A STUDY ON PROFESSIONAL DEVELOPMENT TOWARD SCIENCE CENTERS: CHANGE IN SCIENCE TEACHERS' AWARENESS ABOUT SCIENCE CENTERS AND WAYS OF CONDUCTING SCIENCE CENTER VISITS

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ABSTRACT

A STUDY ON PROFESSIONAL DEVELOPMENT TOWARD SCIENCE CENTERS: CHANGE IN SCIENCE TEACHERS' AWARENESS ABOUT SCIENCE CENTERS AND WAYS OF CONDUCTING SCIENCE CENTER VISITS

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The main aim of the current study was to reveal how the professional development (PD) program developed by "BİLMER Project: A Teacher and Explainer Professional Development Model to Increase the Effectiveness of Science Centers (SCs) in Science and Society Communication and Science Education" influences science teachers' awareness about SCs and their way of conducting a SC visit. Science teachers' way of conducting SC visit was examined in two dimensions: (1) changes in their strategies for conducting SC visit through the lenses of the researcher and (2) characteristics of PD program influencing their instructional planning regarding SC visit through the lenses of the science teachers. The design of this study was case study. Participants were selected purposefully through typical sampling approach. Data were collected through semi-structured interviews, observations and instructional plan. Both descriptive and content analysis were used to analyze the collected data. The results of the study revealed that introduction of SCs both through explainers' presentations and field trips to some of them, providing communication with explainers and presenting tabletop versions of some of exhibits during the PD

program contributed to teachers' awareness about SCs and their resources. Moreover, it was found that teachers' strategies for conducting SC visit has diversified in an extended manner after participating in the PD program. The results also suggested that there were seven different characteristics of the PD program influencing teachers' instructional planning regarding SC visit, which were curriculum connection, exchange of ideas, instructional plan, teaching techniques and methods, tabletop exhibits and emphasis on communication.

Keywords: informal setting, science center, professional development, science teacher, field trip

ÖZ

BİLİM MERKEZLERİNE YÖNELİK MESLEKİ GELİŞİM ÜZERİNE BİR ÇALIŞMA: FEN ÖĞRETMENLERİNİN BİLİM MERKEZLERİ HAKKINDAKİ FARKINDALIKLARINDAKİ VE BİLİM MERKEZLERİNE GEZİ DÜZENLEME YOLLARINDAKİ DEĞİŞİM

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Bu çalışmanın temel amacı; "BİLMER Projesi: Bilim Merkezlerinin Bilim-Toplum İletişiminde ve Bilim Eğitiminde Etkinliğini Arttırmaya Yönelik Bir Öğretmen ve Eğitmen Mesleki Gelişim Modeli" tarafından geliştirilen mesleki gelişim programının fen bilimleri öğretmenlerinin bilim merkezleri hakkındaki farkındalıklarını ve bilim merkezine gezi düzenleme yollarını nasıl etkilediğini ortaya koymaktır. Fen bilimleri öğretmenlerinin bilim merkezine gezi düzenleme yolları iki boyutta incelenmiştir: (1) araştırmacının gözünden öğretmenlerin bilim merkezi ziyaretini gerçekleştirmedeki stratejilerindeki değişiklik, (2) öğretmenlerin gözünden bilim merkezi ziyareti ile ilgili öğretim planlamasını etkileyen mesleki gelişim programının özellikleridir. Bu çalışmanın tasarımı durum çalışmasıdır. Katılımcılar tipik örnekleme yaklaşımıyla araştırmanın amacına yönelik seçilmiştir. Veriler yarı yapılandırılmış görüşmeler, gözlem ve öğretim planı ile toplanmıştır. Toplanan verileri analiz etmek için hem betimsel hem de içerik analizi kullanılmıştır. Araştırmanın sonuçları, mesleki gelişim programında (1) bilim merkezlerinin hem eğitmenlerin sunumları, hem de bazı bilim merkezlerine düzenlenen gezi yoluyla

tanıtılmasının, (2) bilim merkezi eğitmenleri ile iletişimin sağlanmasının ve (3) bazı sergilerin masa üstü versiyonlarının sunulmasının öğretmenlerin bilim merkezleri ve kaynakları hakkındaki farkındalıklarına katkıda bulunduğunu ortaya koymuştur. Bununla birlikte, öğretmenlerin bilim merkezi ziyaretini gerçekleştirken kullandıkları stratejilerinin mesleki gelişim programına katıldıktan sonra geniş bir şekilde çeşitlendiği görülmüştür. Ayrıca, mesleki gelişim programının öğretmenlerin bilim merkezi ziyareti ile ilgili öğretim planlamasını etkileyen, müfredat bağlantısı, fikir alışverişi, öğretim planı, öğretim teknikleri ve yöntemleri, masa üstü sergiler ve iletişime vurgu gibi yedi farklı özelliğinin olduğu bulunmuştur.

Anahtar Kelimeler: okul dışı öğrenme ortamları, bilim merkezi, mesleki gelişim, fen bilimleri öğretmeni, sınıf gezisi

To Myself, My Parents and My Beloved Husband

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LIST OF ABBREVIATIONS

METU	Middle East Technical University
MoNE	Ministry of National Education
PD	Professional Development
RQ	Research Question
SC	Science Center

CHAPTER 1

INTRODUCTION

In many developed countries, science education is seen to have a big trouble regarding the decline in the number of the students who choose to study science as career and at higher school level (Braund & Reiss, 2006b). In Turkey, Bozdoğan and Yalçın (2005) revealed that with increasing grade level (sixth to eight grade), there was a decrease in attitudes of students towards physics topic in the elementary science course. Similarly, university entrance exam results conducted by Measuring, Selection and Placement Centre (ÖSYM) between 2000 and 2014 showed that there is a decrease in percentages (from 85,63% to 38,23%) of the students who prefer STEM areas -science, technology, engineering and mathematics- (Akgündüz, Aydeniz, Çakmakçı, Çavaş, Çorlu, Öner, & Özdemir, 2015). The reason behind might be that current school science is generally boring, outdated and designed to only educate future scientists who constitute the minority of students (Braund & Reiss, 2006b); and science subjects are abstract and not related to everyday life (Laçin Şimşek, 2011). However, the goal of the science education should not be only to raise more scientists; it should be to raise a new generation of citizens who have scientific literacy and reasoning to comprehend new information acquired through the rapid improvements in science and technology in the twenty first century (Bozdoğan & Yalçın, 2009; Braund & Reiss, 2006b; Coombs, 1985). In this context, formal school settings can be supported by informal settings like science centers (Salmi, 2004) because these settings give students opportunity to examine scientific and technological developments (Quin, 1990) and engage in scientific reasoning using scientific language and tools (Fenichel & Schweingruber, 2010). Thus, it is reasonable to assert that informal science experiences might be used to advance students' science learning and in turn, their scientific literacy. Regarding the importance of informal learning context, Ellenbogen and Stevens (2005) revealed the following example approach: "eight to nine percent of a childhood is a great deal of

time for one single activity such as schooling… It is worth adding that in a life of seventy-five years, barely two percent of a person's time will have been spent in schooling. Other educational influences, such as home, community, media, and society must be considered in a complete survey of a person's learning experiences. Here in lies the importance of learning outside of school" (p.5). Moreover, Ellenbogen and Stevens (2005) reported that some children who are not successful in a formal environment like school may learn more effectively in informal settings. Therefore, science studies in the classroom might be complemented, supplemented, deepened, and enhanced by informal science education, as stated by National Science Teachers Association (NSTA, 1998). Thus, it is reasonable to put forward that schools and museums necessitate each other to create harmonious learning context which is crucial for activating and maintaining engagement with science (Jolly, Campbell, & Perlman, 2004).

Although it is an efficacious strategy to integrate informal education into the teaching process, especially in science education, to improve classroom curriculum and formal education work (Duran, Ballone-Duran, & Haney, 2010), school trips to science centers and museums are not organized in such a way to enhance learning (DeWitt & Osborne, 2007). This may be because of what Behrendt and Franklin (2014) claimed that preservice teachers are not educated in science teacher education programs about how to plan and organize a field trip. According to the researchers, if teachers learn how to conduct a successful field trip, they can make their students develop interest in science, which may ultimately result in enhanced learning and scientific literacy. Similar to Behrendt and Franklin's (2014) claim, Taşdemir, Kartal and Özdemir (2014) stated that preservice teachers may graduate without being aware of the opportunities of science centers. Separately, Kisiel (2006) denoted that teachers may not be accustomed to the strategies to integrate classroom content with museum visit. Besides, although many teachers aware of the benefit of the pre-visit preparation and post-visit activities to support students' affective and cognitive gain, they do not utilize from such kind of strategies reporting time constraints and the lack of adequate overlap between school trip and curriculum as their reasons (DeWitt & Osborne, 2007). Likewise, field trips have become rare because of the limited available time

and funding, most importantly school systems' emphasis on standardized testing (Behrendt & Franklin, 2014; Duran, Ballone-Duran, & Haney, 2010). Correspondingly, Braund and Reiss (2006b) claimed that educators are likely to ignore the significant impact of out-of-school experiences on knowledge and understanding, beliefs, attitudes and motivation of students since they do not regard the time spent outside of schooling. In addition to these potential barriers behind the underutilization of informal learning settings like science centers by school groups, it seems reasonable to question that what if teachers were unaware about science centers and their resources? They may not prefer conducting field trip to science centers since they do not have detailed knowledge about them. From this point of view, it could be better to raise teachers' awareness about science centers and their resources.

Moreover, teachers still asked themselves following kind of questions about school visits to informal institutions: "What is the pay-off in terms of my pupils' knowledge and understanding of science?" (Braund & Reiss, 2006a, p.1377). As stated by Rennie and McClafferty (1996, as cited in Braund & Reiss, 2006b, p.220), "the key question is not: do people learn science from a visit to a science centre? But, do science centres help people to develop a more positive relationship with science?" (p.83). At this point, teachers play important role in activating and attracting students' interest and helping them to make connection between their prior knowledge and science center content since the linkage to formal school do not develop inherently during a visit to museum (Cox-Petersen & Pfaffinger, 1998). However, these kinds of activities have some requirements for teachers such as planning and organization (Behrendt & Franklin, 2014). In the literature, teachers are advised to visit informal learning institutions before visit; prepare students for visit; prepare materials like worksheets to use at site; and attract students into pre- and post-visit activities for integration of classroom curriculum into visit (Griffin, 1999). Even so, the way that teachers take advantage of informal science learning institutions still needs to be improved (DeWitt & Osborne, 2007). For instance, it was seen in the literature that teachers do not prepare their students well enough and have any particular objective for the visit or know the ways of learning at the site (Anderson, Kisiel, & Storksdieck,

2006; Griffin, 1994; Griffin & Symington, 1997; Jarvis & Pell, 2005; Kisiel, 2005; Orion & Hofstein, 1994; Storksdieck, 2001). Therefore, teachers are needed to be educated about how to help their students' learning in or how to conduct successful school trip to informal science settings. Consequently, a coherent and comprehensive professional development program is necessary to be effective in influencing knowledge, strategies and instructional planning of teachers regarding field trips to informal settings like science centers.

In addressing abovementioned issues, a professional development (PD) program, called as BİLMER project, is proposed to The Scientific and Technological Research Council of Turkey (TÜBİTAK). The aim of the BİLMER project ("*BİLMER Project: A Teacher Explainer Professional Development Model to Increase the Effectiveness of Science Centers in Science and Society Communication in Science Education" – Project Number: 114K646*) is to raise pre- and in-service teachers' and science centers' explainers' awareness about science centers; improve their utilization from science centers; and increase their efficacy in this area. Furthermore, BİLMER project has an ultimate goal of developing a "Model of Professional Development toward Science Centers" for teachers and explainers through the series of professional development workshops. The current study (3-day-long PD program in the form of workshop: *"BİLMER Project: Teachers and Explainers Professional Development Programs Pilot Workshops-1"*) is related to one of the PD workshops that will contribute to the formation of a larger model "BİLMER Professional Development Model" (for more information see Köseoğlu, 2018). It is hypothesized that if science teachers participate in one of the professional development programs developed by BİLMER project, they can better use learning opportunities in the science centers to maximize the influence on their students' learning. Consequently, the main aim of the current study is to reveal how the PD program developed by BİLMER project influence science teachers' awareness about science centers and their resources and their way of conducting a science center visit. More precisely, the researcher aims to answer the following research questions:

1. How does PD program influence science teachers' awareness about science centers and their resources?
2. How does PD program influence science teachers' way of conducting field trip to a science center?
    a) Through the lenses of the researcher, what are the changes in science teachers' strategies for conducting science center visit from beginning to the end?
    b) Through the lenses of science teachers, what kind of characteristics of PD program had an influence on their instructional planning regarding science center visit?

1.1. Significance of the Study

In Turkey, there are science teaching departments in 69 education faculties in 62 different provinces and a total of 16740 pre-service teachers are studying in this department (Council of Higher Education [CoHE], n.d.). Although each city has at least one museum including ethnographic and archeologic materials (Taşdemir et al., 2014), there are 18 different science centers in 10 different provinces in our country (TÜBİTAK, n.d.) Considering that there is more than one science center in some cities (e.g., Feza Gürsey SC, Polatlı SC and METU SC in Ankara), the number of science centers and intercity distribution of them is quite low compared to the number of education faculties. Moreover, twenty percent of the preservice teachers studying in twenty education faculties can directly benefit from science centers, as claimed by Taşdemir et al. (2014). This quite low percentage indicates that most of the preservice teachers graduated without being aware of the opportunities of science centers. Correspondingly, teachers do not know how to organize a successful trip to informal settings like science centers and integrate their science teaching (Kisiel, 2003a; Taşdemir et al., 2014). However, the importance given to informal learning environments such as science centers in our country is increasing day by day. For instance, at the 23rd meeting of the High Council of Science and Technology, it was decided to carry out the studies for the establishment of science centers in all metropolitan cities as of the year 2016 and in all provinces in 2023 in cooperation

with local administrations (Çolakoğlu, 2017). Similarly, the out-of-school learning environments have been highlighted in the adopted strategies and methods by the Ministry of National Education's science curriculum in 2018, as following:

> Class / in-school and out-of-school learning environments are designed according to the inquiry-based learning strategy so that students can learn meaningfully and permanently. In this context, informal learning environments (school gardens, science centers, museums, planetarium, zoo, botanical gardens, natural enviroments etc.) are utilized (MEB, 2018, p. 11).

Regarding the importance given to science centers today, it is very important to know how teaching and learning in informal context interacts with formal teaching even though teacher's main duty is teaching science in formal context (Lucas, 1983). It is stated in the literature that teachers cannot adequately benefit from science centers for their teaching even in the developed countries (Griffin & Symington, 1997; Ramey-Gassert, Walberg, & Walberg, 1994; Tal, Bamberger, & Morag, 2005) and this might be due to the fact that there is no professional development program for teachers about how to take advantage of the out-of-school learning environment (Melber & Cox-Petersen, 2005). In this respect, investigation of the change in science teacher's way of conducting a science center visit as a result of participating in a PD program is worthwhile.

Limited number of research in the literature revealed that professional development programs regarding informal learning settings focused on teachers' experiential learning experiences in informal settings (Neathery, 1998); science content knowledge and inquiry-based science teaching (Duran, Ballone-Duran, Haney, & Beltyukova, 2009; Duran et al., 2010; Lederman, Holliday, & Lederman, 2012; Melber & Cox-Petersen, 2005); self-efficacy beliefs (Duran et al., 2009; Ferry, 1995; Holliday, Lederman & Lederman, 2013; Ogbomo, 2010); awareness about museums and their resources and utilization from these resources (Chin, 2004; Faria, Chagas, Machado, & Sousa, 2012; Melber & Cox-Petersen, 2005; Ogbomo, 2010). Particularly, studies about teachers' awareness did not directly focus on the awareness issue, but they examined their awareness in addition to other variables such as planning effective field trips, integration of these trips with classroom instruction,

etc. Similar to past studies, the current study will extend the related literature by revealing the change in science teachers' awareness about science centers in Ankara and Turkey, resources of these centers and utilization from them as a result of participating in a PD program.

In the literature, studies related to school field trips generally focused on the identification of teacher's field trip strategies (Kisiel, 2003a) and revealing various suggestions for their pre-visit preparation, during-visit roles and/or post-visit activities (Anderson & Lucas, 1997; Anderson, Lucas, Ginns, & Dierking, 2000; Behrendt & Franklin, 2014; Şentürk, 2015). However, there is no study in the literature which reveals the change in or improvement of these strategies of teachers as a results of an intervention such as professional development programs, in-service training, and summer school programs. Therefore, the current study will extend the related literature by revealing the changes in teachers' strategies for conducting science center visit as a result of participating in a PD program. Identifying the changes in teachers' strategies in a science center visit through the lenses of the researcher, it might become easier for educators of science centers and science teachers to help teachers improve particular strategies to maximize their students' field trip learning experiences.

Regarding close examination of research related to science centers in Turkey, it can be seen that these studies examined the influence of science centers on students' attitude toward science (Şentürk & Özdemir, 2014); perspectives, roles and reflections of teachers regarding field trips to science center (Şentürk, 2015); the educational use of science centers and evaluation of them in terms of science teaching (Bozdoğan, 2008a; Bozdoğan & Yalçın, 2009; Taşdemir et al., 2014); planning and evaluation of visits to informal learning settings (Bozdoğan, 2008b, 2012); science centers' use of Facebook as a social network in Turkey (Bozdoğan, 2017); elementary school students' behaviors at a science center (Hakverdi Can, 2013); and teachers' and explainers' views on forensic science activity developed for science centers (Özdem Yılmaz, Köseoğlu, & Aktaş, 2018). Similarly, there is only one book (Şen et al., 2011) related to science centers for the use of pre- and in-service teachers in

Turkey (Taşdemir et al., 2014). Additionally, pre- and in-service teachers' professional development is mostly studied in university settings and after-school centers by teacher educators (Taşdemir et al., 2014). However, there is no study aiming to examine the influence of professional development programs related to science centers on science teachers' awareness about science centers and their resources, and ways of conducting a science center visit. By extending the related literature and providing a more detailed picture on the influence of PD program on these issues, this study can contribute to the judgements and the decisions of teacher educators, Ministry of National Education (MoNE), PD program developers, and science centers and similar settings.

1.2. Definition of Important Terms

Informal science learning is defined as "activities that occur outside the school setting, are not developed primarily for school use, are not developed to be part of an ongoing school curriculum, and are characterized as voluntary as opposed to mandatory participation as part of a credited school experience" (Crane, Nicholson, Chen, & Bitgood, 1994, p.3).

Even though the researchers in the field use different terms to gather museums, science centers, botanical gardens, zoos, aquariums under one title like informal environments, informal settings, informal learning environments/settings, informal science education institutions, free-choice settings, free-choice learning settings/institutions/environments, out-of-school environments/settings (Falk & Dierking, 2018; Martin, Tran, & Ash, 2019), the researcher of the current study adopted the term "informal learning environments" as National Research Council (NRC, 2009). *Informal learning environments* can be defined as "a physical setting in which an individual has greater autonomy and freedom to attend to, and learn from, stimuli than provided by the more formal setting of school" (Anderson, 1999, p.18).

Professional development (PD) is defined as "any educational activity that attempts to help teachers improve instruction- specifically, science instruction" (Melber &

Cox-Petersen, 2005, p.104). The term “PD program” adopted in the current study refers to 3-day-long PD program in the form of workshop, which is called as “BİLMER Project: Teachers and Explainers Professional Development Programs Pilot Workshops-1”.

Field trip is defined as "a trip arranged by the school and undertaken for educational purposes, in which the students go to places where the materials of instruction may be observed and studied directly in their functional setting: for example, a trip to a factory, a city waterworks, a library, a museum etc." (Krepel & Duvall, 1981, p. 7).

Strategy is defined as “some action taken by teacher” (Kisiel, 2003a, p.77).

Instructional planning refers to the curriculum-integrated visit plan. In other words, instructional plan is comprehensively defined action plan including the integration of curriculum and visit for every part of the visit, which are pre-, during- and post-visit.

Awareness of teachers means whether they have knowledge of something.

Science center is “an informal learning environment containing interactive exhibits and displays designed to provide experiences for visitors which aim to help them construct knowledge relating to sciences” (Anderson, 1999, p.18).

Science center resources refer to various resources, which are available to all visitors through digital platforms (e.g., website, social media such as Facebook, Instagram, etc.) and/or on site, to address many of the topics that the visitors will encounter on their visit. These resources can be a tour program, an activity guide, a field trip guide, a brochure, planetariums, exhibition galleries, hands-on and minds-on exhibits and activities embedded in workshops, demonstrations, science shows, projects, camps, and professional development programs, etc.

Explainer is a person working at science centers whose responsibilities are to accompany school groups throughout their visits, develop and implement various science activities and demonstrations.

Exhibit is "one stand-alone component of an exhibition which visitors to an informal learning environment, such as science centre, can interact with, manipulate, or observe" (Anderson, 1999, p.17).

Tabletop exhibit is a portable exhibit that can be used to extend students' learning in the classrooms (or to introduce related science concepts to the trip before the visitation). It can be a small size of science center exhibits such as "Newton's Cradle". Also, it can be an exhibit be used to extend the same science concept(s) related to science center exhibit(s) such as vacuum bag [tabletop exhibit] for "Magdeburg Spheres" [science center exhibit].

CHAPTER 2

LITERATURE REVIEW

This chapter includes two main sections, which are about the informal science learning and professional development, and five sub-sections referring to the development of and research on field trips to informal learning settings and the features and types/designs/strategies of professional development and research on teachers' professional development programs regarding informal learning settings.

2.1. Informal Science Learning

Although learning in informal environments has various names in the literature such as informal learning, nonformal learning, informal education, free-choice learning and learning in out-of-school contexts (Rennie, 2007), informal science learning can be defined as "activities that occur outside the school setting, are not developed primarily for school use, are not developed to be part of an ongoing school curriculum, and are characterized as voluntary as opposed to mandatory participation as part of a credited school experience" (Crane et al., 1994, p.3). Similarly, different characteristics between the formal and informal learning settings are identified in the different studies (Kisiel, 2003b; Rennie, 2007). For instance, while the primary objective of formal settings is the cognitive outcomes, the primary objectives of informal learning settings are socialization, increasing interest and change in attitude (Kisiel, 2003b). Moreover, these cognitive outcomes are assessed within the formal environment but not assessed in informal learning environment (Kisiel, 2003b). Learning outside of the schools is learner-centered and intrinsically motivated, rather than teacher-centered and extrinsically motivated when compared with formal school environments (Rennie, 2007). These different features could be seen from the experiences of Oliver Sacks (2001) which reflect how he learned about science in London in the late 1940s:

> My school…had no science and hence little interest for me -our curriculum, at this point, was based solely on the classics. But this did not matter, for it was my own reading in the library that provided my real education, and I divided my spare time, when I was not with Uncle Dave, between the library and the wonders of the South Kensington museums, which were crucial for me throughout my boyhood and adolescence. The museums, especially, allowed me to wander in my own way, at leisure, going from one cabinet to another, one exhibit to another, without being forced to follow any curriculum, to attend lessons, to take exams or compete. There was something passive, forced upon one, about sitting in school, whereas museums -and the zoo, and the botanical garden at Kew- made me want to go out into the world and explore for myself, be a rock hound, a plant collector, a zoologist or palaeontologist (p. 57; as cited in Rennie, 2007, p.127).

As opposed the distinctions between formal and informal learning, Dierking (1991) put forward that "learning is learning, and it is strongly influenced by setting, social interaction, and individual beliefs, knowledge, and attitudes" (p.4). In a similar perspective, Falk and Dierking (1997) defined learning in science museums within the frame of social construction of knowledge as "the process of applying prior knowledge and experience to new experiences; this effort is normally played out within a physical context and is mediated in the actions of other individuals. In addition, learning always involves some element of emotion and feeling" (p. 216). In 2000, based upon the cognitive, constructivist and sociocultural learning theories, Falk and Dierking came up with a model, called as "Contextual Model of Learning", as a framework for the learning process within informal settings regarding the interactions between personal, physical and social contexts of the learners. Accordingly, visitors' learning is influenced by the following factors from the "personal contexts" perspective of the model: (1) some degree of choice and control over their own learning; (2) motivations for and expectations from a visit; (3) prior experience, knowledge, and interest (Falk & Storksdieck, 2005). From the perspective of "sociocultural contexts" of the model, visitors' learning is influenced by the following factors: inter-group interaction (i.e., interaction with visitors' own group members like student-student [from the same group] or student-teacher) and intra-group interaction (i.e., interaction with others like student-student [from the other visitor group] or student-explainer) (Falk & Storksdieck, 2005). Finally, from the "physical contexts" perspective of the model, visitors' learning is influenced by the following factors: (1) orientation and use of advance organizers for the navigation

of visitors in the physical environment of the museums; (2) features of architectural design like lightning, color and space; (3) exhibits designs like positioning, content and number of exhibits; (4) post-visit activities (Falk & Storksdieck, 2005). To explain more specifically, Falk and Storksdieck (2005) claimed that every visitor has a different set of "learning trajectories" (p. 771) that shape their learning during visit to an informal setting. However, they also stated that there could be some additional factors influencing visitors' learning process like advance organizers, interactions within groups, etc. Similarly, random events might influence learning of visitors (Falk & Storksdieck, 2005). For example, "a crowd of visitors at an important/preferred exhibit causes the visitor to skip that exhibit" (Falk & Storksdieck, 2005, p.771). Thus, the researchers saw this model as the first step to understand visitors' learning in the informal settings and suggested the need of follow-up studies to refine their model. On the other hand, Anderson, Lucas and Ginns (2003) put forward that "human constructivist view of learning" might be useful for researchers examining visitors' knowledge development that comes from their experiences in informal settings since this view "recognizes an individual's prior knowledge and active involvement in knowledge construction during a museum visit" (p.177). All in all, it might be claimed that constructivist and sociocultural learning theories had a significant role in informal science learning during a museum/science center visit.

