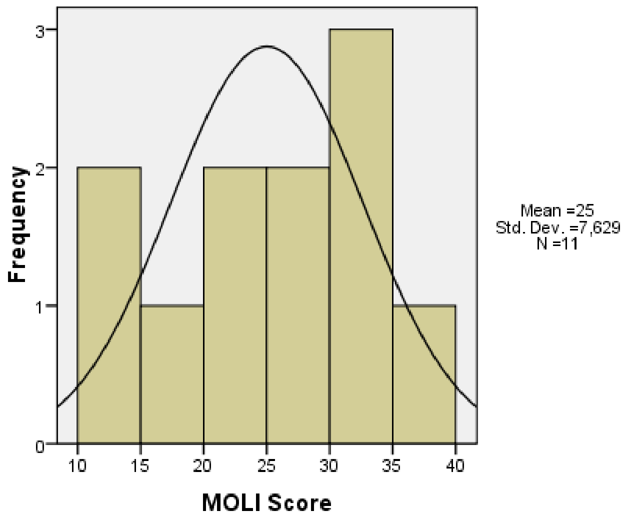
In the private school MOLI was administered to 13 students who were provided with SCLK for their visit. In the following sentences results obtained from the private school are given.

Table 6.18. Descriptive Statistics about the MOLI scores of participants who are provided with SCLK for their visit (Private School)

	n	Minimum	Maximum	Mean	Std. Deviation
MOLI Score	11	13	35	25.00	7.629

The mean of the MOLI scores of the students who were provided with SCLK was found to be M = 25. The minimum score taken from MOLI is 13 and the maximum score is 35 (Table 6.18).

Table 6.19. Frequency distribution of the MOLI scores of participants who are provided with SCLK for their visit (Private School)



MOLI Score	Frequency	Valid Percent
13	1	9.1
14	1	9.1
19	1	9.1
21	1	9.1
24	1	9.1
26	2	18.2
32	2	18.2
33	1	9.1
35	1	9.1
Total	11	100.0

The frequency distribution of the MOLI scores of the private school students who were provided with SCLK for their visit shows that, students' scores ranges from 13 to 35. The possible minimum score that can be taken from MOLI is 11, and there are two students whose scores are very close to the minimum score.

In order to get further information about students' personal declaration about their own learning, answers given for each item of MOLI was also analyzed separately.

Item-1: "I discovered things that I didn't know"

Table 6.20. Frequency distribution for item-1 (private school)

ITEM-1	"no, never"	"no, not at all"	"yes but very little"	"yes, a lot"
Frequency	3	3	6	1
Percent	23.1 %	23.1 %	4.2 %	7.7 %

According to the frequency distribution of the answers given for the first item, the number of the students who stated that they discovered things that they did not know (n=6) is very close to the number of students who stated that they discovered new things (n=7).

Item-2: "I learnt more about things I already knew"

Table 6.21. Frequency distribution for item-2 (private school)

ITEM-2	"no, never"	"no, not at all"	"yes but very little"	"yes, a lot"
Frequency	2	3	7	1
Percent	15.4 %	23.1 %	53.8 %	7.7 %

Except one student, 53.8 per cent of the students stated in the second item that they learn more about things that they already knew. On the other hand, five students stated that the visit did not add to what they already knew.

Item-3: "I remembered things I hadn't thought of for a while"

Table 6.22. Frequency distribution for item-3 (private school)

ITEM-3	"no, never"	"no, not at all"	"yes but very little"	"yes, a lot"
Frequency	3	3	4	3
Percent	23.1 %	23.1 %	30.8 %	23.1 %

According to the frequency distribution of the answers for this item, the numbers of the students who have favorable or unfavorable opinions on that item are about the same.

Item-4: "I shared some of my knowledge with other people"

Table 6.23. Frequency distribution for item-4 (private school)

ITEM-4	"no, never"	"no, not at all"	"yes but very little"	"yes, a lot"
Frequency	5	4	3	1
Percent	38.5 %	30.8 %	23.1 %	7.7 %

The number of the students who shared some knowledge with other people (n=4) is about half of the number of the students who declared that they made no sharing of knowledge with others (n=9).

Item-5: “I got curious about finding out more about some things”

Table 6.24. Frequency distribution for item-5 (private school)

ITEM-5	“no, never”	“no, not at all”	“yes but very little”	“yes, a lot”
Frequency	5	4	3	1
Percent	38.5 %	30.8 %	23.1 %	7.7 %

According to the frequency distribution of the answers given to the 5th item, the number of the students who got curious about finding out more about some things is same as the number of the students who did not get much curious, and their number is lower than the students who never got curious about finding out more about some things.

Item-6: “I was reminded of the importance of some issues”

Table 6.25. Frequency distribution for item-6 (private school)

ITEM-6	“no, never”	“no, not at all”	“yes but very little”	“yes, a lot”
Frequency	4	4	4	1
Percent	30.8 %	30.8 %	30.8 %	7.7 %

Frequency distribution of the answers of the 6th item shows that only one student thinks that he/she was reminded of the importance of some issues. On the other hand, 61.6 per cent of the students stated that they were not reminded of the importance of some issues. And, there are still four students who think that they were reminded but very little.

Item-7: “I got a real buzz out of what I learnt”

Table 6.26. Frequency distribution for item-7 (private school)

ITEM-7	“no, never”	“no, not at all”	“yes but very little”	“yes, a lot”
Frequency	2	1	7	3
Percent	15.4 %	7.7 %	53.8 %	23.1 %

Answers given to the 7th item indicate that a large proportion of students (about 80%) enjoyed what they learnt. However, there are also students who stated that they did not enjoy what they learnt (23.1%).

Item-8: "It was pleasant to be reminded"

Table 6.27. Frequency distribution for item-8 (private school)

ITEM-8	"no, never"	"no, not at all"	"yes but very little"	"yes, a lot"
Frequency	7	2	3	1
Percent	53.8 %	15.4 %	23.1 %	7.7 %

Frequency distribution of the answers for the 8th item shows that except four students the others (n=9) did not find being reminded of their prior understanding related to what they experienced in the science center pleasant.

Item-9: "It was pleasant to learn more"

Table 6.28. Frequency distribution for item-9 (private school)

ITEM-9	"no, never"	"no, not at all"	"yes but very little"	"yes, a lot"
Frequency	4	4	3	2
Percent	30.8 %	30.8 %	23.1 %	15.4 %

According to the frequency of answers, 61.8 per cent of students found learning more unpleasant. On the other hand, there are students (23.1%) who found learning more pleasant but not much, and there are only two students who found learning more very pleasant.

Item-10: "It was all very familiar to me"

Table 6.29. Frequency distribution for item-10 (private school)

ITEM-10	"no, never"	"no, not at all"	"yes but very little"	"yes, a lot"
Frequency	1	3	4	3
Percent	9.1 %	27.3 %	36.4 %	27.3 %

Majority of the students (about 70%) stated in their answers that it was all familiar to them. There is only one student to whom things are not familiar and three students to whom things are not much familiar.

Item-11: “Some of the things I learnt will be very useful to me”

Table 6.30. Frequency distribution for item-11 (private school)

ITEM-11	“no, never”	“no, not at all”	“yes but very little”	“yes, a lot”
Frequency	4	3	5	1
Percent	30.8 %	23.1 %	38.5 %	7.7 %

Frequency distribution of the answers for that item indicates that the proportion of those who think positive about that item is about the same to the proportion of the students who think negative. About 54 per cent of the students stated that some of the things they learn will not be very useful to them. On the other hand, about 46 per cent of students stated that some of what they learn will be very useful to them.

All in all, frequencies of the answers given to each item indicate that large proportion of students in the private school have unfavorable opinions about their own learning. In most of the items the number of students who marked either “no, never” or “no, not at all” is more than the number of the students who marked “yes, but very little” and “yes, a lot”.

Moreover, when each item of MOLI was analyzed in terms of the scores for the groups who are provided with SCLK for their visit it was discovered that there is a difference between the scores of students in the public school and the scores of the students in the private school. Students in the public school seem to have more favorable declaration about their own learning. Because of this, further analysis was made based on the scores given to each item of MOLI by the students in the public school and the private school. In order to test whether there is any significant difference between MOLI scores of students in the public school and the private school, t-test for independent groups was used.

Table 6.31. Difference between two groups of students who are provided with SCLK in terms of MOLI scores

	t-test for Equality of Means				
	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Equal variances assumed	4.282	24	0.000	11.800	2.755

As a result of the t-test analysis it was found that there is a significant difference between the MOLI scores of subjects in the public school (M=36.80, SD=6.4) and in the private school (M=25.00, SD=7.6) in favor of the public school, t(24)= 4.282, p=0.000 (Table 6.31).

Research Question-3: What is the degree of understanding of big ideas of the 7th grade students who are provided with SCLK for the visit?

Analyses of the results for the third research question starts with the data obtained from the public school, and results for the data obtained from the private school follows it.

In the first question, students were asked the most interesting thing they saw in the science center. They were also required to answer what made it interesting for them. 16 students gave an answer to that question. Some students gave the names of more than one exhibit. When their answers were analyzed, it was found that "meteor" is the most interesting exhibit for majority of the students. Then, "experiment with sand" follows "meteor" as the second interesting exhibit. Figure 6.1 shows all the exhibits which were found to be interesting by the students.

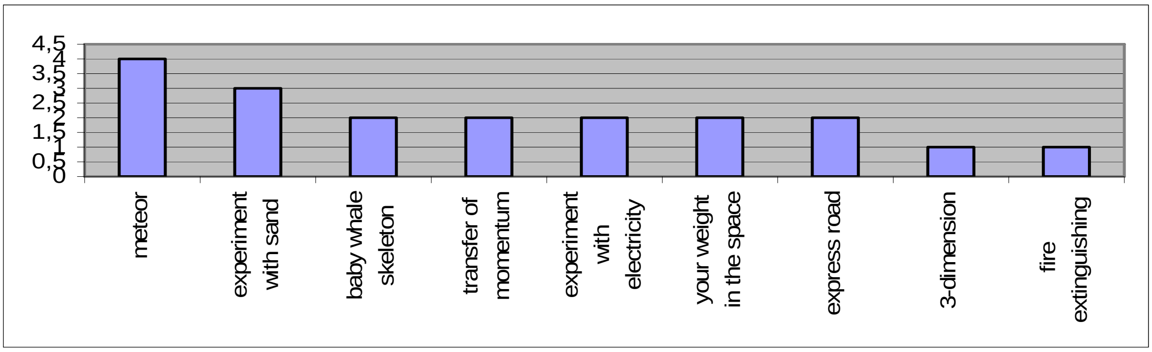


Figure 6.1. Exhibits which were found to be interesting by the students in the public school

Students who found meteor as the most interesting exhibit explained their reasons as "seeing for the fist time", "its coming from the space" and "having an interest toward topics about space".

Students' answers for that first question were also analyzed in terms of the explanations they made about what makes the exhibits interesting for them. Three of the 13 students indicated that they thought that the exhibit was interesting because they saw it for the first time. This implies that students find an exhibit interesting if they see it for the first time. Similarly, two of the 13 students stated that they found an exhibit interesting because they were interested in that content (space).

Additionally, in some of the answers (6/20) students stated that they found an exhibit interesting because they found it pleasant or different. For example,
"newton'un topları çok hoşuma gitti – I found Newton's balls pleasant"
"en güzel şey: meteor uzaydan gelmesi hoşuma gitti – the most beautiful thing is meteor, I liked its coming from the space"

In the second question, students were required to answer the most meaningful exhibit they saw in the in the science center and explain why it was meaningful for them. 16 students gave an answer to that question. Among them, there is one irrelevant answer ("hareket ve kuvvet bu ünitede nerdeyse hepsi bu ünitenin içindeydi"). Moreover, some students gave the names of more than one exhibit as an answer of the question. When their answers were analyzed, results showed that "express road" and "transfer of momentum" exhibits were the most meaningful exhibits for the students. Figure 6.2 shows all the exhibits which were found to be meaningful by the students.

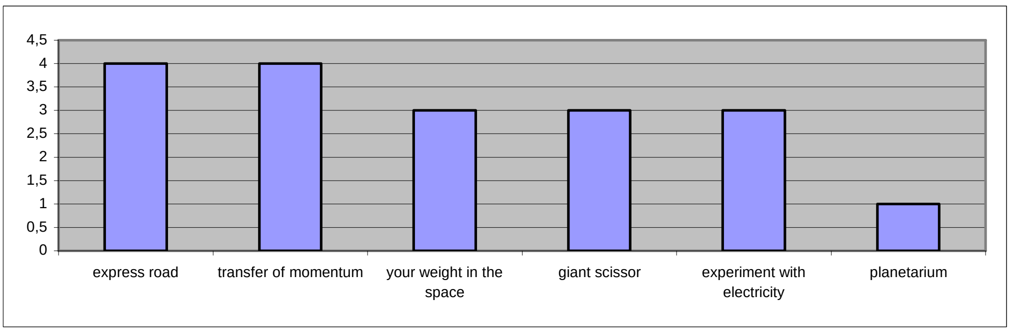


Figure 6.2. Exhibits which were found to be meaningful by the students in the public school

15 students made an explanation about their reasons for finding an exhibit meaningful. Their answers for the second question were also analyzed in terms of the explanations they made about their reasons for finding an exhibit meaningful. Majority of the answers (n=10) seemed to provide irrelevant information and generally referred to the contents of the exhibits rather than the reasons for finding the exhibit meaningful. For example,

"Çünkü yerçekimi heryerde aynı değildir – Because greavity is not same everywhere."

"Makasın ucundan bastırmak tabiki daha kolaydır- Of course it is easier to apply a force to the end point of the scissor."

"Eğimi anlatması –Its explaining slope."

"Çok mantıklı geldi – It is more meaningful for me."

Moreover, a few of the students (n=5) could provide reasons for finding an exhibit meaningful. These were scattered answered such as,

"Öğretmenimiz güzel anlattığı için – Because our teacher explained well."

"Hergün kullandığımız elektriği görmek anlamlı geldiğinden – Because I find seeing electricity that we use in our daily life meaningful."

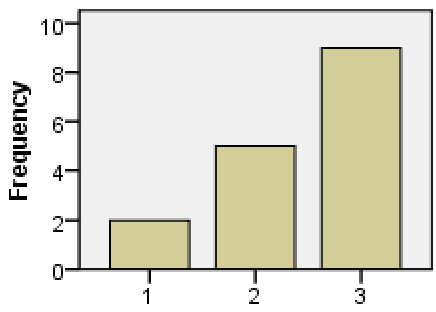
In addition to these two open ended questions students' understanding of the big ideas were also analyzed in terms of their answers to the additional four questions covered in the "Understanding of the Big Ideas Questionnaire". Each of these four questions is related to one of the four exhibits selected for SCLK. In the first part students in the public school and the students in the private school were asked how much they observed this exhibit. They were required to select one of the three answers choices which are: "1=I glanced at the exhibit", "2=I investigated the exhibit carefully", "3=I tried the exhibit by doing myself". Their answers' frequencies were calculated. In the second part of the questions, students were asked the main messages that can be understood in these exhibits. Students' answers were categorized as being concrete observation (correct/incorrect or incomplete), abstract generalization (correct/incorrect or incomplete), isolated concept or irrelevant.

1. The Express Road

In the first part of the question about the “Express Road” exhibit, 16 students expressed their opinions about how much they observed this exhibit.

Table 6.32. Frequency distribution of the answers to the question about “Express Road” (Public School)

		Frequency	Valid Percent
1	**I glanced at the exhibit**	2	12.5
2	**I investigated the exhibit carefully**	5	31.2
3	**I tried the exhibit by doing myself**	9	56.2
Total		16	100.0



Answers about the Express Road

Frequency distribution of the answer choices in the first of the question about the “Express Road” shows that nine of the 16 students tried the exhibit by doing themselves. While five students declared that they investigated the exhibit carefully, only two students stated that they glanced at the exhibit (Table 6.32).

In the second part of the question about the “Express Road” students were required to answer the main messages that can be understood in this exhibit. 16 of the 21 students gave an answer to this part of the question and their answers were categorized as being concrete observation, abstract generalization, isolated concept or irrelevant. There are five answers which are concrete observations of the students. Among them, majority are either incorrect or incomplete. The following answers of the students can be given as examples of answers in that category:

“Düz kaydıraktan topun yavaş kayması ve eğik kaydıraktan daha hızlı kayması – Sliding easily in a flat slide, and sliding hard in an inclined slide” **(correct)**

“Eğimli yoldamı yoksa dik yoldamı top daha hızlı iner – Does a ball slide in a flat or inclined road” **(incomplete)**

"Eğik düzlemi fazla olan şeylerin üzerinden geçenler daha fazla – those passing on the planes which are more inclines are further" **(incorrect)**

On the other hand, there are also answers which reflect abstract generalization. All of these abstract generalizations are either incomplete or incorrect. The following answers can be given as examples for answers in this category for the "Express Road" exhibit.
"Bir yolun eğimi ne kadar çoksa o yolda ilerlemek o kadar kolaydır – the big the slope of a road, the easier to move on that" **(incomplete)**
"Bir cismin dik değil de eğimli bir yolda daha hızlı hareket etmesi – An object's moving faster in an inclines road rather than a perpendicular road" **(incorrect)**

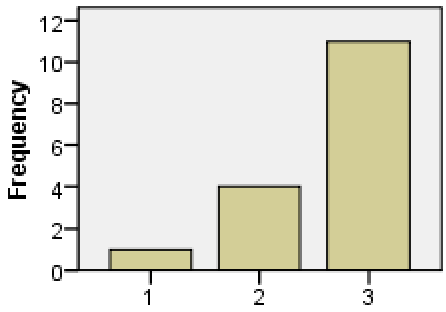
There are also five "isolated concepts" given as an answer to the first question. Answers categorized as "isolated concepts" are the ones which are somehow related to the core concepts or exhibits but do not communicate meaningful explanations. Also, they remain detached from the underlying principles. For example,
"İvme ve sürtünme kuvveti – acceleration and frictional force"
"Bence eğik düzlemle alakalıydı – In my opinion it was related to the inclined plane".

2. The Transfer of Momentum

The second question in the Understanding of the Big Ideas Questionnaire" was about the "Transfer of Momentum" exhibit. Frequencies of 16 students' answers to that part of the question were calculated.

Table 6.33. Frequency distribution of the answers to the question about“Transfer of Momentum” (Public School)

		Frequency	Valid Percent
1	**I glanced at the exhibit**	1	6.2
2	**I investigated the exhibit carefully**	4	25.0
3	**I tried the exhibit by doing myself**	11	68.8
Total		16	100.0



Answers about the Transfer of Momentum

Frequency distribution of the answer choices in the first part of the question about the “Transfer of Momentum” shows that large proportion of students (11/16) tried the exhibit by doing themselves. There is only one student who stated that he/she glanced at the exhibit. The other students (n=4) declared that they investigated the exhibit carefully (Table 6.33).

In the second part of the question about the “Transfer of Momentum” students were asked the main messages that they understood from this exhibit. Among 16 answers five were categorized as concrete observation of the students. Two of these answers are correct and the others are incomplete, such as:

“Burda bir top çekilince ona eşit sonda başka bir topun çekilmesi – when a ball is pulled, another ball which is equal to it is pulled from the other end” **(correct)**

“Bir ağırlığı kaldırdığında öbürününde yani karşı tarfataki bir tanesinin hava kalktığı – When you moves up a weight, a weight from the other side moves up” **(incomplete)**

There are nine answers which were categorized as abstract generalization. None of these abstract generalizations are correct; they are either incorrect or incomplete, such as:

“Enerjinin aktarılması – Transfer of energy” **(incomplete)**

“Verilen kuvvet kadar kuvvet alınması – Taking force in the amount of given force” **(incorrect)**

Additionally, there is one answer which is irrelevant:
"Bence bu harika çok sevdim oyuncak gibi kuvvetin hiç bitmemesi – I think this is wonderful I liked very much; like a toy, force is never ending"

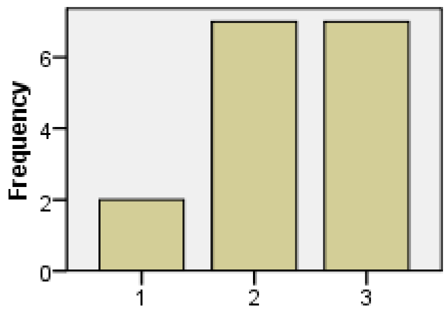
Lastly, there is one answer which was found to be isolated:
"Enerji akımının eşit olması – energy transfer's being equal"

3. The Giant Scissor

The third question was about the "Giant Scissor" exhibit and was composing of two parts. Frequencies of students' answers to that part of the question were calculated.

Table 6.34. Frequency distribution of the answers to the question about "Giant Scissor" (Public School)

		Frequency	Valid Percent
1	**I glanced at the exhibit**	2	12.5
2	**I investigated the exhibit carefully**	7	43.8
3	**I tried the exhibit by doing myself**	7	43.8
Total		16	100.0



Answers about the Giant Scissor

According to the frequency distribution of the answer choices in the first part of the question about the "Giant Scissor" the number of the students (n=7) who stated that they tried the exhibit by doing themselves and the number of the students (n=7) who stated that they investigated the exhibit carefully is same. Apart from them, there are two students who declared that they glanced at the exhibit (Table 6.34).

In the second part of the question about the "Giant Scissor" students were expected to write the main messages that the exhibit was revealing. At the end of the analyses of their answers qualitatively, it was found that there are three isolated answers given by the students, which are:

"Kuvvet – Force"

"Oradaki ağırlık, kuvvet söz konusuydu. Ama çok beğenmedim – It was about weight and force, but I don't like it much"

"Bence bu deney bize hareket ve kuvveti gösterir – In my opinion this exhibit shows us force and motion".

Among the answers five of them are categorized as concrete observations of the students. While two of these five answers are correct, the others were decided as being either incorrect or incomplete answers. The following statements exemplify students' answers which were set in this category:

"Nereden daha çabuk indiğini gösterdi yani bir an baştan birde ortadan basıldığında en baştaki daha kolay basıldığını öğrendim –It showed that from which part it was pressed down easily. In other words, when it was pressed down from its one end, then from the middle, I learned that it is easier to press it down from its one end" **(correct)**

"Makasa bastırılan yerin çökmesi ve ucunun çökmemesi – The point which is pressed down goes down and its end does not go down" **(incorrect)**

"Destek noktasına uzak olan daha kolay basıyor – The one which is far from the fulcrum presses down more easily" **(incomplete)**

The other six answers given to this question were determined to be abstract generalizations of the students. Majority of the answers in this category were decided to be either incorrect or incomplete, such as:

"Kuvvet destek noktasından ne kadar uzaktaysa, o kadar kolay kuvveti uygulayabilir – The farther the applied force to the fulcrum, the easier to apply that force" **(correct)**

"Bence tahterevallinin kaldırma kuvveti – In my opinion, it is lifting force of a lever" **(incorrect)**

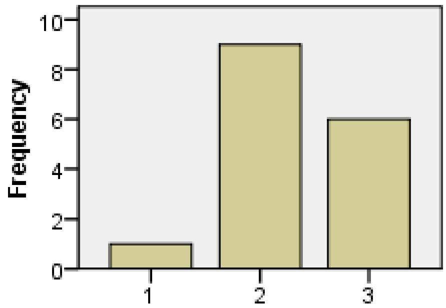
"Daha az kuvvet harcayarak daha fazla iş yapmak – Doing more work by using little force" **(missing)**

4. Your Weight in the Space

The last question of the Understanding of the Big Ideas Questionnaire was about the "Your Weight in the Space" exhibit; it was again composing of two parts. Frequencies of students' answers to that part of the question were calculated.

Table 6.35. Frequency distribution of the answers to the question about "Your Weight in the Space" (Public School)

		Frequency	Valid Percent
1	**I glanced at the exhibit**	1	6.2
2	**I investigated the exhibit carefully**	9	56.2
3	**I tried the exhibit by doing myself**	6	37.5
Total		16	100.0



Answers about the Your Weight in The Space

According to the frequency distribution of the answer choices in the first part of the question about the "Your Weight in the Space" majority of the students (n=9) stated that they investigated the exhibit carefully. There is only one student who declared that he/she glanced at the exhibit. Other six students stated that they tried the exhibit by doing themselves (Table 6.35).

In the second part of the question about the "Your Weight in the Space" students were required to answer the main messages that they understood from the exhibit. When their answers were analyzed qualitatively and the answers were separated into different categories it was found that there were four answers which are in the concrete observations category. The number of the answers which were defined to be incorrect is equal to the number of the answers which incorrect, such as:

"Bazı insanlar kendi kilolarını bildiklerine rağmen diğer evrelerde kilolarını ölçemiyorlar. Bunu kolaylaştırmak için – Although some people know their weight, they could not measure it in the other cosmos. In order to simplify this" **(incorrect)**

“Kilomuzun her gezegende farklı olması – Our weight is different in every planet” **(correct)**

The other 11 answers were put into the abstract generalization category. Two of these 11 answers were found to be correct; the other answers are either incorrect or incomplete. The following student statements exemplify the answers in this category:

“Gezegen ne kadar büyükse bizim kilomuz o kadar fazladır. (o gezegende) Bu da o gezegenin yerçekimi ivmesine bağlıdır – The larger a planet the heavy we are in that planet. This depends on the gravitational acceleration of that planet” **(correct)**

“Yerçekiminin farklılığı – Difference of gravitation” **(incomplete)**

“Kilomuzun her yerde aynı olmadığı ama ağırlığımızın aynı olduğu – Our kilos are not same everywhere but our weight is same everywhere” **(incorrect)**

Among the answers given to this question there is also one answer that can be categorized as an “isolated concept”:

“Bence bu ünitede bana ağırlığı anlattı – In my opinion, this unit explained me the weight”

The following paragraphs include results for the data obtained from the private school. In the private school 37 students gave an answer to the first question which asks students the most interesting thing they saw in the in the science center and what made it interesting for them.

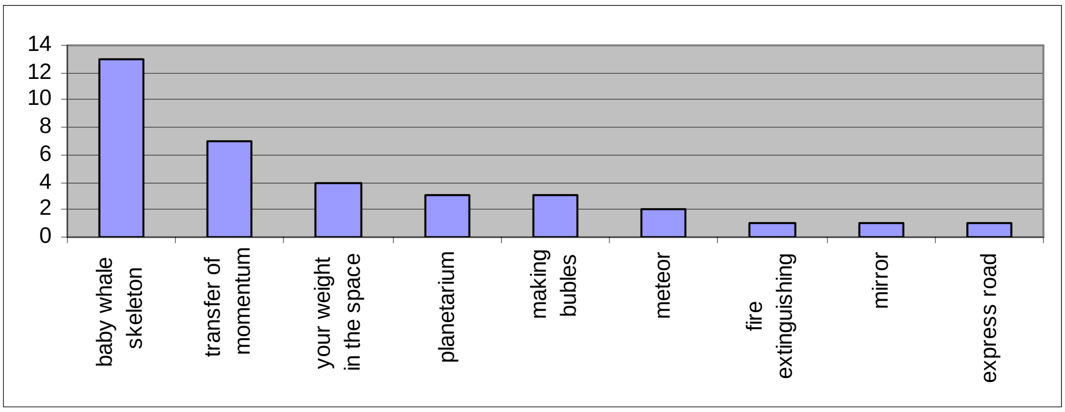


Figure 6.3. Exhibits which were found to be interesting by the students in the private school

When students' answers for the first question analyzed, it was found that "skeleton of a baby whale" was the most interesting exhibit for 13 students. There is one irrelevant answer ("astronomy"). And, some students gave more than one exhibit name. Moreover, while all the exhibits were interesting for one of the students, two students stated that there is nothing interesting for them in the center. Figure 6.3 shows all the exhibits which were found to be interesting by the students.

Students who found baby whale skeleton as the most interesting exhibit explained their reasons as "because it is giant", "because it is real", "because of having an interest in whales", "because of loving animals", "its being very large although it is a baby whale", "and "its bone and length". Five students did not make any explanation about what made that "skeleton of a baby whale" interesting for them.

Students' answers for the first question were also analyzed in terms of the explanations they made about why they found an exhibit interesting. The most frequent answer (6/37) for finding an exhibit interesting is in terms of its having an unexpected result. The following two statements exemplify that situation; they are about "Transfer of Momentum Exhibit" exhibit:

"Çünkü iki top çekince diğer taraftan da iki top gittiğini bilmiyordum – I do not know that two balls will go out at the other end when two balls are released from one end."

"Çünkü iki topu bırakınca tek topun hareket edeceğini zannediyordum – I was expecting that one ball will move from the other hand when two balls are released."

Students made similar emphasis about unexpected results in their explanations about finding "Skeleton of a Baby Whale" interesting. The following are example statements of students:

"Yavru olmasına rağmen çok büyüktü – Although it is baby, it was too large."

"Bebek balinanın çok büyük olduğu için ilgimi çekti. Hayvanları severim. – Because baby whale is very large I found it interesting. I love animals.

Additionally, some (6/37) students stated an exhibit interesting because they found it entertaining and pleasant. For example,

"Yangın söndürme aleti iginç ve öğreticiydi – Fire extinguishing is both entertaining and informative."

"Televizyonda daha önce görmüştüm ve çok merak etmiştim. Burada yapmak hoşuma gitti – I saw it on the television before and I wondered. I enjoyed making it here."

35 students gave an answer to the second question that students were asked the most meaningful exhibit they saw in the in the science center and why it was meaningful for them.

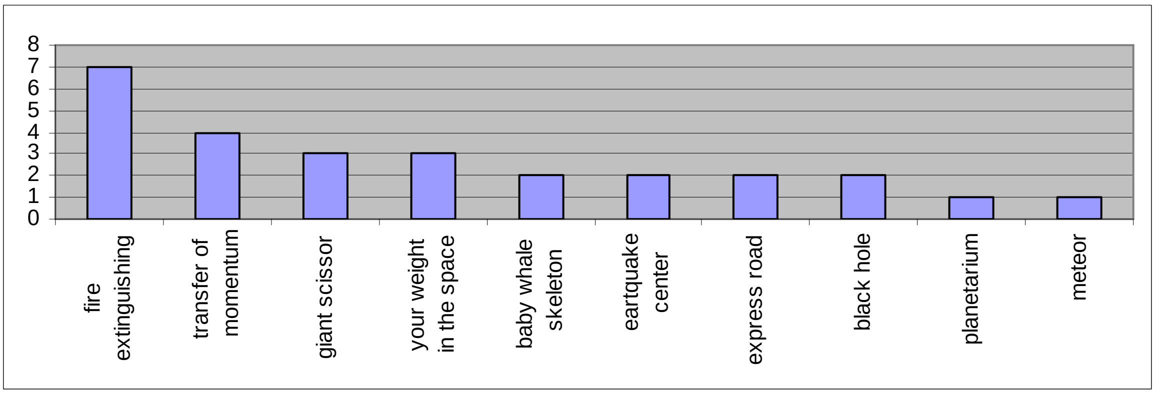


Figure 6.4. Exhibits which were found to be meaningful by the students in the private school

When students' answers were analyzed, it was found that the exhibit related to fire extinguishing was found to be the most meaningful one by the students. For four students all the exhibits were meaningful. On the other hand, one student stated that none of the exhibits were meaningful. Three answers could not been understood by the researcher ("balon, gezegenlerle ilgili olan, iskeletler- yıldızlar"). Figure 6.4 shows all the exhibits which were found to be meaningful by the students. Only two students explained their reasons for finding fire extinguishing meaningful for them. They stated that it is meaningful because it makes people conscious.

Students' answers for the second question were also analyzed in terms of their reasons for finding an exhibit meaningful. Among 29 students who specified "the more meaningful" exhibit 13 students did not make any explanation about why they found it meaningful; two of these 13 students specifically wrote that "I don't know the reason". Among the explanations they made, most frequent reasons were related to their learning about this topic at the school (n=2) and its (fire extinguishing) making people conscious (n=2).

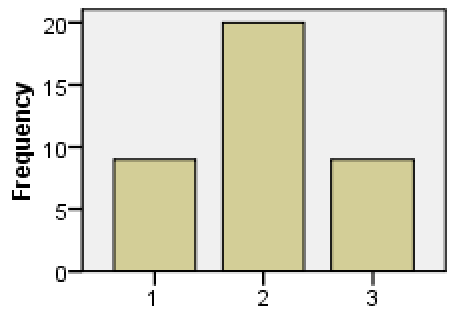
Apart from these analyses of the answers for two open-ended questions, students' understanding of the big ideas was also analyzed in terms of their answers to the additional four questions covered in the "Understanding of the Big Ideas Questionnaire".

1. The Express Road

38 students expressed their opinions about how much they observed the "Express Road" exhibit. Students' answers for the first part of the question were analyzed by using frequency distribution of their answers.

Table 6.36. Frequency distribution of the answers to the question about "Express Road" (Private School)

		Frequency	Valid Percent
1	**I glanced at the exhibit**	9	23.7
2	**I investigated the exhibit carefully**	20	52.6
3	**I tried the exhibit by doing myself**	9	23.7
Total		38	100.0



Answers about the Express Road

Frequency distribution of the answer choices in the first of the question about the "Express Road" shows that majority of the students (20/38) investigated the exhibit carefully. The number of the students who stated that they tried the exhibit by doing themselves (n=9) and those who stated that they glanced at the exhibit (n=9) is same (Table 6.36).

In the second part of the question about the "Express Road" students were expected to write the main messages that can be understood in this exhibit. Among 56 students 21 students gave an answer to that part of the question and their answers were categorized as being concrete observation, abstract generalization, isolated concept or irrelevant. Among the given answers there is one irrelevant answer:
"Hiçbirşeyi dış görünüşüne bakarak değerlendirmemeliyiz – We should not evaluate anything by looking at its appearance"

There are two answers categorized as "isolated concepts", such as:
"Hız – Velocity"

Apart from these, 4 answers were categorized as concrete observation. Among them, there is no correct observation; all of them are either incorrect or incomplete. The following answers of the students were categorized as being concrete observation:
"İvmeli yolda top daha hızlı – the ball is faster in an accelerated road" **(incorrect)**
"Hangi yolun daha hızlı olduğunu öğrenmek – to learn which road is faster" **(incomplete)**

There were also answers which were categorized as abstract generalization. Answers of 8 students were in the abstract generalization category but all of these answers were either incorrect or incomplete, such as:
"Eğim ile yol arasındaki ilişki – the relation between the road and slope" **(incomplete)**
"Yolun kısa olması hızı değiştirir – The road's being short changes the velocity" **(incorrect)**

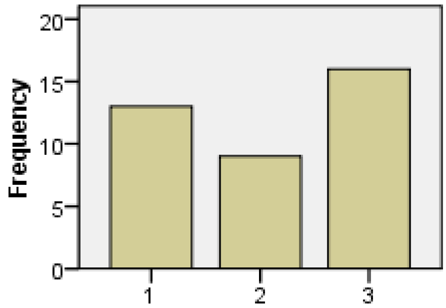
There were also students who specifically expressed that they did not know the answers. 6 students either put question mark or wrote "I don't know" for the answer of that part of the question.

2. The Transfer of Momentum

The second question in the Understanding of the Big Ideas Questionnaire" was about the "Transfer of Momentum" exhibit. Frequencies of 16 students' answers to that part of the question were calculated.

Table 6.37. Frequency distribution of the answers to the question about "Transfer of Momentum" (Private School)

		Frequency	Valid Percent
1	**I glanced at the exhibit**	13	34.2
2	**I investigated the exhibit carefully**	9	23.7
3	**I tried the exhibit by doing myself**	16	42.1
Total		38	100.0



Answers about the Transfer of Momentum

Table 6.37 summarizes frequency distribution of the answer choices in the first part of the question about the "Transfer of Momentum". According to the Table 6.37, 42.1 per cent of the students tried the exhibit by doing themselves. 34.2 per cent of the students stated that they glanced at the exhibit, and 23.7 per cent of the students declared that they investigated the exhibit carefully.

In the second part of the question about the "Transfer of Momentum" students were required to answer the main messages that can be understood in this exhibit. When 18 answers were analyzed qualitatively, it was found that two answers were categorized as concrete observation, where all the answers are either incorrect or incomplete. The answers categorized in this category are stated in the following:

"Bir top diğerini vurursa diğer köşedeki topda gider – When a ball strikes to another ball, a ball on the other side also moves" **(incomplete)**

"Bir yerden kuvet veriyorsun o transfer olarak öbür taraftan çıkıyor – When you give force from one side it is transferred and leaves from the other side" **(incorrect)**

Moreover, there were four students who specifically wrote "I don't know" or put question mark as an answer of that question; and two answers as "isolated concepts", such as:

"enerji – energy"

There are also abstract generalizations among the answers. 13 answers were put under the category of abstract generalization; all of the answers are either incorrect or incomplete. The following student statements exemplify the answers in this category:
"Enerji birbirine aktarma – Transfering energy between one another" **(incomplete)**
"Kuvvet trasferi – Force transfer"

Lastly, there was also one irrelevant answer among the students' answers for this question:
"Öğrenmek - Learning"

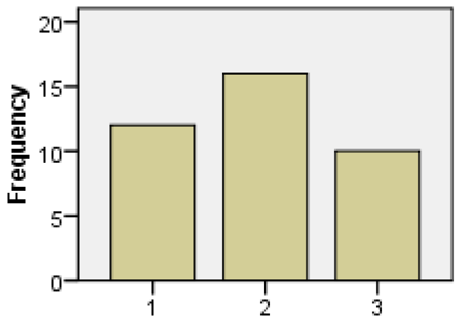
While analyzing students' answers for the question about the "Transfer of Momentum" exhibit both in the public and the private school, it was realized that the answers were given as they were titles of a topic; students could not give meaningful generalizations in their answers. For example, most of the students gave answers such as, *"energy transfer"*, *"force transfer"*, and *"power transfer"*.

3. The Giant Scissor

The third question of Understanding of the Big Ideas was about the "Giant Scissor" exhibit. Students' answers for the first part of that question were analyzed by using frequency distribution of their answers.

Table 6.38. Frequency distribution of the answers to the question about "Giant Scissor" (Private School)

		Frequency	Valid Percent
1	**I glanced at the exhibit**	12	31.6
2	**I investigated the exhibit carefully**	16	42.1
3	**I tried the exhibit by doing myself**	10	26.3
Total		38	100.0



Answers about the Giant Scissor

Frequency distribution of the answer choices in the first part of the question about the "Giant Scissor" indicates that majority of the students (n=16) stated that they investigated the exhibit carefully. According to their answers choices 12 students glanced at the exhibit. The other 10 students declared that they tried the exhibit by doing themselves (Table 6.38).

In the second part of the question about the "Giant Scissor" students were required to answer the main messages that can be understood in this exhibit. Their answers were analyzed qualitatively. At the end of the analyses, it was found that there is one irrelevant answer:

"Bilgimizi artırmak – improve our knowledge"

Moreover, there were four students that specifically expressed either by putting question mark to the answer part or writing "I don't know" that they didn't know the answer.

Furthermore, there are 6 isolated answers, such as:

"Kaldıraç – Lever"

"Kuvvet – Force"

Only one student gave an answer which was categorized as being concrete observation which is an incomplete answer:

"En köşeden basarsak kuvveti çok basit aşağı indirebiliriz – when we press down from the end point, we can easily wind down the weight" **(incomplete)**

The other 12 answers were put into the abstract generalization category. Majority of these answers were identified to be either incomplete or incorrect, such as:

""F.x=P.y formülünün kanıtı – Proof of F.x=P.y formula" **(correct)**

"Uzaklık arttıkça yükü daha rahat kaldırırız – It is easier to lift a weight as the distance increses" **(incomplete)**

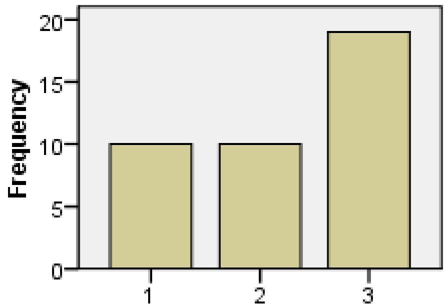
"Tele yapılan basınç – the pressure exerted on a wire" **(incorrect)**

4. Your Weight in the Space

The last question of the Understanding of the Big Ideas Questionnaire was about the "Your Weight in the Space" exhibit. Students' answers for the first part of that question were analyzed by using frequency distribution of their answers.

Table 6.39. Frequency distribution of the answers to the question about "Your Weight in the Space" (Private School)

		Frequency	Valid Percent
1	**I glanced at the exhibit**	10	25.6
2	**I investigated the exhibit carefully**	10	25.6
3	**I tried the exhibit by doing myself**	19	48.7
Total		39	100.0



Answers about the Your Weight in The Space

According to the frequency distribution of the answer choices in the first part of the question about the "Your Weight in the Space" the number of the students who stated that they investigated the exhibit carefully (n=10) is similar to the number of the students who glanced at the exhibit (n=10). Other 19 students stated that they tried the exhibit by doing themselves (Table 6.39).

In the second part of the question about the "Your Weight in the Space" students were asked the main messages that they understood from that exhibit. When their answers are analyzed qualitatively, 14 answers were put into the concrete observation category. Among them, majority were found to be correct, while others are either incomplete or incorrect, such as:

"Kütlenin her gezegene göre değişmesi – Mass changes in every planet" **(incorrect)**

"Ağırlık gezegenden gezegene değişir – Weight changes in every planet" **(correct)**

"Ağırlık her yerde farklıdır – Weight is different everywhere" **(incomplete)**

The other five answers given to that question were put into the abstract generalization category. All of the answers given to that category were found to be incomplete, such as:
"Yerçekimi ivmesinin her gezegende farklı olabileceği – Gravitational acceleration is different in every planet" **(incomplete)**

Moreover, there were two students who pointed out either by putting a question mark, or by specifically writing "I don't know"that they did not know the answer. Apart from these, there are six isolated answers, such as:
"İvme değişir – acceleration changes"
"Kilo farklılıkları – kilo differences"

It was also found that there is one irrelevant answer:
"Öğrendiklerimizi pekiştirmek – solidifying what we learned"

In general, what was investigated in the answers of the students is that they made some abstract generalizations. However these abstractions did not necessarily indicate that the students could induce generalizations from their observations. Rather the answers seemed to be written without real meaning and implied that the students gave an immediate response using the connotation of the titles of the exhibits (especially in the "transfer of momentum" and "your weight in the space" exhibits). So they might not be really abstractions of the students. If specific observations were written, these answers might indicate more meaningful understanding.