2.1.1. The history and development of the field of informal science learning

Over the past 40 years, the field of the informal science education has expanded greatly (Ucko, 2010). The growth of the Association of Science-Technology Centers (ASTC) since 1971, creation of Public Understanding of Science (PUOS), the Informal Science Education (ISE) program, and the National Science Foundation (NSF) have played an important role in supporting this emerging field (Ucko, 2010). In 1984, National Science Foundation brought about the Division of Informal Science Education to promote scientific literacy, public understanding of science and participation in the scientific and technological enterprise (Pedretti, 2006). Phipps

(2010) revealed that informal science education institutions (e.g., science museums, natural history museums, national parks, hands-on science centers, zoos, aquariums, arboretums), the internet, scientific programs on TV, print materials, after school opportunities are ever-growing resources to fulfill people's science learning needs. This enhancement in the opportunities of learning science in addition to schools or formal education leads to the rapid increase of informal science educators in greater science education community and the area of informal science education over the 1990s and 2000s (Phipps, 2010). For example, in 1996, the Museum Learning Collaborative was formed to create a research base to lead the study of learning in informal contexts (Ucko, 2010). Correspondingly, remarkable recent events include the establishment of the Informal Science Education Strand Nine of the National Association of Research in Science Teaching (NARST), the Informal Learning Environments Research Special Interest Group of the American Educational Research Association (AERA), and the Special Interest Group in Museum Studies of the Canadian Society for Studies in Education (CSSE) (Pedretti, 2006). The journal "*Science Education"* founded a permanent special section devoted to the topic of informal science education, with two special issues devoted entirely to the topic in 1997 and 2004 (Pedretti, 2006). Similarly, DeWitt and Storksdieck (2008) reported that in 1970s, 1980s and 1990s, many studies about field trip focused on the learning potential of informal learning environments or compared learning opportunities of informal learning environment with in-school instruction. Considering all of the developments in informal science education, it could be claimed that here in clearly lies the importance of informal science education given by the world.

In Turkey, informal education has partially started with the opening of Village Institutes in the 1940s, which allows students to learn by doing in informal environments (Köy Enstitüleri, n.d.; Türkmen, 2010). In the elementary school programs prior to the 2004 one's, school trips were organized to informal settings such as museums due to the factors like entertainment and the necessity only at the end of the year and on certain days (Baykan, 2007). However, Baykan stated that in 2004 elementary education program, it was seen that these trips were organized in a more planned, effective and appropriate way. Nonetheless, these activities were

related to the content areas of history, geography and art rather than science (Türkmen, 2010). In 2008, the Ministry of National Education published a booklet titled "Museum Education in Turkish, Mathematics, Social Science, and Science for education programs of grades 1th to 8th". In this booklet, the relationships between objectives of elementary science education and school trips to informal learning environments such as museums were put forward. Moreover, the importance given to informal learning environments such as science centers in our country has been increasing day by day. For instance, the informal learning environments (e.g., school gardens, science centers, museums, planetariums, zoo etc.) have been highlighted in the adopted strategies and methods by the Ministry of National Education's science curriculum in 2018 (MEB, 2018). Similarly, at the 23rd meeting of the High Council of Science and Technology, it was decided to carry out the studies for the establishment of science centers in all metropolitan cities as of the year 2016 and in all provinces in 2023 in cooperation with local administrations (Çolakoğlu, 2017). In a few universities (e.g., Gazi University and Hacettepe University), courses on informal learning environments have more recently begun to be offered (Şentürk, 2015). In 2006, the journal "Research in Informal Environments", which is an electronic refereed journal published twice a year, was established. Regarding the abovementioned developments, it might be claimed that the importance of informal learning environments and informal science education has recently understood in Turkey.

2.1.1.1. The place of science centers in informal science learning

Science centers played an important role in improving public's understanding and interest in science and technology and also, raising more scientists and engineers who are helpful for the successful development of the country (Fros, 2006). In the literature, there are many terms used for science center such as science and technology centers (ASTC), hands-on science centers (Bradburne, 1998) and interactive science and technology centers (Rennie & McClafferty, 1995). However, the researcher will mostly prefer to use the science center in the current study. McManus (1992) characterized science centers as "third generation" museums, in

which exhibits built on ideas rather than exhibits based on objects. According to Salmi (2004), a science center can be seen as a learning laboratory in two senses: "(1) it is a place where visitors can learn scientific ideas by themselves using interactive exhibit units, (2) it is a place where informal education can be studied in an open learning environment" (p. 8). Similarly, Weitze (2003) pointed out that science centers are informal learning environments, where learning and fun are together. Moreover, Quin (1990) identified the common features of science centers. Accordingly, science centers are;

1. largely devoted to science and technology (including engineering and industrial processes).
2. contemporary rather than historic
3. interactive ('hands-on'), with specially-constructed exhibits that encourage visitors to investigate natural phenomena and experiment with technology
4. informal places-'explainers', 'guides' or 'pilots' are always on hand to welcome, discuss the exhibits and help if required
5. publicly and educationally oriented-the aim is to make a visit enlightening as well as entertaining (Quin, 1990, p.243).

Still, developments in science and technology has been increasing rapidly and people need to gain both comprehension and practical skills in today's world (Salmi, 2004). At this point, science centers build a bridge between science and education and technology, as shown in Figure 2.1.

According to Figure 2.1, while science education is located at the intersection point of science and education, science center is located at the intersection point of science, technology and education, meaning that a science center combines all of these three's features (Salmi, 2004). Therefore, as discussed by Salmi (2004), it could be inferred "science centres are no longer isolated hands-on workshops created by a couple of 'science freaks'" (p.5) but they serve to promote the public understanding of science.

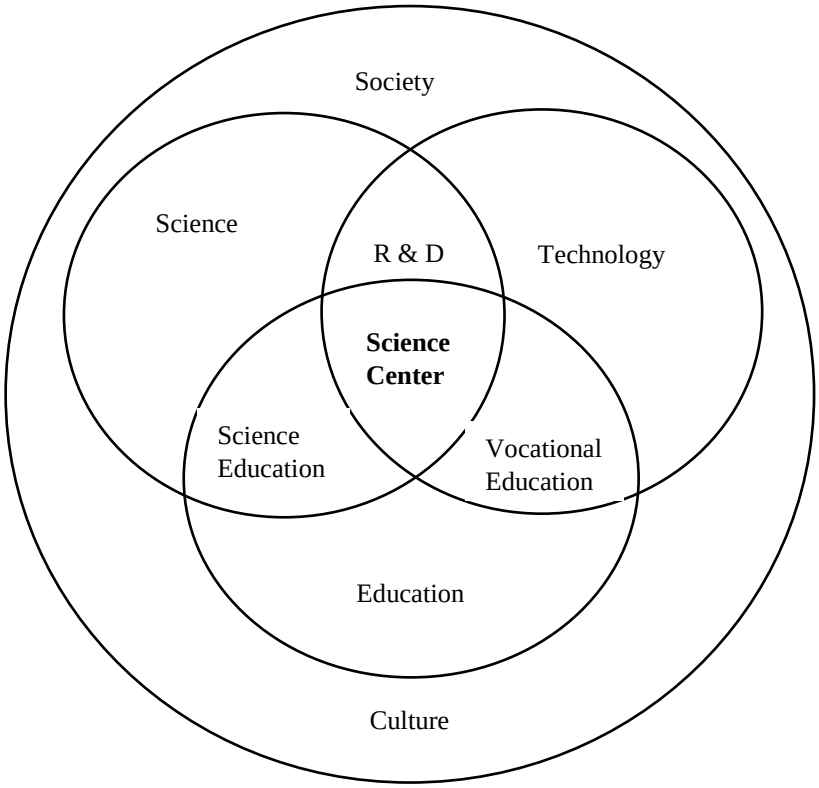

Figure 2.1. Science, technology, education and a science center in relation to society and culture. R&D = Research and Development. Adapted from "Science Centre Education. Motivation and Learning in Informal Education. Research Report 119," by H. Salmi, 1993, Doctoral Dissertation, p.65. Copyright 1993 by the Educational Resources Information Center (ERIC). (ERIC Number: ED363613).

2.1.2. Research on field trips to informal learning settings

One way of obtaining and comprehending new information acquired through the rapid developments in science and technology is to support formal educational settings with informal (out-of-school) settings such as museums, zoo, botanical garden, science museums and science centers (Bozdoğan & Yalçın, 2009). The importance of school field trips emerges here. School field trips can be defined as "a trip to outside of the school organized by teachers for the educational purposes" (Şentürk, 2015, p.14). In other words, school field trips to museums, science centers and similar informal environments are a kind of instructional strategies used by teachers to encourage student interest in science (Kisiel, 2006). There are many studies in the available literature about it. For instance, some studies focused on

affective outcomes from field trips such as enhancement of interest, attitude, motivation (Holmes, 2011; Meredith, Fortner, & Mullins, 1997; Ramey-Gassert et al., 1994; Şentürk & Özdemir, 2014); cognitive gains from informal settings (Anderson et al., 2000; Beiers & McRobbie, 1992; Miglietta, Belmonte, & Boero, 2008; Orion, 1993; Ramey-Gassert et al., 1994; Rennie & McClafferty, 1995), and survey on the use of science centers in Ankara (Bozdoğan & Yalçın, 2009).

Ramey-Gassert et al. (1994) stated that "museum learning has many potential advantages: nurturing curiosity, improving motivation and attitudes, engaging the audience through participation and social interaction, and enrichment. By nurturing curiosity, the desire to learn can be enhanced" (p.351). There are many studies about affective outcomes from field trips such as enhancement of interest, attitude, motivation (Holmes, 2011; Meredith, Fortner, & Mullins, 1997; Ramey-Gassert et al., 1994; Şentürk & Özdemir, 2014). For instance, Holmes (2011) investigated student achievement and motivation in science through museum-based learning with a sample of 228 sixth grade students in a pretest-posttest control comparison group design. "Children's Academic Intrinsic Motivation Inventory" and an achievement test developed by the researcher were used to collect data. No significant difference in science achievement was found between students who get museum-based learning and students who didn't. The novelty of the museum setting and its effects on learning were indicated the reason behind the result (Holmes, 2011). Also, there was no difference in motivational levels between students who experienced museum-based learning and those who did not. The reason behind as suggested by Holmes (2011) could be that many of these students were highly motivated toward science at the onset of the study, which could have made it difficult to show significant increases in motivation toward science. As a result, museum-based learning, as it was explored in this study, had minimal effects on student motivation towards science and achievement in science (Holmes, 2011). Regarding attitudes, Şentürk and Özdemir (2014) conducted a study with a sample of 251 students to investigate the effectiveness of the Middle East Technical University's Science Centre (METU SC) on students' attitudes towards science. Data were collected by means of "Attitude towards Science Scale" before, immediately after, and one week after a visit to the

METU SC. The researchers found that science centers might have high potential on increasing students' attitudes towards science. Moreover, this increase in students' attitudes is independent of their gender, science achievement scores, and grades. As a result, Şentürk and Özdemir (2014) suggested that educators might use science centers as an effective way of increasing students' attitudes towards science because of the fact that this increase in students' attitudes was accomplished in quite a short time.

Regarding cognitive gains from informal settings, Beiers and McRobbie (1992) conducted a phenomenographic study to determine changes in understanding levels of 27 seventh grade primary children about the concept of sound as a result of interactive science center visit. Data were collected through concept mapping and interview. Children were assessed one week before and after the visit. Thus, learning is measured as a change between qualitatively different conceptions between the pretest and posttest. It was found that 22 students showed a change between the pre- and post-test describing their level of understanding. The researchers also underlined that prior knowledge of students was an important factor on children's learning. Also, they concluded that this study supported to the potential of science learning in informal sources connecting with formal learning in classrooms to improve science learning. Similarly, Miglietta et al. (2008) aimed to measure students' prior knowledge, and its modification at short- and medium-term as a result of a didactic museum experience. The investigation was conducted in 5 steps: entrance questionnaire, a short lecture on the subject sharks, guided tour of museum, exit questionnaire and follow-up questionnaire. Data were collected from 537 students at aged 9-18. The researchers found that there were significant differences, F (1, 520) = 1969.38, $p < .001$, in the number of correct responses between entrance and exit stages (indicating efficacy of the didactic activity) and between exit and follow-up stages (indicating loss of concepts over time), F (1, 960) = 256.38, $p < .001$. However, the number of follow-up correct answers remained significantly higher than the entrance scores, indicating efficacy of the didactic activity after three months, F (1, 961) = 644.30, $p < .001$. As in line with the study of Beier and McRobbie (1992), Miglietta et al. (2008) suggested that prior knowledge should be considered for

planning didactic activities. They also recommended that the subjects to be presented in the museum should be carefully chosen and close collaboration between museum operators and school teachers should be built.

To conclude, in 1991, Wellington (as cited in Beiers & McRobbie, 1992, p.39) stated that it is "surprising that children's informal science learning in science, with its acknowledged influence on pupils and its potential for classroom enrichment, remains a relatively under-valued and under-researched area" (p.364). However, the available literature mentioned above demonstrated that informal science learning area has rapidly and greatly expanded up to now and still continues to the expanding by showing the importance of itself on the level of cognitive, affective and social learning experiences of individuals.

2.1.2.1. Strategies that have potential to improve a field trip experience

Related literature shows that up to now, numerous research effort have been made to prescribe optimal field trip experience. For instance, some studies proposed pre-visit preparation (Anderson & Lucas, 1997; Anderson, Kisiel, & Storksdieck, 2006; Orion & Hofstein, 1994); or during-visit activities (Bamberger & Tal, 2007; Doğan, Çavuş, & Güngören, 2011; Griffin, 1994; Kisiel, 2003b, 2007; Krombaβ & Harms, 2008; Mortensen & Smart, 2007); or post-visit activities (Anderson et al., 2000); whole-phase preparation (Anderson et al., 2000); or some general strategies (Behrendt & Franklin, 2014; DeWitt & Osborne, 2007; Griffin & Symington, 1997; Şentürk, 2015) for teachers to enhance school groups' learning potential throughout an entire field trip experience.

Regarding pre-visit preparation, Orion and Hofstein (1994) revealed that a preparation unit designed to inform students about setting, procedure and content one day before the visit had an influence on students' learning. Similarly, Anderson and Lucas (1997) recommended 40-minute orientation program including location and floor plans of science center, arrival procedures and activity program etc. to reduce students' novelty as pre-visit preparation. Anderson, Kisiel, and Storksdieck (2006)

investigated teacher's agenda, perceptions and perspectives on field trips in three different countries: the United States, Germany and Canada. In both Canada and the United States studies, teachers reported that completion of pre-visit activities was more important and more frequent than post-visit activities for a successful field trip. For instance, according to teachers in United States case, it is important to visit museum before the visit to become familiar with the setting and offerings of it (Anderson et al., 2006). In a more general perspective, Laçin Şimşek (2011) classified pre-visit preparations as educational preparations, bureaucratic works and transportation, eating and drinking. For instance, teacher's familiarization with the setting, preparing a field trip brochure for students, informing students about the setting, purpose of the visit and what they will do are the example suggestions of educational preparations. On the other hand, bureaucratic works and transportation preparations include organization of transportation, entry costs, booking, getting related permissions, etc. Moreover, eating-drinking arrangements should be made if the destination is outside the city or if the round trip is going to take more than a day (Laçin Şimşek, 2011, p.14).

Regarding during-visit activities, Bamberger and Tal (2007) investigated the effect of the level of choice and control on students' learning during visit to four different museums in Israeli. Data collection was made by means of three different methods: (1) observation of 750 students in twenty-nine classes from fourth grade to eighth grade, to obtain data about interactions between student-student, student-guide and student-teacher, actions of students and guiding in the museums (2) semi-structured interviews with 41 students in grades 6-8 –since they visited all four museums- to figure out student's perception of learning during museum experience, connection of scientific content to student's life and how the museum visit was linked to student's prior knowledge and curriculum in school, (3) museum worksheets, based on Kisiel (2003b), to get data about how museum visit was linked to student's prior knowledge and experience and about level of choice given in the museum. As a result, Bamberger and Tal (2007) found that limited choice activities, in which students have some choice and control in their learning -by choosing the exploration order or objects related to the task they received- were more appropriate for students' learning, as

compared to free- or no-choice activities. Moreover, in the light of the researches in the literature, students and many teachers believe that properly developed worksheets are necessary for learning during field trip (Doğan et al., 2011; Griffin, 1994; Kisiel, 2003b, 2007; Krombaβ & Harms, 2008; Mortensen & Smart, 2007). However, if teachers want to use worksheets during the field trip, worksheets should be designed to (1) enable social interaction; (2) include tasks based on museum site or specific exhibit; (3) direct students object-dependent information sources rather than text-dependent one; (4) include low task density; (5) orient students through museum; and (6) give students some freedom in their responses (Kisiel, 2003b). For instance, Kisiel (2007) investigated the choices of pre-service (N=40) and in-service teachers (N=66) for museum worksheets while conducting a field trip. Teachers were asked to select which one, survey- or concept-oriented worksheet, they would use for upper elementary or middle school students. It was found that for either grade levels, the open-ended, concept-oriented worksheets were chosen less frequently than the more detailed, survey-oriented worksheet (70%). The researcher also asked teachers their rationales for their choice of worksheet. It was found that teachers were more likely to refer to task density (50%), compared to question level (20%) or cognitive level (9%) in their explanations of choice of worksheet. Kisiel (2007) concluded that teachers' perspective toward museum visits must be taken into consideration to enhance learning experiences during school field trips. In 2008, Krombaβ and Harms investigated the effectiveness of the use of worksheets while acquiring knowledge about biodiversity in a natural history museum with a sample of 148 students in grades six to nine. Participants took part in pre- and post-test questionnaire study including one-hour learning phase with worksheets in the museum. A high learning effect (d=1.03) from pre- to post-test was found as a result of the knowledge tests. Moreover, Krombaβ and Harms (2008) found that the contribution of worksheet tasks and prior knowledge was similar on the learning outcomes. The researchers suggested that the use of worksheets should be continued to improve the effectiveness of informal learning sessions. However, they emphasized the importance of the design of the worksheets for knowledge gain. In Turkey, Doğan et al. (2011) investigated the effects of school trips on learning science using colorful science cards and a writing acting activity with a sample of 34 pre-service teachers. Before the study,

conducted in the Rahmi Koç Museum in Istanbul, some concepts and questions written on colorful cards regarding science and technology were given the participants to search in the museum. After the field trip, participants were asked to write an essay consisting the knowledge that they found about concepts and questions. Moreover, participants were asked to participate in the completion of activity assessment scale as well as semi-structured interviews. During semi-structured interviews, the answers were obtained from participants for that question: "Can you evaluate the science-card activity during the museum trip positively or negatively?" (p. 5). It was found that the majority of pre-service teachers stated that there were positive effects of card activity on the informal learning environments such as enhancing curiosity, learning with realizing and detailed examining. The results of activity evaluation scale revealed that writing activity contributes to the learning new knowledge (91.4%) and make participants revise their prior knowledge (62.9%). Moreover, in a more general perspective, Laçin Şimşek (2011) summarized during-visit activities as follows: (1) activities that support social interaction between students, (2) free exploration time for students to explore within the framework of their interest, (3) participating guided tours, and (4) making observation and discussion through teacher's limited number of open-ended questions (pp.14-15).

Regarding post-visit process, Anderson et al. (2000) evidenced that follow-up activities (e.g., completion of concept maps, practical experiments which have similarity to exhibits in science center) resulted in the construction and reconstruction of students' science concepts and principles symbolized in exhibits of science museum. Similarly, Braund and Reiss (2006a) put forward that learning from field trips to out-of-school settings can be complemented and carried on through laboratories in school and teacher-initiated discussions among students in science classes. Moreover, in the chapter, in which Laçin Şimşek (2011) mentioned about the points that should be considered in the out-of-school learning environments, she listed some post-visit activities as follows: (1) drawing, writing or discussion of activities about their favorite exhibits including the description of involvement with it and its working principle, (2) photos taken on the trip can be displayed on school boards, (3) correcting student's misconceptions through in class discussions, and (4)

formal assessment about what students observed during their visits, technical terms, new information learned (pp.15-16).

Regarding an entire visit preparation, Anderson et al. (2000) investigated the effect of experiences during an interactive science museum visit and follow-up classroom activities on 11- and 12-year-old students' knowledge construction about electricity and magnetism. Study was comprised of three phases: pre-visit, Science center visit and post-visit. During pre-visit phase, researchers examined students' prior knowledge about electricity and magnetism through concept maps. Science center phase included (1) pre-visit orientation, during which 30-minute presentation about the layout of the Science center, the schedule of activities and exhibit types to be faced was shown to students, (2) actual visit, during which students engaged and interacted with exhibits and participated in the explainer's presentation, and (3) a brief follow-up session, during which students drew another concept map about electricity and magnetism. Post-visit phase included two parts. During first part, students described, in pairs, their involvement with exhibits in Sciencenter and explained working principle of them. During the second part of post-visit phase, students conducted open-ended practical experiments similar to the two exhibits of Sciencenter. The findings showed that students constructed knowledge about magnetism and electricity as a result of the integrated series of activities, which are considering students' prior knowledge, orienting them about visit, visit itself and classroom-based post-visit activities.

In a similar manner, some studies (Behrendt & Franklin, 2014; DeWitt & Osborne, 2007; Griffin & Symington, 1997; Şentürk, 2015) recommended general strategies for teachers to improve learning outcomes of a school trip. For instance, Griffin and Symington (1997) suggested following recommendations for teachers in planning school excursions: (1) trips should be complementary to curriculum topics, (2) approaches should be used where students will find answers to their questions themselves, (3) students should be encouraged to ask more questions in out-of-school settings, (4) behaviors used by informal groups and learning methods should be applied to the school group's specialized program, (5) learning styles, approaches and

strategies that trigger social interaction should be developed, and (6) the needs of the students and teachers should be taken into consideration to adapt different out-of-school learning environments. In 2007, DeWitt and Osborne summarized the recommendations for teachers as follows: (1) familiarization with the setting before the visit, (2) students' orientation about setting, agenda and learning objectives, (3) planning of pre-visit activities in line with curriculum objectives (4) give students free exploration time during visit, (5) planning of curriculum supportive activities and benefiting from the setting's uniqueness, and (6) planning and conducting post-visit activities to strengthen the trip's experiences in the class. In 2014, Behrendt and Franklin summarized some tips about field trip preparation and implementation for teachers from the related literature. For instance, before the visit, teachers should prepare a plan; visit the venue to get information about layout, activities and meet staff; orient students about layout and activities to reduce the novelty effect. If necessary, student grouping and chaperone training should be done before visit. For during visit, the researchers went on to say that teachers should keep students on task; give some free time to explore; and guide students if necessary. Moreover, they argued that after visit, teachers should allocate time for reflection and discussion about students' experiences to maximize their learning and built connection between experience and concepts. Similarly, in his dissertation, Şentürk (2015) reviewed related literature about factors that have an influence on the learning potential of an entire field trip experience and argued some suggestions for them from the literature. Accordingly, pre-visit preparation, orientation, novelty and prior knowledge were the pre-visit factors that affect the success of the field trip. To overcome these, Şentürk (2015) suggested that teachers should determine the visit's purpose and make a plan; visit venue before; orient students through pre-visit lessons to reduce the novelty effect of both setting, procedure and content. On the other hand, degree of structure, worksheets, explainers and social contexts of the setting were the during-visit factors that affects the success of the field trip. Şentürk (2015) also presented some recommendations for teachers about these factors. For instance, teachers should stimulate social interactions; and give students "limited choice" including both structured and unstructured tasks. Post-visit recommendations pointed out by Şentürk

(2015) were follow-up activities like poster presentations, peer teaching and practical activities, etc.