To summarize, the results obtained from the private school seemed to show a number of differences from the results obtained from the public school in terms of the answers related to the four exhibits. In the first part of the questions students in the public school and the students in the private school were asked how much they observed this exhibit. Frequency tables indicate that public school students seemed to try out the exhibits more frequently than private school students. When the frequency tables are studied it is seen that students in the public school most frequently stated that they investigated the exhibits and they tried them by doing themselves. On the other hand, when the frequency tables of the answers of the students in the private school were investigated, it was seen that they did not show a common build up in any of the three answer choices. On the contrary answers were spread out among the three answer choices. In the second part of these four questions, students were asked the main messages that can be understood in these exhibits. For both of the groups (public/private) students' answers were categorized as being concrete observation (correct/incorrect or incomplete), abstract generalization (correct/incorrect or incomplete), isolated concept or irrelevant. In order to get a better picture of the understanding of the big ideas of the students in the public school and the students in the private school, number of the correct, incorrect, incomplete, isolated and irrelevant answers given by the students were calculated (Table 6.40).

Table 6.40. The number of the correct, incorrect, incomplete, isolated and irrelevant answers given by public school and private school students

	CONCRETE OBSERVATION		**ABSTRACT GENERALIZATION**		**ISOLATED**	**IRRELEVANT**	**TOTAL NUMBER OF ANSWERS**
	Correct	Incorrect/ Incomplete	Correct	Incorrect/ Incomplete			
Answers about the Question related to the "**Express Road**" Exhibit							
PUBLIC	1	4	0	6	5	0	16
PRIVATE	0	4	0	8	2	1	15
Answers about the Question related to the "**Transfer of Momentum**" Exhibit							
PUBLIC	2	3	0	9	1	1	16
PRIVATE	0	2	0	13	2	1	18
Answers about the Question related to the "**Giant Scissor**" Exhibit							
PUBLIC	2	3	2	4	3	0	14
PRIVATE	0	1	4	8	6	1	20
Answers about the Question related to the "**Your Weight in the Space**" Exhibit							
PUBLIC	2	2	2	9	1	0	16
PRIVATE	9	5	0	5	6	1	26

Table 6.40 summarizes the results for the 3rd research question. Understanding of the Big Ideas Questionnaire was administered to 16 students in the public school, and 40 students in the private school. Looking at the total number of the answers of the private

school students in Table 6.40, one can see that the proportion of the given answers (15/40, 18/40, 20/40, 26/40) is very less when compared to the number of the students taking this questionnaire. The number of the correct answers given by private school students is the highest in the question about “your weight in the space” exhibit. In the public school, the highest number of correct answer is in the questions about “giant scissor” and “your weight in the space” exhibits (Table 6.40). These two exhibits were found to be meaningful by the students in the public and the private school. As it can be seen it Table 6.40, both public school and private school students made abstract generalization in the questions about the “express road” and the “transfer of momentum” exhibits but all of their abstractions were found to be either incorrect or incomplete. None of the students in the public school and the private school could make correct abstract generalizations about the main messages that these two exhibits are revealing. However, these two exhibits were found to be the most meaningful exhibits by the students in the public school.

Research Question-4: Will the 7^th^ grade students who use the SCLK and students who do not use SCLK during their visit differ in terms of their understanding of the big ideas in the exhibits?

Students’ answers for the questions about the four exhibits selected for SCLK were separated in to categories as being “concrete observation”, “abstract generalization”, “isolated concept”, and “irrelevant”. Then, frequencies of the answers of the students in each category were computed for control group and the experimental group separately. The results are summarized in Table 6.41.

Table 6.41. Frequency and percentage distribution of “big ideas” categories of the students in the control group and the experimental group

	CONCRETE OBSERVATION		ABSTRACT GENERALIZATION		ISOLATED	IRRELEVANT	TOTAL NUMBER OF ANSWERS
	Correct	Incorrect/ Incomplete	Correct	Incorrect/ Incomplete			
Answers about the Question related to the “**Express Road**” Exhibit							
Exp. Group	0 (0%)	4 (50%)	0 (0%)	3 (37.5%)	1 (12.5%)	0 (0%)	8 (100%)
Control Group	0 (0%)	0 (0%)	0 (0%)	5 (71.43%)	1 (14.3%)	1 (14.3%)	7 (100%)
Answers about the Question related to the “**Transfer of Momentum**” Exhibit							
Exp. Group	0 (0%)	1 (11.1%)	0 (0%)	6 (66.7%)	1 (11.1%)	1 (11.1%)	9 (100%)
Control Group	0 (0%)	1 (10%)	0 (0%)	8 (80%)	1 (10%)	0 (0%)	10 (100%)
Answers about the Question related to the “**Giant Scissor**” Exhibit							
Exp. Group	0 (0%)	1 (9.09%)	3 (27.27%)	3 (27.27%)	3 (27.27%)	1 (9.09%)	11 (100%)
Control Group	1 (11.1%)	0 (0%)	0 (0%)	5 (55.5%)	3 (33.3%)	0 (0%)	9 (100%)
Answers about the Question related to the “**Your Weight in the Space**” Exhibit							
Exp. Group	2 (18.18%)	2 (18.18%)	0 (0%)	3 (27.27%)	3 (27.27%)	1 (9.09%)	11 (100%)
Control Group	7 (46.67%)	3 (20%)	0 (0%)	2 (13.33%)	3 (20%)	0 (0%)	15 (100%)

As Table 6.41 shows the number of the answers in each category are very few. Therefore no statistical analysis except frequencies could be used to analyze the data in this research question. Comparison of the groups was based on descriptive statistics. According to the frequencies of the answers given for the “Express Road” exhibit neither students in the experimental group, nor students in the control group could give any correct answer for the question. Half of the students in the experimental group (n=4) could state their concrete observation which are either incorrect or irrelevant. Three students in the experimental group and five students in the control group made either incorrect or irrelevant abstract generalizations. Again, students in the experimental and the control groups could not give any correct answer to the second question about the "Transfer of Momentum". Experimental group is better in abstraction in their answers to the third question which is about the "Giant Scissor". Three students in the experimental group had answers in the abstract generalization category. On the other hand none of the students in the experimental group could make abstract generalizations in their answers. None of the students in the experimental and control group could give correct answer in the abstract generalization category to the question about "Your Weight in a Space" exhibit. Number of the students who could state correct concrete observation (n=7) in the control group is more than the number of the students who could give answers in the concrete observation category (n=2) in the experimental group.

Hypothesis-1: 7th grade students who are provided with the SCLK for their visit will score higher then the 7th grade students who are not provided with SCLK for the visit in terms of their conceptual understanding regarding the concepts force and motion as measured by Conceptual Understanding Questionnaire.

In order to test this first hypothesis, whether there is any difference between groups in terms of students' performances in CUQ-Force & Motion should be tested. Repeated measures ANOVA was used in order to test whether there is any significant difference between the groups' performances in terms of CUQ-Force & Motion scores.

Table 6.42. Descriptive Statistics about CUQ-Force & Motion of the participants

	Experimental-Control Group	**Mean**	**Std. Deviation**	**N**
CUQ-Force & Motion (Pre-test)	Experimental group	21.7083	4.97475	12
	Control group-1	17.2333	6.87092	15
	Control group-2	21.0833	6.50466	12
	Total	19.7949	6.40900	39
CUQ-Force & Motion (Post-test)	Experimental group	23.0417	5.43331	12
	Control group-1	16.6000	7.55976	15
	Control group-2	20.1667	6.81687	12
	Total	19.6795	7.10216	39

Table 6.42 shows mean and standard deviation of scores of students in each group and both in pre-test and post-test. In the pre-test the mean of scores of the students in the experimental group (M=21.7083) is higher than the mean of scores of the students in the first control group (M=17.2333) and the mean of scores of the students in the second control group (M=21.0833). Because of this, the mean scores in the post-test were also calculated for each group. The mean scores in the post-test were found to be M=23.0417 for experimental group, M=16.6000 for the first control group and M=20.16.67 for the second control group. The mean values of the groups indicate that there is no improvement in students' performances in the control groups in terms of CUQ-Force & Motion; on the contrary there is a decline in their performances. On the other when the mean values of the pre and post test scores of the students in the experimental group are compared, there seems to be a small shift (towards higher mean from pre to post test) in the students' performance in the experimental group.

In order to test whether there is any significant difference between the groups and also to test their pre-post difference, repeated measures ANOVA was carried out.

Table 6.43. Repeated measures ANOVA results on CUQ-Force & Motion pre-post test scores of participants

Source		**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
factor1	Pre-Post Measures	0.101	1	0.101	0.006	0.939
factor1 * GROUP		18.457	2	9.229	0.542	0.586
Error(factor1)		612.908	36	17.025		

The results obtained from repeated measures ANOVA test indicate no significant changes from pre to post measures (factor1) when the experimental and control groups are analyzed as a whole group. As it can be followed from the first row of the Table 6.43, there is no statistically significant difference between pre and post performances of the students in three groups in terms of CUQ-Force & Motion scores, $F(1.36)=0.006$, $p=0.930$. Moreover, no significant interaction (between pre-post measures and the study groups) was observed when the changes from pre to post measures were analyzed for the three groups (factor1*GROUP). Second row of the Table 6.43 shows that, the changes from pre to post measures is not significantly different for the experimental group and the control groups; which implies that there is no effect of the treatment, $F(2.36)=0.542$, $p=0.586$. Therefore, results did not support the first hypothesis.

Hypothesis-2: 7th grade students who are provided with the SCLK for their visit will score higher than the 7th grade students who are not provided with SCLK for their visit in terms of their personal declaration about their own learning as measured by MOLI.

In order to test the second hypothesis, the mean scores obtained from MOLI were compared. The comparison was made between the groups who are provided with and without SCLK for their visits. Opposite to what is hypothesized by the researcher, the mean score of the experimental group was found to be smaller that the two control groups (Table 6.43)

Table 6.44. Descriptive Statistics about MOLI scores of the participants

	N	Mean	Std. Deviation	Std. Error	Min.	Max.
Experimental group	11	**25.00**	7.629	2.300	13	35
Control group-1	14	**28.79**	7.051	1.885	16	40
Control group-2	11	**28.91**	3.562	1.074	23	35
Total	36	27.67	6.476	1.079	13	40

In order to test whether this difference between the mean scores of the experimental group and the control groups is statistically significant or not, One Way ANOVA between independent groups was used.

Table 6.45. One Way ANOVA results on MOLI scores of the participants

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	112.734	2	56.367	1.373	0.268
Within Groups	1355.266	33	41.069		
Total	1468.000	35			

According to one way ANOVA results, it was found that there is no statistically significant difference between the groups who are provided with and without SCLK in terms of MOLI scores, $F(2,33)=1.373$, $p=0.268$ (Table 6.45). Therefore, results did not support the second hypothesis.

6.2. Analysis Done on the Questions about Participants' Prior Science Center Experiences

Apart from the three questionnaires, there were also four questions asked participants about their prior science center experiences. Analyses of the first, the second and the fourth questions were based on the descriptive statistics; frequencies of the given answers were calculated. Analysis of the third question was made qualitatively.

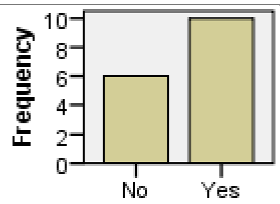
Analysis done on the questions about participants' prior science center experiences starts with the analysis of the results for the data obtained from the public school.

First Question: *Before this visit have you ever visited a science center?*

Analysis of this first question was based on the frequency distribution of 16 students' answers for the first question.

Table 6.46. Frequency table&histogram for the answers of the first question (public school)

QUESTION-1		
	Frequency	**Valid Percent**
"Yes"	10	62.5 %
"No"	6	37.5 %



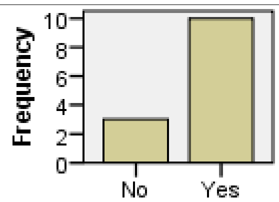
When the frequencies of the answers given to the first question were calculated, it was found that while 10 students visited the science center before; six students declared that they haven't visited the science center before (Table 6.46).

Second Question: *If your answer is "Yes" for the first question: Did you find this visit different from the previous ones?*

According to the answers given to the first question only 10 students who said "yes" should have answered this question. However, three students who said "no" for the first question also gave an answer to the second question.

Table 6.47. Frequency table&histogram for the answers of the second question (public school)

QUESTION-2		
	Frequency	**Valid Percent**
"Yes"	10	76.9 %
"No"	3	23.1 %



Frequencies of the answers for the second question were calculated. It was found that 10 of the 13 students found this visit different from their previous visits (Table 6.47).

Third Question: *If your answer is "Yes" for the second question: What do you think makes this visit different from the others?*

11 students gave an answer to the 3rd question. Their answers are as in the following:

- *"Bence bu gezide daha da çok bilgilendik. Çünkü bu sefer bize rehberlik yapan bir abla oldu - Learning more because of some who made guidance for us"*
- *"Daha zevkli – More enjoyable"* (this answer is stated by two students)
- *"More informative – Daha bilgili"*
- *"Bir de daha önce bu kadar deneyler görmemiştim - I haven't seen so many experiments before*
- *"Anketler – Questionnaires"*
- *"Geziye gitmeden önce bize verilen çalışma kağıtları farklıydı - Worksheets given before going to the center"*
- *"Bu sefer bence ordaki deneyleri daha iyi kavradık - Better understanding of the exhibits"*
- *"Bizi serbest bırakınca deneyleri yapabilme fırsatımız oldu - Having a chance to try the exhibits by ourselves when we were free"*
- *"Gezi öncesinde ve sonrasında çalışmalar yapıldı - Activities done prior to and after the visit"*
- *"Sorular vardı. Sorular bu konuyu bizim kavramamızı sağladı. En farklısı buydu. Şimdi daha iyi anlıyorum. Oradakilerin ne işe yaradığını - Questions which helped us to understand the topic and the exhibits better"*
- *"Ayrı projeler – Projects"*
- *"Ayrı bilgiler – Information"*
- *"Daha fazla uygulama yaptık – More practice"*

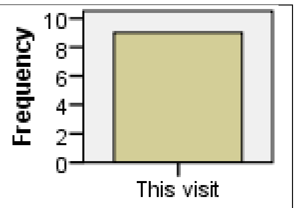
Among these 11 students who answered this question two students gave their opinions about what made this visit different from the previous ones in terms of the exhibits in the science center. They stated in their answers that previously, there were no experiment with electricity, giant scissor, fire extinguishing, and rotating exhibit upstairs.

Fourth Question: *If your answer is "Yes" for the second question: When you are expected to make a comparison between this visit and your previous visits, in which one did you learn more?*

Nine students (100%) who answered the fourth question indicated that the present visit was better than the previous ones. Their frequency distributions are shown in Table 6.48.

Table 6.48. Frequency table&histogram for the answers of the fourth question (public school)

QUESTION-4		
	Frequency	**Valid Percent**
"This visit"	**9**	**100 %**
"Previous visits"	**0**	**0 %**



As shown in Table 6.48, analysis of these answers revealed that all the students answering this question learned more from this visit when compared to their previous visits.

Analysis of these four questions was based on all the answers given to each question. However there are some inconsistencies in the answers of the students. For instance, one of the students indicates that he hasn't visited the science center before. In the second question, the same student tells that he didn't find this visit different from the previous ones. Again, the same student tells in the third question, according to him what makes this visit different from the previous ones is that this visit was more enjoyable, more informative, and he added that he hasn't seen such more experiments before. Similar inconsistencies were also discovered in some of the other student responses. However, because one could not decide which one was answered by mistake, all the answers for each question were analyzed by the researcher.

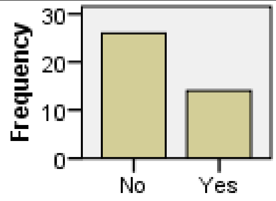
Analysis done on the questions about participants' prior science center experiences were also done for the results of the data gathered from the private school.

First Question: *Before this visit have you ever visited a science center?*

Among 56 students 40 students answered this question. Analysis of the answers was based on their frequency distribution.

Table 6.49. Frequency table&histogram for the answers of the first question (private school)

QUESTION-1		
	Frequency	**Valid Percent**
"Yes"	14	35 %
"No"	26	65 %



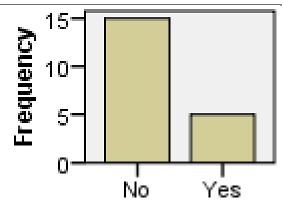
As a result of the analysis of the answers given to the first question, it was found that while 14 students visited the science center before, 26 students declared that they haven't visited the science center before (Table 6.49).

Second Question: *If your question is "Yes" for the first question: Did you find this visit different from the previous ones?*

20 students gave an answer to the second question. Six students who told that they haven't visited the science center before stated their ideas in the second question. Frequencies of the answers were calculated.

Table 6.50. Frequency table&histogram for the answers of the second question (private school)

QUESTION-2		
	Frequency	**Valid Percent**
"Yes"	5	25 %
"No"	15	75 %



According to answers of 20 students, 15 of them did not find this visit different from their previous visits (Table 6.50). Only five students stated that they found the visit different when compared to their previous visits. However the students showed inconsistencies in their answers, because six students who stated that they had not visited a science center before (in question-1) compared their current visit with previous visits.

Third Question: *If your answer is "Yes" for the second question: What do you think makes this visit different from the others?*

Only five students gave an answer to that question. The following are the answers given to that question:

- *"Okulla gitmem – Visiting the center with the school"*
- *"Değişik buluşlar – Different discoveries"*
- *"Daha güzel anlatılmış olması – Being explained better"*
- *"Daha beğenmem – Admiring more"*
- *"Daha çok kişiyle gitmek – Going to the center with more people"*
- *"Deneylerin asıl amacının öğrencilerin derslerine yardımcı olması - Because exhibits' main goal is supporting students' lessons"*
- *"İstediklerime bakamamam – Not being able to look at the exhibits that I wanted"*
- *"Daha az göreselliğe dayanması - Being based on less visuals"*

Fourth Question: *If your answer is "Yes" for the second question: When you are expected to make a comparison between this visit and your previous visits, in which one did you learn more?*

Only nine students answered this question. Two of these nine students previously stated that they haven't visited the science center before.

Table 6.51. Frequency table&histogram for the answers of the fourth question (private school)

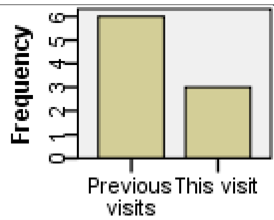
QUESTION-4			
	Frequency	**Valid Percent**	
"This visit"	3	33.3 %	
"Previous visits"	6	66.7 %	

Table 6.51 shows the results according to analysis of these 9 answers given o the fourth question. Only 3 students stated that they learned more in this visit. On the other hand, other 6 students stated that they learned more in their previous visits.

7. DISCUSSION AND CONCLUSION

This study was designed and conducted with two major goals. The first goal is concerned with the development of a kit which guides student learning experiences specific to several exhibits at the science center in İstanbul. Therefore, the Science Center Learning Kit (SCLK) was developed after careful consideration of the suggestions and cautions raised in the literature. The second major goal of the study is to measure the effects of the (SCLK) though an implementation in a science center in İstanbul. Its effects were measured by examining the learning outcomes of the 7^{th} grade students who completed the visit, and also by comparing the learning outcomes of the groups who completed the visit with and without the SCLK. The learning outcomes of these groups were compared in terms of their level of conceptual understanding about force and motion unit, personal declaration of their own learning, and their understanding of the big ideas underlying the selected exhibits. In the study both quantitative and qualitative data obtained from 21 public school students and 56 private school students were used.

The study was implemented in two different kinds of schools in İstanbul with two different research designs. The effectiveness of SCLK was analyzed using pre-experimental design (pre-test post-test design) and quassi-experimental design (pre-test, post-test, control group design) for the public and private school respectively.

In the public school, CUQ-Force & Motion was administered to the students in the experimental group. Then, students made their visit to the center as suggested in SCLK. After this guided science center visit experience of the students (which covers the pre-during-post visit experiences), CUQ-Force & Motion was administered to the students again. Additionally, MOLI and Understanding of the Big Ideas Questionnaires were also administered to the students and their opinions about the implementation were taken.

Similarly, in the private school, CUQ-Force & Motion was administered to the whole group by the teachers. Then, one group visited the science center with SCLK and the other two groups visited the center without SCLK. At the end of the implementation CUQ-Force & Motion was administered to the students in these three groups for the second time. In addition to CUQ-Force & Motion, MOLI and Understanding of the Big Ideas Questionnaire were also administered to the students in three groups.

The study questioned the degree of change in the 7th grade students' conceptual understanding about force and motion topic following their visit with SCLK. The study also aimed to investigate whether 7th grade students who use the SCLK and students who do not use SCLK during their visit differ in terms of their conceptual understanding regarding the selected concepts in the "force and motion" unit.

In order to determine the degree of change in conceptual understanding of the 7th grade students who are provided with SCLK for the visit, the students were administered "CUQ-Force and Motion" prior to and following their visit. In the public school, the mean of scores of the students in the pre-test was $M=9.50$. After their visit experience as suggested in SCLK the mean of scores of the students made a little shift, and the mean of scores increased to $M=10.88$. However, there was no statistically significant difference between pre-test scores ($M=9.50$; $SD=6.16$) and post-test scores ($M=10.88$; $SD=5.69$) of the students who are provided with SCLK for the science center visit, $t(12)=-1.703$, $p=0.114$. Similar measurements were also made in the private school. The mean of scores of students in the experimental group was $M=21.71$ in the beginning. Then, this group of students made their visit to the center as suggested in SCLK. After the visit, CUQ-Force and Motion was administered again and their mean score was found to be $M=23.04$. Similar to the results in the public school, no statistically significant difference was found between pre-test results ($M=21.71$, $SD=4.97$) and post test results ($M=23.04$, $SD=5.43$) of the students in the experimental group, $t(11)= -0.782$, $p=0.451$.

In CUQ-Force & Motion public school students' mean scores were lower than the private school students' mean scores. The reason for this may be due to the fact that in the public school 6th grade students ($n=12$) also participated to the study; their numbers were more than the 7th grade students ($n=9$) participating in the study. Because SCLK was prepared to address 7th grade students, CUQ-Force & Motion was prepared in the 7th grade level. So, 6th grade students did not know majority of the subjects covered in the questionnaire. Therefore, it is not unexpected to see higher CUQ-Force & Motion mean scores in the public school.

In order to test the first hypothesis, repeated measures ANOVA was used to examine whether there is any significant difference between the experimental and control groups' performances in terms of CUQ-Force & Motion scores. The results did not support the first hypothesis. It was found that there is no statistically significant difference between the experimental group and the control groups. The results implied that the treatment was not effective in improving the conceptual understanding of the students, $F(2.36)=0.542$, $p=0.586$. The reason behind this result may depend on the fact that SCLK could not be used in the way suggested. There are primary bases of the kit and everything covered in the kit were prepared by taking these bases into consideration. Therefore, SCLK should be used by applying everything suggested in the kit. However, throughout the implementation both in the public and the private school, some of the steps suggested in the SCLK could not be applied in the way suggested. For example, there were four authentic tasks in the kit were expected to be used as a follow-up activity. They should have been completed by the student groups in the public and the private schools, and then students should have presented what they did to their friends on the day specified. As, Connolly, *et al.* (2006) stated when students turn back to school after visiting the center, they are expected to have a wealth of information. And, it becomes important to focus on students' experiences on a class time. However, majority of the groups were not ready on the day specified for creating this classroom environment for the presentations. Thus, extra time was given to them, after a little preparation they presented their work to their friends. Because students did not make enough preparation and they were not willing to do the tasks, well-prepared products could not be produced. Also, no discussion environment could be established; they could not adequately reflect on what they had experienced in the center. Groups simply made their presentations and some students listened while others did not. Therefore, students could not solidify what they saw in the center. Moreover, they could not make the connection between what they saw in the center, what they prepared in the authentic tasks and what they learned in the school. In other words, students in the experimental groups were treated different from the control group by using SCLK but since it could not be used properly, the results showed no difference. As a result, no significant results were obtained in terms of the CUQ-Force & Motion scores, and no significant increase could be observed between pre and post-test results of the students both in the public and the private schools.

Another reason for not observing the significant difference between pre-test results and post-test results of the students who were provided with SCLK may depend on students' reluctance to complete the questionnaires. The study was implemented at the end of the semester both in the public and the private school. Because of this, majority of school exams had finished and students were already in a "holiday" mood.

The reason behind students' having low performance during the implementation may be due to the fact that students did not have enough competencies which were required for completing most of the activities in SCLK. For example, in order to complete the group task, students should have competencies required for group work; they should be successful in scheduling their time that they could have given the task on time. Apart from these, although some of them previously had visited an informal setting, they were not accustomed to have a guided tour. For example, in the center students were required to complete a worksheet, yet majority of the students may not have the necessary competencies for completing a worksheet individually and properly by investigating the exhibits carefully. They may not have sufficient experiences which are required for the development of such competencies. Therefore, it is apparent that teachers are critical in the implementation; they should have scaffolded their students to complete their group tasks or complete the worksheets in a proper way. The other side of the coin is that, teachers may not have enough experience in and knowledge about the informal settings such that they themselves lack the competencies required to guide their students in these settings. Or, they might not believe in the value of these settings and related activities. This is more parallel to the views put forth by Kisiel (2003) who points out that the teachers' perception of what happens in a classroom setting conflicts with what happens in an informal setting. Certainly, teachers have the skills of teaching in a classroom environment. When they organize a field trip to an informal setting, they are actually placed in an environment where they are not much familiar with. Therefore, teachers' experiences about the informal learning environments are also important to increase the effectiveness of such settings in learning.

Apart from testing conceptual understanding of the students, the study also aimed to examine the personal declaration of the 7th grade students who are provided with SCLK for the visit about their own learning as measured by MOLI. It was also investigated whether the 7th grade students who use the SCLK and students who did not use SCLK during their visit would differ in terms of their personal declarations about their own learning.

With the intention of examining the personal declaration of the 7th grade students who were provided with SCLK for the visit about their own learning, descriptive statistics were used to analyze data from both the public and the private school. In the public school, students got higher scores from MOLI; the mean of their scores was found to be 36.80 where 44 is the possible highest score. This implies that, students in the public school were frequently in agreement with favorable declarations about their own learning as measured by MOLI. Analysis about students' personal declaration about their own learning was also done for each item of MOLI separately. These item-specific analyses also showed that students generally have favorable declarations about their own learning. The same analyses were done according to the MOLI scores of the students in the private school. The mean of scores of the students in the private school were found to be lower than the mean of scores of the students in the public school. Analyses done for each item of MOLI also showed that large proportion of the students in the private school have unfavorable declerations about their own learning. This result stimulated a need for further analyses, in order to examine whether there was any significant difference between the scores of students in the public school and the scores of the students in the private school. The results indicated a significant difference between the MOLI scores of students in the public school ($M=36.80$, $SD=6.41$) and the students in the private school ($M=25.00$, $SD=7.62$) in favor of the public school, $t(24)=4.282$, $p=0.000$. The reason behind this result may depend on the fact that while private school students were accustomed to different kinds of activities such as field trips, projects or group works, public school students were not familiar with such experiences. As Braund and Reiss (2006) pointed out, students appeared to be more enthused when they visited or were taught in places where science is explained in new and exciting ways. For sure, when we say "science centre experience" we look at it as a whole with pre-during-post visit experiences; and the students in the public school are not used to have frequent experiences with such activities as suggested in SCLK.

The study also investigated the differences in personal declarations of 7th grade students who used the SCLK and students who did not use SCLK during their visit. The results indicated no statistically significant difference between the MOLI scores of groups who completed the visit with and without SCLK, $F(2,33)=1.373$, $p=0.268$. The reason for this may depend on several factors. Firstly, as it was mentioned previously, because the study was implemented at the end of the term, the students were not willing to do the activities covered in SCLK. For example, majority of the students did not prefer to read the “enjoy & learn” cards distributed to them throughout their visit. Moreover, majority of the students did not do their group task which they should have prepared and presented to the other groups. In short, students did not get involved in the science center visit and this resulted in similar outcomes for the students in the experimental and the control groups. Second reason for not observing significance may be due to their teachers’ attitude. Teachers in the private school were not willing to be a part of the study; they did not want to lead many of the activities, such as presentation prior to visit or group presentations about the tasks. Therefore, all the activities were led by the researcher. This may cause students to feel that all the work they were expected to make was something independent of them and they did not feel themselves responsible for learning and also doing all the activities properly.

According to Michie (1998) teachers found field trips as valuable experiences for the students. However, school administrators are generally believed to be the barriers for teachers’ organizing field trips. What is required is school administrators’ understanding the value of field trips (as cited in Anderson *et al.*, 2006). However for the present study, the school administrator in the public school seemed to reveal an example quite contrary to what Michie (1998) proposes. The school principle was willing and personally led the organization of the field trip in the public school.

When mean of the MOLI scores of the students were compared, it was found that the mean score of the students in the experimental group was lower than the mean score of the students in the control group. This may be due to the fact that students in the private school had to study a lot by doing tasks, completing the worksheets, making presentations, etc. On the other hand, students in the control group visited the center just for fun. When other factors such as unwilling teachers, who did not want take any responsibility for the implementation, giving students with extra load at the end of the term after their exams had finished, etc. are considered it is possible that having a science center visit for fun was favored to having a science center visit that requires the completion of several tasks as experienced by the students in the experimental group. Apart from these, students' opinions about learning and their motivation to learn were not known at the beginning of the study. The reason for having this kind of difference between the mean scores of the students in the control group and in the experimental group may be due to the fact that students in these three groups may normally have this difference in their modes of learning.

In addition to the conceptual understanding and the personal declarations of learning, the degree of understanding of big ideas of the 7th grade students who are provided with SCLK for the visit was probed. The understanding of the big ideas in the exhibits was examined in order to understand whether there was any difference between the 7th grade students who use the SCLK and students who did not use SCLK during their visit. Majority of the questions in this questionnaire were open-ended questions that asked students their ideas, opinions or understanding. Notable results were obtained at the end of the analyses.

To start with, in the first question, students were asked the most interesting thing they saw in the science center. They were also required to answer what made it interesting for them. Public school students found meteor interesting. Majority of them stated that meteor was interesting because of "seeing it for the fist time", "its coming from the space" and "having an interest toward topics about space". Private school students found skeleton of a baby whale interesting. They explained their reasons as "because it is giant", "because it is real", because of "having an interest in whales", because of "loving animals", "its being very large although it is a baby whale", "and "its bone and length". As it can be inferred from the answers, there are some similarities in the answers of students in the public and private schools. The results may be interpreted by using these similarities, such that students found things interesting when they see something they are interested in, something real or something for the first time and something unexpected. As Griffin (1998) states, one of the unique contributions that informal learning setting make is confronting visitors with real things. It is believed that visitors can use these real objects in the setting to extend their perceived realities and pre-existing mental constructs (Dierking, 1996 as cited in Griffin, 1998). Moreover, one of the conspicuous results private school students gave for finding skeleton of a baby whale interesting is its being giant. This is consistent with the study conducted by Anderson, *et al.* (2002) about young children and the nature of their learning through museum experiences. According to their findings large-scale exhibits can be readily recalled by children. They found that for children such large-scale objects and exhibits have a strong attracting and holding power. It was reported by Anderson *et al.* (2002) that in their study children frequently recalled large-scale animal models, similar with the finding in the current study where majority of the students found skeleton of a baby whale interesting.

Students' answers for finding something interesting or meaningful were also interpreted in terms of the reasons they gave. In the private school students declared that they found something meaningful when the exhibit is related to what they learn at the school (n=2) and when it serves as a means to increase conscientiousness such as a fire extinguisher (n=2). Public school students could not provide relevant information for that question. But among the answers of the private school students there was an emphasis on school curriculum. Students indicated that when they see something in the center about what they learn related to that topic at the school they found it meaningful. Although numbers of the students giving such answers are not many, such kind of an explanation among students' answers support the significance of the curriculum connection of the field trips. As being one of the primary bases of SCLK, learning experiences of students in an informal setting should be integrated into the formal school science learning (Anderson and Zhang, 2003; Bell and Rabkin, 2002; Griffin, 2004).

Public school students found the "express road" and the "transfer of momentum" as the most meaningful exhibits in the center. These two exhibits are the ones which were tried by the students by themselves most frequently. According to their answers, 56.2 per cent of the students tried the "express road" exhibit by themselves and 68.8 per cent of the students tried "transfer of momentum" exhibits by themselves. This is consistent with the words of Piaget (1964, p.176) who stated that "to know an object is to act on it" (as cited in Rudmann, 1994). Rudmann (1994) declared that in order to internalize what they learn individuals must physically manipulate objects. He suggests organizing longer visits by providing objects for manipulation. Again parallel with this idea, some of the private school students participating the study (n=3) complained about not trying the exhibits.

Three students stated in their answers to the question about the “Express Road” that they were not allowed to try the exhibits by themselves. Among these three students one also gave similar answer to the question about the “Transfer of Momentum”, and stated that she could not try the exhibit by herself. These complains of the students may reflect their willingness to try the exhibits for better understanding.

In the Understanding of the Big Ideas Questionnaire students were also asked the main messages that they understood in the four exhibits covered in SCLK. When the answers of the students in the public and the private school were analyzed, it was noticed that students used the term “kilo” instead of “weight” in their answers to the question about the “your weight in the space”. This may be due to the fact that in the title of the exhibit “kilo” is used instead of “weight”; so students might have used that title as a cue while writing their answers. Additionally, while explaining the main ideas revealed in the “Express Road” exhibit, students in the public school used the term “straight” (düz) in their answers for the inclined plane which is perpendicular to the ground. However, this road is also inclined.

At the end of the implementation in the public school, while administering the questionnaires, students’ were requested to give their thoughts about their science center experience. The opinions of the 13 students who told their opinions showed that they generally have positive feelings about the implementation (Appendix L).

7.1. Limitations

Kisiel (2007) calls attention to the fact that school field-trip experience is a complex phenomenon. Factors such as teacher perceptions of field-trip pedagogy, teacher prior experiences, student prior experiences, school support of field trips, museum policies, etc. may have an influence on it. Because of this it is unavoidable to encounter some limitations during the implementation of the study. In this part limitations of the study will be discussed.

First of all, the results of the study could not be generalized to the all 7th grade students, because the sample size of the study is very small. In the public school the study had to be conducted also with the participation of the 6th grade students; the number of the 7th grade students were less than the number of the 7th grade students. Apart from this, sample of the study were not selected randomly. Selection of the schools was done conveniently by the researcher. Participants from the public school (n=21) were selected by their teachers and the administrator of the school. Participants in the private school (n=56) were selected by the science teachers of the school. Another constraint is again about the participation of the 6th grade students. Because the questionnaires and the tasks were not in their level, they had difficulty, especially while they were having CUQ-Force & Motion. This also resulted in inadequate data about their level of conceptual understanding.

Another limitation of the study is about the science teachers in the public and the private school. In the design of the study, science teachers of the participating group of students should be a part of the study and that they should lead all the activities suggested in SCLK. Teachers should have conducted all the activities and managed their students as if this science center visit was a part of their science course in the school. However, this was not the case both in the public and the private school. In the public school the teacher was not willing to take part in the study. The researcher managed the study, and at the same time implemented all the activities and used materials with students as suggested in SCLK. The teacher did not come to the science center and she did not observe any of the activities prior to and after the visit. Similarly, in the private school teachers did not want to get involved in the study a lot. Except one teacher, others did not follow the steps in the study adequately. But they implemented all the questionnaires at the beginning and at the end of the study. Although she did not want to lead the activities suggested in SCLK, only one teacher took part in all parts of the study with the researcher. Because students did not see their teacher as an authority who is conducting the steps as part of their science course, they might have felt that this implementation was something independent of them and might not have paid enough attention to the implementation. The importance of teacher presence and teacher guidance is indicated by Kisiel (2007) who points out that even the fill-in-blank worksheet can support the learning experience of students with proper teacher guidance. As such, lack of teacher involvement might have decreased the effectiveness of the treatment. Therefore, as Kisiel (2007) suggested, helping teachers to become aware of the characteristics of informal learning environments and their role in facilitating learning can contribute to move beyond a traditional tour in an informal setting. This can also increase the use of tools such as SCLK and any kinds of materials that support learning in an informal setting.

The researchers' dual role seemed confuse students' minds in the public school. The researcher acted as both the person who was conducting the science center visit by using the materials and the activities suggested in SCLK like a teacher, and also being a person who was administering the questionnaires for collecting data to measure the effectiveness of the implementation by using SCLK. Therefore some students had a difficulty to differentiate which parts belong to the research and which parts belong to the real science center visit experience for them. This is more explicit in their answers to the question, "what do you think makes the visit different from the others?". Some of the students gave answers about the activities that they experienced and materials that they used, but some made comments about the questionnaires which were administered to them for collecting data. The following are some examples from the students' answers to that question:

- *"Anketler – Questionnaires"*
- *"Bu sefer bence ordaki deneyleri daha iyi kavradık - Better understanding of the exhibits"*
- *"Gezi öncesinde ve sonrasında çalışmalar yapıldı - Activities done prior to and after the visit"*

Another limitation is about the time of implementation. The study was implemented at the end of the term both in the public and the private school. In the private school, the study was implemented after all the science exams were over. Therefore, students, especially the ones in the private school, were not willing to have any task, do any test or make anything about a science course. The other limitation about timing can be discussed in terms of the period given to the students for completing the authentic tasks. The students may be expected to complete the tasks in a longer period taking care that these tasks should be used as a follow up for the science center experience. All in all, these limitations about timing might have also decreased the effectiveness of the treatment.

There are also some limitations about the implementation of the study. At the beginning of the study, three control and three experimental groups and three science teachers were identified in the private school. On the day of the science center visit, most of the students changed their mind and did not want to come to the science center. Two of the classes were excluded from the study because very few students from these two classes joined in the visit to the science center. Therefore the researcher had to decrease the number of both the control and experimental classes. As a result of these, the number of students participating to the study from the private school decreased to 56.

There are also limitations about the collection of the data. Students gave some inconsistent answers to the questions about their prior science center experiences. For example, 15 students out of 20 students from the private school sample indicated that they did not find this visit different from their previous visits. Only five students stated that they found the visit different when compared to their previous visits. However, there were a number of inconsistencies in students' answers to consecutive questions. For example six students who stated that they had not visited a science center before (in question 1) compared their current visit with their (nonexistent) previous visits. Similarly, in the public school six students stated that they hadn't visited the science center before. Among them, three students made a comparison between this visit and their (nonexistent) previous visits; while one student stated that he/she found this exhibit different from the others, other two students stated that they found no difference between the visits. Despite such inconsistencies, all answers were considered during the analysis. However, the existence of such inconsistencies cautions about careful interpretation of results.

It is better to mention that some of these limitations such as teachers' staying away to involve in the study, time of implementation, students' lower motivation to complete the activities and the taks included in the kit, and researcher's dual role throughout the implementation are also drawbacks of the study.

All in all, the current study showed the difficulties of conducting a research in an informal setting and understanding learning in informal settings. According to Osborne and Dillon (2007), it is not easy to study learning of science in informal settings. For them, "while the study of learning science in formal contexts has at least reached the foothills of knowledge and understanding, researchers working in informal contexts are still in the plains gazing at the mountain in far distance". Therefore, although the current study has some limitations about the implementation, it can contribute to our understanding of learning in informal learning environments.

7.2. Recommendations for Further Research and Implications

This study was conducted in order to develop Science Center Learning Kit (SCLK) and measure its effectiveness in terms of students' conceptual understanding about the force and motion unit, their personal declaration of their own learning, and their understanding of the big ideas underlying the selected exhibits. Although results did not support the effectiveness of SCLK, further research with better implementation can increase its effectiveness, and provide necessary feedback to make revisions in the kit. Therefore, SCLK can be used as a model for developing similar kits specific for different content areas and for different grade levels.

SCLK could be used by the researchers for different kinds of studies and by the educators (teachers, curriculum developers, museum educators) for educational purposes. It might be possible to measure the effectiveness of the kit more accurately with a larger sample and better implementation. As the results of the study indicated, in order get benefits of the kit, it should be implemented as suggested and by taking its bases into consideration.

In order to get generalizable results the study should be carried out again with larger number of sample consisting of only 7th grade students. And the teachers should also be integrated into the study such that they should lead all the activities and they should integrate the science center visit into their science course.

In order to increase students' motivation towards completing tasks suggested in the SCLK, they should receive credits for their work and their performances should be made more public. Their products can be displayed in a poster; they can make their presentation to a larger group composing of their friends, teachers and maybe parents.

Majority of the results indicated that SCLK is not effective in terms of students learning outcomes. However, the results may not be due to the kit, but implementers of the kit. Having teachers who would be more motivated and willing to use such kits for their visits to informal settings, and to use informal learning settings by integrating them into their science classes should be selected in the following possible research studies.

For further research, Turkish teachers' attitudes towards using such kits as developed in this study and their opinions about using informal learning environments in science learning can be studied. As it is seen in this study, teachers are critical factors to make use of informal learning environments in their science courses. The results of the study conducted by Kisiel (2007) suggest that teachers may not be aware of research-based pedagogical practices that can support learning in informal settings. Moreover, teachers' comments in their study implied that their concerns about logistics and student control may have considerable influence on teacher's conception of successful field trips. Therefore, teachers' conceptions of organizing field trips and integrating them into the science courses at schools can be studied. Teacher characteristics can also be considered as a variable when examining and planning for effective practices about using the science centers as part of a science course and when trying to provide students a wider science learning environment.

It is also important to examine teachers' attitudes when introducing this kit for classroom use. Ne notable extention of the present research would be to understand why teachers stay away from implementing SCLK, and how it would be possible to change these attitudes so that they become more open to use and adopt the kit in principle. Subsequently, they can manipulate it according to their teaching environments and the characteristics of the students.

School age children spend two-thirds of their waking lives outside formal schooling. Instead of ignoring critical influences of out-of-school contexts on children, one should realize how important students' experiences in these environments are for their knowledge, understanding, and also for their beliefs, attitudes and motivation to learn (Braund and Reiss, 2006). Worldwide, informal learning environments such as science centers, planetariums, aquaria, botanical gardens are often used effectively as part of science courses in the schools. In Turkey there are limited numbers of such environments which are used for educational purposes. In order to improve student gains from these environments, it is important to create a pool of educational resources such as educational programs, learning kits (like the one developed in this study) and teaching materials specifically designed for these environments. If and when teachers are supplied with a number of resources that can help them improve student gains from informal settings, they may feel better equipped to integrate students' experiences in informal science environments (such as science centers) into their learning experiences in the schools. That way teachers can help students feel that science is not only a course in the school; it is in their daily lives and they can use what they learn in school in a science center, in a botanical garden, or somewhere else.