Although other researchers (Anderson & Lucas, 1997; Anderson et al., 2006; Anderson et al., 2000; Bamberger & Tal, 2007; Behrendt & Franklin, 2014; DeWitt & Osborne, 2007; Doğan et al., 2011; Griffin, 1994; Griffin & Symington, 1997; Kisiel, 2003b, 2007; Krombaβ & Harms, 2008; Mortensen & Smart, 2007; Orion & Hofstein, 1994; Şentürk, 2015) put forward various recommendations and suggestions to maximize the learning potential of a field trip, Kisiel (2003a), in his dissertation, came up with a more detailed picture of strategies used by teachers during an entire field trip, from beginning (before visit) to the end (after visit). The researcher questioned teachers about what they did before, during and after the visit. Both quantitative and qualitative data collection method were used in his study, respectively. First of all, a sample of 115 teachers working in Los Angeles area were surveyed via mailing to identify their instructional strategies for a field trip. The second part of Kisiel's (2003a) study was comprised of three stages, which were interview based on survey questions before visit, observations of teachers and students during visit to Natural History Museum and a follow-up interview about their visit. A smaller sample of ten teachers gave a contribution on these in-depth studies. Survey results indicated that ninety-two percent of teachers utilized from some sort of pre-visit strategies and seventy percent of teachers described some instructional strategies used during and after visit. As a result of the study, Kisiel (2003a) categorized field trip strategies used by teachers as pre-visit, during-visit and after visit strategies. Explanation of these strategies was given in Table 2.1.

2.2. Professional Development (PD)

The importance given professional development of teachers has been increasing day by day (Garet, Porter, Desimone, Briman, & Yoon, 2001; NSTA, 1998). Professional development (PD) of teachers is defined as "any educational activity that attempts to help teachers improve instruction - specifically, science instruction" (Melber & Cox-Petersen, 2005, p.104).

Table 2.1.
Explanations of Successful Field Trip Strategies

PRE-VISIT STRATEGIES	
1. Familiarization Strategies: were related to the arragement of some sort of background knowledge for teacher and/or students.	
a) Site familiarization	is about the field trip site's general introduction. These strategies might be [*for students*] (1) discussion of what they will see at the site (e.g., exhibits, halls, objects…etc.) on a museum map or browsing the website of the museum, (2) sharing their previous museum experience (if any); [*for teachers*] (3) finding out the location of the site browsing the Internet map, (4) the field trip site visitation before the trip, (5) participating an exhibit preview (if any), (6) obtaining information about ongoing events
b) Content familiarization	involves providing prior information about the topics of museum's displays or science center's exhibits to help students familiarize with them. Teacher might also need to familiarize themselves with them if the trip will be unguided tour.
c) Procedure familiarization	refers to get familiar with what will be going on the trip. These strategies might be [*for students*] (1) the introduction of the detailed trip schedule, planned activities, trip's goals and what is expected of them do during the trip; [*for teachers*] (2) information about visitor rules and regulations such as admission, food & drink, security, guidance, demonstrations, film/video recording etc.
2. Supervision Strategies: involves student behavior clarification and supervision coordination.	
a) Behavior clarification	refers to the discussion of which behaviors are expected of students as well as possible consequences of inappropriate behavior.
b) Supervision coordination	refers to arranging parent chaperones and dividing students into small groups.
3. Activity Development (Other Pre-visit Activities): is used as a way to motivate students to learn or bring up their questions or incorporating their prior knowledge into the new concepts in the setting by means of discussions, assignments before going.	

Table 2.1. (cont'd)
Explanations of Successful Field Trip Strategies

DURING-VISIT STRATEGIES	
1. Student Engagement Strategies: can be divided as structured and unstructured student engagement activities based on the structure level of activities like questioning, taking notes, exploring, completing scavenger hunts and guided tours, etc.	
a) Structured student engagement	refers to similar classrom learning activities like worksheets or explanation of guide.
i. Information seeking activities	refer to such activities as completing worksheets, note-taking or exploring and recording information presented through the exhibits are used to help students engaged in activities and keep up proper behavior
ii. Information receiving activities	refer to such activities as guided tours or expert presentations about particular topics, which require students' listening to or observation.
b) Unstructured student engagement	refers to less formal activities, that is more spontaneous and less dependent on specific pre-visit preparation. E.g., discussing, sharing, asking or answering questions, pointing out items of interest, reflecting, facilitating, and guiding.
i. Interpretation	interpretation of exhibits' meaning based upon teachers' knowledge or exhibit's label to draw students' attention to particular topic or exhibit
ii. Connecting	helping students correlate some parts of curriculum with the exhibits
iii. Facilitation	asking open-ended questions to help students' meaning-making
iv. Free exploration	allowing students to hang around and explore items/exhibits of interest
v. Label reading	• *Deliberate label reading*: prompting one student to read information on the label out loud to the class and interfere to clarify unfamiliar things • *Complementary label reading: directing students to read and find the answer to a particular question or more about the exhibits*
vi. Orientation and advance organizers	e.g, maps for introducing exhibit halls

Table 2.1. (cont'd)
Explanations of Successful Field Trip Strategies

2. Supervision Strategies: refer to the chaperone guidance, monitor time spent on site, keeping an eye on students, refocusing students about the rules and learning objectives etc.	
3. Event Documentation: includes taking photos or videotaping during the trip.	
POST-VISIT STRATEGIES	
1. Review and Discussion	talking about what students saw, did, liked and why they like; sharing experiences; relating what they saw to curriculum
2. Documentation	not-graded writing or drawing assignment, photo memory board, students' presentations or posters
3. Other Post-visit Activities	activities other than writing or discussion to correlate special exhibits or the day with classroom unit. E.g., create classroom wordbanks and organizational visual maps, etc.
4. Assessment	graded descriptive writing assignment or report about students' experiences.

Note. Strategies to make field trip successful. Adapted from *Revealing teacher agendas: An examination of teacher motivations and strategies for conducting museum fieldtrips* (pp.77-81; 106-148), J. F. Kisiel, 2003a, University of Southern California, Los Angeles.

According to a research report conducted by Mundry, Spector, Stiles and Loucks-Horsley (1999), professional development of teachers should continue starting from the bachelor's level until the end of his/her career; offered professional development programs should respond to different needs, such as teachers' pedagogical content knowledge, scientific content. Similarly, in the literature, it was strongly recommended to know teachers' needs before planning and implementing PD programs (Lieberman & Wilkins, 2006; Loucks-Horsley et al., 2010; Oktay, 2015). In their study, Lieberman and Wilkins (2006) pointed out that teachers were not satisfied by professional development programs since they had minimal connection to teachers' daily life world of teaching and learning. For instance, Lieberman and Wilkins (2006) presented some examples of teachers' complaints such as: "'*That was an interesting workshop, but I don't see how I can use that information in my classroom.*', Or '*I wish these after-school in-services were more applicable to my*

needs and my students"" (p.125). Correspondingly, the researchers drew attention to the conduction of need assessment before developing and implementing PD programs. They proposed a model called as "Professional Development Pathways Model". This model included four steps in general. In the first step, need assessment was conducted to decide invidual needs regarding improvement plan of school. The results of need assessment were evaluated based on adult learning theory and teacher development levels. Then, appropriate PD pathways were suggested. For instance, inquiry activities like cognitive coaching or analyzing student work were suggested regarding the grade-level, and/or content-area. In the third step, reflections were conducted to see teachers' practice and impact on student learning. Finally, the improvement plan of school was revisited.

2.2.1. Features of PD programs

Effective professional development was defined as structured professional learning that culminates in changes in practices of teacher and improvements in learning outcome of students (Darling-Hammond, Hyler, & Gardner, 2017). For decades, researchers (Darling-Hammond et al., 2017; Guskey, 2000; Loucks-Horsley, Hewson, Love, & Stiles, 1998) have tried to determine the effective features of professional development related to education (see Table 2.2).

According to Astor-Jack, McCallie, and Balcerzak (2007), the main purpose of the professional development program is to enhance student learning enriching the teachers' inquiry-based science teaching practices. On the other hand, Melber and Cox-Petersen (2005) stated that the purposes of teacher professional development programs are generally to have teachers (1) communicate with scientists and do scientific research with them, (2) enrich their scientific knowledge, and (3) develop inquiry-based science lessons in parallel with national science education standards. According to National Research Council report (1996), professional development training offered for teachers should not be like recipes including how scientific activities are done step by step, on the contrary, teachers should have a training that

teaches the steps of scientific research in order to develop their own teaching activities in parallel with curriculum.

Table 2.2.
Features of Effective PD related to Education

Loucks-Horsley et al. (1998)	**Guskey (2000)**	**Darling-Hammond et al. (2017)**
Effective professional development:		
1. is induced by a clear image of effective classroom teaching and learning	1. primarily focuses on issues related to learners and learning	1. is supportive of collaborative learning
2. gives teachers opportunities to develop their skills and knowledge and extend their teaching approaches	2. emphasizes on organizational and individual change for collaborative efforts to accommodate individual improvements	2. involves expert support – sharing of expertise about content and practice
3. is supportive of teachers to perform in leadership roles	3. involves incremental steps guided by the idea of "think big" (Guskey, 1995) (i.e., seeing beyond the walls)	3. centers on teaching strategies connected with particular curriculum content
4. models or applies with teachers the strategies they will use with their students	4. refers to continuous professional development meaning that it is embedded in the process of instructional activities, assessment of students and so on.	4. uses effective practice models such as lesson plans, observation of peers etc.
5. develops a learning community		5. provides feedback and reflection
6. provides links to the educational system's other parts		6. integrates active learning
7. assesses constantly themselves and make improvements		7. gives sufficient time to learn, practice, implement and reflect

In their research-based study, Birman, Desimone, Porter and Garet (2000) identified core and structural features of PD that works effectively. Accordingly, there were three core features describing the processes that take place during PD experience, which were content, active learning and coherence. "*Content*" refers to subject-specific activities to increase teachers' content knowledge. "*Active learning*" refers

to the active participation of teachers into the activities like developing lesson plans or classroom implementations, presenting a demonstration, etc. "*Coherence*" is related to the coherence of PD activities with national/state/district assessments, standards and policies. Similarly, there were three structural features that form the context of PD, which were form, duration and participation. "*Form*" deals with whether the form of the activities will be traditional (e.g., seminars, workshops) or reform-based (e.g., teacher network, internship, study group). "*Collective participation*" refers to the teachers' participation from the same or different schools, same grade level, etc. "*Duration*" refers to the activities' duration or span time of PD program from beginning to the end. Likewise, as a result of review and analysis of nine well-designed studies related to PD, Guskey and Yoon (2009) found that the time spent (contact hour) in PD was crucial in the success of it. Accordingly, PD programs lasted in 30 or more hours were more effective. On other hand, Loucks-Horsley et al. (2010) stated that PD programs lasted in at least 50 hour were more effective. However, it might be put forward that "doing ineffective things longer does not make them any better" (Guskey & Yoon, 2009, p.497). As a result, it could be inferred that the duration of a PD program should not be considered alone regarding effectiveness of the PD program.

2.2.2. Types/designs/strategies of PD programs

Many different professional development program designs were used by researchers, which are training, observation/assessment, involvement in a development process, study groups, inquiry/action research, mentoring and individually guided activities (Guskey, 2000). Correspondingly, based on data from over 70,000 teachers and school principals who represent lower secondary teachers in the 23 participating countries, the results of OECD's Teaching and Learning International Survey (TALIS) showed that teachers generally participated in the following types of professional development activities: courses/workshops, education seminars/conferences, qualification programmes, observation visits to other schools, individual or collaborative research, professional development network, mentoring and peer observation (OECD -The Organisation for Economic Co-operation and Development-, 2009). In their book, Loucks-Horsley, Stiles, Mundry, Love and

Hewson (2010) mentioned about strategies for professional development under four main headings, which were: (1) immersion in content, standards and research, (2) aligning and implementing curriculum, (3) examining teaching and learning, (4) professional development structures. Details of the strategies under these headings were presented in the following paragraphs.

"*Immersion in content, standards, and research*" refers to deepening teachers' content knowledge and pedagogical content knowledge, which is necessary to teach science or mathematics. There are three strategies under this heading: "curriculum topic study", "immersion in inquiry in science and problem-solving in mathematics" and "content courses". By means of these strategies, teachers are subjected to direct experience with the content of science and mathematics, inquiry and problem-solving processes, and the differences in the content of science and mathematics content from grade to grade (Loucks-Horsley et al., 2010).

"*Aligning and implementing in curriculum*" refers to the learning, reflecting and sharing knowledge about learning and teaching while choosing instructional materials or implementing curriculum. Teachers are the key players in selecting and implementing both instructional materials and curriculum. While learning activities of students, teaching activities, and content of the teaching should be considered in the selection of instructional materials, a plan should be used to support teachers' curriculum implementation (Loucks-Horsley et al., 2010).

"*Examining teaching and learning*" refers to the participation of teachers in collaborative learning experiences, which are practice-based. There are seven different strategies under this heading: "examining student work and thinking", "demonstration lessons", "lesson study", "action research", "case discussion", "coaching", and "mentoring". These practice-based strategies give teachers chance to examine product of their own works. For instance, teachers can review and give/take feedback on their own or other groups' work by means of an observation activity in classroom or watching a video (Loucks-Horsley et al., 2010).

- ***Examining student work and thinking*** is used to augment teachers' and students' learning (e.g., reviewing learning data of students in a classroom gives teachers an idea about her improvement in instructional strategies) (Loucks-Horsley et al., 2010).
- ***Demonstration lessons*** are used to help teachers classroom practice and review their instructions' design and implementation. For instance, a group of teachers come together to discuss the goal of a demonstration lesson that they will observe. Then, demonstration lesson is conducted by one of the teachers from the group. Finally, they meet again for debriefing about this demonstration lesson to improve practice (Loucks-Horsley et al., 2010).
- ***Lesson study*** "… is a cycle of instructional improvement focused on planning, observing and discussing research lessons and drawing out their implications for teaching and learning" (Lewis, 2008, p.175, as cited in Loucks-Horsley et al., 2010, p.202). Lesson study has similar process with demonstration lessons. Unlike the demonstration lessons, lesson study centers on the fine-tuning of a lesson (Loucks-Horsley et al., 2010).
- ***Action research*** is used to examine and improve teachers' own teaching practices and subsequent students' learning by means of putting teachers into the center of the research process. That is, teachers identify problem(s), find a solution and put it into action. By working as a researcher, teachers collect data, analyze and reflect on the process by the help of descriptive reporting, outside researcher, etc. (Loucks-Horsley et al., 2010).
- ***Case discussion*** is used to review on teaching and learning through scrutinizing, discussing and reflecting narrative stories and/or videotapes, which are based on specifically designed events such as images of students' thinking and learning process, students engaged in science and mathematics issues like problem-solving, etc. (Loucks-Horsley et al., 2010).
- ***Coaching*** is used to improve teaching by means of observing teachers' practice and providing feedback to them by a coach. Coaching can be in the form of (1) collaborative peer learning, in which both teacher and coach work together to improve classroom practice; or (2) content-focused coaching, in

which coach helps teacher to improve in content knowledge, instructional strategies, and ways to develop lessons, etc. (Loucks-Horsley et al., 2010).

- ***Mentoring*** is used to help a new teacher or a teacher new to the field by a mentor (Loucks-Horsley et al., 2010). A mentor can be an experienced teacher as well as "collegial guide, helping to orient and acclimate the new teacher to the culture of the school; a consultant who actively supports the new teacher in identifying strategies for managing and resolving struggles; a seasoned teacher who shares wisdom and practical knowledge; and coach, who leads the new teacher through a process of collaborative inquiry that expands and improves the new teachers' instructional repertoire" (Dunne & Villani, 2007, p.30, as cited in Loucks-Horsley et al., 2010, p.230).

"*Professional development structures*" "are used as structures into which the other strategies are often embedded" (Loucks-Horsley et al., 2010, p.168). For instance, within a study group, teachers generally participate in workshops. There are four different strategies under this heading: "study groups", "workshops, institutes, and seminars", "professional networks", and "online professional development". These strategies (structures) do not usually have specific process or target. They are merely comprehensive way to organize content for the learning of the teacher (Loucks-Horsley et al., 2010).

- ***Study groups*** are composed of collegial and collaborative groups, who are organized around specific subject or problem of learning and teaching (e.g., to learn more about the evaluation of students' understanding of science/mathematics concepts). Teachers voluntarily participate in study groups (Loucks-Horsley et al., 2010).
- ***Workshops, institutes, and seminars*** give teachers chance to learn from experts, facilitators, educators, as well as from their peers. More distinct issues like learning to implementing new assessment strategy are addressed in workshops (within shorter periods of time). Sharing of experience and knowledge through discussions takes place in seminars. Institutes "include more immersion experiences and experiential or hands-on activities through

which participants engage in-depth with new ideas and materials" (Loucks-Horsley et al., 2010, p.260). Effective workshops, seminars and institutes include various learning activities, opportunities for networking, reference resources to be used in the future, development of products like plans and time for reflection (Loucks-Horsley et al., 2010).

- ***Professional networks*** are used to share experience and knowledge with others and learn from others in the network. Participation in professional networks is voluntary. Since ongoing interactions take place, continuity is essential (Loucks-Horsley et al., 2010).
- ***Online professional development*** programs (e.g., online courses, video conferencing, etc.) "use technology and the Internet as a means of communication, delivery, and support of teachers' learning" (Loucks-Horsley et al., 2010, p.272).

Since the development processes of BİLMER PD program and model were within the scope of the BİLMER project (for more information see Köseoğlu, 2018), information about PD program was briefly described in the light of abovementioned literature. Accordingly, science teachers' professional development needs related to teaching and learning in science centers were assessed through BİLMER Teacher Questionnaire while planning the BİLMER PD program and its workshops. In this context, some presentations and activities were developed in accordance with the needs of teachers. For instance, teachers reported in the questionnaire that they did not receive training on "*developing and implementing instructional plans for learning in science centers*" subject and needed training on this subject. As a consequence, a session was held in the PD program on this subject, in which teachers working together with explainers to develop instructional plans. Moreover, PD program was conducted as in the form of the series of three-day-long workshops. Although workshops were underrated regarding its effectiveness (Guskey & Yoon, 2009), it was claimed that by the help of various learning and engaging activities in which learners could process information (*"active learning experiences"* as also suggested by Birman et al., 2000; Garet et al., 2001), effective workshops can be designed (Loucks-Horsley et al., 2010). Some activities that can be used for this purpose can

be summarized as follows: analysis of sample videos, discussions, lesson modeling, demonstrations, presentations, group activities and reflections from the groups, etc. (Mundry, Britton, Raizen, & Loucks-Horsley 2000; Loucks-Horsley et al., 2010). Correspondingly, some types of these activities were adopted in the PD program. For instance, to show how science centers can be used as complementary environments to school curriculum, modelling lessons were presented to teachers and explainers by means of "The Teaching Sequence of Sound Topic" video and "The Teaching Sequence of Magdeburg Spheres" demonstrations. Moreover, as another key element of effective workshops, teachers were given opportunities to learn in collegial environment (Birman et al., 2000; Loucks-Horsley & Matsumoto, 1999; Loucks-Horsley et al., 2010; Oktay, 2015), in which they can learn from one another, explainers, experts and educators. Teachers and explainers were given chance to share their knowledge, experience and ideas not only while developing instructional plan for a successful science center visit, but also other activities conducted throughout the PD program (e.g., "The Heart of Daphnia"). Similarly, presentations conducted during the PD program were not just an ordinary powerpoint presentations, in which teachers just sit back and listen. They were interactive presentations, in which teachers actively participated in by means of discussing and asking questions to experts, educators, colleagues and explainers. Furthermore, coherence between school curriculum and PD program's activities was regarded so that teachers can easily integrate them into their daily life school work (as suggested by Birman et al., 2000; Garet et al., 2001). Separately, according to one of the characteristics of effective learning experiences for teachers, called as assessment-centered, teachers should be helped to reflect about what they learnt and how to apply what they learnt (Loucks-Horsley & Matsumoto, 1999). Correspondingly, the current study gave teachers opportunity to monitor themselves about what they learnt and their own improvement in organizing and conducting field trips to a science center. In other words, the teachers had a trip experience before the PD program, saw their deficiencies, learnt about them in the PD program and then applied their learning through a second visit.

2.2.3. Research on teachers' PD programs regarding informal learning settings

Informal learning settings have a potential to engage teachers in professional development that assembles pedagogy, professionalism and content (Melber & Cox-Peterson, 2005). As a matter of fact, professional development opportunities for teachers have been provided by informal education sites for a long time, that center on presenting exhibits to teachers and teaching how they can connect classroom curricula with the exhibits' objectives (Lederman et al., 2012). For instance, a large majority of 2500 informal learning environments in the United States offer professional development programs for teachers and more than 150.000 teachers participate in professional development programs offered by this type of environment (Center for Informal Learning and Schools, 2004). Considering this, it could be claimed that informal settings have been playing significant role in teachers' professional development. Regarding science teachers, "informal science learning experiences offer teachers a powerful means to enhance both professional and personal development in science content knowledge and accessibility to unique resources" (NSTA, 1998, p. 17).

Studies in the literature revealed that professional development programs focused on teachers' experiential learning experiences in informal settings (Neathery, 1998); science content knowledge and inquiry-based science teaching (Duran et al., 2009, 2010; Lederman et al., 2012; Melber & Cox-Petersen, 2005); self-efficacy beliefs (Duran et al., 2009; Ferry, 1995; Holliday et al., 2013; Ogbomo, 2010); awareness about museums and their resources and utilization from these resources (Chin, 2004; Faria et al., 2012; Melber & Cox-Petersen, 2005; Ogbomo, 2010). For instance, in 1998, Neathery provided professional development program about environmental science in informal settings for twenty elementary teachers. The purpose of the researcher was to assess participants' experiential learning experiences in informal settings including wildlife refuge, science center and zoological sanctuary. Through the program, the researcher gave teachers opportunity to engage in hands-on activities, instruction by guides and to explore the informal settings. Informal learning

questionnaire, including semantic-differential items and open-ended response items, was used to collect data. Data analysis revealed four assertions related to teachers' informal learning experiences. The first one indicated the importance of instructions given by guides (e.g., "*The guides open up series of thoughts and ideas in how to use experiences as a part of our curriculum*", p.43) (Neathery, 1998). The second assertion was related to firsthand experiences, according to which teachers meaningfully understand concepts through real-life experiences. The third assertion was about the significance of free choice and participatory design in informal learning experiences. The last assertion refers to the utilizing from informal learning settings as an educational complement to teachers' classroom instruction. At the end, Neathery (1998) concluded experiental activities enhanced learning in informal settings.