APPENDIX A: EXHIBITS SELECTED FOR SCLK AND THE OBJECTIVES ASSOCIATED WITH THE MAIN IDEAS UNDERLYING THE SELECTED EXHIBITS

<table>
<tr><th>1</th><th>THE EXPRESS ROAD (EKSPRES YOL)</th></tr>
<tr><td>
</td><td><u>7th Grade Science and Technology Curriculum Objectives</u>

Related to force, work and energy students,
✓ realize moving objects having kinetic energy,
✓ discover relation of kinetic energy with speed and mass.</td></tr>
<tr><td colspan="2">“Parmaklarınızın yardımıyla aralıktan topu yukarı doğru çekmeye çalışın, toplardan birini düz diğerini ise eğimi olan aralıktan yukarıya çekin ve sonra toplardan her ikisini de aynı anda bırakın. Eğik düzlemden aşağı kayan topun aşağıya daha çabuk ulaştığını göreceksiniz. Eğik düzlem bir sikloid özelliği taşır. Nesneler en fazla eğik düzlemlerde hız kazanır ve kısa yolun düz olan olmasına rağmen eğik olandan aşağıya daha çabuk ulaşır.”
(Şişli Bilim Merkezi)</td></tr>
</table>

<table>
<tr><th>2</th><th>TRANSFER OF MOMENTUM
(MOMENTUM TRANSFERİ)</th></tr>
<tr><td></td><td><u>7th Grade Science and Technology Curriculum Objectives</u>

Related to force, work and energy students,
✓ realize moving objects having kinetic energy,
✓ discover relation of kinetic energy with speed and mass,
✓ state that objects have gravitational potential energy due to their positions,
✓ discover that gravitational potential energy depends on weight and height of an object,
✓ explain with examples that kinetic energy and potential energy can be transferred into one another,
✓ from transfer of energy, reach at a conclusion that energy is conserved.

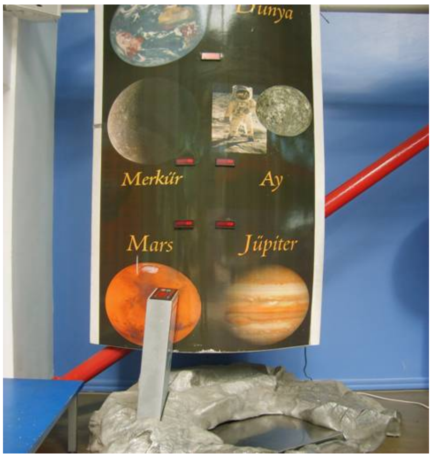
Related to frictional force’s resulting in energy loss students,
✓ realize that frictional force cause decrease in kinetic energy,
✓ explain decrease in kinetic energy with transfer of energy,
✓ make a generalization that air and water resistance result in decrease in kinetic energy.</td></tr>
<tr><td colspan="2">“Toplardan birini çekin ve sonra serbest bırakın. Diğer uçtaki toplardan yalnızca birinin hareket ettiğini gözlemleyeceksiniz. 3 topu çekip serbest bıraktığınızda aynı şekilde diğer uçtan 3 tane top hareket edecektir. Sizce 5 topu çekip bırakırsanız ne olur? Hareket halindeki bir cismin momentumu kütlesinin ve hızının çarpımına eşittir. Toplardan biri önündeki topa çarptığında, momentumunu bu ikinci topa aktarır ve momentumun aktarıldığı top ilk topun hızıyla hareket eder. Aynı şekilde 2 veya 3 top çekip bırakıldığında, aktarılan momentum 2 veya 3 katına çıkar ve böylece kaç top çekilip bırakıldıysa diğer uçtan aynı sayıda top hareket eder. 5 top çekilip bırakıldığında da momentum 5 katına çıkar ve diğer uçtan 5 top hareket eder. Bu duurumda ortadaki top kendini yeniden gruplandırmak durumundadır.” (Şişli Bilim Merkezi)</td></tr>
</table>

<table>
<tr><th>3</th><th>GIANT SCISSOR (DEV MAKAS)</th></tr>
<tr><td></td><td><u>7th Grade Science and Technology Curriculum Objectives</u>

Related to the simple machines students,
✓ name kits which are used to change a force’s direction and/or magnitude as simple machines,
✓ realize that it is possible to obtain exit force larger than entrance force by using simple machines,
✓ state that while doing work using simple machine will not cause energy saving but it will simplify the work being done.</td></tr>
<tr><td colspan="2">“Kolay iş yapmak.
Sırası ile 1,2,3,4 noktalarından bastırarak makası kapatmaya çalışın. Makası hangi noktada en az kuvvetle kapatabiliyorsunuz?
NEDEN?
Kol kuvvetimizi arttırmaya yarayan aletlere kaldıraç denir. Eğer bir destek noktanız ve bir kaldıraç kolunuz varsa, az kuvvetle çok iş yapabilirsiniz. Arşimet “Bana bir destek noktası gösterin dünyayı yerinden oynatırım’’, demişti. Makas, cımbız, tahtaravalli, maşa, pense, kerpeten, el arabası, ceviz kıracağı gibi aletlerin hepsi birer kaldıraç örneğidir. Çevrenizde başka hangi kaldıraç örnekleri var? Bize bildirin. Siz de yeni bir kaldıraç tasarlayabilir misiniz?

(Kaldıraçlarda, yükün bulunduğu nokta ile destek noktası arasındaki uzaklığa yük kolu, destek noktası ile kuvvetin uygulandığı nokta arasındaki uzaklığa da kuvvet kolu denir.)

Kaldıraç prensibini anlatıyor: Yük x Yük Kolu = Kuvvet x Kuvvet Kolu”
(Şişli Bilim Merkezi)</td></tr>
</table>

<table>
<tr><th>4</th><th>YOUR WEIGHT IN THE SPACE
(UZAYDA KİLONUZ)</th></tr>
<tr><td></td><td><u>6th Grade Science and Technology Curriculum Objectives</u>

Related to weight students,
✓ observe the existence of force between masses in the Earth from events around them,
✓ name the force between masses in the earth and the Earth as gravitational force,
✓ name gravitational force acting on a mass as weight,
✓ explain how weight of an object with the same mass will be different in different planets,
✓ differentiate mass and weight.</td></tr>
<tr><td colspan="2">“Önce, ayaklı kumanda levhasındaki sarı renkli ayar düğmesine basarak teraziyi sıfırlayın. Sonra teraziye çıkınve dünyada, eğer olabilseydiniz Merkür, Ay, Mars ve Jüpiter gezegenlerinde kaçar kilo olduğunuzu görün.
NEDEN?
Her gezegenin çekim ivmesi birbirinden farklıdır. Örneğin, dünyanın çekim ivmesine genellikle yer çekimi (g) denir ve ayın veya başka bir gezegenin çekim ivmesinden farklıdır. Cisimlerde sabit olan (değişmeyen) kavram kütledir (m). Bir cismin ağırlığı (W) ise kuvvet olarak tanımlanır (W = mxg). Bu nedenle, sabit olan kütle, her gezegende farklı olan çekim ivmeleri ile çarpıldığında bulunan kuvvetler birbirinden farklı olacağı için o cismin farklı gezegenlerdeki ağırlığı da farklı olur.” (Şişli Bilim Merkezi)</td></tr>
</table>

APPENDIX B: GUIDING BOOKLET FOR TEACHERS: INTRODUCTION SECTION

BİLİM MERKEZİ ÖĞRENME ARACI
ÖĞRETMEN EL KİTABI

(Giriş Bölümü)

Giriş: “Bilim Merkezi Öğrenme Aracı”

Bilim Merkezi Öğrenme Aracı, okul gruplarının Bilim Merkezi’ne gezisi sırasında örencilerin öğrenmelerini kolaylaştırmak amacıyla öğretmene rehberlik etmesi için geliştirilmiştir.

Araçta Bilim Merkezi’ndeki deney ünitelerinden 7. sınıf Fen ve Teknoloji Dersi’ndeki “Kuvvet ve Hareket Ünitesi”nde işlenen belli kavram ve olaylarla ilişkili olan deney üniteleri kullanılmıştır. Bu bağlamda araç özellikle 7. sınıf öğrencilerine ve fen ve teknoloji öğretmenlerine yönelik hazırlanmıştır.

“Kuvvet ve Hareket Ünitesi”nde işlenen temel kavram ve olayları gösteren ve *Bilim Merkezi Öğrenme Aracı*’nın kapsamına alınan dört deney ünitesi:

1. Ekspres Yol
2. Dev Makas
3. Momentum Transferi
4. Uzayda Kilonuz

Bu deney ünitelerinin her biri Fen ve Teknoloji Dersi “Kuvvet ve Hareket” ünitesindeki belli kazanımlar ile eşleştirilmiştir. Böylece öğretmenlerin Bilim Merkezi’ne gezilerini kolaylıkla dersleriyle ilişkilendirebilecekleri düşünülmektedir. Kitapçığın birinci ekinde bu dört deney ünitesinin açıklaması, öğretim programındaki kazanımlarla ilişkileri ve *Bilim Merkezi Öğrenme Aracı*’nda öğrencilerin o deney ünitesi ile ilgili kazanımları yer almaktadır.

Bilim Merkezi Öğrenme Aracı **üç bölümden oluşmaktadır:**

Bölüm-1: Bilim Merkezi Gezisine Hazırlık

Bilim Merkezi'ne hazırlık aşamasında öğretmenin kullanabileceği iki temel materyal bulunmaktadır.

1. **PowetPoint Sunum (kitapçığın ikinci eki): Öğrencileri Bilim Merkezi gezisine ve gezi bağlamında yapılacak etkinliklere hazırlamak amacıyla kullanılabilir. Kesinlikle Bilim Merkezi gezisi öncesinde yapılması önerilmektedir.**

2. **Öğretmen El Kitabı: Öğretmenin Bilim Merkezi'ne gezi bağlamında yararlanması amacıyla tasarlanmıştır. Gezi öncesi, gezi süresinde ve sonrasında gerçekleştirilecek tüm etkinlikler açıklamalarıyla birlikte bu rehber kitapta bulunmaktadır.**

Bölüm-2: Bilim Merkezi Gezisi

Gezi başlamadan önce, öğretmen, öğrencilerine gezinin bu aşamasında kullanılacak çalışma kağıtlarını (kitapçığın üçüncü eki) dağıtmalıdır. Öğrenciler, gezi süresince çalışma kağıtlarının doldurulup, gezi tamamlandıktan sonra öğretmene geri verilmesi gerektiği konusunda yönlendirilmelidir.

Ayrıca, aracın amacına uygun olarak seçilen deney üniteleri ile ilgili geliştirilen "eğlen ve öğren kartları" (kitapçığın dördüncü eki) geziden önce rehberlere öğretmen tarafından verilmelidir. Böylece, rehberler deney ünitelerini açıklarken öğrencilere o deney ünitesiyle ilgili kartı dağıtabilirler.

1. **Bilim Merkezi Gezisine Yardımcı Çalışma Kağıdı: Öğrencilerin "Kuvvet ve Hareket Ünitesi" ile ilgili deney ünitelerini daha iyi anlayabilmeleri, bu ünitelerin altında yatan fen ilkelerini yorumlayabilmeleri için geliştirilen çeşitli sorulardan oluşmaktadır.**
2. **"Eğlen ve Öğren" Kartları: Öğrencilerin, "Kuvvet ve Hareket Ünitesi" ile ilgili deney üniteleri hakkında daha fazla bilgiye sahip olmaları amacıyla geliştirilmiştir.**

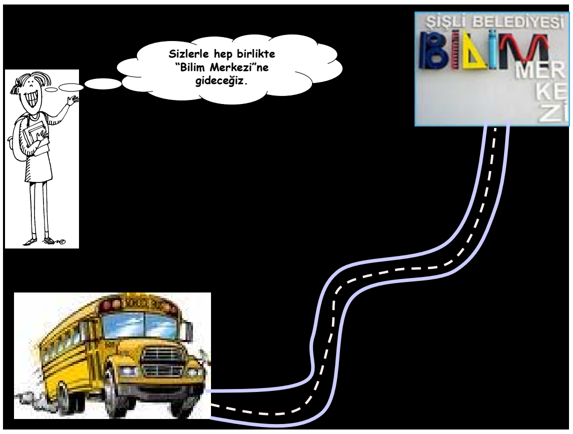
Bölüm-3: Bilim Merkezi Gezisi Sonrası

Öğrencilerin Bilim Merkezi'ne gezi sırasındaki öğrenme ve deneyimlerinin ders içi öğrenmeler ile ilişkilendirilmesi ve Bilim Merkezi'ndeki deneyimlerin daha anlamlı hale getirilmesi için tasarlanmıştır.

1. **Tanıtım ve Tasarım Görevleri (kitapçığın beşinci eki): Öğrencilerin Bilim Merkezi'ndeki 4 deney ünitesini kullanarak günlük yaşantıdaki bazı problemleri çözmelerini hedefleyen görevlerdir. Öğrenciler gruplar halinde çalışarak kendi gruplarına verilen görevi gerçekleştirmeye çalışacaktır. Görevler gerçekleştirildikten sonra her gruptan çalışmalarını diğer gruplarla sözlü ya da poster sunumu yoluyla paylaşması istenecektir.**

2. **Sunum Kontrol Listesi (kitapçığın altıncı eki): Öğrencilerin sunumlarını belli bir takım kriterler çerçevesinde hazırlayabilmesi için geliştirilmiştir. Böylece gruplardan nasıl bir sunum yapmaları beklendiği daha açık ve net bir biçimde ortaya konmuş olacaktır.**

APPENDIX C: PRESENTATION FOR THE PRIOR ORGANIZATION OF THE VISIT



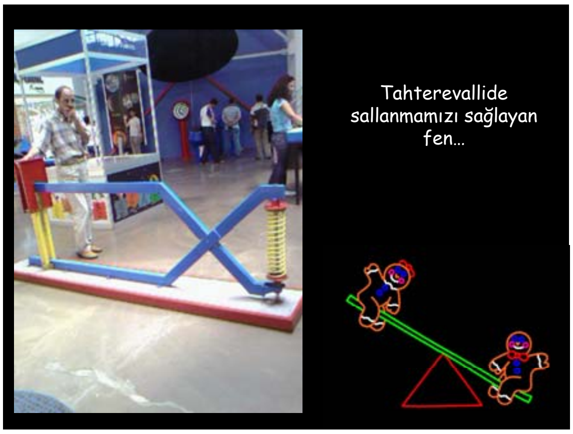

Kuvvet ve Hareket Ünitesi'nde işlediğimiz konuları hatırlamak
Deney ünitelerinin yardımıyla sınıfta öğrendiğimiz kavramların somut gözlemlerini yapmak
Okul dışı öğrenme ortamı olarak "Bilim Merkezi"ni kullanarak fen derlerimizi daha eğlenceli hale getirmek


Bilim Merkezi'nde Neler Göreceğiz?


Eğik düzlemde cisimlerin hareketini gösteren deneyler


Dünya
Merkür
Ay
Mars
Jüpiter
Güneş Sistemi'ne kısa bir gezinti…


Newton'un salıncağında topların hareketi…


Tahterevallide sallanmamızı sağlayan fen…


Ve daha pek çoğu…

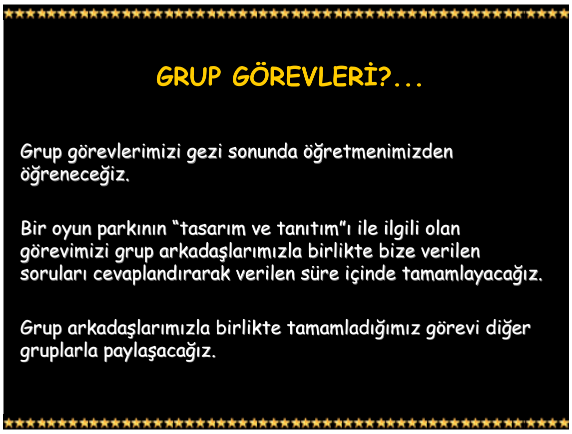

Bilim Merkezi'nde Neler Yapacağız?
ÇALIŞMA PLANIMIZ


1. Çalışma gruplarını oluşturalım
2. Merkeze gidelim
3. Çalışma kağıtlarımızı öğretmenimizden alalım
4. Merkezi gezelim
5. Çalışma kağıtlarımızı doldurup öğretmenimize geri verelim
6. Grupça öğretmenimizden görevlerimizi alalım
7. Grup çalışmalarına başlayarak görevlerimizi tamamlayalım
SON. Grup çalışmamızı sunalım


ÇALIŞMA GRUPLARI?...
Bilim Merkezi'ne gezi öncesi 4 grup oluşturacağız.
Gezi sırasındaki ve sonrasındaki çalışmalarımızın çoğunu bu grupla yürüteceğiz.


ÇALIŞMA KAĞITLARI?...
Gezi öncesi her birimiz öğretmenimizden ayrı bir çalışma kağıdı alacağız.
Çalışma kağıtlarımızı gezi sırasında bireysel olarak cevaplandıracağız.
Gezi sonrası çalışma kağıdımızı öğretmenimize teslim edeceğiz.


BİLİM MERKEZİ'NDE GEZİ?...
Bilim Merkezi'ndeki abla ve ağabeyler bizleri gruplar halinde deney ünitelerinin her biri hakkında bilgi vererek gezdirecek.
Gezi sırasında deney üniteleriyle ilgili aklımıza takılan soruları sormakta serbest olacağız.
Gezi sırasında ya da sonrasında çalışma kağıtlarımızı doldurabileceğiz.
Bilim merkezinde koşmak uygun bir davranış değildir.
Deney düzenekleri hakkında bilgi verilirken dinlemeye özen göstermeliyiz.


GRUP GÖREVLERİ?...
Grup görevlerimizi gezi sonunda öğretmenimizden öğreneceğiz.
Bir oyun parkının "tasarım ve tanıtım"ı ile ilgili olan görevimizi grup arkadaşlarımızla birlikte bize verilen soruları cevaplandırarak verilen süre içinde tamamlayacağız.
Grup arkadaşlarımızla birlikte tamamladığımız görevi diğer gruplarla paylaşacağız.


GRUP GÖREVİMİZ
Tanıtım ve Tarasım Görevleri ne demek?
İstanbul'da Dünya'nın en büyük ve en özgün oyun parklarından biri kurulmaktadır. Parktaki alanların her biri ustalıkla planlanmakta; tüm ayrıntıları düşünülerek inşa edilmektedir. Oyun parkının sahiplerinin en çok önem verdiği oyun parkındaki tüm oyuncakların bilimsel bir çerçevede tasarlanmasıdır. İşte bu aşamada sizlere ihtiyaç duyulacaktır:
Oyun parkının mimarları karşılaştıkları bir takım problemlere sizlerle paylaşacak, çözüm bulmakta sizlerden yardım isteyecektir. Bu problemlerin fen ilkelerine dayandırılarak çözülmesi önem taşımaktadır.
Oyun parkının sahipleri parktaki çeşitli oyun alanlarını tanıtan reklam afişleri oluşturmanızı isteyecek, tanıtılan oyun alanlarının açıklamalarında fen prensiplerine göre yapmanız önem taşıyacaktır.


GRUP GÖREVİMİZ
Tanıtım ve Tasarım Görevlerimiz Neler Olacak?
1. Eğlence Havuzu
2. Tahterevalli
3. Neşeli Fok'un Topları
4. Gezegen Alanı


GRUP GÖREVİMİZ
Tanıtım ve Tasarım Görevlerimizi Nasıl Tamamlayacağız?
EĞLENCE HAVUZU
Görevin tanıtımına giriş sayfası
Görev olarak problemin sunulduğu sayfa
Görevle ilgili yanıtlanması gereken soruların bulunduğu sayfa


GRUP ÇALIŞMALARI?...
Grup olarak ders dışında bir araya gelerek öğretmenimizin verdiği görevleri tamamlayacağız.
Gruplar görevlerini verilen süre içinde tamamlayacak ve belirtilen zamanda diğer gruplara sunacak.


GRUP SUNUMLARI?...
Grup çalışmalarımızı sözlü ya da poster olarak sunacağız.
Sunumlarımızı hazırlarken "kontrol listesi"nden yararlanacağız.


HOS VE BOL
ÖGRENMELERLE DOLU
BIR GEZI OLMASI
DILEGIYLE...

APPENDIX D: WORKSHEET

AD-SOYAD: ....

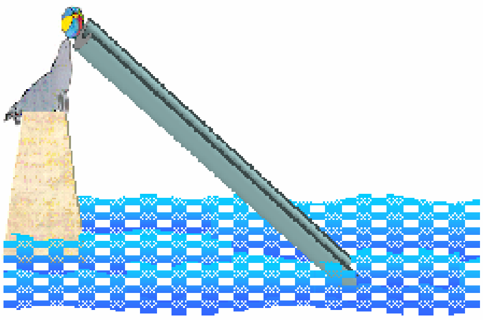
Sınıf: ....

BİLİM MERKEZİ GEZİSİ ÇALIŞMA KAĞIDI

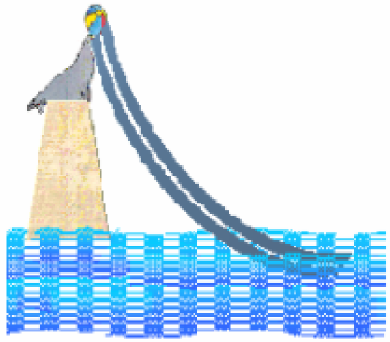
1. ***Fok topu kaydıraktan aşağı bıraktığında en kısa sürede havuza düşmesi isteniyor.***

i. Sence top hangi kaydırakta havuza en kısa sürede düşer?

A)



B)



ii. Bu soruyu cevaplandırırken Bilim Merkezi'ndeki hangi deney ünitesinden yararlandın?

....

iii. Sence bu deney ünitesi ile anlatılmak istenen kavram/olaylar nelerdir? *(Okulda "Kuvvet ve Hareket Ünitesi" nde işlediklerinizi dikkate alarak cevaplandırabilirsin.)*

....

....

2. ***Küçük bir fare ile maymunun bir tahterevallide dengede durması gerekiyor.***

i. Bu tahterevallinin denge noktası nerede olmalıdır?

A) Fareye daha yakın olmalı

B) Maymuna daha yakın olmalı

C) Fare ile maymunun tam ortasında olmalı

ii. Bu soruyu cevaplandırırken Bilim Merkezi'ndeki hangi deney ünitesinden yararlandın?

....

iii. Sence bu deney ünitesi ile anlatılmak istenen kavram/olaylar nelerdir? *(Okulda "Kuvvet ve Hareket Ünitesi'nde işlediklerinizi dikkate alarak cevaplandırabilirsin.)*

....

....

3.

i. Eğer farklı gezegenlere gidebilseydi 120 kg'lık yavru bir fil aşağıdakilerden hangisinde en ağır olurdu?

A) Jüpiter

B) Merkür

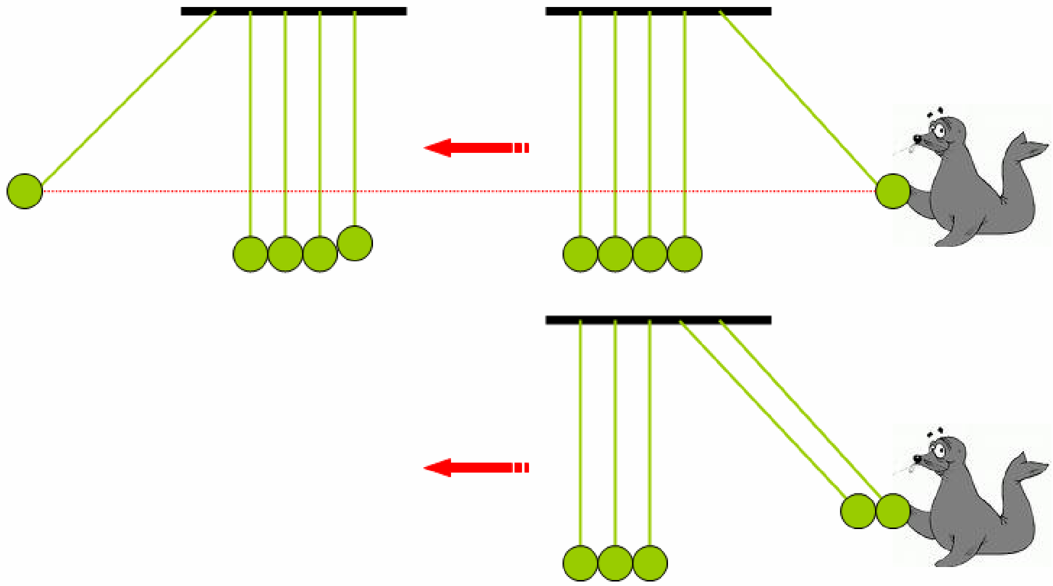
C) Mars

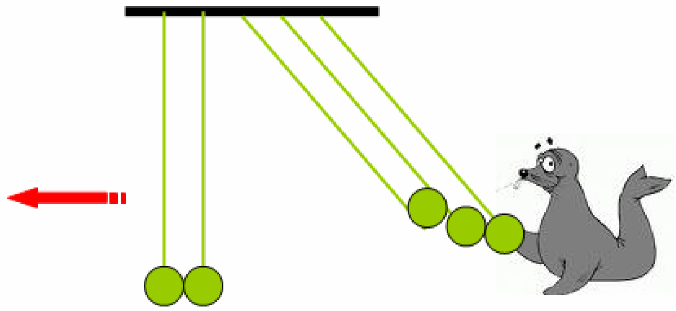
ii. Bu soruyu cevaplandırırken Bilim Merkezi'ndeki hangi deney ünitesinden yararlandın?

iii. Sence bu deney ünitesi ile anlatılmak istenen kavram/olaylar nelerdir? *(Okulda "Kuvvet ve Hareket Ünitesi'nde işlediklerinizi dikkate alarak cevaplandırabilirsin.)*

4. Aşağıda özdeş topların aynı yükseklikten asılmasıyla oluşturulan bir düzeneğin resmini görüyorsunuz. Fok toplardan birini belli bir yüksekliğe kadar çekip sonra serbest bıraktığında bu top diğerlerine çarpıyor ve diğer uçtaki ilk top aynı yükseklikte dışa fırlıyor.

i. Fok daha fazla sayıda topu çekip bıraksa ne olur? Çizerek gösterin.



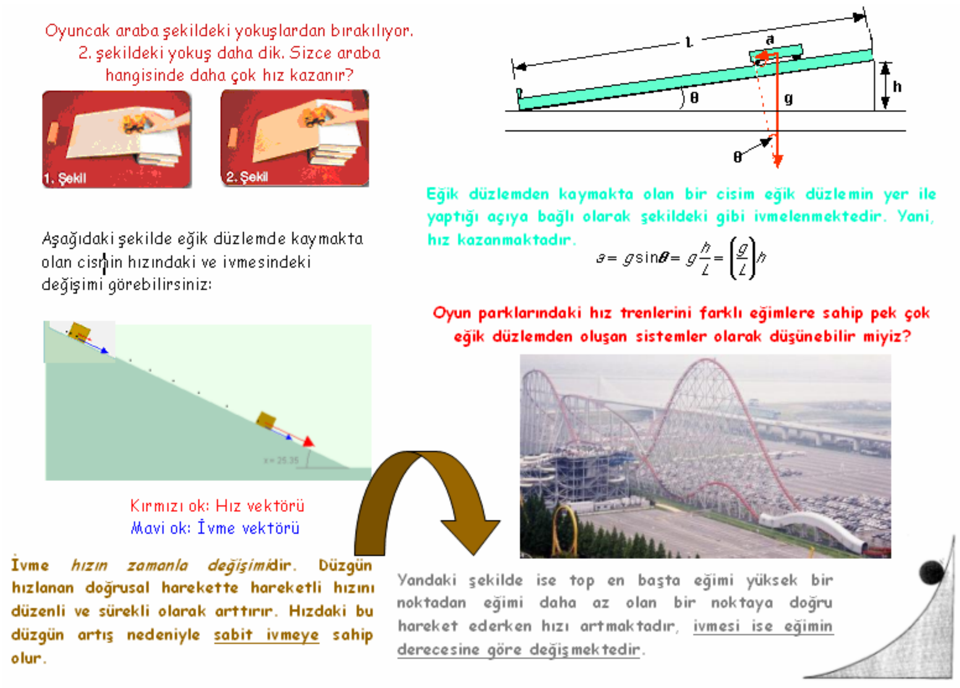


ii. Çizimlerini yaparken Bilim Merkezi'ndeki hangi deney ünitesinden yararlandın?

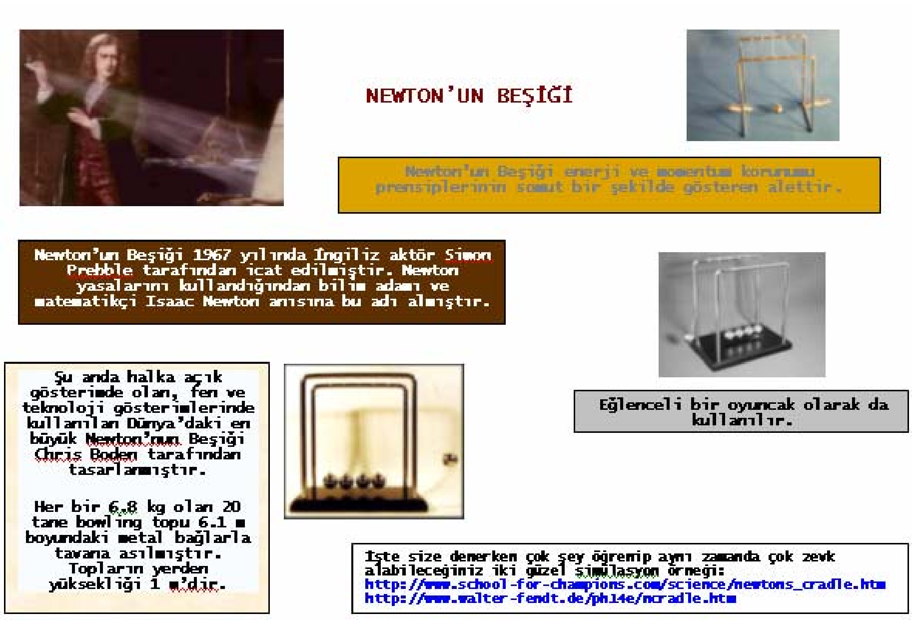
iii. Bu deney ünitesi ile açıklanmak istenen kavram/olaylar nelerdir? *(Okulda "Kuvvet ve Hareket Ünitesi'nde işlediklerinizi dikkate alarak cevaplandırabilirsin.)*

APPENDIX E: ENJOY & LEARN CARDS

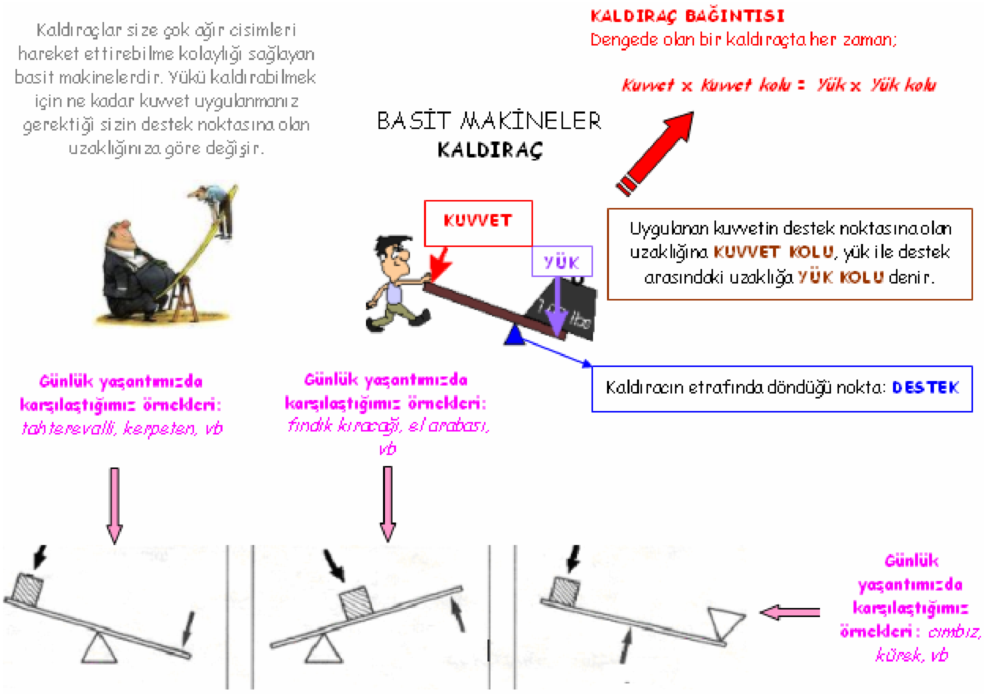
The Card about the "Express Road" Exhibit



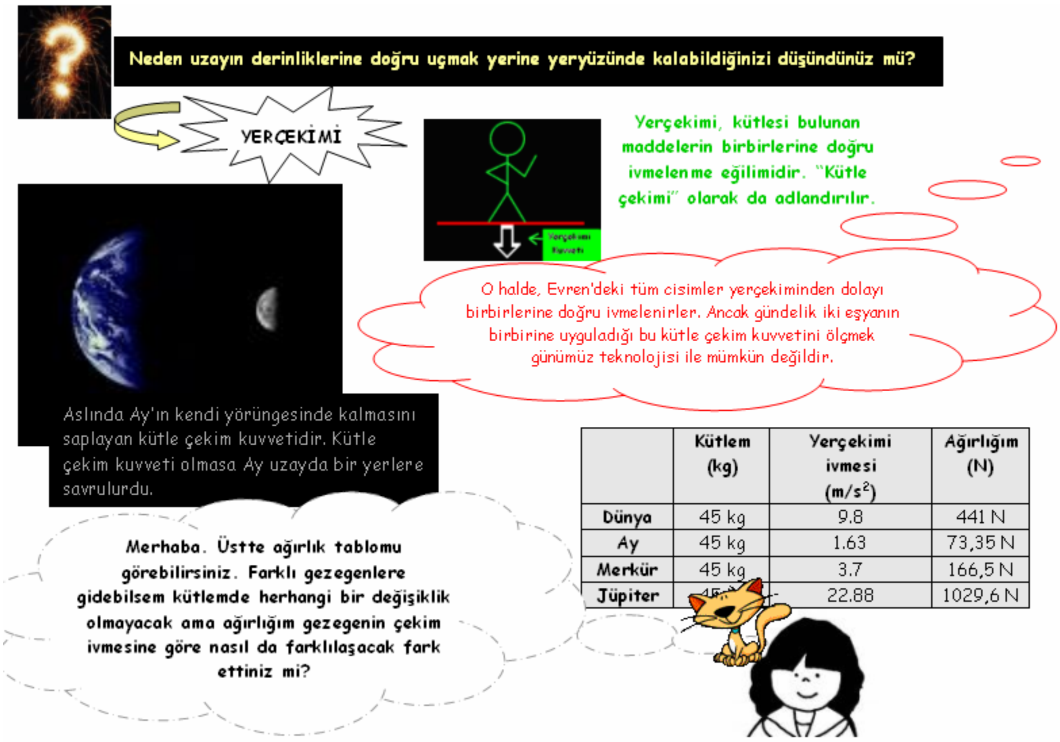
The Card about the "Transfer of Momentum" Exhibit



The Card about the "Giant Scissor" Exhibit



The Card about the "Your Weight in the Space" Exhibit



APPENDIX F: AUTHENTIC TASKS

TASARIM & TANITIM GÖREVLERİ

İstanbul'da Dünya'nın en büyük ve en özgün oyun parklarından biri kurulmaktadır. Parktaki alanların her biri ustalıkla planlanmakta; tüm ayrıntıları düşünülerek inşa edilmektedir. Oyun parkının sahipleri oyun parkındaki tüm oyuncakların bilimsel bir çerçevede tasarlanmasına çok önem vermektedir. İste bu aşamada sizlere ihtiyaç duyulacaktır:

1. Oyun parkının mimarları karsılaştıkları bir takım problemlere sizlerle paylaşacak, çözüm bulmakta sizlerden yardım isteyecektir. Bu problemlerin fen ilkelerine dayandırılarak çözülmesi önem taşımaktaktadır.
2. Oyun parkının sahipleri parktaki çeşitli oyun alanlarını tanıtan reklam afisleri oluşturmanızı isteyecek, tanıtılan oyun alanlarının açıklamalarında fen prensiplerine göre yapmanız önem taşıyacaktır.

Bu oyun parkının diğer pek çok oyun parkından farklı olarak bir takım kahramanları da var. Bunlar:

- ☼ Neşeli Fok
- ☼ Minik Fare
- ☼ Heyecanlı Fil
- ☼ Meraklı Sincap

GÖREV–1
EĞLENCE HAVUZUNDA BIR KAYDIRAK

İstanbul'da Dünya'nın en büyük ve en özgün oyun parklarından biri kurulmaktadır. Parktaki alanların her biri ustalıkla planlanmakta; tüm ayrıntıları düşünülerek inşa edilmektedir. Oyun parkının sahipleri oyun parkındaki tüm oyuncakların bilimsel bir çerçevede tasarlanmasına çok önem vermektedir. İste bu aşamada sizlere ihtiyaç duyulacaktır.

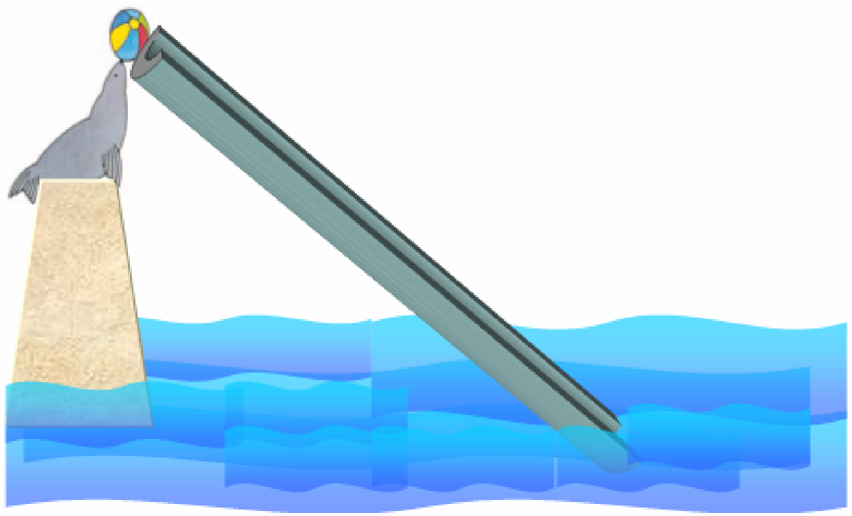
Oyun parkına bir eğlence havuzu yapılması planlanmaktadır. Eğlence havuzunda olmazsa olmazlardan biri de havuzun içine doğru uzanan bir kaydırak.

Oyun parkının mimarları tasarım sırasında karşılaştıkları bir probleme çözüm üretip, bu çözüme göre bir kaydırak planlamak zorundadır.

Sizden bu probleme çözüm üreterek oyun parkının mimarlarına yardım etmeniz talep edilmektedir.

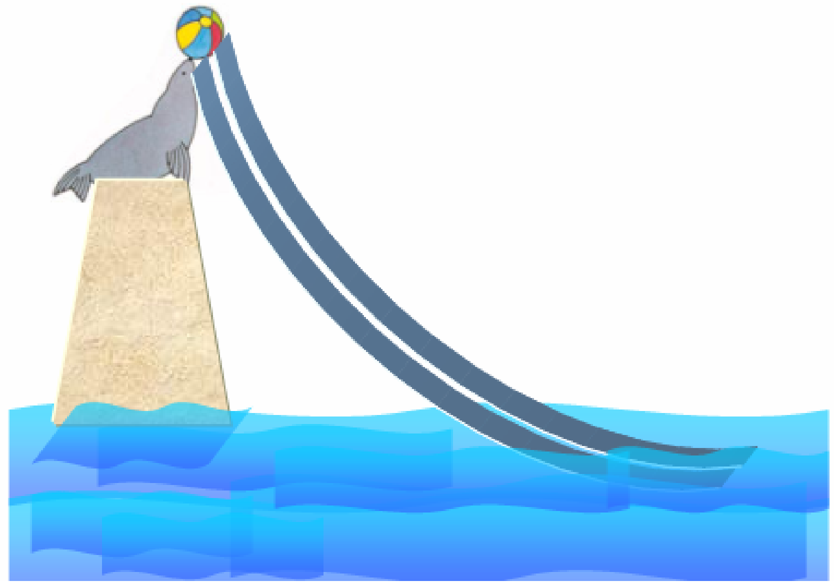
Oyun parkına inşa edilecek eğlence havuzundaki kaydırakta oyun parkının kahramanlarından "Neşeli Fok" topuyla birlikte çeşitli gösteriler sergileyecektir.

Neşeli Fok topu kaydıraktan aşağı bıraktığında topun hızlı bir biçimde havuza düşmesi istenmektedir.



Sizce top havuza hangi kaydırakta en kısa sürede düşer?

Oyun parkının mimarlarına karşılaştıkları bu probleme çözüm olduğunu düşündüğünüz hangi kaydırağı tercih etmelerini önerirsiniz?



1) Oyun parkının mimarlarının problemine çözüm üretirken yalnızca hangi kaydırağı tercih etmeleri gerektiğini önermeniz yeterli değil.

Sizden önerdiğiniz kaydırağı tercih etme sebebinizi savunan bir açıklama da beklemektedir. Buna göre,

a. Sizce hangi kaydırağı tercih etmeliler?

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b. Neden? (Lütfen tercihinizi hangi fen ilkelerini temel alarak yaptığınızı belirterek nedenleriyle birlikte açıklayınız.)

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2) Bu problemi çözerken Bilim Merkezi'nde gördüğünüz hangi düzenekten yararlandınız?

....

a. Sizce bu düzenekte açıklanmak istenen nedir?

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3) Bu düzenek size okulda "Kuvvet ve Hareket Ünitesi" nde işledikleriniz arasından en çok hangi kavram/olayı hatırlattı? Neden?

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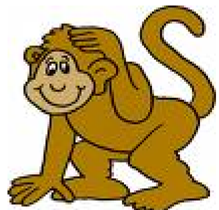
GÖREV-2
TAHTEREVALLİ

İstanbul'da Dünya'nın en büyük ve en özgün oyun parklarından biri kurulmaktadır. Parktaki alanların her biri ustalıkla planlanmakta; tüm ayrıntıları düşünülerek inşa edilmektedir. Oyun parkının sahipleri oyun parkındaki tüm oyuncakların bilimsel bir çerçevede tasarlanmasına çok önem vermektedir. İste bu aşamada sizlere ihtiyaç duyulacaktır.

Oyun parkında olması istenilenlerden biri de Minik Fare ve Sevimli Maymun'un Oyun Parkı'nın açıldığı gün konuklara pek çok gösteriyi sergileyecekleri bir tahterevalli.

Minik Fare ve Sevimli Maymun gösteri sırasında tahterevalli üzerinde birlikte dengede kalıp izleyicilere hoş anlar yaşatacaklar. Bunun için özel bir tahterevalli tasarımı gerekmektedir.

Minik Fare



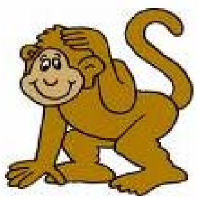
Sevimli Maymun

Oyun parkının sahipleri en güzel tahterevalli tasarımını oyun parkında kullanılacaklarını belirtiyorlar.