In the view of Cohen and Hill (2000), the development of teachers' subject matter knowledge is important because teachers whose subject matter is developed can improve their teaching practice, so that their students' gains can increase. In line with this view, Lederman, Holliday, and Lederman (2012) explored the influence of exhibit-based professional development program on 4^{th}-8^{th} grade teachers' PCK, pedagogy and understanding of subject matter. The program was administered by in collaboration with science center and university. There were three groups of teachers (N=94) in the study: two groups of them attended the 42-hour course, including the guided tours, free exploration and tour with a worksheet, throughout the school year and one group of teachers attended the same course during the summer, having 35 contact hour overall. The course was about Life Sciences including the topics such as cells, organs, and genetics. During the course, teachers discussed the science content, lessons and science center exhibits with each other. Also, the researchers provided teachers opportunity to plan how to best integrate and implement their exhibit-based learning into their instruction. During the guided tours, teachers were explained all of the exhibition themes in the science center and particular exhibits within each area by the exhibit designers. However, during free exploration time, teachers were allowed to carry on personal, content-based and pedagogical exhibit related discussions, while answering open-ended questions. Moreover, teachers were given

a worksheet to complete visiting four exhibits areas in the science center. It was required teachers to read text labels, observe the content of the exhibits, interact with computer simulations or animations and watch a movie. Data were collected by means of video and audiotape as well as observations and field notes. The researchers found that pedagogical discussions of teachers were generally about how their students react materials or exhibit's text panels. Moreover, it was concluded that the understanding of how exhibits play a role in developing science content knowledge of teachers and how these affect content related social interactions of them were substantial to go beyond only getting teachers ready for the field trips (Lederman et al., 2012). In a similar perspective, Melber and Cox-Petersen (2005) evaluated the influence of three variations of workshops within professional development program (based on museum, museum and field, field) on sixty secondary and elementary school teachers' comprehension of science content, instructional practices based on inquiry and awareness of museum and field resources. Data were collected through an end-of-workshop questionnaire, open-ended follow-up questionnaire, semi-structured interviews. There were three workshop models, (1) *Model A* – 3-day workshop was held in the museum (*n*=22) and the significant part of it (%40) consisted of self-guided exploration of the halls, (2) *Model B* – one day in the museum and one day at the field site (*n*=20), (3) *Model C* – 2-day workshop was held at the field site (*n*=18). In all workshop models, a packet of curricular materials to be useful in transferring workshop activities in classroom were given the all participants. It was found that there were statistically significant gains in teachers' perceived content knowledge (e.g., concepts in desert ecology, history of tar pits, etc.) within all workshops. Similarly, results revealed that there was an increase in teachers' understanding of scientific processes and a change in the teaching methods they use (e.g., more use of inquiry-based and hands-on activities). Furthermore, the researchers tried to figure out the components of workshop that lead to change in teachers. According to all participants of these three workshops, the most worthful elements of the workshop were interactions with artifacts and specimens of museum and hands-on activities. Moreover, when asked to participants in Model B and C to specify the most helpful workshop components, they indicated "spending time with scientists" and "classroom activities" (only participants in Model B). All in all,

connections to the science instruction, scientific field work, and time spent in the museum were reported by teachers as the most valuable elements of the professional development program. Correspondingly, they expressed their feelings about the experiences they had, as follows: "*These are very valuable workshops in order to have personal growth and to feel confident in teaching the subject material*" (Melber & Cox-Petersen, 2005, p.117). In another study, Duran et al. (2010) investigated the effect of a professional development program called as ASTER III (Active Science Teaching Encourages Reform) on the perceptions of early childhood teachers about the role and effect of visits to science museum and consequently on teaching and learning of students. Project ASTER III consisted of three phases, spanned over one year. During first phase, teachers participated in a series of seminars about inquiry-based science teaching, which focused on designing and implementing 5E learning model lessons. During second phase, "ASTER Teams" including teachers, science educator, university scientist and science museum member were formed. These teams developed a 5E learning model science lessons related state standards with a science museum (COSI-Center of Science and Industry-) exhibits. Moreover, teachers explored the science museum exhibits on their own to experience inquiry. During the last phase, teachers organized a field trip to COSI with their students to test their lessons developed before. Then, some refinements and modifications were made based on the experiences in this field trip. Data were collected both quantitatively (*survey to assess teachers' beliefs about inquiry and science teaching*) and qualitatively (*reflection papers to assess teachers' perceptions about themselves and their students*). As a result of the study, the researchers hypothesized that according to teachers' perceptions, there was a positive impact of informal science education on both teacher's and student's content knowledge and ability to learn by exploring scientific concepts via hands-on experience. However, the researchers could not say about which phase of this professional development program had an influence on teachers' perceptions. Nevertheless, they argued the necessity of interplay of all phases. In the same project, Duran et al. (2009) also investigated the effect of as Project ASTER III on early childhood teachers' (N=26) perceptions of inquiry-based science teaching and their self-efficacy beliefs. One of the main purposes of the Project ASTER III was to develop science curriculums, enriched with inquiry-based

science museum exhibits, and in parallel with national and state science education standards. As mentioned above, there were three phases of ASTER III Project including various programs. Data were collected through (1) "*Survey of Teacher Beliefs in Inquiry-Based Teaching*" - to assess teachers' beliefs about inquiry-based teaching, (2) "*Science Teaching Efficacy Belief Instrument (STEBI-A)*" - to assess teachers' beliefs about science teaching and (3) *Reflection papers* – to learn more their professional development experiences in the project. At the end of the study, the Duran et al. (2009) revealed three themes from the analysis of reflection papers, which were influence on teacher understanding of inquiry, increased confidence about science teaching and benefits of collaboration. The following quotes represent these themes respectively:

> …It really helped me understand how to conduct an inquiry-based lesson. Actually exploring the exhibits ourselves and asking testable questions gave me the understanding I need to plan a lesson using the 5E Model (p.62).

> When I brought my class to COSI, I was able to teach my students better than I ever could have without this experience. I feel much more confident in my knowledge as I explain physical science to my students (p.62).

> One portion of ASTER III that was most beneficial was working with other members of the class that taught at the same grade level. The educator that worked in our groups was helpful and supportive of our ideas and gave suggestions as we went through COSI. The scientist who worked with us was also quite helpful. He explained concepts in a scientific manner that we may have completely misunderstood otherwise. It was nice to have the background knowledge so that we as teachers have a clear understanding (p.63)

In sum, the researchers concluded that teachers were more likely to agree that inquiry-based teaching enhances individualized learning and assists students to deeply examine the topics (Duran et al., 2009). Moreover, according to the researchers, teachers' confidence increased as a result of professional development program. For instance, teachers had the following beliefs: "*I can explain to students why science experiments work, I have the necessary skills to teach science, and an inadequate science background of a student could be overcome by good teaching*" (Duran et al., 2009, p.66).

Teachers' attitudes, beliefs and self-efficacy regarding science teaching are the subject areas that has long been subject under the spotlight of the researchers. For instance, in 1995, Ferry investigated the influence of a teacher training program based on small group teaching experiences at an interactive science center, on preservice teachers' confidence (*N*=102). During the program, preservice teachers participated in one-hour guided tour and one-hour self-exploration tour at the science center. They also observed an explainer, who was guiding children in the explanations of exhibits over a two-hour period. Then, it was asked to preservice teachers to guide a group of children through the science center. The methods of data collection were a questionnaire measuring the impact of the program and an interview with randomly selected preservice teachers. Ferry (1995) found that majority of preservice teachers' (89% of men and 92% of women) confidence in their ability to instruct students in hands-on science was increased by means of teacher training program based on small group teaching experiences at an interactive science center. Similarly, in 2010, Ogbomo conducted a case study to investigate the impact of a science museum/center professional development program on six elementary science teachers' instructional practices and self-efficacy beliefs regarding the science teaching. While three teachers participated in science center workshops, three of them participated in museum workshop. The methods for data collection were (1) *observations* – focusing on the teachers' science teaching before and after participating in the professional development program, (2) *self-efficacy survey (STEBI-A)* – focusing on science teaching efficacy beliefs of in-service teachers before participating in the professional development program, (3) *semi-structured interviews* – focusing on the teachers' reflection on the changes in their instructional practice and self-efficacy beliefs. Analysis of observation and interview data revealed two major themes, which were: "Program was beneficial" and "Program did not improve instructional practice". Reasons of the failure of the program were listed by Ogbomo (2010) as: lacking of follow-up activities, teachers' strong science background, time constraint on the application of new learnings and seeing the program as a "loss of the day of teaching". On the other hand, the program was seen as benefical since it gave teachers a chance to (1) build content knowledge, (2) experience and discuss materials, which were related to state goals, (3) work together with their colleagues, and (4) increase their

confidence in science teaching. Moreover, Ogbomo (2010) found two factors contributing teachers' self-efficacy, which were the having opportunity to experience lessons at first hand and having a model teacher who teaches lessons.

In another study, the effectiveness of Informal Science Institution (ISI) course including life sciences was examined with a sample of three groups of elementary and middle school teachers (*N*=62) (Holliday et al., 2013). Two groups participated in professional development programs held six times each month during the academic year, forty-two hours in total. In summer, the third group was subjected to thirty-five-hour course, in five consecutive days. The program was created on the basis of the scientific content of the exhibits, inquiry-based teaching methods and activities. In addition to lectures in the course, variety of activities were conducted such as guided tours, utilization of worksheets, and free exploration in the exhibitions. Data were collected through subject matter knowledge test at the beginning and end of every course. At the same time, teachers were asked to keep their portfolio to get opinion about their overall thoughts and impressions about the course. The results of the applied test showed that teachers did not completely learn, although they reported in their portfolios as they did learn well. On the other hand, teachers denoted regarding questions for course evaluation that the time for hands-on experience, scientific content and museum trip was sufficient. Some teachers stated that more time was necessary to discuss students' misconceptions and museum trip. Finally, results of portfolio evaluation showed that improvement of teachers were in four area: (1) content, (2) comfort and confidence in science teaching, (3) cooperation with other teachers, (4) museum resources and their utilization. The researchers indicated that providing all available museum resources to teachers and exposing them to various ISI exhibits could be the reason behind the increased comfort and confidence of teachers. For instance, the following quote of a teacher was presented as an evidence for this:

> being in this workshop series gave me a greater understanding of the resources available to me at the ISI, and gave me a greater ability to plan a well-thought-out field trip at the ISI, where the students were able to see and do specific things that tied into what they were learning. (Holliday et al., 2013, p.10).

In the light of the study of Holiday et al. (2013), it might be inferred that teachers' efficacy in science teaching and awareness of museum resources are somehow related each other, especially while utilizing from such kind of places in their lessons. Likewise, Faria et al. (2012) believed that in-service science teacher program is needed to show how to design and implement effective school trip and integrate resources of informal settings into their teaching practice. Therefore, the researchers investigated the impact of science teacher training course, which was developed by and conducted in a science center, on teachers' (N=38) utilization of science centers' resources. The teacher training course consisted of two units: (1) a 16-hour tutorial unit – refers to practical and theoretical work in class, and (2) a 10-hour autonomous unit – refers to the development of a portfolio and the organization and implementation of two science center visits by teachers. Moreover, there were four sessions of tutorial unit. During first session of tutorial unit, teachers were asked to critically analyze the resources in science center and discuss the similarities and differences between non-formal and formal learning environments. During the second session, teachers' awareness about organizing purposeful visit to a science center was tried to promote. During the third session, teachers were asked to classify different science center resources based on its degree of interactivity. During the final session teachers' awareness about the evaluation of school visit to science center was tried to promote. To comprehend teachers' perspectives on the course, an online questionnaire was used. Similarly, to evaluate the impact of the course, direct observations of the tutorial sessions and school visits were used. Findings indicated that teachers (1) realized the importance of knowing exhibitions before conducting a school visit, (2) obtained in-depth knowledge about the resources of center, (3) played more active role during school visit, and (4) felt that they were more enthusiastic and capable to conduct a school visit to a science center, as a result of participating in science teacher course, in which they can critically analyze exhibits with science center educators and can design trip plans to be used in a science center visit (Faria et al., 2012). In a similar perspective, in their study, Melber and Cox-Petersen (2005) tried to support secondary and elementary school teachers' classroom instruction by increasing their awareness of the museum resources such as free curriculum guides, exhibit tours, website resources and a loan service enabling teachers to borrow

specimens and artifacts for use in the class. It was found that teachers' awareness of museum resources available to them was higher on post-workshop self-reports (M=2.56, SD=1.09) than on self-reports of pre-workshops (M=4.06, SD=077), $t(16)=4.39$, $p<.01$, for museum-based workshop, in which teachers participated in hands-on activities and problem-solving sessions using museum resources; self-guided exploration and learnt about how to acquire loan-service and free of charge items. However, only three participants from field-based workshop and only one participant from museum- and field-based workshop chose "learning about museum resources" as the most helpful elements of workshop for their teaching. After all, Melber and Cox-Petersen (2005) concluded that museums help teachers built knowledge about available resources and these type of workshops empower them to make better decisions about their science teaching by improving their understanding of available museum resources. In another study, Ogbomo (2010) found that teachers, who participated in museum/science center workshops -including presentations about introduction of activities and a typical visit, guided tours, and teacher manuels (consists of student activities, information needed for a visit to there)- built augmented knowledge of resources avaliable to them and learnt how to use them in their classes. For instance, one teacher reported workshop benefits as: "*At the workshop they gave us more than enough materials and they teach you how to do the activities...The museum workshop really prepares you to teach...*" (Ogbomo, 2010, p.82). Regarding preservice teachers, in 2004, Chin investigated twenty-one preservice secondary science teachers' ways to deal with resources and contexts of National Museum of Natural Science and how teachers use museum resources to enhance their science teaching as a result of teaching method course. First of all, a-four-stage teaching method course was designed by the researcher. Besides lecturing, there were such kinds of sections in the course as (i) an arranged visit to science museum, (ii) discussion with educators of museum, (iii) development of lesson plans on a topic as a group work, and (iv) teaching practice in the museum. In the first stage, the nature of informal science education and effective teaching strategies like constructivism related to science museum were introduced to the participants. Then, a special arranged visit to the National Museum of Natural Science was conducted to increase preservice teachers' knowledge about museum resources and give them

opportunity to meet museum educators. In the second stage, preservice teachers were asked to first develop a science lesson plan for use in the classroom and then transform it into the museum context. In the third stage, preservice teachers did their teaching practices regarding their lesson plans in the science museum context. Finally, in the fourth stage, they wrote reflective journals about their experiences. Researcher collected data from multiple resources, which were interviews, teachers' diaries, field notes, observations, pre- and post-lesson plans, and videotapes. Chin (2004) found that preservice teachers' in-depth knowledge about museum and its resources improved as a result of two consecutive stages, which are specially arranged visit guided by instructor and several self-visits fulfilling the lesson plan development task. These subsequently contributed their ability to integrate science museum resources into school science. Moreover, it was found that getting feedback from their peers and reviewing the lesson plans developed by other groups paved the way for preservice teachers to observe several teaching strategies and concept representation ways used by other groups and consequently to refine their own lesson plans. Chin (2004) also indicated that the role of the preservice science teachers changed from being only as an ordinary visitor to the goal-directed observer and a lesson producer. To sum up, preservice teachers enhanced their comprehension and their ways to utilize from museum resources in their teaching at the end of museum-focused professional development course.

To sum up, regarding informal settings, teachers' content knowledge and instructional practices based on inquiry improved after participating in professional development programs including inquiry-based science teaching (Duran et al., 2009, 2010), collaboration between science educators, university scientist and science museum member (Duran et al., 2009), exploration of exhibits on their own (Duran et al., 2010; Melber & Cox-Peterson, 2005), hands-on activities (Melber & Cox-Peterson, 2005), and connections of museum- and field-based activities to classroom science instruction (Melber & Cox-Peterson, 2005). In a similar manner, professional development programs, which give teachers opportunity to learn more about all museum resources available to them (Holliday et al., 2013); experience teaching hands-on exhibits at first hand (Ferry, 1995; Ogbomo 2010); observe model teachers

teaching (Ogbomo, 2010); develop lessons relating state standards with exhibits and test them through a visit to science museum (Duran et al., 2009), increased teachers' comfort and confidence in science teaching. Moreover, the above-mentioned literature put forward that teachers built knowledge of science museum/center resources and learnt to utilize from these resources in their lessons as a result of PD programs, in which they;

- were introduced to activities, teacher manuals, loan-service and free of charge items (Melber & Cox-Peterson, 2005; Ogbomo, 2010)
- critically analyzed exhibits with science center educators (Faria et al., 2012)
- participated in specially arranged visit guided by instructor and problem-solving sessions using museum resources (Chin, 2004; Melber & Cox-Peterson, 2005; Ogbomo 2010)
- explored science museum/center on their own given free exploration time (Chin, 2004; Melber & Cox-Peterson, 2005)
- designed trip plans to be used in a science center visit, got feedback from their peers and reviewed plans developed by others (Chin, 2004; Faria et al., 2012)

CHAPTER 3

METHODOLOGY

This chapter includes information about the research questions, design of the study, participants, instruments, data collection and analysis, assumptions and limitations, validity and reliability related to the current study, information about field trip site and PD program.

3.1. Research Questions (RQs)

The main and sub-research questions of this study were:

1. How does PD program influence science teachers' awareness about science centers and their resources?
2. How does PD program influence science teachers' way of conducting field trip to a science center?
    a) Through the lenses of the researcher, what are the changes in science teachers' strategies for conducting science center visit from beginning to the end?
    b) Through the lenses of science teachers, what kind of characteristics of PD program had an influence on their instructional planning regarding science center visit?

3.2. Design of the Study and Rationale

The design of this study was case study, which was defined by Creswell (2012, p.465) as: "an in-depth exploration of a bounded system (e.g., activity, event, process, or individuals) based on extensive data collection (Creswell, 2007). *Bounded* means that the case is separated out for research in terms of time, place, or some physical

boundaries". According to Creswell (2012), a single individual or several individuals separately or in group might be a case. In this study, three science teachers participating in BİLMER PD program formed the case since they were unique in that there were no other teachers participating in the professional development program for the purpose of this study and there were no other teachers conducting visit to METU SC both before and after participating in the PD program. Similarly, the posed research questions (i.e., "how" questions), being explanatory in nature, likely led to the use of case study, as explained by Yin (2009).

There were three types of case studies used often by qualitative resarchers: (1) *intrinsic case study* - deals with the understanding of particular situation or individual, (2) *instrumental case study* - deals with shedding light on specific issue as a means to larger purpose, and (3) *collective or multiple case study* – deals with multiple cases providing insight into one overall study (Creswell, 2012; Fraenkel & Wallen, 2006). The current study constituted a single case study by fitting into intrinsic type since the researcher described the specifics of the case in detail to provide insight into specific phenomena (i.e., the influences of PD program on teachers).

3.3. Participants

The purpose of qualitative study was to reveal in-depth exploration of a phenomenon, not to generalize a population. Therefore, researcher selected the sample purposefully to best comprehend the phenomenon (Creswell, 2012). Typical sampling approach, which "is a form of purposeful sampling in which the researcher studies a person or site that is typical to those unfamiliar with the situation" (Creswell, 2012, p.208) was used in the current study. For that purpose, the researcher studied three typical science teachers at a private and public school in Ankara since these individuals have at least one-year experience in teaching and have assimilated the school's cultural norms. Moreover, teachers' interest in informal learning environments, and their enthusiasm and willingness for research were also considered as selection criteria because of the loss of individuals is a common problem while progressing the study (Fraenkel & Wallen, 2006). Thus, the researcher tried to study with these participants in the study

over time keeping their motivation high. Besides, they had never participated in professional development program about out-of-school environments, especially science center, before. Separately, since the larger number of cases or individuals can be inconvenient to report details about each individual and result in superficial perspectives and decrease in the overall ability of a researcher to provide an in-depth picture (Creswell, 2012), the number of participants was held at three. The demographic information about participants was given in the following paragraphs.

Teacher A was graduated from Department of Elementary Science Education at Middle East Technical University (METU). In 2016, she was continuing master program in the field of science education. She was a science teacher at a public school in Ankara, who had three years of teaching experience as of 2016. Also, she said that she was working at this school since February 2016. Before, she had worked another public school in Ankara. Although she had participated in-service training courses, she had never participated in professional development program about informal learning environments, especially science center before. She also mentioned that she had occasionally taken the students at her previous school to out-of-school environments like a museum and Eymir Lake in Ankara.

Teacher B was graduated from Department of Elementary Science Education Department at METU. She was a science teacher at a private school in Ankara, who had four years of teaching experience as of 2016. She had participated in-service training courses but she had never participated in professional development program about informal learning environments, especially science center before. However, she expressed that while she was a university student, she worked at METU Science Center for a short period of time (about twenty-eight hours) as a volunteer within the community service course. Moreover, she mentioned that she generally organizes field trips to out-of-school environments like theater, museums, and natural parks twice a year.

Teacher C was graduated from Department of Elementary Science Education at METU. She was a science teacher at a private school in Ankara, who had four years

of teaching experience as of 2016. Although she had participated in-service training courses, she had never participated in professional development program about informal learning environments, especially science center before. Moreover, she mentioned that she regularly organizes field trips to out-of-school environments like nursing home, fire station, and earthquake simulation center.

3.4. Instruments

3.4.1. Semi-structured interviews

In this study, a total of four semi-structured interviews (see Appendix A for interview questions and see Table 3.1. for data collection procedure) were conducted with the participating teachers: (1) interviews after the science center visits organized by teachers before and after the PD program, (2) interviews about their science center awareness before and after the PD program (also about evaluation of the PD program).

The purpose of these interviews was to identify the influence of PD program on science teacher's awareness of science centers and their use, teachers' way of conducting field trip to a science center. Semi-structured interview questions were developed by the researcher by considering relevant literature and research questions (Chin, 2004; Harkins, 2013; Kisiel, 2003a; Melber & Cox-Petersen, 2005; Michie, 1998; Ogbomo, 2010). Interviews took place at the office of the researcher. They were held on the day and hour appropriate to the teachers' schedule. The approximate duration of each interview was about 90 minutes. All interviews were recorded with the help of a voice recorder. The first two interviews (i.e., about their awareness and visits before PD program) were transcribed prior to the second interviews.

3.4.2. Observations

Observations were made to answer the following research question: "Through the lenses of the researcher, what are the changes in science teachers' strategies for

conducting science center visit from beginning to end?". Nonparticipant observation was adopted while observing teachers during their visits to METU SC. During the observations, the researcher tried to record all interactions of teachers with students, explainers, exhibits, verbally or non-verbally by both using observation checklist developing by the researcher taking into account relevant literature (see Appendix A) and taking detailed field notes. During the observations throughout the entire visit, observer was generally positioned herself closer to teachers being observed to hear what they were talking. Teachers were only told that they would be observed during the visit, they were not informed of the purpose of the observation until the data have been collected. Therefore, it was assumed that behaviors of teachers during science center visit were not significantly changed while the researcher was observing them, compared with the absence of the researcher. On the other hand, Fraenkel and Wallen (2006) argued that observer bias (i.e., observer's ideas or characteristics may influence what s/he really sees) may impact on the outcomes of the study. To handle observer bias, the researcher adopted member checking technique. Birt et al. (2016) argued that the potential of researcher bias can be reduced by including participants of the study in controlling and verifying the results. They called this technique as member checking and defined as method of returning an interview transcript or analysed data to a research participant to validate, confirm, or provide the trustworthiness of qualitative results. Therefore, the analysed observational data were returned to teachers to check for accuracy and resonance with their experiences during science center visit after the post interview. For instance, the researcher said Teacher A: "During stationary presentation, you just sat and watched. Also, you did not make any association with the curriculum or ask any question to your students about the subject. You mostly toured exhibits on your own, reading the explanations about them on the labels… Do you agree on these analysed observational data?". As a result, teachers agreed on the analysed observational data without making any changes and these data were included in the study to be used to triangulate the data from other instruments such as interviews and instructional plan.

3.4.3. Instructional plan

Concurring with the claim by Behrendt and Franklin (2014) that preservice teachers are not educated in science teacher education programs about how to plan and organize a field trip, some strategies and activity examples required to organize and conduct a field trip to the science center and a sample instructional plan (see Appendix E) were suggested to the teachers during PD program in order to be used when developing their instructional plan for their future trips. The suggested sample instructional plan was prepared for 11^{th} grade students on the subject of force and motion in physics. It was a plan where the purpose of the trip, teaching methods and techniques, and the curriculum link were presented. Moreover, it was a plan where the introduction, development and conclusion sections of a standard instructional plan were presented as pre-, during-, and post-visit sections.

The purpose of the use of instructional plan as an instrument was to triangulate the data from other instruments such as interviews and observations. In other words, the researcher used instructional plans to determine whether teachers' answers to interview questions about their visit and their observed actions during their visits matched with what was written in their instructional plans.

In both visitations to METU SC, teachers (A, B, and C) brought their same sixth graders, fifth graders and fourth graders respectively. They also prepared their instructional plans according to these grade levels. While they were not requested to prepare a plan for their first visits to determine whether teachers would prepare a plan when it was not required, they were requested for preparing a plan for their second visits to triangulate the data from other instruments such as interviews and observations. On the other hand, they determined the topic, the sections, the inclusion, and format of their instructional plans and the like on their own (see Appendix F).

3.5. Data Collection Procedure

The details of data collection procedure is given in Table 3.1.

Table 3.1.
Data Collection Plan

Phases	Months	Instruments	Explanation	Related RQ
1	February-March	Observation	Before PD program, all teachers organized a trip to METU SC. Teachers were observed during the trip.	RQ 2
2	February-March	Interview	Interview about their first trip	RQ 2
3	February-March	Interview	Interview about their science center awareness	RQ 1
4	March		Teachers participated in PD program.	
5	March-April	Instructional plan	Teachers were requested to prepare an instructional plan for their second trip to the METU SC based on their learning in the PD program.	RQ 2
6	April-May	Observation	After PD program, all teachers organized second trip to METU SC. Teachers were observed during the trip.	RQ 2
7	June	Interview	Interview about their second trip	RQ 2
8	June	Interview	Interview about their science center awareness and evaluation of PD program	RQ 1 and RQ 2

3.6. Data Analysis

In the current study, both descriptive and content analysis were used to analyze the collected data. Descriptive analysis is the summation and interpretation of data obtained by various data collection techniques according to pre-determined themes (Yıldırım & Şimşek, 2013). In this type of analysis, the researcher often places direct quatotations in order to strikingly reflect the views of individuals who have been interviewed or observed. The main purpose of the descriptive analysis approach is to present the findings in a summarized and interpreted way to the reader (Yıldırım & Şimşek, 2013). Descriptive analysis involves four stages. In the first stage, a framework is established for data analysis regarding the research questions, the conceptual framework of the research, or the dimensions in interviews and observations. Thus, it is determined on which themes the data will be organized and presented. In the second stage, the researcher reads and organizes the data according to the created framework. In this process, it is important to bring together the data in a meaningful and logical way. In the third stage, researcher defines the data that s/he has organized and supports with direct quotations where necessary. In the last stage, the researcher explains, associates, and interprets the findings that s/he has identified. Moreover, the researcher may explain the cause and effect relationships between the findings and, if necessary, compare different phenomena to further reinforce the comments s/he has made (Yıldırım & Şimşek, 2013). Results related to teachers' science center awareness and their strategies used for conducting visits to METU SC were descriptively presented in the current study. More specifically, teachers' science center awareness were descriptively presented under the following frameworks based on the interview questions: awareness about science centers in Ankara and in Turkey (out of Ankara), awareness about science center resources and utilization from these resources. Similarly, teachers' strategies used for conducting visits to METU SC were descriptively presented under the following frameworks based on the related literature: pre-, during- and post-visit strategies.