Sizin tasarımınızın oyun parkında kullanılması için belirtilen kriterlere uygun bir tahterevalli tasarlamaya çalışın.

Gösteri sırasında oyun parkının kahramanlarından "Minik Fare" ve "Sevimli Maymun" un 2010 m uzunluğundaki bir tahterevallide dengede durması gerekiyor. Minik fare 1 N, Sevimli Maymun da 200 N olduğuna göre Sevimli Maymun ve Minik Fare bu tahterevallide nasıl oturarak dengede kalabilirler?

Minik Fare



Sevimli Maymun

Tasarımınızın oyun parkında kullanılabilmesi için,

1) Lütfen tasarladığınız tahterevalliyi çizerek gösteriniz.

2) Lütfen neden böyle bir tasarım yaptığınızı destekleyen bir açıklama yapınız. Açıklamanızda aşağıdaki soruları da cevaplandırınız.

   a) Destek noktası Minik Fare'den ve Sevimli Maymun'dan ne kadar uzaklıkta olmalıdır? Uzunlukları çizimlerinize mutlaka ekleyin.

   b) Destek noktası kime (Minik Fare ya da Sevimli Maymun) daha yakın olmalıdır? Neden?

1) Tahterevalliyi tasarlarken bilim merkezinde gördüğünüz hangi düzenekten yararlandınız?

....

a. Sizce bu düzenekte açıklanmak istenen nedir?

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2) Okulunuzda Fen ve Teknoloji Dersi'nde işlediklerinize göre bu tahterevallinin çalışma prensibini hangi konu/kavram/formül ile açıklayabilirsiniz?

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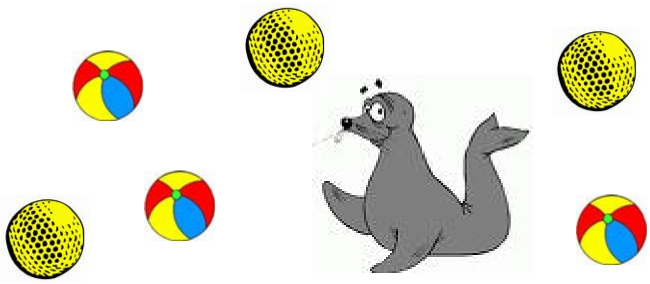
GÖREV-3

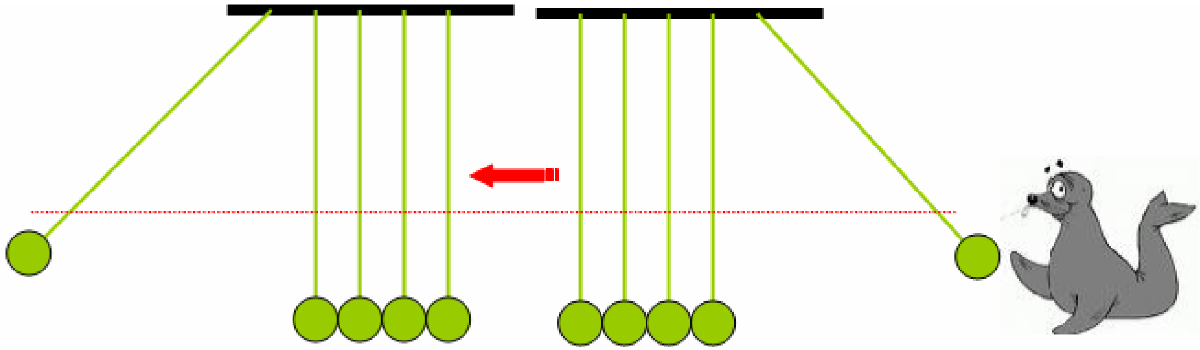
NESELI FOK'UN TOPLARI

İstanbul'da Dünya'nın en büyük ve en özgün oyun parklarından biri kurulmaktadır. Parktaki alanların her biri ustalıkla planlanmakta; tüm ayrıntıları düşünülerek inşa edilmektedir. Oyun parkının sahipleri oyun parkındaki tüm oyuncakların bilimsel bir çerçevede tasarlanmasına çok önem vermektedir. İste bu aşamada sizlere ihtiyaç duyulacaktır.

Oyun parkının mimarlarının tasarladığı özgün alanlarından biri de "Neşeli Fok'un Topları Alanı"dır. Neşeli Fok toplarla oynamayı çok seviyor. Bunu dikkate alan mimarlar, oyun parkını ziyaret eden çocukların Neşeli Fok ile birlikte oynayabileceği bir alan tasarlamışlar. Ancak tasarlama aşamasında bir problemle karsılaşmışlar, bu probleme çözüm bulamadıklarından sizlere ihtiyaçları var.



Neşeli Fok



Neşeli Fok şekildeki gibi toplardan birini belli bir yüksekliğe kadar çekip bırakınca diğer uçtaki ilk top aynı yükseklikte havaya sıçrıyor. Peki, Neşeli Fok birden fazla top çekip bırakınca ne olacak?

I. Bir uçtan çekip bıraktığı kadar top diğer uçtan aynı yüksekliğe kadar sıçrayacak

II. Diğer uçtaki en son top artan bir hızla daha yükseğe fırlayacak.

Sizce oyun parkının çelişkiye düştüğü bu iki durumdan (I ve II) hangisi olacak? ....

1) Oyun parkının mimarlarının çözüm bulamadığı bu problem ile ilgili çözüm önerinizi onlara açıklarken, lütfen cevabınızı çizimlerinizle birlikte ayrıntılı bir biçimde yazmaya özen gösterin.

a) Neşeli Fok iki top çekip bıraktığında ne olur? Neden?

b) Neşeli Fok üç top çekip bıraktığında ne olur? Neden?

c) Neşeli Fok dört top çekip bıraktığında ne olur? Neden?

2) Oyun parkının mimarlarının sizin bulduğunuz çözüme ikna olabilmesi için onlara bilimsel bir açıklama yapmanız da gerekmektedir. Bu sebeple çözümünüzü hangi fen ilkelerine dayandırdığınızı mutlaka belirtiniz.

1) Oyun parkının mimarlarının sizden çözmenizi istediği probleme çözüm üretirken bilim merkezinde gördüğünüz hangi düzenekten yararlandınız?

....

a. Sizce bu düzenekte açıklanmak istenen nedir?

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....

....

2) Okulunuzda Fen ve Teknoloji Dersi'nde "Kuvvet ve Hareket Ünitesi"nde işlediklerinize göre Neşeli Fok'un toplarının hareketini hangi konu/kavram ile açıklayabilirsiniz?

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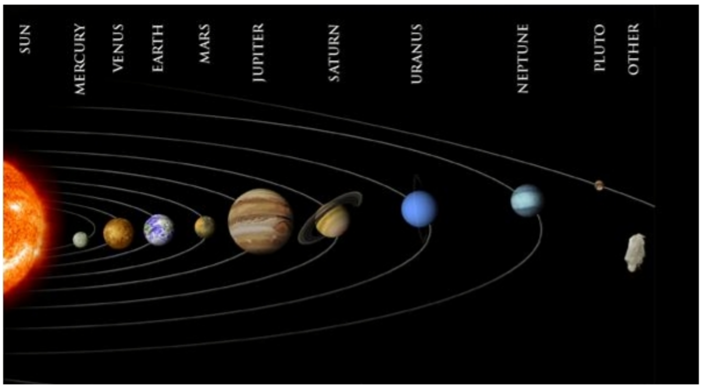
GÖREV-4

GEZEGEN ALANI



İstanbul'da Dünya'nın en büyük ve en özgün oyun parklarından biri kurulmaktadır. Parktaki alanların her biri ustalıkla planlanmakta; tüm ayrıntıları düşünülerek inşa edilmektedir. Oyun parkının sahipleri oyun parkındaki tüm oyuncakların bilimsel bir çerçevede tasarlanmasına çok önem vermektedir. İste bu aşamada sizlere ihtiyaç duyulacaktır.

"Gezegen Alanı" oyun parkında tasarlanıp yapımı tamamlanan ilk özgün mekânlardan bir tanesidir. Su anda da bu alanın tanıtım afisleri hazırlanıyor.

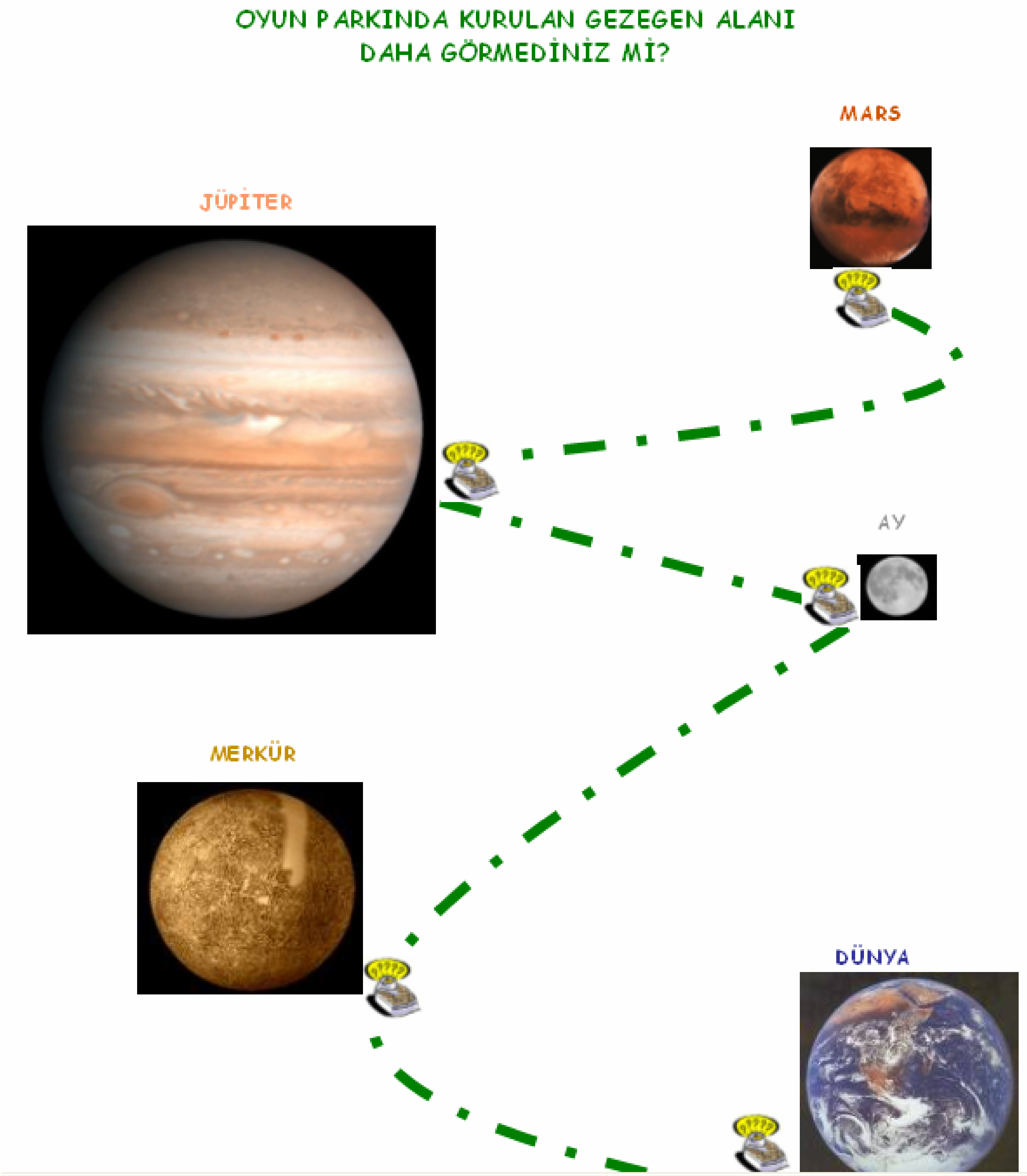
Bir reklâm yazarı tanıtım için çizimleri büyük ölçüde yapıp gerisini tamamlayamadan bırakmış. Oyun parkının sahipleri sizden bu eksik kalan tanıtım afisini tamamlamanızı istiyor.

Arka sayfada reklam yazarının eksik bıraktığı iki sayfadan oluşan bu afişi görebilirsiniz.

Reklam yazarı afişte oyun parkının iki kahramanı "Meraklı Sincap" ve "Minik Fare"yi reklamın ana karakterlerleri olarak kullanmış. Afişte Minik Fare Meraklı Sincap'a Oyun Parkı'nda arkadaşlarıyla birlikte neler yaptıklarından bahsetmektedir. Meraklı Sincap Minik Fare'ye Oyun Parkı'ndaki Gezegen Alanı ile ilgili çeşitli sorular sormaktadır.

Eksik bırakılan bu reklam afişini tamamlarken "Meraklı Sincap"ın sorularını yanıtlamanız büyük önem taşımaktadır!!! Oyun parkının sahiplerinin sizden "Meraklı Sincap'ın" sorularını dikkate alıp, bu soruların cevaplarını afişte kullanmanızı istemelerinin sebebi Meraklı Sincap gibi oyun parkını hiç görmemiş kişilerin de aklına benzer sorular gelebileceğini düşünmeleridir.

Lütfen "Gezegen Alanı"nı tanıtan bu reklâm afişini, oyun parkının sahiplerinin sizden istediği gibi Meraklı Sincap'ın sorularını yanıtlayarak tamamlayın.


OYUN PARKINDA KURULAN GEZEGEN ALANI
DAHA GÖRMEDİNİZ Mİ?
MARS
JÜPİTER
AY
MERKÜR
DÜNYA

1) Meraklı Sincap'ın sorusuna cevap ararken ve reklam afişini hazırlarken Bilim Merkezi'ndeki hangi düzenekten yararlandınız?

....

a. Sizce bu düzenekte açıklanmak istenen nedir?

....

....

....

....

....

....

....

....

2) Okulunuzda Fen ve Teknoloji Dersi'nde işlediklerinize göre sizce Sincap hangi konuyu anlayamamış olabilir? Onun sorusunu cevaplandırmak için hangi konu/kavram/formülü kullandınız?

....

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APPENDIX G: UNDERSTANDING OF THE BIG IDEAS QUESTIONNAIRE-FORCE&MOTION

KUVVET VE HAREKET: TEMEL KAVRAMLAR TESTİ

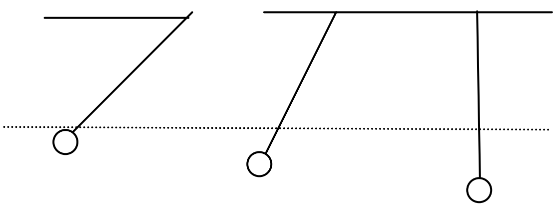
BÖLÜM–1

Lütfen aşağıdaki cümlelerde boş bırakılan yerlere uygun kelimeleri yazarak eksik kalan ifadeleri tamamlayınız.

1. Her gezegenin büyüklüğüne göre değişen bir yerçekimi ivmesi (g) olduğundan .... gezegene göre değişir. Ama .... uzayın her yerinde aynıdır.

2. Tahterevalli, basit makinelerden .... örnek olarak verilebilir.

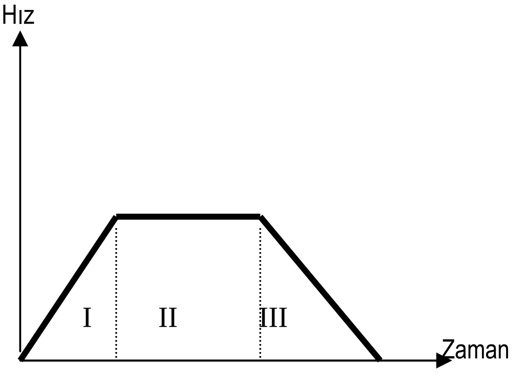
3. Aşağıdaki resim basit sarkacın hareketi ile birlikte enerji değişimini göstermektedir. Sarkacın başlangıçta sahip olduğu enerji şekildeki gibi değişmektedir.



PE= 10j	**PE= 2j**	**PE= 0j**
KE = 0j	**KE =........**	**KE = ...**

4. Çift taraflı bir kaldıraçta yük kolu kaldıraç uzunluğunun 3/5'i kadardır. Buna göre, 70 N'luk yük .... N'luk kuvvet ile dengelenebilir.

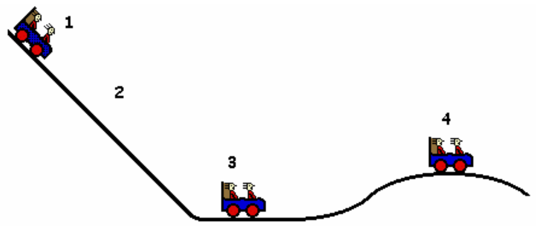
5. Hız



Şekilde hız-zaman grafiği verilen aracın .... no'lu aralık(lar)da kinetik enerjisi değişmiştir.

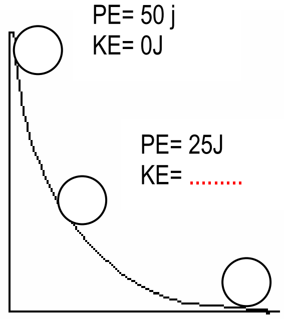
6. ...., kütlesi bulunan maddelerin birbirlerine doğru ivmelenme eğilimidir.

7. Aşağıda hız trenin farklı konumlarda numaralandırılmış şekli verilmiştir. Resme göre cümlelerdeki boşlukları doldurunuz.



........konumunda hız treninin potansiyel enerjisi, ...konumunda da kinetik enerjisi en büyüktür. 2 konumunda .... enerjisi azalır, ... enerjisi artar. .... konum(lar)nda trenin hem potansiyel hem de kinetik enerjisi vardır.

8. Sürtünmesiz eğik düzlem kaymakta olan topun sahip olduğu enerji ile ilgili boş bırakılan yerleri tamamlayınız.



BÖLÜM–2

Aşağıdaki cümlelerin başındaki boşluğa ifadenin doğru olduğunu düşünüyorsanız "D", yanlış olduğunu düşünüyorsanız "Y" yazınız.

.... **9.** Dünya'daki kütlesi 52 kg olan bir astronotun Mars'taki kütlesi 52 kg'dan daha azdır.

.... **10.** Eğer bir sürücü kullandığı arabanın hızını 2 kayına çıkarır, daha sonra da durmak için frene basarsa, arabayı durdurmak için gereken mesafe hızlanmadan önce durabileceği mesafenin 2 katı olacaktır.

.... **11.** Ağaçta duran bir elma potansiyel enerjiye sahiptir. Aynı daldaki büyük bir elma, hemen yanındaki daha küçük elmaya göre daha fazla potansiyel enerjiye sahiptir.

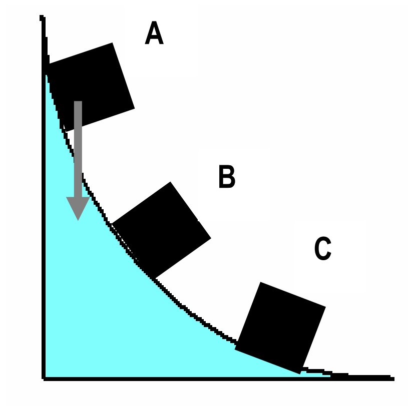
.... **12.** Hareketli bir cismin belli bir süre hızı değişmezse bu süre boyunca ivmesi sıfır olur.

.... **13.** Dünya'daki 52 kg kütleli bir cismin Ay, Mars ve Jüpiter'deki kütleleri sırasıyla 8.6kg, 18.6kg ve 122.9 kg olmasının sebebi her gezegenlerin sahip olduğu farklı yerçekimi ivmesidir.

.... **14.**

Yukarıdaki şekilde özdeş topların ipler yardımıyla tahta çubuğa asıldığı bir sistem görülmektedir. Bu sistemde en sağdaki iki top belli bir yüksekliğe kadar çekip bırakılırsa soldan diğer uçtaki en son top daha büyük bir hızla havaya yükselir. Bu yükseklik iki topun çekip bırakıldığı yükseklikten daha fazla olur.

15. ve 16. soruları aşağıdaki şekle göre cevaplandırınız.



.... **15.** Eğik düzlemin sürtünmesiz yüzeyinde kaymakta olan cisim en fazla ivmeye A noktasında sahiptir.

.... **16.** Eğik düzlemin sürtünmesiz yüzeyinde kaymakta olan cisim en az ivmeye C noktasında sahiptir.

.... **17.** Cismin hızı ivmesinin en az olduğu noktada en büyüktür.

BÖLÜM–3
Lütfen aşağıdaki eşleştirme sorularını yanıtlayınız.

A sütunundaki her bir tanım B sütunundaki kavram ya da olaya aittir. Bu tanımların hangi kavram ya da olaya ait olduğunu, sol taraftaki rakamların yanındaki boşluğa uygun harfleri yazarak eşleştirin.

18. Bir maddenin içerdiği madde miktarıdır.

19. Enerjinin bir formdan diğerine dönüşebileceğini; ancak yoktan var, vardan da yok edilemeyeceğini açıklayan kanundur.

20. Hızın zamana göre değişim hızı olarak tanımlanabilir.

21. Harekete karşı koyan, cismin kinetik enerjisinde azalmasına sebep olan kuvvete verilen isimdir.

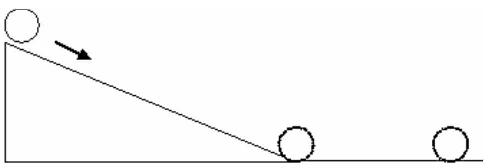
22. Her gezegenin birim kütleye uyguladığı yerçekimi kuvvetidir.

a.Kütle
b. Ağırlık
c. Sürtünme kuvveti
d. Potansiyel enerji
e. İvme
f. Enerjinin korunumu
g. Kinetik enerji
h. Kuvvet kazancı
i. Yerçekimi ivmesi

BÖLÜM–4
Aşağıdaki çoktan seçmeli soruları doğru olduğunu düşündüğünüz yalnızca bir şıkkı işaretleyerek yanıtlayınız.