Content analysis is used to gain insight in which "situations, settings, styles, images, meanings and nuances are key topics" (Altheide, 1987, p.68). In their books, Yıldırım and Şimşek (2013) explained three different coding types for the content analysis

suggested by Strauss and Corbin (1990), which are coding based on pre-defined concepts, coding based on concepts derived from the data and coding within a general framework. The explanation of these coding types was presented below.

1. *Coding based on pre-defined concepts:* In the case of a theory or conceptual framework that forms the basis of the research, it is possible to extract a list of codes before the data is collected. In such situations, it is easier to encode collected data because there is already a structure for the analysis of the data (Yıldırım & Şimşek, 2013, p.261).

2. *Coding based on concepts derived from data:* It is used for research that do not have a specific theoretical basis. Since there is no conceptual structure to guide the analysis of the collected data, this structure is revealed by the researcher through inductive analysis of collected data. In such cases, the researcher reads the data in a line-by-line and tries to determine the dimensions that are important within the scope of the research. Then, the researcher generates certain codes. In summary, codes are generated directly from the data in the inductive analysis (Yıldırım & Şimşek, 2013, p.264).

3. *Coding within a general framework:* Such coding consists of a combination of the aforementioned coding formats. That is, it is possible to create a general conceptual structure before the analysis of the data. Coding is done based on this conceptual structure. However, new codes are included in the list. In this way, while a predetermined list of codes directs the content analysis, data emerging from the inductive analysis is added to the previously generated code list or old codes are revised according to new ones (Yıldırım & Şimşek, 2013, p.264).

In the current study, the first two coding types were used in analysing the data. Accordingly, data related to teachers' strategies used for conducting visits to METU SC were coded based on pre-defined concepts. More specifically, Kisiel's (2003a) strategies (pre-, during-, and post-visit) were the main coding source during the

analysis of the changes in teachers' strategies for conducting science center visit. Detailed explanation of these strategies was given in Chapter 2 (see Table 2.1). However, the researcher of the current study made some changes in the categories of these strategies. For instance, "General Things to Do" and "Instructional Planning" categories were added to the pre-visit strategies section. Similarly, "Following Instructional Plan" category was added to the during-visit strategies. "General Things to Do" category was created by the researcher inspiring from the Laçin Şimşek's (2011, p.14) "Bureaucratic Works" strategy, which is related to the general works to do such as permissions, booking, etc. On the other hand, "Instructional Planning" category was created by the researcher inspiring from the Kisiel's (2003a, p.121) "Plan of Action" strategy. In 2003, Kisiel used "Plan of Action" term, which was defined as an action plan for the field trip day, as during-visit strategies of teachers to discuss whether teachers follow an action plan and to what degree teachers follow it during their fieldtrip. However, the researcher purposefully divided this term into two categories, which are "Instructional Planning" and "Following Instructional Plan". In the current study, "Instructional Planning" category was put under the pre-visit strategies section since the researcher wondered whether teachers prepare an instructional plan for their trips. Furthermore, "Following Instructional Plan" category was put under the during-visit strategies section since the researcher wanted to learn whether teachers follow their plan during visit. A new protocol for coding (see Appendix G) was created regarding all these changes and the data were analyzed accordingly.

Data related to teachers' science center awareness and their views on the characteristics of PD program influencing their instructional planning regarding science center visit were coded based on concepts derived from the data. Accordingly, the researcher read the data in line-by-line and tried to determine the dimensions that are relevant to scope of the research question. Then, the researcher generate codes and created a protocol to be used for ensuring the reliability of coders and coding. The detailed explanations of these codes were presented in Appendix G.

All in all, "there is no one correct analysis for qualitative data. Additionally, qualitative research has design and analysis flexibility (Bogdan & Biklen, 2007; Marshall & Rossman, 2006; Merriam, 2009; Patton, 2002), which is an indicator of research's richness", as stated by Aydın (2012, p.99). Besides, the use of both content analysis and the detailed and direct-quatotation-supported descriptive data analysis ensures the public justifiability of the data. That is, readers or reviewers can directly assess the quality of the coding (Ahuvia, 2001) referring to codings with their main texts and protocols for these codings.

3.7. Incentive

In order to keep teachers' enthusiasm and willingness for their participation and to thank them for their participation in the research, a total of three different gifts were given. The first present was a pencil and a notebook given before the professional development program. The second one was a houseplant to thank them for participating in the professional development program. Finally, a book about informal learning environments was presented as a gift after the last interview.

3.8. Description of Field Trip Site

In the current study, METU Society and Science Application and Research Center (METU SSARC), founded in 2006, was used as field trip site. This institution is located in the campus area of METU in Ankara, which is one of Turkey's most competitive universities. It is annually visited by about 20,000 students and teachers on school field trips. METU SSARC consists of 3 different buildings that serve different purposes and an outdoor exhibition. A steam train and various airplanes are on display in outdoor exhibition. "*Science and Technology History Exhibition*" building contains objects describing the history of science and technology from ancient times to present day. In "*Classic Car Exhibition*" building, there is a private collection of cars utilized in the past. "*Science Center (SC)*" building contains the exhibits designed with the principle of 'Interact with Science'. That is, visitors get hands-on experience inside.

This science center was selected for convenience due to four reasons. First of all, there were two different science centers option for teachers in the center of Ankara: 1) METU SC and 2) Feza Gürsey Science Center. Teachers prefered to organize trip to METU SC since they were METU graduates and familiar with the campus. Second, the researcher has been working on there since 2011. Third, this SC offers free of charge service. Lastly, it offers some free of charge resources for teachers like trip guide, suggestions for pre-visit activities and introductory presentations of monthly activities on their websites.

3.8.1. General information about METU SC

The METU Science Center serves all grade levels from the 4th grade, in addition to individual visitors. Individual visitors are permitted from 9 am to 5 pm, except on days when it is closed. The science center is generally closed on Sundays and official and religious holidays. Three sessions (9.30 am, 11 am and 2 pm) are held on weekdays to school groups for that monthly activity program. One and half hour time slots are reserved for each group. Visitor student groups should be at least 15 and at most 40 people. For groups of 40 students, at least 2 teachers should accompany the students. School groups are responsible for transportation expenses.

The METU Science Center has over 80 exhibits, appealing special themes (e.g., mechanics, electricity and magnetisim, optics, maths & intelligence, sound & waves). Some of the exhibits are interactive that presents different outcomes in response to the visitors' action. For instance, visitors can learn their weight in the Moon and other planets by means of "Weight Simulator".

3.8.2. Typical field trip process at METU SC

A typical field trip at METU SC consists of two sections: stationary and interactive presentation and free exploration time. During field trips, school groups are greeted at the entrance and requested to seat in theater seating arrangement in the seating area to participate in explainers' presentation. This presentation consists of the explanation

about three or four exhibits related to that months' topic, which is usually structured by the explainers in parallel to the school curriculum. For instance, the presentation program of March is about sound topic and that month, students learn this topic at their schools. The monthly program is announced through METU Science Center's Trip Guide on their website. About 20-minute interactive presentation is provided by the explainers, in which students actively participate by means of asking question, discussing with each other and the explainer, touching and observing exhibit. Then, free time is given to students to explore other exhibits attracting their attention. In that time interval, explainers are avaliable to interact with students to answer their questions and help them when they need.

3.9. Professional Development (PD) Program

The PD Program was held on March 11-13, 2016 in Gazi Faculty of Education in Ankara. Within the framework of the "BİLMER Project: Teachers and Explainers Professional Development Programs Pilot Workshops-1", which was planned for 36 hours in total and consisted of 16 sessions, some activities were carried out in the METU SC, Ahlatlıbel Observatory and Feza Gürsey Science Center (see Appendix B for the program brochure). A total of 38 participants (13 explainers and 25 teachers from different schools and branches) participated in the workshops. The detailed information about the program was given below.

3.9.1. Information about explainers in the PD program

Participant explainers were people working in eight different science centers in seven different cities, which were Konya (*n*=1), Eskişehir (*n*=2), Gaziantep (*n*=2), İzmir (*n*=2), Bursa (*n*=2), Kocaeli (*n*=2) and İstanbul (*n*=2). Five female and eight male explainers were selected on the basis of volunteerism considering some specific criteria (e.g., studying at the graduate level, participating in activities organized by MoNE and TÜBİTAK, etc.).

During two science center visits in the PD program, participants were also brought together with explainers of science centers in Ankara, which were METU SC and Feza Gürsey SC. There were two different explainers at METU SC, who were also from the BİLMER project team. One of them had science background and five-year experience as an explainer. The other one had physics background and nine-year experience as an explainer. Explainer of the Feza Gürsey SC had geology background and about twenty-year experience as an explainer.

3.9.2. First day of the PD program

First day of the PD program consisted of six sessions held at classroom of Gazi Education Faculty. *In the first session*, the purpose of the BİLMER Project and the PD Program was shared with the participants. Then, the first session was completed with explainers' introductory presentations about their science centers (Detailed information from presentations of explainers were given Appendix C). This was not just an ordinary powerpoint presentation of the explainers, in which teachers just sit back and listen. This was an interactive presentation, in which teachers actively participated in by means of asking questions to the explainers, discussing with each other and the explainers about science centers and their resources.

In the second session, presentations supported by various videos were given to emphasize science communication and the importance of science centers in the science education. Moreover, various activities were conducted such named as "Defying Gravity" to demonstrate how inquiry-based teaching strategies could be applied to a science show, and "Cold, Even Colder" to show how a science show could be presented using the Predict-Observe-Explain (POE) technique. Also, it was tried to emphasize that "science centers should provide real experiences that create a desire for more learning" through these activities. The "Teaching Sequence of Sound Topic" videos were watched, which was developed to show that science centers can be used as complementary environments, not as alternatives to school curriculums. Subsequently, the influence of helium and sulfur hexafluoride were shown on the

human voice to demonstrate how the fun dimension of science could be integrated into the sequence.

In the third session, teachers and explainers participated in "The Heart of Daphnia" workshop. During workshop, information about how to conduct this activity integrated to science center field trip efficiently had been presented to teachers in three different titles: Before going to the science center, during the science center and after the science center. The main purpose was that during this workshop, explainers or teachers should use guided inquiry for 6th grade and open inquiry for 11th grade students. By this way, students could be encouraged to create questions during the workshop (make prediction / generate hypothesis) and to design an appropriate experiment (research planning). Zebra Fish was also introduced as a biology exhibition. Participants examined Zebra Fish in the aquarium. While developing this exhibition, science communication and learning in science centers were considered since it is important to present scientific studies in an understandable and simple language. It was also aimed to discuss the issue of gene transfer, a controversial socio-scientific issue, thorugh on Zebra fish, one of the model animals.

In the fourth session, in the context of the talks with scientists, Assoc. Prof. Dr. Selçuk Tunalı, who was from TOBB Economy and Technology, University Faculty of Medicine, made a presentation about his specialty "Plastination". The purpose of the talk with scientist was to introduce new technologies/practices that could be used as education material in both schools and science centers to teachers and explainers. Also, the "Black Box" activity, developed by Lederman and Abd-El-Khalick (1998), was conducted with teachers and explainers to serve nature of science and presented a tabletop version of exhibits in science centers. In other words, this activity can be used as a tabletop version which models pedagogically one of the exhibits at the Konya Science Center, or it can be integrated by science center explainers to teach the nature of science during workshops.

In the fifth session, to demonstrate how to do a lesson utilizing from science center exhibits by means of POE technique, “Sticking Wheels of a Train to the Rails”

activity was introduced to teachers and explainers. This activity was an example for activities that can be done with simple tools for classroom applications in schools, as well as an example material for workshops of science centers.

In the last session, two different activities were introduced to teachers and explainers, named as “Liquid Nitrogen Ice-cream” and “Looking but not Seeing”. Highlighted points related to science teaching in the “Looking but not Seeing” activity were: (1) "Everyone observes nature, but scientists use imagination and creativity trying to understand the functioning of nature. ", (2) "Science is a mental activity, limited to creativity and imagination.", (3) "Scientists make qualitative observations as well as quantitative observations.". During the activity “Liquid Nitrogen Ice-cream”, which was developed for the purpose of "Development of Science Shows", liquid nitrogen and its properties were firstly discussed. In other words, attempts were made to raise awareness of both teachers and explainers about liquid nitrogen, an indispensable part of science shows. The session completed with the service of ice-cream, frozen by the help of liquid nitrogen.

3.9.3. Second day of the PD program

The second day of PD Program consisted of six sessions. While morning sessions were held at METU SC, afternoon sessions were held at one of the classrooms of Gazi Education Faculty. *In the first session of the second day*, participants were asked to take a tour at the METU SC individually for about one hour. During this tour, various mobile science applications (e.g., 3D elements, 3D human body, etc.) and “Skyscrapers” exhibit, which is a mathematical and intelligence game, were introduced to the teachers and explainers as an exemplary activities that can be used in classrooms and/or integrated into other science centers. After the tour, the "Teaching Sequence of Magdeburg Spheres" and the "Climbing Cone" exhibit were discussed with the participants. At the beginning, volunteer science center explainers were asked to explain these exhibits, then opinions were gathered from participants about how they found the explanation. After that, the project team shared their own presentations about this exhibit. Finally, everyone reached a consensus of the opinion

of how to better explain to the students. Moreover, a demonstration called as "Teaching Sequence of Magdeburg Spheres", which is an example of teaching sequence, was presented to participants as an example of how science center field trip can be used as complementary to school curriculum. During demonstration, how to use discourse analysis technique and communication skills were emphasized. For instance, you should always start introducing an exhibit with an interesting question (e.g., Why do not you feel the air's effect when you are all is surrounded by it?). During demostrations of exhibits, you can utilize from the POE technique. In other words, students should first make predictions (e.g., What will happen if you join the spheres and empty the air in them?); then make observations (e.g, After the air inside the spheres is drained, you want the two students to separate the spheres.); and then ask their explanations. During this, you should avoid to use of such words: "Wrong!", "Right!". Instead, you can use such sentence as: "Do you have any other ideas?", "Do you agree with your friend's idea?", "Why do you think so?" to actively participate the students into the process.

In the second session of the second day, a series of chemistry activities were carried out as both science show (e.g, Magnesium flash, Hydrogen balloon blasting,) and worskhop (e.g., making soap, battery construction with lemon, etc.) at the METU SC. It distinguishes itself from other science shows in terms of discussing why and how parts of a show should be. Besides, the activity entitled with "Monsters We can not See", which was the visualization of the area where the microbes were seen by means of blacklight UV, was introduced participants as a biology activity that could be done in science centers and schools.

In the third session, a presentation about how to conduct a successful field trip was made to the participants. During presentation, example activities and suggestions for what teachers and science center explainers need to do before (e.g., for teachers; preparing instructional plan, worksheet, information brochure -including purpose of trip, site introduction, what they will do, etc.-; using KWL chart, doing Observe-Inference activity for students' preparation, etc.), during (e.g., for teachers; group working, social interaction with each other, structured/unstructured activities, etc.),

and after a trip (e.g., for teachers; poster presentation, writing composition, drawing, completing KWL chart, tabletop versions of exhibits, etc.) were introduced. Meanwhile, examples of tabletop versions with different topics (e.g., vortex, radiometer, ufo ball, mirage, popper toy, etc.) that can be used in classroom activities after the trip were shown and discussed with the participants. Towards the end of the session, the views of the science center explainers and teachers about the things to do to maximize the science center-school cooperation were obtained by forming working groups between them.

In the fourth session, participants developed science center visit instructional plan that correlate science curriculum with exhibits of METU SC or Feza Gürsey SC. First of all, they were divided into 6 groups with purposeful sampling method. In this context, care was taken to ensure that there were at least 1 explainer and at least 4 teachers in each group and that the teachers in the group were from the same branch. For instance, two explainers from different science centers and three science teachers formed one group. Moreover, the reason why the explainer and the teacher coexist in groups is that both teachers and explainers expressed their wish to cooperate on this issue in needs analysis studies of the project. Then, they were asked to develop an instructional plan for a field trip to the science center within 45 minutes. After that, each group presented their plans to other groups to get opinions from all participants to improve their plans. After the group presentations, each group was also asked the following question by the project team: "Why did you choose this science center exhibit in your plan?", "Can you say the three most powerful features of your plan?". At the end of the session, a sample instructional plan was presented to all participants. The sections that need to be included in a field trip plan like purpose of the trip, what will be done before, during and after the trip were highlighted.

In the last two sections, participants were taken to the Ankara University Ahlatlıbel Observatory within the framework of the activities prepared for the purposes of the project. Before the trip, a question sheet was distributed in which there were several questions (e.g., Why do we always see the same face of the Moon?) that prompted participants to measure the participants' prior knowledge in order to make the trip

more effective. After the trip, the answers to the questions were checked together. First in the observatory, experts in the field of astronomy and space made about one hour presentation about "Observatories and Telescopes in Turkey and in the World". Then, astronomical activities were completed with Jupiter and Moon observation by means of special telescopes.

3.9.4. Third day of the PD program

The third day of the PD Program consisted of four sessions. While morning sessions were held at Feza Gürsey SC, afternoon sessions were held at one of the classrooms of Gazi Education Faculty. *In the first session of the third day*, participants were asked to take a tour at the Feza Gürsey SC individually for about one hour. Then, the Feza Gürsey SC explainer made a static electricity demonstration with the biggest Van De Graaff generator in Turkey. At the same time, he gave brief information about the Feza Gürsey SC and informed teachers and other science centers' explainers about how they can conduct a field trip to the Feza Gürsey SC including activities, reservation process etc. Later, in the workshop titled "Mystery of Fish Pulp", teachers and explainers tried to find the age of the fish by using the fish pulp. In this workshop, explanations were made on how teachers and explainers could perform this activity to their students when they are planning a field trip to a science center.

In the second session, two more activities related to the exhibits "Reflex Meter" and "Downhill Race" were introduced to the participants to show how they can create a teaching sequence utilizing from exhibits of science center. These activities were "Does anyone have a claim?" and "Is it really easy to rotate?". The activity titled "Does anyone have a claim?" was designed to make it possible to effectively use the "Reflex Meter" exhibit, which was one of the exhibits found in most science centers. This activity was made to show that the reflexes in biology and free falling concepts in physics were presented together. In this way, students can realize interdisciplinary knowledge. It was also designed as an in-class activity before or after the visit to the science center. On the other hand, "Is it really easy to rotate?" activity was designed to make it possible to effectively use the "Downhill Race" exhibit, which was one of

the exhibits found in most science centers. It was also designed as an in-class activity before or after the visit to the science center. It was shown that the rulers are rotated by masses -hanging at the ends of ruler of 1 m length and middle of ruler of 1 m length-. Thus, the inertia of the bodies could be discussed. The argumentation method was used in the activity. By this way, participants had an opportunity to see how this method can be used in the activities in science center. Finally, participants were shown how to make a simple microscope using smart phones or tablets that could be made in science centers and schools. What was intended here is that the participants can prepare a simple device that serves as a microscope using simple materials. Also, this activity can be used as a before- or after-trip activity for students to learn more about microscopes. Moreover, most of the participants claimed that it was the first time to see such a design and this would be practical for their students.

In the third session, "The Elephant's Toothpaste" activity was introduced to the participants. In this activity, participants made arguments about catalyst effects and produced scientific arguments. Therefore, it distinguishes itself from other science shows in terms of discussing why and how parts of a science show should be.

In the last session, opinions of participating teachers and explainers about professional development program were both in writing and verbally taken within a discussion environment. Later, a certificate of appreciation was presented to each participant. To sum up, details of the PD program were summarized at the Table 3.2.

3.10. Assumptions

There were several assumptions inherent to the study;

- The teachers honestly responded to the questions of interviews.
- The teachers were typical science teachers located in Ankara, where the study took place.
- Behaviors of teachers during science center field trip were not significantly changed while the researcher was observing them, compared with the absence of the researcher.

Table 3.2.
Summary of the PD Program Details

Sessions	Content
1. Session	• Introduction of BİLMER Project and PD program • Explainers' interactive presentations of their SCs
2. Session	• Experts' interactive presentation about science communication and importance of SCs in science education • "Teaching Sequence of Sound Topic" Video - to show that SCs can be used as complementary environments, not as alternatives to school curriculums • "Defying Gravity" Activity - to demonstrate how inquiry-based teaching strategies will be applied to a science show • "Cold, Even Colder" Activity - to show how a science show can be presented using the Predict-Observe-Explain (POE) technique
3. Session	• "The Heart of Daphnia" Activity - to show how to conduct an activity integrated to SC visit efficiently • "Zebra Fish" Exhibition - to show how to present scientific studies in an understandable and simple language
4. Session	• "Black Box" Activity - to serve nature of science and present a tabletop version of exhibits in SCs. • "Plastination" Presentation - to introduce new technologies/practices that can be used as education material in both schools and SCs
5. Session	• "Sticking Wheels of a Train to the Rails" Activity - to demonstrate how to do a lesson utilizing from SC exhibits by means of POE technique
6. Session	• "Looking but not Seeing" Activity - to emphasize nature of science • "Liquid Nitrogen Ice-cream" Activity - to raise awareness of both teachers and explainers about liquid nitrogen, an indispensable part of the development of science shows
7. & 8. Session	• Field Trip to METU SC; o Free time to explore o "Climbing Cone" Demonstration - to show how to better explain an exhibit to students o "Teaching Sequence of Magdeburg Spheres" Demonstration - to show of how SC field trip can be used as complementary to school curriculum o A series of chemistry activities - Magnesium flash, Hydrogen balloon blasting, making soap, battery construction with lemon, etc. o "Monsters We can not See" Activity - as a biology activity that could be done in science centers and schools

Table 3.2. (cont'd)
Summary of the PD Program Details

Sessions	Content
9. Session	• Experts' presentation about "How to conduct a successful field trip"
10. Session	• "SC Visit Instructional Plan Development" Activity
11. & 12. Session	• Field Trip to "Ankara University Ahlatlıbel Observatory" – to learn more about astronomical activities, observatories and telescopes in Turkey and in the World
13. & 14. Session	• Field Trip to Feza Gürsey SC; o Free time to explore o "Van De Graaff Generator" Demonstration o Presentation about field trip process in Feza Gürsey SC o "Mystery of Fish Pulp" Activity - to show how to conduct an activity integrated to SC visit efficiently o "Reflex Meter" Activity - to give an example in-class activity used to before or after the SC visit o "Downhill Race" Activity - to give an example in-class activity used to before or after the SC visit
15. Session	• "Elephant's Toothpaste" Demonstration - to show how a science show should be conducted
16. Session	• Evaluation of PD program and presentation of certificate

- During PD program, behaviors of the teachers were not significantly changed while the researcher was together with them, compared with the absence of the researcher.
- Teachers who had at least one year experience in teaching and graduated from elementary science education department participated in the professional development program. When their background were taken into account, it was assumed that they knew the instructional planning procedures.

3.11. Limitations

There were several limitations inherent to the study;

- This study examined science teachers (4^{th}, 5^{th}, and 6^{th} grades) and their field trip experiences. Therefore, findings of the study may not be applicable to other grade teachers.
- Since field trip experience occured only in a particular science center, findings of the study may be applicable to the similar settings.
- Teachers were not observed conducting pre- and post-visit activities. Therefore, data for these was dependent on the reports of teachers during the interview sessions.
- Teachers were not asked to prepare an instructional plan before the first trip with their students to science center. It was tried to be determined whether they would prepare a plan without being asked.
- Teachers behavior during the second field trip to the science center may be affected by not only the experiences in the PD program but also the experiences during the first visit to the METU SC.

3.12. Validity and Reliability of the Study

Rather than using quantitative researchers' terminologies, qualitative researchers developed their own terminology to desribe reliability and validity (Creswell, 2007) since qualitative studies are so dependent on the researcher in both collecting and interpreting cases which are unique and context-dependent (Fraenkel & Wallen, 2006). Lincoln and Guba (1985) introduced to the use of "credibility, dependability, transferability, and comformability" rather than the use of "internal validity, reliability, external validity, and objectivity" respectively. The combination of credibility, dependability and transferability ensures the trustworthiness of a study. The following parts explain how these issues were addressed in the current study.

3.12.1. Credibility of the research and researcher

Five techniques which are triangulation, member checks, adequate engagement in data collection, peer review and the credibility and role of the researcher can be used to increase credibility of qualitative research (Merriam, 2009). In this study, triangulation, peer review and the credibility of the researcher were employed to ensure credibility.

Triangulation refers to the use of multiple methods, data sources, investigators and theories by analyzing the data to get corroborate evidence (Merriam, 2009). In this study, data triangulation was achieved by using multiple data sources including observation, pre- and post-interviews, and instructional plans.

Regarding peer review, the researcher asked a colleague (who has a doctorate degree in Physics Education Department of METU) and an expert in Science Education Department of METU to evaluate professionally whether the findings are credible based on the data.

The credibility of the researcher, "which is dependent on training, experience, track record, status and presentation of self" (Patton, 2002, p. 552), should also be reported to enhance trustworthiness. I, as the researcher of the current study, worked at METU SC for years between 2011-2019 as both explainer and researcher. I served about one thousand students with different grades per year. Moreover, I took part in every steps of the many research projects granted at METU SC (e.g., TUBITAK, H2020-MSCA-NIGHT) from designing and writing to the reporting. Therefore, I improved myself in various research methodologies such as selecting appropriate design, collecting and analyzing the data. Moreover, the role of the researcher, which is "the process of reflecting critically on the self as researcher, the 'human as instrument' (Guba & Lincoln, 1981)" (Lincoln & Guba, 2000, p. 183) should be reported. One of the significant issue related to researcher's role is to decide what extent his/her observational role will be in the investigated setting (Merriam, 2009; Patton, 2002). Accordingly, the observational role of the researcher might be participant observer,

nonparticipant observer and changing observer role depending on the situation (Creswell, 2012). In the present study, I adopted a nonparticipant role while observing teachers during their visits to METU SC since I aimed to investigate teachers' strategies during their visit. During the observations, I tried to record all interactions of teachers with students, explainers, exhibits, verbally or non-verbally by both using observation checklist and taking detailed field notes. I generally positioned myself closer to teachers being observed to hear what they were talking. Another significant issue related to researcher's role is to decide what extent participants will be informed about their observations and purpose of the study (Patton, 2002). At the beginning of the study, I asked participants to sign a voluntary consent form, in which purpose of the study, expectations from the teachers (e.g., participating in 3-day PD program, conducting a SC visit both before and after PD program, data collection procedure etc.), and data confidentiality were explained. For the observations, I only told teachers that they would be observed during the visits, they were not informed about the purpose of the observation until the data have been collected. Therefore, it was assumed that behaviors of teachers during science center visit were not significantly changed while the researcher was observing them, compared with the absence of the researcher. The other significant issue related to researcher's role is the amount of time which is spent by the researcher in the context (Patton, 2002). Conducting this study, I made several phone callings with teachers to request them to (1) participate in the study, (2) schedule their visits to science center and (3) remind them about the date and time of the PD program. Moreover, since I was the member of the BİLMER project team, I also spent time with teachers throughout 3-day PD program. More specifically, I conducted "SC Visit Instructional Plan Development" and "Liquid Nitrogen Ice-cream" activities in the PD program and helped other project team members when needed. Similarly, I tried to fulfill the demands of the teachers and answer their questions, as much as possible, throughout the PD program. We also ate lunch and dinner together with teachers and chatted during breaks. On the other hand, based on the request of teachers, I also visited them in their schools after the PD program to talk about their workloads, other expectations from them and schedule their second visit to the science center. Besides, one teacher, who was studying master degree, said that she could understand research process as being a master-degree

student and wanted to help me. Therefore, we had enough time to trust and understand each other.

3.12.2. Dependability

Traditionally, reliability of a study is about obtaining same results after every repetition of a study. However, a researcher will not get the same results after replication of a qualitative study since "human behavior is never static" (Merriam, 2009, p. 221). This situation does not lower the credit of the results of any specific study because same data might be interpreted in numerous ways. Therefore, in qualitative studies, the focus question should not be related to the repetition of study. Rather, it should be related to the dependability of study, which refers to the consistency of results with the collected data (Merriam, 2009). There are two ways to ensure the dependability, which are consistency of data sources and inter-rater reliability. In this study, various data sources including instructional plans, interviews, and observations were used and all these data sources were internally consistent with each other. Moreover, inter-rater reliability was achieved in the analysis of teachers' awareness about science centers, their strategies for conducting science center visit and their views on the characteristics of PD program influencing their instructional planning regarding science center visit. Inter-rater reliabilities of teachers' awareness about science centers and their strategies for conducting science center visit were calculated by using the formula suggested by Miles and Huberman (1994). The formula was;

$$\text{Reliability} = [\text{Number of agreements} / (\text{Total number of agreements} + \text{disagreements})] \times 100$$

For that purpose, additional one coder who has experience in qualitative research, physics education, science centers and science center visits coded the data of the teachers in the current study regarding the protocols for coding awareness and strategies. Inter-rater reliability was calculated as 89% for awareness and 97% for strategies. Inter-rater reliability of teachers' views on the characteristics of PD

program influencing their instructional planning regarding science center visit was calculated using Kappa Measure of Agreement. Accordingly, additional two coders who have experience in qualitative research, respectively in chemistry education and physics education coded the data of teachers regarding the protocol for their views on the characteristics of the PD program. Statistical analysis shows that the value of Kappa Measure of Agreement of two external coders and the researcher for Rater 1 and 2 was .82; for Rater 1 and 3 was .91; and for Rater 2 and 3 was .91 with a significance of $p < .0005$. Moreover, intraclass correlation coefficient (mean Kappa across all raters) was found as .88 with a significance of $p < .0005$. "A value of .5 for Kappa represents moderate agreement, above .7 represents good agreement, and above .8 represents very good agreement" (Pallant, 2007, p.220). Accordingly, the level of agreement between coders was very good in the current study.

3.12.3. Transferability

Transferability of a study is related about the generalization of results to the other situations (Merriam, 2009). To ensure transferability of study, a researcher should make a thick description. Therefore, the researcher described the settings, professional development program, participants, and findings with some evidences in the form of quotes, in detail. Moreover, this study examined purposefully selected science teachers located in Ankara. Therefore, generalization of the current study is limited. The generalizability of this study would be acceptable for the science teachers whose characteristics and backgrounds are similar to the sample of the current study. Moreover, observations of teachers and organization of trip to a science center occurred in one particular setting – METU Science Center. Although using only one setting limits the variability between cases, generalizability to other science centers may have been limited.

CHAPTER 4

RESULTS

This chapter includes the results of investigation regarding research questions. First, science teachers' awareness about science centers and then changes in their strategies conducting field trips to METU SC were presented. Finally, science teachers' views on the characteristics of PD program influencing their instructional planning regarding science center visit were presented.

4.1. Teachers' Awareness about Science Centers and Their Resources

To learn more about how PD program influence science teachers' awareness about science centers and their resources, the researcher asked the following questions during interviews conducted both before and after PD program:

1. *Do you have any idea about the science centers in Ankara?*
   Probes for 'Yes':
   - *Could you please tell me what they are?*
   - *How much do you recognize the X Science Center? (Very / Little / Never)*
   - *How does the X Science Center function? What kind of procedure is followed?*
   - *What's in the X Science Center?*
   - *What kind of activities are conducted at the X Science Center? (Is there only workshops? / Is there only exhibits?)*
   - *Do you know what needs to be done to organize a trip to the X Science Center (reservation and trip process)? What would you do?*

   Probe for 'No': *Have you visited any science center before?*
2. *Do you have any idea about the science centers in Turkey (out of Ankara)?*
3. *Do you have any idea about science center resources?*

4. *Do you think that using science center resources (trip guide, worksheets, exhibits etc.) will be useful for your science teaching? How?*

These questions were asked both before and after the PD program. The questions were asked twice because the researcher wanted to know how much information the teacher had about the science centers before the program. Thus, by comparing the previous information with the information they learned during the PD program, researcher could be more accurate in the results in terms of the teachers' awareness about science centers and their resources.

4.1.1. Case 1: Teacher A

4.1.1.1. Awareness about science centers in Ankara (Q1)

Regarding science centers in Ankara, the researcher tried to figure out how aware of science teachers about the science centers that existed around the place where they live. It is expected from them as a science teacher that they must have knowledge of science centers in Ankara about where they are and how they operate. There are three different science centers in Ankara: METU SC, Feza Gürsey SC, and Polatlı SC. When asked what science centers she knew at the pre-interview, Teacher A responded that she only knew two of them, which are METU SC and Feza Gürsey SC. When asked to elaborate on METU SC, it was found that she previously knew METU SC by name because she was graduated from METU but then teacher got an idea about this place and its functions during the first-organized visit for this study.

> Teacher A [pre-interview]: I have known METU SC for being a METU student once.
> Researcher: Could you please tell me more about this center?
> Teacher A [pre-interview]: I can talk about what I saw during my first trip with my students. There are various exhibits inside. Within a structured program, an interactive show including a few exhibits is offered to students. Then, enough time is given to students to explore on their own.
> Researcher: Do you know what procedure should be followed to organize a trip here?
> Teacher A [pre-interview]: I know that for school groups, you need to make a reservation by following the procedure that is available on its website.

When asked to elaborate on Feza Gürsey SC, she talked about the memories of a trip taken by a middle school teacher when she was a student.

> Teacher A [pre-interview]: My middle school teacher took us there for a trip. As far as I remember, there were various exhibits. There were things that were interesting to me, such as the composition of our shadows in different colors, and the photograph of the shadow. Besides, electrification was explained us by means of an exhibit.
> Researcher: Do you know what procedure should be followed to organize a trip here? How is an ordinary trip procedure?
> Teacher A [pre-interview]: I do not know because I have never taken my students there for a trip.

In addition, it was seen that field trips to METU and Feza Gürsey Science Centers during PD program to learn more about them their functions and resources were beneficial for teachers. At the post-interview, Teacher A stated that "they [project team] gave us free time during the visit so that we could thoroughly examine the science centers. At this time, we were able to examine both the exhibits in detail with our colleagues and explainers, as well as to get more detailed information about the activities conducted there from the science center's explainers". By this means, she had more information about the Feza Gürsey SC than before.

> Teacher A [post-interview]: There were almost the same exhibits as in my childhood (like the Van de Graaff Generator) …. An explainer of the science center gave us an introductory presentation. I learned that they offer various activities such as joining science festivals in shopping centers, organizing science-based birthday events, organizing workshops. I also learned that they were working with reservation system for schools and that they offered a science show to school groups. After the show, they explain 4-5 exhibits in the center through guided tour. Finally, the students are given free time to explore.

As a remarkable result, Teacher A was aware of the differences between the two science centers after participating in the PD program. For instance, she said that she had seen microscope kit and the examples of plastinization in Feza Gürsey SC but there were no exhibits regarding biology in METU. The science center trips in the PD program seemed to be beneficial for teachers in this regard. Moreover, this awareness would help teachers in making proper trip venue choice regarding the

needs of her students and lessons in the future. On the other hand, she referred that she had also learned more about the METU SC from the website of it.

> Teacher A [post-interview]: I have seen on the website that there is an active planetarium in certain periods. In the guide on their website, there were alternate activities, including physics and planetarium, on a monthly basis. They offer specific show [stationary presentation] themes for physics activities such as sound, electricity and optics. I also learned that in certain periods, they organize "Science is fun!" event, which is a kind of science festival.

4.1.1.2. Awareness about science centers in Turkey (Q2)

Regarding science centers (out of Ankara) in Turkey, Teacher A declared that she had no idea about the other science centers in Turkey at the pre-interview. She has not seen or heard about other centers in Turkey so far. However, she could name seven different science centers for the post-interview, which are Kocaeli, Eskişehir, Konya, İzmir, Gaziantep, and Istanbul (İTÜ and Sancaktepe) science centers. When further prompted how she knew them, she pointed out the PD program: "There were explainers from various science centers in the PD program. On the first day of the program, each explainer made a presentation of the science center where s/he works at. Thus, I had an idea about science centers in Turkey.". When asked to elaborate on what she learnt about these science centers, she talked about general things. For instance, "in almost all science centers, there were various exhibits even if they are not identical with each other. Many of them conduct projects supported by TÜBİTAK. Almost all of them organize science festivals and workshops, which seem already like the scope of science centers.". However, she specifically mentioned a little about each science center as far as she remembered.

> Teacher A [post-interview]: Eskişehir and Gaziantep science centers have planetarium buildings. I do not remember any information about Konya science center. I think there was an exhibition about dinosaurs [she actually implies the "Fossil Science Exhibition"] in İzmir, and I like it very much. Children are very impressed with dinosaurs. Moreover, the science center in İzmir is mostly based on workshops. The thing I remember most about Kocaeli SC is that teachers could conduct their lessons in the laboratories or

> workshop area there. Also, there are special events for certain days, like Mother's Day.

Moreover, when she was asked whether she had done any individual research on science centers she learned in the PD program, she said "No!". Thus, presentations in the professional development program about science centers could be accepted as a source of her knowledge.

4.1.1.3. Awareness about science centers' resources (Q3)

The researcher also tried to figure out the awareness of science teachers about the resources provided by science centers. If teachers had knowledge about science center resources, they could use resources in their lessons consciously and decide what and how to use them in their plans. At the pre-interview, she said that she only knew the exhibits. She added some additional knowledge such as brochures about activities and planetariums, referring to the explainers' presentations during PD program at the post-interview.

> Teacher A [post-interview]: As I said before, they include various exhibits. Some of them have planetarium, which could be great experience for students because they could not have in classroom context. They have brochures about activities conducted at their centers. They [explainers] even mentioned in the introduction presentation that if requested, they also send brochures to schools including information about their workshops.

4.1.1.4. Awareness about utilization from science centers' resources (Q4)

Regarding utilization from science center resources, Teacher A talked about the opportunities of science center being a source of inspiration for her science teaching in terms of science teaching material and activities.

> Teacher A [pre-interview]: The demonstration about the sound we watched at the METU Science Center gave me an idea of how to teach the sound concept in my lessons. I see that you can also do good things with everyday stuff without having a lab in schools. For example, the plastic tube explainers used when talking about the thickness of sound was very simple but very

> impressive. This gave me an idea in terms of teaching materials that I can use in my lessons.

Considering her explanations, it could be claimed that the experiences on the first-trip with her students to the METU SC had an influence on her thoughts. On the other hand, it was seen in her following explanations that she was influenced by the idea of utilization from tabletop exhibits integrating science center resources into the science lessons. In addition, explainers' presentations in the PD program might influence her approach to utilization from resources through visits.

> Teacher A [post-interview]: We learned [from the presentations of explainers] that science festivals or workshops were being held in almost all science centers. For example, I can take my students to the science festival of a science center. Thus, they can see new projects and broaden their horizons. Do not forget the tabletop versions... The tabletop versions of some exhibits made me thrive on integrating science center resources into my science teaching. For instance, when I see something in the science center, I think of "I can do a miniatur of it and integrate this into my lesson"

All in all, the results indicated that she (1) had more information about the Feza Gürsey SC than before and was aware of the differences between METU SC and Feza Gürsey SC; (2) was able to talk about the science centers in Turkey after gaining knowledge in the PD program; (3) could count planetarium and brochures in addition to exhibits as science center resources after participating in the PD program and (4) was influenced by the idea of utilization from tabletop exhibits integrating science center resources into her science lessons. As seen in the Table 4.1, these results led the researcher to conclude that providing field trips to METU SC and Feza Gürsey SC, communication with explainers, explainer's presentation and tabletop exhibits in the PD program might help Teacher A to become more aware of these issues.

4.1.2. Case 2: Teacher B

4.1.2.1. Awareness about science centers in Ankara (Q1)

Regarding science centers in Ankara, the researcher tried to figure out how aware of science teachers about the science centers that existed around the place where they

Table 4.1.
Summary of Findings related to Influence on Teacher A's Awareness about Science Centers and Their Resources

Awareness Before PD Program	Awareness After PD Program	Evidence of Influence on Awareness
(Q1) Do you have any idea about the science centers in Ankara?		
About METU SC – *"I can talk METU SC about what I saw during my first visit with my students for this study. There are various exhibits inside. Within a structured program, an interactive show including a few exhibits is offered to students. Then, enough time is given to students to explore on their own."*	**About METU SC –** *"In the guide on their website, there were alternate activities, including physics and planetarium, on a monthly basis."*	**Website –** *"I have seen on the website that there is active planetarium in certain periods."*
	About Feza Gürsey SC – *"…I learned that they offer various activities such as organizing science-based birthday events… they were working with reservation system for schools…"*	**Field trip to SC** – *"They [project team] gave us free time during visit so that we could througly examine science centers."*
About Feza Gürsey SC – *"My middle school teacher took us Feza Gürsey SC for a trip …there were various exhibits. There were …the composition of our shadows in different colors, and the photograph of the shadow…"*	**About Differences between METU SC and Feza Gürsey SC** – *"I saw microscope kit and the examples of plastinization in Feza Gürsey SC but there were no exhibits regarding biology in METU SC."*	**Communication with explainers** - *"They [project team] gave us free time during the visit …we were able to get more detailed information about the activities conducted there from science center's explainers."*
Summary: The findings indicated that she had more information about the Feza Gürsey SC than before and was aware of the differences between METU SC and Feza Gürsey SC after participating in the PD program.		
Conclusion: Providing field trips to science centers and communication with explainers in the PD program contributed to her awareness about well-known science centers in Ankara.		
(Q2) Do you have any idea about the science centers (out of Ankara) in Turkey?		
No idea - *"I have no idea about the other science centers in Turkey."*	**About Eskişehir, Gaziantep, İzmir and Kocaeli SCs** - *"In almost all science centers, there were various exhibits even if they are not identical with each other… Eskişehir and Gaziantep science centers have planetariums… I think there was an exhibition about dinosaurs in İzmir…. The thing I remember most about Kocaeli SC is that teachers could conduct their lessons in the laboratories or workshop area there."*	**Explainer's presentation** – *"There were explainers from various science centers in the PD program. On the first day of the program, each explainer made a presentation of the science center that s/he works. Thus, I had an idea…"*
Summary: The findings indicated that she was able to talk about the science centers in Turkey after gaining knowledge in the PD program.		
Conclusion: Presentations of explainers in the PD program contributed to her awareness regarding science centers in Turkey.		

Table 4.1. (cont'd)
Summary of Findings related to Influence on Teacher A's Awareness about Science Centers and Their Resources

Awareness Before PD Program	Awareness After PD Program	Evidence of Influence on Awareness
(Q3) Do you have any idea about science center resources?		
About exhibits - "I only knew exhibits."	**About planetarium, brochures** -*"…Some of them have planetarium… They have brochures about activities conducted at their centers. They [explainers] even mentioned in the introduction presentation that if requested, they also send brochures to schools including information about their workshops."*	**Explainer's presentation** – *"They [explainers] even mentioned in the introduction presentation that if requested, they also send brochures to schools."*
Summary: The findings indicated that she could count planetarium and brochures in addition to exhibits as science center resources after participating in the PD program.		
Conclusion: Presentations of explainers in the PD program contributed to her awareness regarding science center resources.		
(Q4) Do you think that using science center resources will be useful for your science teaching?		
Inspiration from activities of science center – *"The demonstration about the sound we watched at the METU SC gave me an idea of how to teach sound concept in my lessons."*	**Utilization from science festival of science centers and tabletop exhibits –** *"I can take my students to the science festival of a science center. Thus, they can... broaden their horizons. Do not forget the tabletop versions... The tabletop versions of some exhibits made me thrive on integrating science center resources into my science teaching. For instance…"*	**Explainer's presentation – "***We learned [from the presentations of explainers] that science festivals or workshops were being held."* **Tabletop exhibits –** *"The tabletop versions of some exhibits made me thrive on integrating."*
Summary: Although she was inspired from the science center activities for her science teaching before, the findings indicated that she was influenced by the idea of utilization from tabletop exhibits integrating science center resources into the science lessons.		
Conclusion: Tabletop exhibits and explainers' presentations contributed to her awareness regarding utilization from science center resources.		

live. When asked what science centers she knew at the pre-interview, Teacher B responded that there are three different science centers, which were Armada SC [which is closed now], METU SC and Feza Gürsey SC. When asked in detail about Armada SC, researcher found that she didn't really know this science center very well. She had just an idea about it by reviewing its website. Teacher B: "As far as I have seen from the website, it is a commercial organization and does paid science

activities.”. When asked to elaborate on METU SC, researcher found that she previously knew this place when she was student at METU.

> Teacher B [*pre-interview*]: I worked there for short period of time as a volunteer student within the community service course.
> Researcher: Could you please tell me more about this center?
> Teacher B [*pre-interview*]: There are mostly physics-related exhibits inside. Alternately, there are one month physics presentations, one month planetarium presentations.
> Researcher: Do you know what procedure should be followed to organize a trip here?
> Teacher B [*pre-interview*]: First of all, you need to make a reservation for school groups. When they come, there is a science show related to curriculum. Then, free time is given to students to explore by themselves.

When asked to elaborate on Feza Gürsey SC, she talked about the memories of a trip taken by her colleague.

> Teacher B [*pre-interview*]: My colleague took our fourth graders to learn more about the Sun. I participated in this trip as an assistant teacher to look after students, not as the main responsible.
> Researcher: Could you please tell me more about this center?
> Teacher B [*pre-interview*]: The students watched the video under the theme 'Here comes to Sun'. Then, they looked around the exhibits. But there were explainers near the exhibits to explain.
> Researcher: Do you know what procedure should be followed to organize a trip here?
> Teacher B [*pre-interview*]: As far as I can observe, there is a process similar to METU SC.

Regarding aforementioned explanations, it was seen that Teacher B had some information about science centers in Ankara. At the post-interview, she mentioned the same memories about Feza Gürsey SC and the static electricity demonstration which was shown in the PD program. Moreover, she reported some additional knowledge about METU SC such as theme-specific presentations and workshop on worms.

> Teacher B [*post-interview*]: I have learned that presentations for the specific themes like sound, electricity were made thanks to the trips that I organized within this study. I also learned that a workshop on worms was organized at regular intervals.

4.1.2.2. Awareness about science centers in Turkey (Q2)

Regarding science centers out of Ankara in Turkey, Teacher B declared that she only went to the Eskişehir SC and knew Konya SC just by name. She had no idea about the other science centers in Turkey at the pre-interview. She had not seen or heard about other centers in Turkey so far. About Eskişehir SC, she mentioned as far as she remembered: "There was a planetarium in Eskişehir SC. Apart from exhibits, there were some models and historical things about dinosaurs". However, she could name six different science centers for the post-interview, which were Bursa, Konya, Eskişehir, Gaziantep, Kocaeli, İzmir, İstanbul (İTÜ and Sancaktepe) science centers. When further prompted how she knew them, she pointed out the PD program: "First day, I learned a lot from the introductory presentations of science centers. Explainers made presentations involved a lot of information from science shows to exhibits and visitor profiles.". When asked to elaborate on what she learnt about these science centers, she mentioned a little about science centers as far as she remembered.

> Teacher B [*post-interview*]: I got an idea about the science centers that have planetarium such as Bursa, Konya, Eskişehir and Gaziantep. There were various tours like 'geography tour' and 'thematic tour' in Eskişehir Science Center. Another interesting thing was the workshops, especially conducted in the Kocaeli Science Center. For instance, on Mother's Day, "Science with my Mom" workshop, on Teachers' Day "The best gift to my teacher" workshop. But still, they all have similar exhibits inside.

Moreover, when Teacher B was asked whether she had done any individual research on science centers she learned in the PD program, she said "No! I did not have a chance to do research". Thus, presentations in the professional development program could be accepted as a source of her knowledge.

4.1.2.3. Awareness about science centers' resources (Q3)

The researcher also tried to figure out the awareness of science teachers about the resources provided by the science centers. At the pre-interview, Teacher B said that she could count exhibits and planetarium as resources of science center. Actually, this answer was expected regarding her volunteer service at the METU SC during her

undergraduate years. On the other hand, Teacher B mentioned some other resources such as brochures and exhibitions at the post-interview. It was seen that the PD program left an imprint in her knowledge about science centers and their resources.

> Teacher B [*post-interview*]: Of course, the exhibits and planetarium are the main ones. I think about presentations made by the different science centers' explainers during the PD program. For example, the Eskişehir SC has different theme-based tours or Konya Science Center has exhibitions such as the "Sultans of Science". Similarly, brochures distributed by the explainers can be counted. In this way, I realized that the science centers are very rich places in terms of resources, such as tours, exhibits, brochures, etc.