23. Aşağıdaki bilgilerden hangisi yanlıştır?
A. Gezegenlerin çekim kuvveti Dünya'nın çekim kuvvetinden büyük olabilir.
B. Kütle her yerde aynıdır, değişmez.
C. Ekvatordan kutuplara gidildikçe ağırlık artar.
D. Bir cismin aydaki kütlesi, Dünya'daki kütlesinin altıda biridir.

24. ve 25. soruları aşağıdaki şekle göre cevaplandırınız.



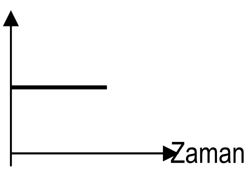
Top yatay ile $\alpha°$'lik açısı olan eğik düzlemden şekildeki gibi aşağıya doğru yuvarlanmaktadır.

24. Topun ivmesi eğik düzlemden aşağıya doğru kayarken,
A. azalmaktadır.
B. değişmez.
C. artmaktadır.

25. Eğik düzlem daha dik olsa, topun ivmesi,
A. daha fazla olur.
B. aynı kalır.
C. daha az olur.

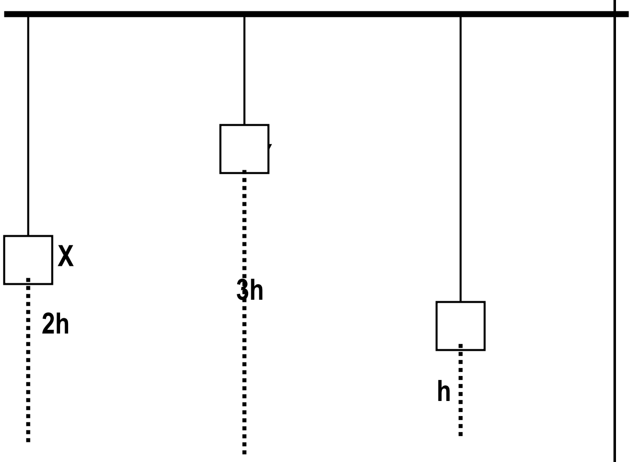
26. Aşağıdakilerden hangisi basit makinelerin kullanılış amaçlarından olamaz?
A. Kuvvetten kazanç sağlamak
B. Kuvvetin doğrultusunu değiştirmek
C. İşten kazanç saplamak
D. Yükü dengede tutmak

27. İvme, hızın birim zamandaki değişmesidir. Buna göre aşağıdaki grafik aşağıdaki hareketlerden hangisi için doğru olabilir?



A. Yüksekten düşen bir kutu
B. Otoyolda sabit hızla giden bir araba
C. Sabit hızla giderken ani fren yapan otobüs
D. Duran bir top

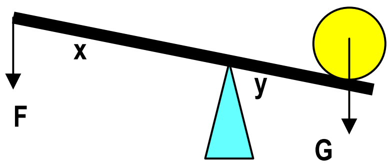
28.



İplerle tavana asılmış X, Y ve Z cisimleri şekildeki gibi dengededir. Cisimleri dengede tutan ipler kesildiğinde yere eşit büyüklükteki kinetik enerjilerle ulaştıklarına göre, cisimlerin kütleleri m_X, m_Y ve m_Z arasındaki ilişki aşağıdakilerden hangisindeki gibidir?

A. $m_X = m_Y = m_Z$
B. $m_Y > m_X > m_Z$
C. $m_Z > m_X > m_Y$
D. $m_X = m_Y > m_Z$

29. Ağırlığı önemsiz bir çubuk destek noktası üzerinde iken G ağırlıklı cisim F kuvveti ile dengede tutuluyor. F kuvvetinin şiddeti sabit kalmak şartıyla daha fazla yük dengelemek için hangi işlem yapılamaz?



A. x uzunluğunu arttırmak
B. y uzunluğunu azaltmak
C. Kuvveti çubuğa dik uygulamak
D. x ve y yi aynı oranda arttırmak

30. Kütle ölçümünde kullanılan eşit kollu terazinin çalışma prensibi aşağıdaki basit makinelerden hangisine benzer?

A. Eğik düzlem
B. Çıkrık
C. Makara
D. Kaldıraç

31. Aşağıdaki boşluklara yazılması gereken uygun ifadeler nelerdir?

I. Yüzeyi düz eğik düzlemlerde kayan cismin ivmesi ……………….
II. Yüzeyi eğimli eğik düzlemlerde kayan cismin ivmesi ……………….

A. değişir-sabittir
B. sabittir-değişir
C. değişir-değişir

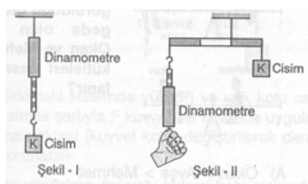
32. Aşağıda ağırlıkla belirtilenlerden hangisi yanlıştır?

A. Kütleye etki eden yerçekimi kuvvetidir.
B. Yerçekimi kuvveti azaldıkça ağırlık da azalır.
C. Ağırlık her yerde aynıdır, değişmez.

33. Şekildeki basit sarkacın bir süre sallandıktan sonra durmasının sebebi nedir?

A. Yerçekiminin basit sarkacın ucundaki topu aşağı doğru çekmesi
B. Rüzgârın topun hareketiyle aynı yönde esmesi
C. Topun bir süre sonra enerjisini kaybetmesi
D. Topun hava ile sürtünmesi

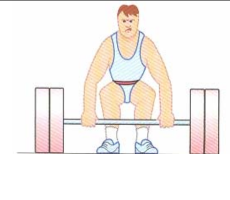
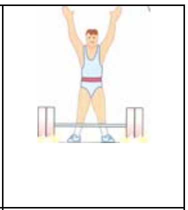
34.



Yukarıdaki sistemler dengededir. Şekil-I'deki dinamometrenin gösterdiği değer, Şekil-II'deki dinamometrenin gösterdiği değerden daha büyüktür.
Bu durum aşağıdakilerden hangisinin açıklamasında kullanılmaz?

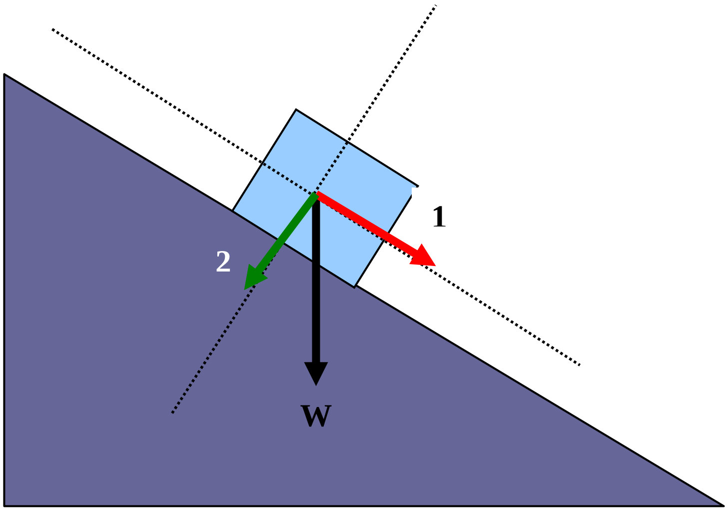
A. Bazı basit makineler kuvvetten kazandırır.
B. Büyük kuvvet gerektiren işler küçük bir kuvvetle yapılabilir.
C. Basit makineler cismin ağırlığını azaltır.
D. Basit makinler kuvvetin yönünü değiştirebilir.

35. Aşağıdaki şekilde boş bırakılan yerlerdeki enerji çeşitleri nelerdir?

				
Kimyasal enerji	Kinetik enerji	………………	………………	Isı enerjisi

A. Kinetik enerji-Kinetik enerji
B. Potansiyel enerji-Kinetik enerji
C. Kinetik enerji-Isı enerjisi
D. Kimyasal enerji-Kinetik enerji

36. soruyu aşağıdaki açıklamayı dikkate alarak cevaplandırınız.



Eğik düzlemin üzerindeki cismin ağırlığı W ile gösterilmektedir. Eğik düzlemin yüzeyinde koordinatları kesik çizgilerle belirtilmiştir.
1 no'lu ok *ağrılığın eğik düzleme paralel olan bileşenini göstermektedir, bu paralel kuvvet cismin eğik düzlemden aşağı doğru ivmelenmesine neden olmaktadır.*
2 no'lu ok *ağrılığın eğik düzleme dik olan bileşenini göstermektedir, bu kuvvet eğik düzlemin cisme uyguladığı tepki kuvveti ile dengededir.*

36.a) Buna göre cisim daha dik sürtünmesiz bir eğik düzlemin üzerine yerleştirilse, cismin ağırlığının eğik düzlemin yüzeyine paralel bileşeni (yukarıdaki şekildeki kırmızı ok),

A. daha büyük olur
B. aynı kalır
C. daha küçük olur

36.b) Buna göre cisim daha dik bir eğik düzlemin üzerine yerleştirilse, cisim eğik düzlemden

A. daha büyük bir ivme ile kayar.
B. daha küçük bir ivme ile kayar.
C. cismin ivmesi değişmez, aynı hızla kayar

APPENDIX H: TEST PLAN

Kazanımlar	Knowledge (Puan)	Application (Puan)	Toplam Puan	Olçüldüğü Sorular	Ait Olduğu Düzenek
Yerçekimi-Kütle-Ağırlık					
1. Yerçekimini tanımlayabilmesi	0.5+0,5		1	6, 22	4
2. Kütleyi tanımlayabilmesi	0,5		0,5	18	4
3. Ağırlığı tanımlayabilmesi	1		1	32	4
4. Farklı gezegenlerde aynı kütlenin neden farklı ağırlığa sahip olacağını açıklayabilmesi	1+1		2	9, 13	4
5. Kütle ile ağırlığı birbirinden ayırt etmesi	1	3	4	1, 23	4
Enerji					
6. Cisimlerin potansiyel enerjiye sahip olduğu durumları tespit edebilmesi	0.5+0,5		1	7, 7	3
7. Potansiyel enerjiyi etkileyen faktörleri belirtebilmesi	1		1	11	3
8. Cisimlerin kinetik enerjiye sahip olduğu durumları tespit edebilmesi	1+0,5+0,5		2	5, 7, 7	3
9. Kinetik enerjiyi etkileyen faktörleri belirtebilmesi		3	3	10	3
10. Cismin potansiyel enerjisinin kinetik enerjiye dönüştüğü durumları tespit edebilmesi	0,5		0,5	7	1,3
11. Cismin kinetik enerjisinin potansiyel enerjiye dönüştüğü durumları tespit edebilmesi	1 (10 ile 11)		1	34	3
12. Enerji korunumu nedir, açıklayabilmesi ve enerjinin korunduğu durumlara örnekler verebilmesi	1+1+1+0,5	3 (9, 10, 12)	6.5	3, 8, 14, 19, 28	1,3
13. Sürtünme kuvvetinin cismin sahip olduğu kinetik enerjide azalmaya sebep olduğunu açıklayabilmesi	0,5+1		1.5	21, 33	3
Basit Makineler/Kaldıraç					
14. Basit makinelerin kullanımı ile hayatımızı ne kadar kolaylaştırdığını fark etmesi	1	3	4	26, 36	2
15. Farklı tür kaldıraçlara günlük hayattan örnekler verebilmesi	0.5+1		1,5	2,30	2
16. Kaldıracın çalışma prensibini açıklayabilmesi	1	3	3	4, 29	2
Hız-İvme					
17. İvmeyi tanımlayabilmesi	0.5		0.5	20	1
18. Cismin ivmelendiği durumları tespit edebilmesi	1	3	4	12, 27	1
19. Eğik düzlemde eğimin cismin hızına etkisini fark edebilmesi	1	3	4	25, 35	1
20. Eğik düzlem boyunca ivmedeki değişimi yorumlayabilmesi	1+1	1	3	15, 16, 17	1
21. Sabit ve değişen ivmeli hareketleri ayırt edebilmesi	1	3	4	24	1
TOPLAM PUAN	25	25	50		

APPENDIX I: MODES OF LEARNING INVENTORY

ÖĞRENME DURUMLARI ÖLÇEĞİ

Bilim Merkezi'ndeki gezine göre aşağıdaki ifadelerin sana ne kadar uyduğunu "Evet hem de çok"**,** "Evet ama biraz"**,** "Hayır (pek değil)"**,** "Hayır hem de hiç" **şıklarından yalnızca birini işaretleyerek (x) belirtiniz.**

	Evet hem de çok	Evet ama biraz	Hayır (Pek değil)	Hayır hem de hiç
Bilmediğim şeyleri keşfettim.				
Bildiklerimle ilgili daha çok şey öğrendim.				
Bir süredir düşünmediğim şeyleri hatırladım.				
Bildiklerimi diğer insanlarla paylaştım.				
Bazı konulara karşı merakım arttı.				
Bazı konuların önemini hatırlatılmış oldum.				
Öğrendiklerim çok hoşuma gitti.				
Öğrendiklerimi tekrar hatırlamak hoşuma gitti.				
Daha çok öğrenmek hoştu.				
Hepsi bildiğim şeylerdi.				
Öğrendiğim bazı şeyler benim için çok yararlı olacak.				

APPENDIX J: UNDERSTANDING OF THE BIF IDEAS QUESTIONNAIRE

ANA FİKİRLERİ ANLAMA ÖLÇEĞİ

Aşağıdaki soruları Bilim Merkezi'nde gördüğünüz resmi verilen deney ünitelerini dikkate alarak cevaplandırınız

1. Bilim Merkezi'nde en çok ilgini çeken şey neydi? Onu senin için ilginç kılan neydi?

....

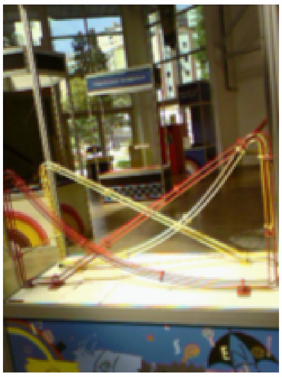
....

2. Bilim Merkezi'nde sana en anlamlı gelen deney ünitesi hangisiydi? Neden?

....

....

1. Aşağıdaki soruları altta resmi verilen Bilim Merkezi'ndeki "Ekspres Yol" adlı deney ünitesini dikkate alarak cevaplandırınız.



a. Aşağıdakilerden hangisi sana en uygun? (Yalnızca birini işaretleyin.)

- ☐ Deney ünitesine şöyle bir göz attım.
- ☐ Deney ünitesini dikkatlice inceledim.
- ☐ Deney ünitesini kendim de yaparak denedim

b. Sence bu deney ünitesinin vermek istediği esas mesajlar nedir?

....

....

3. Aşağıdaki soruları altta resmi verilen Bilim Merkezi'ndeki "Dev Makas" adlı deney ünitesini dikkate alarak cevaplandırınız.

a. Aşağıdakilerden hangisi sana en uygun? (Yalnızca birini işaretleyin.)

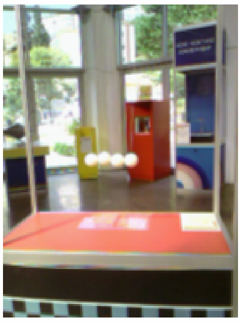
- ☐ Deney ünitesine şöyle bir göz attım.
- ☐ Deney ünitesini dikkatlice inceledim.
- ☐ Deney ünitesini kendim de yaparak denedim

b. Sence bu deney ünitesinin vermek istediği esas mesajlar nedir?

....

....

2. Aşağıdaki soruları altta resmi verilen Bilim Merkezi'ndeki "Momentum Transferi" adlı deney ünitesini dikkate alarak cevaplandırınız.



a. Aşağıdakilerden hangisi sana en uygun? (Yalnızca birini işaretleyin.)

- ☐ **Deney ünitesine şöyle bir göz attım.**
- ☐ **Deney ünitesini dikkatlice inceledim.**
- ☐ **Deney ünitesini kendim de yaparak denedim**

b. Sence bu deney ünitesinin vermek istediği esas mesajlar nedir?

....

....

4. Aşağıdaki soruları altta resmi verilen Bilim Merkezi'ndeki "Uzayda Kilonuz" adlı deney ünitesini dikkate alarak cevaplandırınız.

a. Aşağıdakilerden hangisi sana en uygun? (Yalnızca birini işaretleyin.)

- ☐ **Deney ünitesine şöyle bir göz attım.**
- ☐ **Deney ünitesini dikkatlice inceledim.**
- ☐ **Deney ünitesini kendim de yaparak denedim**

b. Sence bu deney ünitesinin vermek istediği esas mesajlar nedir?

....

....

"Öğrenme Durumları Ölçeği" ve "Ana Fikirleri Anlama Ölçeği" Prof. Dr. Dilek Ardaç ve Miray Tekkumru tarafından geliştirilmiştir.

APPENDIX K: QUESTIONS ON PRIOR SCIENCE CENTER EXPERINCES

Ad/Soyad: ....

Sınıf: ....

Lütfen aşağıdaki soruları cevaplayınız

1. **Daha önce bilim merkezine gelmiş miydin?**

   ☐ Evet ☐ Hayır

1. sorudaki cevabın "evet" ise:

2. **Bu geziyi diğerlerinden farklı buldun mu?**

   ☐ Evet ☐ Hayır

2. sorudaki cevabın "evet" ise:

3. **Sence bu geziyi öncekilerden farklı yapan nedir?**

....

....

2. sorudaki cevabın "evet" ise:

4. **Bilim Merkezi'ne önceki ziyaretlerin ile bu gelişin arasında bir karşılaştırma yapacak olursan en çok hangi gezi sırasında bir şey öğrendin?**

☐ Önceki gezilerde ☐ Bu gezide

APPENDIX L: PUBLIC SCHOOL STUDENTS’ OPINIONS ABOUT THE IMPLEMENTATION

- ✓ Çok güzeldi. Çok şey öğrendim. Ama bazı soruların cevabını merak ediyorum.
- ✓ Bence slayt şeklinde hazırlanması güzel oldu. Görevleri çok beğendim. Kendi görevimi de çok güzel yaptım. Bilim merkezi çok güzeldi.
- ✓ Testlerin uygulanmasını sevmedim bilim merkezinde rehberlik olmasını sevdim, sizin verdiğiniz projeyi yapmak güzel ve zevkliydi.
- ✓ Bilim merkezine gittik ve çok zevkli geçti. Bilmediğim konuları daha iyi öğrenme fırsatını Miray abla bize sağladı. Ona çok teşekkürler. (thank you) Bir de boşuna gidip gelmedik. Geldiğimizde Miray abla bize zevkli testler verdi. Testlerle öğrenmemizi ve daha da kuvvetlenmesini sağladı. Teşekkürler Miray Abla
- ✓ Hepsi çok zevkliydi. Ama bazı sorular vardı ki çok kazıklardı. Grupça çok zorlandık. Bazen uykum geldi ama yine de eğlendim. Fenle ilgili farklı konularda değişik çalışmalar yaptık. Çok eğlendim ve keyif aldım. Teşekkürler Miray Ablacım :)
- ✓ Ben ilk önce Bilim Merkezi'ni çok beğendim. Ablamız bize eşlik etti. Bize sunum hazırladı. Bu bence çok harika oldu. Çünkü daha iyi öğrendik. Belki abla olmasaydı bazı şeyleri anlayamazdık.
- ✓ Bence geçen seneyle aynıydı testlerde çok sıkıcıydı ama en azından ders kaynadı bilim merkezide tıpa tıp aynıydı hiçbir yenilik yoktu
- ✓ Bence güzeldi gezi sırasında verilen çalışma kağıtlarını araştırırken daha iyi anladım. Bütün geziler umarım böyle olur.
- ✓ Bence bu gezi çok güzeldi. Ben daha önce gitmiştim ama deneyleri pek fazla inceleyememiştim. Şimdi hem daha güzel kavradım hemde bizi serbest bırakınca deneyleri deneme fırsatımız oldu. Test etkinlikleri de güzeldi.
- ✓ Bence bu gezi harikaydı. 5. sınıftaki gezide güzeldi ama öğretmen biz nereye gitsek yok şuna ellemeyin yok buna ellemeyin diyordu. Ama bu gezi daha güzeldi. Çünkü serbest kaldık. Çok eğlenceliydi. Ablaya çok teşekkür ederim.
- ✓ Bence ilk yapılan testler hem eğlenceli, hem de seviyemize göreydi. Ama bu test hem seviyemize uygun değil, hemde sıkıcıydı. Bir daha böyle bir yere gittiğimizde anket yapılmasını isterim, ama fen, sosyal, türkçe, matematik yani ders içerikli olmayan.

- ✓ Ben bu çalışmaları beğendim. Gitmeden önce ve gittikten sonra yapılan çalışmalar bizim ilerde unutmamamızı sağlar.
- ✓ Ben genellikle bir geziden sonra görüşleri yazıp anket uygulanması biraz şaşırtıcı. Ama güzel. Bizlerde olan ve orada öğrendiklerimizi pekiştirme fırsatı oluyor. Ayrıca biz bir geziye gittiğimizde orada öğrendiklerimizi hemen unutuyoruz. Bu bizim için daha kavrayıcı oldu. Teşekkürler.

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