4.1.2.4. Awareness about utilization from science centers' resources (Q4)

Regarding utilization from science center resources, Teacher B talked about science center visits as an effective way for learning opportunites and enriching class lessons.

> Teacher B [*pre-interview*]: First, you enrich the lessons with the science center resources. When you conduct a visit to a science center, you can provide more effective learning opportunities for students. I mean… My students learn by doing on their own in science center.

On the other hand, it was seen in her following explanations at the post-interview that introduction of science centers might influence her approach to utilization from science center resources through visits.

> Teacher B [*post-interview*]: Of course! Owing to the introductions of science centers in the PD program, I realized that some activities that I had even not known were conducted at the science centers. I also had the idea of participating in workshops as a part of science center visit in addition to the exploration of science center. For instance, we can visit the exhibits in the science center first, and then join a workshop like "Science with my mom", if possible.

All in all, the results indicated that she (1) had more information about the well-known science centers in Ankara; (2) was able to talk about the science centers in Turkey after gaining knowledge in the PD program; (3) could count brochures, theme-based tours, and exhibitions in addition to exhibits and planetariums as science

center resources after participating in the PD program and (4) had the idea of participating workhops in science centers as a part of science center visit. As seen in the Table 4.2, these results led the researcher to conclude that METU SC visits for the current study, providing field trip to Feza Gürsey SC and explainers' presentations in the PD program might help Teacher B to become more aware of these issues.

4.1.3. Case 3: Teacher C

4.1.3.1. Awareness about science centers in Ankara (Q1)

Regarding science centers in Ankara, the researcher tried to figure out how aware of science teachers about the science centers that existed around the place where they live. When asked what science centers she knew at the pre-interview, Teacher C responded that she only knew two of them, which are METU SC and Feza Gürsey SC. When asked to elaborate on METU SC, researcher found that she previously knew about this place and its functions thanks to two trips, one of them was the first-organized trip for this study.

> Teacher C [*pre-interview*]: I had the chance to visit the METU SC twice with my students. The last one was the first-organized trip for this study.
> Researcher: Could you please tell me more about this center?
> Teacher C [*pre-interview*]: There is a variety of exhibits within this science center. For instance, tangrams drew my attention very much on the last trip. Generally, explainers give a brief presentation on a pre-determined topic to the school group. Later, students and teachers are given the opportunity to try out the exhibits there.
> Researcher: Do you know what procedure should be followed to organize a trip here?
> Teacher C [*pre-interview*]: You need to make a reservation by following the procedure that is available on its website.

When asked to elaborate on Feza Gürsey SC at the pre-interview, she admitted that she knew only the name of this science center: "I did not go there myself nor took my students. I just heard the name of it". Based on Teacher C statements, it could be claimed that she actually recognizes only one science center more or less in Ankara.

Table 4.2

Summary of Findings related to Influence on Teacher B's Awareness about Science Centers and Their Resources

Awareness Before PD Program	Awareness After PD Program	Evidence of Influence on Awareness
(Q1) Do you have any idea about the science centers in Ankara?		
About METU SC – *"I worked there for short period of time as a volunteer student within the community service course. There are mostly physics-related exhibits inside..."* **About Feza Gürsey SC** – "*My colleague took our fourth graders to Feza Gürsey SC... I participated in this trip as an assistant teacher to look after students… The students watched the video about Sun… looked around the exhibits. There were explainers near the exhibits to explain."*	**About METU SC –** *"I have learned that presentations for the specific themes like sound, electricity were made thanks to the trips that I organized within this study. I also learned that a workshop on worms was organized at regular intervals."* **About Feza Gürsey SC** – *"During actual visit to Feza Gürsey SC in the PD program, we watched a static electricity demonstration."*	**METU SC visit** – *"I have learned … thanks to the trips that I organized within this study."* **Field trip to SC** - *"During actual visit to Feza Gürsey SC in the PD program, we…"*
Summary: The findings indicated that she had some additional knowledge about METU SC (e.g., theme-specific presentations, workshop on worms) and about Feza Gürsey SC (e.g., static electricity demonstration). **Conclusion:** Providing field trips to both science centers contributed to her awareness about well-known science centers in Ankara.		
(Q2) Do you have any idea about the science centers (out of Ankara) in Turkey?		
About Konya and Eskişehir SCs - *"I heard Konya SC. I went Eskişehir SC within our school's trip. There was a planetarium in Eskişehir SC. Apart from exhibits, there were some models and historical things about dinosaurs."*	**About Bursa, Konya, Eskişehir, Gaziantep, and Kocaeli SCs** - *"… science centers that have planetarium such as Bursa, Konya, Eskişehir and Gaziantep. There were various tours like 'geography tour' and 'thematic tour' in Eskisehir Science Center… the workshops, especially conducted in the Kocaeli Science Center. For instance, on Mother's Day, "Science with my Mom" workshop…"*	**Explainer's presentation** – *"I learned a lot from introductory presentations of science centers. Explainers made presentations involved a lot of information…"*
Summary: The findings indicated that she was able to talk about the science centers in Turkey after gaining knowledge in the PD program. **Conclusion:** Presentations of explainers in the PD program contributed to her awareness regarding science centers in Turkey.		

Table 4.2 (cont'd)
Summary of Findings related to Influence on Teacher B's Awareness about Science Centers and Their Resources

Awareness Before PD Program	Awareness After PD Program	Evidence of Influence on Awareness
(Q3) Do you have any idea about science center resources?		
About exhibits and planetariums - "Exhibits and planetariums can be resources of science centers."	**About brochures, exhibitions, theme-based tours** -*"... Eskişehir SC has different theme-based tours or Konya Science Center has exhibitions such as the "Sultans of Science". Similarly, brochures distributed by the explainers can be counted…"*	**Explainer's presentation** – *"... I think about presentations made by the different science centers' explainers during the PD program. For example…"*
Summary: The findings indicated that she could count brochures, theme-based tours, and exhibitions in addition to exhibits and planetariums as science center resources after gaining knowledge in the PD program.		
Conclusion: Explainer's presentation in the PD program contributed to her awareness regarding science center resources.		
(Q4) Do you think that using science center resources will be useful for your science teaching?		
Enriching lessons with science center visit – *"You enrich the lessons with … resources. When you conduct a … visit, you can provide more effective learning opportunities for students. I mean… My students learn by doing…"*	**Utilization from workshops** – *"… I also had the idea of participating workshops as a part of science center visit in addition to the exploration of science center. For instance…"*	**Explainer's presentation** - *"Owing to the introductions of science centers in the PD program… I also had the idea of participating workshops…"*
Summary: Although she saw science center visits as effective learning opportunities for her students before, the findings indicated that introduction of science centers influenced her approach to utilization from resources through visits.		
Conclusion: Explainer's presentation in the PD program contributed to her awareness regarding utilization from science center resources.		

At the post-interview, when asked to elaborate on Feza Gürsey SC, she claimed that she had information about this science center thanks to the trip organized during the PD program.

> Teacher C [*post-interview*]: I visited Feza Gürsey SC for the first time in the PD program. They [project team] gave us free time to explore. As far as I can see, there were exhibits relevant for both physics and biology. Then, they [explainers of Feza Gürsey SC] presented a scientific demonstration and gave some information about functioning of science center. I learned that they offer

> various activities such as workshops, organizing science-based birthday events and so on.

At the post-interview, Teacher C mentioned the same things for METU SC that she said in the previous interview. However, as a remarkable result, Teacher C was aware of the differences between the METU SC and Feza Gürsey SC after participating in the PD program. For instance, she said that Feza Gürsey SC has a wider area and more exhibits than the METU SC. Similarly, she added that there are no workshops in METU SC as in Feza Gürsey SC. In terms of fields of exhibits, she compared that METU SC has only a few exhibits related to biology but Feza Gürsey has more rich content in this field. The science center trips in the PD program seemed to be beneficial for teachers. In addition to having detailed knowledge of a science center she has never known before, Teacher C has reached the level of awareness that can compare the resources of these science centers. Moreover, this awareness might help her in making proper trip venue choice regarding the needs of her students and lessons in the future. On the other hand, she also mentioned the Polatlı SC in addition to the METU SC and Feza Gürsey SC at the post-interview.

> Teacher C [*post-interview*]: It was not mentioned during the PD program. After that, when I was searching on the internet about science centers in Ankara for planning future school trips, I learned that one was in Polatlı. If you ask for details, I do not know because I did not visit.

Although she did not have detailed knowledge about Polatlı SC, she increased her awareness about science centers in Ankara at least by doing research on the internet. Who knows! Perhaps, she was influenced by the PD program and felt the need to do research as a science teacher.

4.1.3.2. Awareness about science centers in Turkey (Q2)

Regarding science centers out of Ankara in Turkey, Teacher C declared that she had no idea about the other science centers in Turkey at the pre-interview. She has not seen or heard about other centers in Turkey so far. However, she could name six different science centers for the post-interview, which are Kocaeli, Eskişehir, Konya,

İzmir, Gaziantep and Istanbul İTÜ science centers. When further prompted how she knew them, she pointed out the PD program: "Before participating the PD program, I had no knowledge of the science centers in Turkey. Presentations made by the explainers helped me to recognize that there are many science centers in Turkey. But yet, I have not seen any of them.". When asked to elaborate on what she learned about these science centers, she mentioned a little about science centers as far as she remembered.

> Teacher C [*post-interview*]: It seemed to me that almost all of them have the same exbihits. One of the most appealing was the Kocaeli Science Center because they are doing a variety of activities besides science shows and exhibits. For example, on Mother's Day, "Science with my Mom" event, during Disability Awareness Week "Science Without Barriers" event and so on. Another science center that draws my attention due to its proximity to Ankara is Eskişehir. Here, there are various tours such as "free tour", "guided tour", and "thematic tour" are offered to visitors. In addition, they organize workshops, science festivals and various seminars. I learned that the İTÜ Science Center also provided some training for teachers within a project.

Moreover, when Teacher C was asked whether she had done any individual research on science centers she learned in the PD program, she said "No! I just searched on the internet about science centers in Ankara for planning future school trips". Thus, presentations in the professional development program could be accepted as a source of her knowledge.

4.1.3.3. Awareness about science centers' resources (Q3)

The researcher also tried to figure out the awareness level of science teachers about the resources provided by the science centers. At the pre-interview, Teacher C said referring to the past trips organized to the METU SC that she can count exhibits and explainers as resources of science centers. She added some additional knowledge such as workshops, science festivals, brochures and planning guides for teachers referring to the explainers' presentations and the actual visits to science centers during PD program at the post-interview.

> Teacher C [*post-interview*]: Exhibits are the main resources of science centers. In addition to these, there are also workshops, science festivals and exhibitions that explainers have mentioned. What's more, websites… Brochures and planning guides for teachers distributed by explainers in the PD program can also be counted as resources. Moreover, the impact of science center visits cannot be denied in terms of seeing inside of SC buildings and listening to activities conducted by explainers from the first hand at there. In this regard, the contribution of the program to us is great.

4.1.3.4. Awareness about utilization from science centers' resources (Q4)

Regarding utilization from science center resources, Teacher C talked about the science center resources as a source of review and inspirational materials for her lessons.

> Teacher C [*pre-interview*]: Sound topic was presented with simple materials [referring to METU SC visit for the current study]. I would like to handle sound topic in a similar way in the classroom. In short, science-related activities inspired me. On the other hand, if the science center could have brochures for exhibits or activities, these brochures may be helpful in repeating science center's activities in the classroom.

Considering her explanations, it could be claimed that the experiences on the first-trip organized for this study had an influence on her thoughts. On the other hand, it was seen in her following explanations that Teacher C was influenced by the idea of the utilization from tabletop exhibits integrating science center resources into the science lessons.

> Teacher C [*post-interview*]: Previously, I think that I could use the resources as follows: during the visit the students see the exhibits, the explainers present them something and ends here. Now, after participating in the PD program, I realize that I can integrate these resources into my lessons in some way. For instance, if science centers provide us with brochures, guides – including brief explanations of activities/exhibits etc. – I can produce tabletop version of exhibits as I learned in the PD program and do some curriculum-fit activities related to them in the class. Thus, I can do much more different activities that will excite my students in my classes.

All in all, the results indicated that she (1) gained knowledge about Feza Gürsey SC and was aware of the differences between METU SC and Feza Gürsey SC; (2) was

able to talk about the science centers in Turkey after gaining knowledge in the PD program; (3) could count workshops, brochures and planning guides for teachers in addition to exhibits and explainers as science center resources after participating in the PD program and (4) was influenced by the idea of utilization from tabletop exhibits integrating science center resources into her science lessons. As seen in the Table 4.3., these results led the researcher to conclude that providing field trip to Feza Gürsey SC, communication with explainers, explainers' presentations and tabletop exhibits in the PD program might help Teacher C to become more aware of these issues.

Table 4.3.
Summary of Findings related to Influence on Teacher C's Awareness about Science Centers and Their Resources

Awareness Before PD Program	Awareness After PD Program	Evidence of Influence on Awareness
(Q1) Do you have any idea about the science centers in Ankara?		
About METU SC – *"I had the chance to visit METU SC twice with my students. The last one was the first-organized trip for this study. There is a variety of exhibits...Generally, explainers give a brief presentation on…Later, students and teachers… try out exhibits there…"* **About Feza Gürsey SC** – "*I did not go there myself nor took my students. I just heard the name of it."*	**About METU SC –** She mentioned the same things as in the previous interview. **About Feza Gürsey SC** – *"There were exhibits relevant for both physics and biology… I learned that they offer various activities such as workshops, science-based birthday…"* **About Differences between METU SC and Feza Gürsey SC** – *"Feza Gürsey SC has a wider area and more exhibits than METU SC. There were no workshops in METU SC… Feza Gürsey SC has more rich content in biology field."*	**Field trip to SC -** *"I visited Feza Gürsey SC for the first time in the PD program."* **Communication with explainers** - *"I visited Feza Gürsey SC for the first time in the PD program… they [explainers of Feza Gürsey SC] … gave some information about functioning of science center."*
Summary: The findings indicated that she gained knowledge about Feza Gürsey SC and was aware of the differences between METU SC and Feza Gürsey SC after participating in the PD program.		
Conclusion: Providing field trip to Feza Gürsey SC and communication with explainers in the PD program contributed to her awareness about well-known science centers in Ankara.		

Table 4.3. (cont'd)
Summary of Findings related to Influence on Teacher C's Awareness about Science Centers and Their Resources

Awareness Before PD Program	Awareness After PD Program	Evidence of Influence on Awareness
(Q2) Do you have any idea about the science centers (out of Ankara) in Turkey?		
No idea - *"I have no idea about the other science centers in Turkey."*	**About Eskişehir, Istanbul İTÜ, and Kocaeli SCs** - *"… the Kocaeli Science Center … a variety of activities besides science shows and exhibits. For example, on Mother's Day, "Science with my Mom" event... Another science center … is Eskişehir. Here, there are various tours such as 'free tour'… I learned that the İTÜ Science Center also provided some training for teachers within a project."*	**Explainer's presentation** – "*Presentations made by the explainers helped me to recognize that there are many science centers in Turkey."*
Summary: The findings indicated that she was able to talk about the science centers in Turkey after gaining knowledge in the PD program. **Conclusion:** Presentations of explainers in the PD program contributed to her awareness regarding science centers in Turkey.		
(Q3) Do you have any idea about science center resources?		
About exhibits and planetariums - "I can count exhibits and explainers as resources of science centers."	**About workshops, brochures and planning guides for teachers** - *"Exhibits are the main resources… there are also workshops, science festivals and exhibitions that explainers have mentioned. What's more, websites… Brochures and planning guides for teachers distributed by explainers in the PD program…"*	**Explainer's presentation** – *"there are also workshops, science festivals and exhibitions that explainers have mentioned."* **Field trip to SC** - *"…the impact of science center visits cannot be denied in terms of seeing what is its inside and listening to activities conducted by explainers from the first hand. In this regard, the contribution of the program to us is great."*
Summary: The findings indicated that she could count workshops, brochures and planning guide in addition to exhibits and explainers as science center resources after gaining knowledge in the PD program. **Conclusion:** Explainers' presentations and field trips to science centers in the PD program contributed to her awareness regarding science center resources.		

Table 4.3. (cont'd)
Summary of Findings related to Influence on Teacher C's Awareness about Science Centers and Their Resources

Awareness Before PD Program	Awareness After PD Program	Evidence of Influence on Awareness
(Q4) Do you think that using science center resources will be useful for your science teaching?		
Inspiration from activities of science center – *"Sound topic was presented with simple materials [refers to METU SC visit for the current study]. I would like to handle sound topic in a similar way in the class… science-related activities inspired me."*	**Utilization from tabletop exhibits** - *"I can integrate these resources into my lessons… I can produce tabletop versions of exhibits as I learned in the PD program and do some curriculum-fit activities related to them in the class."*	**Tabletop exhibits –** *"I can produce tabletop versions of exhibits as I learned in the PD program."*
Summary: Although she was inspired from the science center activities for her science teaching before, the findings indicated that she was influenced by the idea of utilization from tabletop exhibits integrating science center resources into the science lessons.		
Conclusion: Tabletop exhibits contributed to her awareness regarding utilization from science center resources.		

4.1.4. Summary

Introduction of science centers both through explainers' presentations and field trips to some of them, providing communication with explainers and presenting tabletop versions of some of exhibits during the professional development program contributed to teachers' awareness about science centers, their resources and educational potentials. The results indicated that teachers are now more aware of making a proper trip venue choice comparing the resources of science centers to maximize students' gains. Summary of findings related to influence on teachers' awareness about science centers and their resources were presented in the Table 4.4.

4.2. Through the Lenses of the Researcher: Change in Teachers' Strategies for Conducting Science Center Visit

In this section, changes in science teachers' strategies for conducting science center visit was presented through the lenses of the researcher. Accordingly, the researcher examined answers given by teachers to the interview questions as a main data source.

Their instructional plans and observations during science center visits were also used as data sources. During interview sessions, teachers were asked to describe what they did before, during and after the visit to make their trip successful. In the analysis, categories were constructed according to the fieldtrip (pre-, during-, and post-visit) strategies mentioned in Kisiel's (2003a) dissertation. Data from observations and interviews indicated that teachers didn't make any plan for their first trip. On the other hand, they did some preparations for their second trip by considering their learning from PD program.

Table 4.4.
Summary of Findings related to Influence on Teachers' Awareness about Science Centers and Their Resources

Influence on Teachers' Awareness about Science Centers and Their Resources as a Result of…		
(Q1) Awareness about Science Centers in Ankara		
Teacher A PD Program; ➢ Field trip to SC ➢ Communication with explainers Other; ➢ Website of METU SC	**Teacher B** PD Program; ➢ Field trip to SC Current Study; ➢ METU SC visit	**Teacher C** PD Program; ➢ Field trip to SC ➢ Communication with explainers
(Q2) Awareness about Science Centers in Turkey (out of Ankara)		
Teacher A PD Program; ➢ Explainer's presentation	**Teacher B** PD Program; ➢ Explainer's presentation	**Teacher C** PD Program; ➢ Explainer's presentation
(Q3) Awareness about Science Centers' Resources		
Teacher A PD Program; ➢ Explainer's presentation	**Teacher B** PD Program; ➢ Explainer's presentation	**Teacher C** PD Program; ➢ Explainer's presentation, ➢ Field trip to SC
(Q4) Awareness about Utilization from Science Centers' Resources		
Teacher A PD Program; ➢ Explainer' presentation, ➢ Tabletop exhibits	**Teacher B** PD Program; ➢ Explainer's presentation	**Teacher C** PD Program; ➢ Tabletop exhibits

4.2.1. Case 1: Teacher A

4.2.1.1. Before field trip to the METU SC

It is important to note that Teacher A brought about the nearly same number of sixth grade students (±1-2 students), who were in the same class, on both excursions. Remember that pre-visit activities were not observed - all of them were reported by teacher during the interview sessions. Researcher also analyzed the instructional plan of Teacher A.

4.2.1.1.1. First field trip to the METU SC

Teacher A organized a trip to the METU SC for the first time in March 2016. She reported that she had only made a reservation and she was informed about that activities related to the sound unit were presented [During February - March 2016, interactive presentations (see Appendix D) related to the sound unit were conducted at the METU SC. Thus, they participated in the typical process of the science center.]. She also mentioned that she did not ask to the explainer for any details about what to do or information about how the process would go on in the science center. Teacher A reported that they had completed the sound topic in the curriculum before the first trip. But this was not an action the teacher did purposefully. Coincidentally the topic presented at the science center and taught in the school were the same. Moreover, Teacher A just mentioned about doing some sort of general preparation for the field trip, "I just made preparation like getting necessary permission (from school administration/ families/ provincial directorate of national education), arranging transportation service, and booking visit". Although Teacher A was aware of the importance of preparing an instructional plan, she reported that she did not make any planning for either the curriculum, the student gains or things to do during visit. When further prompted: "Why did not you make preparations other than general things to do?", she complained about various reasons due to being a teacher in a new school environment.

> Teacher A: I changed my school. I was assigned a new school in this semester. Obviously, I did not have time to prepare because of some situations as acclimatization to the school, getting to know the students, learning the principles of the school administration.

Teacher A also reported conducting some sort of site familiarization with her sixth grade students about a week before the visit to give them some idea of science center, "My students did not know anything about what the science center was like. I said that there are various hands-on exhibits that they can touch and try. I also mentioned that they could take part in the activities in an interactive way, not in a passive position like during a normal museum visit. There were also those who did not know where METU was. I talked about that it was a university that I had studied, and that science center was located in the part of this university campus.".

4.2.1.1.2. Second field trip to the METU SC

Teacher A could make the second trip to METU SC in May 2016. Again, she mentioned about general preparation same as the first trip: "I just made preparation like getting necessary permission (from school administration/ families/ provincial directorate of national education), arranging transportation service, and booking visit". On the other hand, this time, field trip was planned. In other words, an instructional plan was prepared, and it was determined that what was to be shown in the science center's presentations and which exhibits were to be addressed during the trip. In this context, Teacher A reported that she called the science center for making a reservation and communicate with the explainer of METU SC.

> Teacher A: I was going to start to teach electricity topic in my class and so I wanted to plan a trip related to electricity. Thus, when I called the science center, I informed the explainer about that. I also requested the explainer to send me explanations of exhibits related to electricity. On request, the explainer shared with me both the past years' "electricity and magnetism" presentation program (including interactive demonstration of Van de Graaff Generator, Energy Ball, Magnets and Copper Pipe) and explanations of the exhibits related to electricity. There was an exhibit called as Copper Pipe in the presentation program. Science behind it was related to Eddy currents and this topic was not included in the sixth grade science curriculum. Nevertheless, I requested the explainer to demonstrate us as a show because I

> thought that watching interesting science shows would increase students' attitudes toward and curiosity about science.

One of the pre-visit strategies, which is procedure familiarization, might be traced on the above explanations of Teacher A. For instance, she became aware of the presentation program and exhibits related to electricity in detail. In terms of students, procedure familiarization strategy might also be traced on descriptions of Teacher A's instructional plan (see Appendix F) as well as the explanations below. She claimed that she tried to provide awareness of what will happen on trip and what students will be doing during trip.

> Our trip to the METU Science Center will be composed of two parts. In the first part, the explainers in the science center will perform you a stationary presentation with exhibits about electricity. During this presentation, you will meet with 'Van de Graaff Jenerator', 'UFO Ball', 'Magnets', and 'Mysterious currents: Eddy'. The second part will take the form of free-choice trips. You can explore other exhibits in the center by testing and examining them on your own. Do not forget to read explanations right next to the exhibits. (*Excerpt from Teacher A's Instructional Plan –Information Form-*)

> Teacher A: The previous class hour before the trip, I distributed an "Information Form" (see Appendix F) to my students. Then, we talked about the information on the front page of the form, which was about trip's date, time, objectives, exhibits that we will see and procedure that will be followed. Moreover, I mentioned to my students that they will fill 'L' part of the KWL chart, which was on the back page of the form, after watching explainer's presentation about electricity in the science center – before free time exploration-. For free time, I also gave my students an assignment, which was about the detail examination of any one of the exhibits that interests them and making presentation about it when they return to the class. For that purpose, I divided my students into groups of four and provided each group with having one hard-working student [*Supervision Coordination*]. However, I was not able to locate any chaperone for the groups. I was only responsible person for my students.

In terms of site familiarization, it might be claimed that Teacher A and her students were familiar with the site since they conducted a field trip to the same science center a few months earlier. However, by the help of "Information Form", students were familiar with what they would see at the science center at this time (pictures and explanations of target exhibits such as Van de Graaff Jenerator, UFO Ball etc.). On

the other hand, brief explanations about target exhibits right next to their pictures provide students with introductory information regarding exhibit topics, which were introduced during explainer's presentation. These explanations might be considered as content familiarization because they provide students some prior knowledge before museum visit.

Moreover, Teacher A reported that she purposefully used the trip as a means of introducing the sixth grade electricity topic. Therefore, she did not give any information to the students about the electricity topic before the trip. She mentioned that she took the trip to her students with only the information they learned from the fifth grade electricity topic.

> Teacher A: I did not give any information to the students about the electricity. We just repeated what they learned in the fifth grade. That is, I prepared a KWL chart behind the "Information form". The previous class hour before the trip, I requested my students to fill "K" and "W" parts of the KWL chart to see what they remember about electricity topic taught at fifth grade level, whether they have misconceptions, and what they want to learn about the topic during the trip.

In terms of other pre-visit activities, completing "K" (Know) and "W" (Want to Know) parts of the KWL chart before the trip might be considered as a kind of preparation activity in which students shared their prior knowledge about electricity and generated questions related to electricity. The summary of the comparison of Teacher A's pre-visit strategies for conducting SC visits was shown in the Table 4.5.

4.2.1.2. During field trip to the METU SC

It is important to note that during-visit activities were observed and all of them were reported by Teacher A during the interview sessions as well. Also, the researcher utilized instructional plan of Teacher A to analyze her during-visit strategies.

Table 4.5.
Comparison of Teacher A's Pre-visit Strategies for Conducting SC Visits

PRE-VISIT STRATEGIES	Before PD (1st Trip to SC)	After PD (2nd Trip to SC)	Evidence
1. Familiarization Strategies			
1.1. Site familiarization (introduction of field trip site)	✓	✓	***1st Trip:*** Explanation of inside the METU SC ***2nd Trip:*** Talking with students about what they will see at the SC by means of 'Information Form'
1.2. Content familiarization (introduction of field trip content)		✓	***2nd Trip:*** Providing students some prior knowledge about target exhibits by means of "Information Form"
1.3. Procedure familiarization (knowing about or introduction of what will happen on the trip)		✓	***2nd Trip:*** Communicating with explainer to become familiar with the presentation program and the exhibits related to electricity / Informing students about how the visit will go on in the SC by means of "Information Form"
2. Supervision Strategies			
2.1. Behavior clarification (discussions with students about expected behaviors and consequences of unexpected ones)			
2.2. Supervision coordination (finding chaperones and assistants, dividing students into groups)		✓	***2nd Trip:*** Dividing students into groups of four
3. General Things to Do (organization of transportation, entry costs, booking, getting related permissions, etc.)	✓	✓	***1st and 2nd Trip:*** Booking visit, getting necessary permissions, arranging transportation
4. Instructional Planning (comprehensively defined action plan including the integration of curriculum and visit)		✓	***2nd Trip:*** Preparing an instructional plan
5. Other Pre-visit Activities (preparing worksheet, study guide or activity in which students generate questions related to visit or activity to use during trip)		✓	***2nd Trip:*** Preparing KWL chart to be used in both pre- and during-visit

Note. Pre-visit strategies. Adapted from *Revealing teacher agendas: An examination of teacher motivations and strategies for conducting museum fieldtrips* (pp. 77-79; 106-118), J. F. Kisiel, 2003a, University of Southern California, Los Angeles.

4.2.1.2.1. First field trip to the METU SC

Although Teacher A did not make any plan for the first field trip, she was so lucky during-visit. Remember that a typical field trip at METU SC consists of two sections: stationary and interactive presentation and free exploration time. METU SC has its own structured procedure. By this means, their trip began with the orientation and presentation of experienced explainer of the science center. Even if stationary presentation of the science center's explainer seems to fit the "Information receiving activities", because students get information about particular topic (sound unit) from the explainer, it would not be categorized as "Structured Student Engagement Strategy", since presentation was not intentionally planned together by the teacher and the explainer before the trip. During presentation about sound unit by explainer, Teacher A just sat and watched. Neither did she make any association with the curriculum nor asked any question to her students about the subject (Observation record, March 2, 2016).

During free exploration time offered by the science center, students explored whatever they wanted within the science center alone or in small groups. They ran from there to there, talked to each other about what they saw. Some of them pulled their friends to show an interesting or particular exhibit (Observation record, March 2, 2016). When asked during interview whether she gave any direction to her students about how they were going to explore the science center during free time, she reported that she actually did not know there would be a free time option so that she was unprepare to direct her students. Therefore, it could be assumed that her students roamed at the science center.

Meantime, Teacher A mostly toured exhibits on her own, reading their labels. Sometimes she communicated with her students (Observation record, March 2, 2016). For instance, there was a student struggling with 'Tower of Hanoi'. Student asked the teacher how to do it. Then, Teacher A read out loud the explanation on the label, and then reiterate it to the student.

Teacher A: You can only move one disk at a time. Large disks are not placed on small disks. You have to count your movement.
Student: [Tries to do it without counting…]
Teacher A: [shows how to do a movement] This counts as one. [makes another movement]. This counts as two…You will continue like this.

This conversation between them indicated that Teacher A utilized interpretation strategy because teacher interpreted the meaning of the exhibit based on the label and then direct the student what he should focus on. In another example, there was also the sign of interpretation strategy, according to which Teacher A interpreted the meaning of "Pulley System" exhibit based on her knowledge.

Student: I can lift myself
Teacher A: How can you lift yourself up so easily?
Student: …
Teacher A: How much is your mass?
Student: 30 kg.
Teacher A: If I give you 30kg box, can you lift it easily?
Student: No.
Teacher A: So, how can you easily lift yourself here? Did you read the explanation?
Student: No.
Teacher A: Look! [Pointing pulley wheel and rope]. Thanks to the pulley system, much work is done with little force. Think about the cranes used in construction. We will learn more about pulleys in higher grade level.

In order to document their experiences at the science center, Teacher A took some photos using her cell phone, especially when some students helping the explainer's demonstration (Observation record, March 2, 2016).

4.2.1.2.2. Second field trip to the METU SC

As stated by Kisiel (2003a), following an instructional plan during visit could be considered as the issue of during-visit visit strategy. For instance, Teacher A and her students, firstly, participated in stationary and interactive presentation about electiricity, then students were requested to complete the "L" (Learned) part of the KWL chart and finally, they explored exhibits during free time, as stated in Teacher A's instructional plan (Observation record, May 4, 2016).

Since the Teacher A had organized a planned trip this time, it was possible to find examples of structured student engagement strategies during the trip. For instance, presentation of the science center's explainer seemed to fit the "Information receiving activities" because students got information about particular topic (electricity unit) from the explainer and this time, it was intentionally planned together by the teacher and the explainer before the visit. During presentation, Teacher A mostly sat and watched like her students.

After the presentation, Teacher A requested her students to fill "L" part of the KWL chart in the science center in five minutes – before free exploration time -. However, the teacher did not succeed in running this process since some students tried to fill out the KWL chart, while others began to roam in the science center, ignoring the teacher's direction. Within a few minutes, the teacher, being aware of this situation, collected the papers from the students and announced that she would distribute their papers back to them at the school and they have to complete the chart at home as an homework (Observation record, May 4, 2016). When asked during interview: "What causes this process to fail?", Teacher A said that "I was worried that my students would not remember the information they learned if they filled out the chart in class after visit. In addition, some students need to learn some answers related to questions of "W" part by asking questions to the explainer. For this reason, I thought that the best time to do this might be after the presentation. However, they did not want to fill out the chart because they wanted to start free exploration time after the presentation. Free time activities were more attractive for them.". When prompted further what solution you propose to solve this problem, Teacher A suggested that "More during-visit time should be allocated. We had an average hour and a half of time. The presentation lasted about half an hour. There was also the assignment I had wanted them to do in free time. For this reason, the students wanted immediately look at everything. I think that if we had more time, we would not face such a situation.". On the other hand, completing "L" part of the KWL chart and the detail examination of any one of the exhibits that interests students seemed to fit the "Information seeking activities" because these activities helped students focus their attention on exhibits and carry on appropriate behavior.

Unstructured student engagement strategies could be sometimes inevitable, especially during free exploration time since these strategies might be counted as spontaneous (Kisiel, 2003a). During free time, Teacher A wanted students, who had already been grouped, to conduct detailed observation and research on anyone of the exhibits. Some student groups tried to gather information, some other just took photos of the exhibits and their explanation on the labels while others began to roam in the science center, ignoring the teacher's direction (Observation record, May 4, 2016). Moreover, Teacher A was observed helping her students. For instance, a student, standing next to the "Magnetic Field" exhibit, called the teacher and the following conversation took place between them.

> Student: Teacher! What's in it? Dirt / dust?
> Teacher A: It's like an iron dust. Look! this is a magnet.
> Student: Woooow!
> Teacher A: Actually, you can find necessary information about how we find the north and south direction of the magnet by reading label. [Then, she attracted her student attention on the figure about the magnetic field lines around the Earth]
> Student: [For a while, students read the some part of the explanation and focused on the figure. Then tried to see these lines on the exhibit]. This must be the north pole.

Above conversation indicated that Teacher A motivated her student to read the label to find more about exhibit. Observation of Teacher A also revealed a few common supervision strategies, which were keeping track of time and eye on students. The following examples represented direct quotations from Teacher A: "You have five minutes to complete KWL chart", "We do not have much time. Last five minutes left", "Did you do your group work?", "Where's your group of friends?", "Do not wander around. Did you finish your group work?".

In terms of event documentation, most of the time, students took photos of exhibits and their explanations, as requested by the Teacher A (Observation record, May 4, 2016). In this way, students were able to utilize from them while preparing their presentation as well as document their experience at the science center. The summary of the comparison of Teacher A's during-visit strategies for conducting science center visits was shown in the Table 4.6.

Table 4.6.
Comparison of Teacher A's During-visit Strategies for Conducting SC Visits

DURING-VISIT STRATEGIES	Before PD (1st Trip to SC)	After PD (2nd Trip to SC)	Evidence
1. Student Engagement Strategies			
1.1. Structured student engagement			
1.1.1. Information seeking activities (e.g., completing worksheets, notetaking, drawing artifacts, finding and recording information presented through the exhibits)		✓	***2nd Trip:*** Completing 'L' part of the KWL chart and examining exhibits in detail to gather information
1.1.2. Information receiving activities (guided tours or staff presentations or stationary presentation)		✓	***2nd Trip:*** Participating in stationary presentation
1.2. Unstructured student engagement			
1.2.1. Interpretation (interpretation of exhibits' meaning based upon teachers' knowledge or information panel to draw students' attention to particular topic or exhibit)	✓		***1st Trip:*** Explaining "Tower of Hanoi" exhibit and "Pulley System" exhibit
1.2.2. Connecting (helping students correlate some parts of curriculum with exhibits)			
1.2.3. Facilitation (asking open-ended questions to help students' meaning-making)			
1.2.4. Label reading			
1.2.4.1. Deliberate label reading (prompting one student to read information on the panel out loud to the class and interfere to clarify unfamiliar things)			
1.2.4.2. Complementary label reading (directing students to read and find the answer to a particular question or more about the exhibits)		✓	***2nd Trip:*** Motivating her student to read the label to find more about exhibit.
1.2.5. Orientation and advance organizers (e.g., maps for introducing exhibit halls)			
1.2.6. Free exploration (allowing students to hang around and explore items/exhibits of interest)	✓	✓	***1st and 2nd Trip:*** Permitting students to roam
2. Supervision Strategies (dividing students into groups, guidance of chaperone, monitor time spent on site, keeping an eye on students, refocusing students about the rules and learning objectives etc.)		✓	***2nd Trip:*** Keeping track of time and eye on students

Table 4.6. (cont'd)
Comparison of Teacher A's During-visit Strategies for Conducting SC Visits

DURING-VISIT STRATEGIES	Before PD (1st Trip to SC)	After PD (2nd Trip to SC)	Evidence
3. Event Documentation (taking photo, videotaping)	✓	✓	***1st and 2nd Trip:*** Documenting the trip using her cell phone
4. Following Instructional Plan		✓	***2nd Trip:*** Following her previously prepared plan

Note. During-visit strategies. Adapted from *Revealing teacher agendas: An examination of teacher motivations and strategies for conducting museum fieldtrips* (pp. 79-80; 119-145), J. F. Kisiel, 2003a, University of Southern California, Los Angeles.

4.2.1.3. After field trip to the METU SC

It is important to note that post-visit activities were not observed - all of them were reported by teachers during the interview sessions. The researcher also utilized from instructional plan of Teacher A for analyzing her post-visit strategies.

4.2.1.3.1. First field trip to the METU SC

Teacher A explained that they conducted some sort of review session about what students did or saw. Based on her claim, she tried to relate the exhibits in science center to what students learn about sound unit in the class. Teacher A also stated that since there is no laboratory in the school, the children have experienced the practice of the theoretical issues in the science center. The following example represented direct quotations from Teacher A:

> Teacher A: There was an exhibit showing that no sound was emitted in space. I asked my students "Do you remember?". I do not have the opportunity to show them in school. However, in the science center, they have a chance to interact with the exhibit, called "Vacuum Bell Jar". I also explain in the class that sound spreads in waves. However, at the science center, they saw the wave form created by a rod-like device and learned that the wave was also an energy form just like sound. The plastic tube about the thickness of sound was one of the memorable materials. Thus, we summarize and repeat the sound

topic. In other words, we made both the curriculum review and the curriculum adaptation of the contents of the trip activities.

4.2.1.3.2. Second field trip to the METU SC

Teacher A explained that they conducted some sort of review session about what students did or saw by means of going over the answers of students to the "L" part of the KWL chart and the student groups' presentations about some exhibits in the science center that attract their attention, as stated in her instructional plan.

Unlike the previous field trip, Teacher A also referred to conducting some sort of post-visit activities to extend students learning about electrical conductivity/nonconductivity. She reported that students tested some materials' conductivity (e.g., pencil point, eraser, scissor, nail… etc.) by using their test circuits. She also told very interesting and noteworthy question of a student: "I am touching the cables of the two ends of this simple electric circuit but light bulb doesn't work as in UFO Ball that we saw in the science center. Why?". Teacher A also mentioned that in this example, student was able to relate his/her experience with their one of the topics in electricity unit. Thereon, Teacher A claimed that she witnessed both the impact of the field trip on students and the need for follow-up activity. The summary of the comparison of Teacher A's post-visit strategies for conducting science center visits was shown in the Table 4.7.

4.2.2. Case 2: Teacher B

4.2.2.1. Before field trip to the METU SC

It is important to note that Teacher B brought about the same number of (±1-2 students) fifth grade students, who are in the same class, on both excursions. Moreover, pre-visit activities were not observed - all of them were reported by teacher during the interview sessions. Also, researcher utilized the instructional plan of Teacher B for analyzing her pre-visit strategies.

Table 4.7.
Comparison of Teacher A's Post-visit Strategies for Conducting SC Visits

POST-VISIT STRATEGIES	Before PD (1st Trip to SC)	After PD (2nd Trip to SC)	Evidence
1. Review and Discussion (to talk about what students saw, did, liked and why they like; share experience; relate what they saw to curriculum etc.)	✓	✓	***1st Trip:*** Reviewing what they saw during explainer's presentation ***2nd Trip:*** Going over the answers of students to the 'L' part of the KWL chart and the student groups' presentation about some exhibits
2. Documentation (not-graded writing or drawing assignment, photo memory board, students' presentations or posters)			
3. Assessment (graded descriptive writing assignment or report about students' experiences)			
4. Other Post-visit Activities (activity to correlate special exhibits with classroom unit, integration of tabletop version of exhibits)		✓	***2nd Trip:*** Extending students' learning by using electrical test circuits.

Note. Post-visit strategies. Adapted from *Revealing teacher agendas: An examination of teacher motivations and strategies for conducting museum fieldtrips* (pp. 80-81; 145-148), J. F. Kisiel, 2003a, University of Southern California, Los Angeles.

4.2.2.1.1. First field trip to the METU SC

Teacher B organized a trip to the METU SC for the first time in February 2016. She reported that she had only made a reservation and did not ask to the explainer for any details about what to do, what would happen on the trip, or information about how the process would go on in the science center. On the other hand, they participated in the typical process of the science center since demonstrations related to the sound unit were conducted at the METU SC during February - March 2016. That is, she was not aware about that there would be a stationary presentation about sound for students.

Teacher B reported that before the trip, they had started the sound topic by making an activity showing that the sound was a vibration. But this was not an action that the teacher did purposefully. Coincidentally, the topic presented at the science center and taught in the school were the same. Moreover, Teacher B just mentioned about doing some sort of general preparation for the field trip, "I set the day of the trip according to the schedule of the school and booked the visit. I had prepared permission slips and made sure my students returned their permission slips. Also, I arranged transportation service". On the other hand, she reported that she did not make any planning for either the curriculum, the student gains or things to do during visit though she thought that preparing an instructional plan was useful. Upon this, the researcher tried to find out why she did not make any preparations other than general things to do.

> Researcher: Why did not you make any preparations other than general things to do?
> Teacher B: My workload at school is too much. Besides, I have never had a trip to the METU SC before. For this reason, I felt like a teacher in the first years of profession who did not know what to do.
> Researcher: Did you get information about what to do at the science center when you make a reservation?
> Teacher B: No. Obviously it did not come to my mind because I thought that the students would freely try the exhibits in the science center on their own. I did not think that they [explainers] could make presentation about a subject to the students. For example, if I knew that they would make a presentation about the sound, maybe I could have prepared a worksheet to take notes, but I did not.

Above responses led the researcher conclude that in addition to the having a lot of workload at school, confidence of Teacher B seemed low in this issue and so she couldn't know what to do for her first time. Similarly, Teacher B reported that she benefited from some sort of site familiarization: "I told my students that we were going to the METU SC and that there were a wide-variety of science-related exhibits. In order to satisfy their curiosity, I showed the students photos of buildings and some exhibits from the web page of the METU SC on the internet."

Furthermore, based on the interview results, it could be said that Teacher B also utilized pre-visit strategy related to supervision, which was behavior clarification.

> Teacher B: I reminded my students on the bus that "please carefully observe all the exhibits that you will explore at the science center. Also, when anything is told or explained to you, please listen carefully to explainers of the science center. When we return to the school, we will share our learnings all together."

4.2.2.1.2. Second field trip to the METU SC

Teacher B could make their second trip to METU SC in April 2016. Again, she mentioned general preparation same as the first trip: "I set the day of the trip according to the schedule of the school and booked the visit. I had prepared permission slips and made sure my students returned their permission slips. Also, I arranged transportation service". On the other hand, this time, field trip was planned. In other words, an instructional plan was prepared, and it was determined that what was to be shown in the science center's presentations and which exhibits were to be addressed during the trip. In this context, Teacher B mentioned that she called the science center to book the visit and communicate with the explainer.

> Teacher B: I said explainer that I want to plan a trip related to electricity unit because I was teaching electricity to the class in those days. I know from our first trip that they make various stationary presentation programs related to some curriculum topics and so, I demanded their presentation programs. Upon this, the explainer proposed me to send electricity presentation program and explanations of the science center exhibits related to electricity so that I will become more aware about presentation program and exhibits related to electricity. I made a second call to the explainer after reviewing the program. I said that I did not want Copper Pipe demonstration removed from our program, although Eddy currents described by Copper Pipe are not included in fifth grade science curriculum. I requested that it can be shown as an interesting science show since I thought that my students can meet the curious and fun aspects of the science by means of this type different and interesting science demonstrations.

Pre-visit strategy, which was procedure familiarization, might be traced on the above explanations of Teacher B. For instance, she became aware of presentation program and different exhibits related to electricity in detail. Moreover, as written on her instructional plan, she mentioned during the interview that she did not do any site familiarization as follows: "This time, I did not need to re-introduce METU SC to my students because they had gone before". Furthermore, Teacher B reported that she

gave information to the students about the "Electricity in Our Lives" topic before the trip by means of worksheets and activities conducted in the class.

> Teacher B: In my previous lessons, I started to talk about electricity. The previous class hour before the trip, we completed the worksheets containing questions about the elements of and setting up a simple electric circuit (see Appendix F). Then, I asked students to set up their own electrical circuits with supplied materials. Afterwards, I mentioned my students that they will participate a presentation about electricity in the METU SC. I briefly introduced exhibits of electricity presentation using field trip guide of the METU SC. Subsequently, I made my students to try a tabletop version of "Hand-eye-brain Coordination" exhibit, that I brought in the class. Using this tabletop version of the exhibit, I emphasized that when any circuit was not completed, bulb did not light up. Thus, my students were both motivated and got the idea about an exhibit of METU SC. And finally, I finished the lesson with another activity that would allow them to think about why a broken electrical circuit does not work. Now, I had made sure my students were ready to go on science center trip related to electricity.

Above explanations of Teacher B indicated preparation strategy related to content familiarization, according to which she provided students prior knowledge before the visit. Furthermore, based on the interview results, it could be said that Teacher B also utilized pre-visit strategy related to supervision, which was behavior clarification.

> Teacher B: I reminded my students on the bus that "Do not ask every question that comes to your mind. Ask questions that are really important to you and relevant to the topic. Do not behave that will leave me in trouble. If you have any trouble, contact me or the explainer".

The summary of the comparison of Teacher B's pre-visit strategies for conducting science center visits was shown in the Table 4.8.

4.2.2.2. During field trip to the METU SC

It is important to note that during-visit activities were observed and all of them were reported by Teacher B during the interview sessions as well. Researcher also utilized the instructional plan of Teacher B for analyzing her during-visit strategies.

Table 4.8.
Comparison of Teacher B's Pre-visit Strategies for Conducting SC Visits

PRE-VISIT STRATEGIES	Before PD (1st Trip to SC)	After PD (2nd Trip to SC)	Evidence
1. Familiarization Strategies			
1.1. Site familiarization (introduction of field trip site)	✓		***1st Trip:*** Browsing the web page of METU SC
1.2. Content familiarization (introduction of field trip content)		✓	***2nd Trip:*** Completing worksheets about the elements of and setting up a simple electric circuit / Making an activity in which students set up electric circuit / Trying a tabletop version of "Hand-eye-brain Coordination" exhibit
1.3. Procedure familiarization (knowing about or introduction of what will happen on the trip)		✓	***2nd Trip:*** Communicating with explainer to become familiar with the presentation program
2. Supervision Strategies			
2.1. Behavior clarification (discussions with students about expected behaviors and consequences of unexpected ones)	✓	✓	***1st Trip:*** Reminding careful observation of exhibits and listening of explainers ***2nd Trip:*** Emphasizing questioning related to topic / Emphasizing behavior expectations
2.2. Supervision coordination (finding chaperones and assistants, dividing students into groups)			
3. General Things to Do (organization of transportation, entry costs, booking, getting related permissions, etc.)	✓	✓	***1st and 2nd Trip:*** Setting the day and booking, preparing and getting permission slips, arranging transportation
4. Instructional Planning (comprehensively defined action plan including the integration of curriculum and visit)		✓	***2nd Trip:*** Preparing an instructional plan
5. Other Pre-visit Activities (preparing worksheet, study guide or activity in which students generate questions related to visit or activity to use during trip)			

Note. Pre-visit strategies. Adapted from *Revealing teacher agendas: An examination of teacher motivations and strategies for conducting museum fieldtrips* (pp. 77-79; 106-118), J. F. Kisiel, 2003a, University of Southern California, Los Angeles.

4.2.2.2.1. First field trip to the METU SC

Even if stationary presentation of the science center's explainer seemed to fit the "Information receiving activities", because students got information about particular topic (sound unit) from the explainer, it would not be categorized as "Structured Student Engagement Strategy", since Teacher B did not intentionally plan explainer's presentation before the trip. During presentation about sound unit, Teacher B mostly sat and watched like her students and sometimes took photos and videos using her cell phone (Observation record, February 24, 2016).

Moreover, as the explainer began to demonstrate "Vacuum Bell Jar" exhibit, she refocussed her students attention to the demonstration with the following statements: "This exhibit is also mentioned in our textbook. But we do not have this exhibit in our school. For this reason, let's observe this part carefully. I will remind you on a subsequent lesson."

During free exploration time offered by the science center, students explored whatever they wanted within the science center alone or in small groups. They ran from there to there, talked each other about what they saw. Some of them pulled their friends to show an interesting or particular exhibit (Observation record, February 24, 2016). When asked during interview session whether she gave any direction to her students about how they are going to explore the science center during free time, she said: "No. This happened spontaneously. When the explainer said 'Now it is free time', students went to the exhibits that attract their attention. Afterwards, I did not interfere.". Therefore, it could be assumed that her students roamed at the science center.

Meantime, Teacher B explored some exhibits on her own and took some photos of both students and some exhibits. Sometimes she communicated with her students (Observation record, February 24, 2016). For instance, there was a small student group asking Teacher B how to try "Depth Spinner" exhibit. Then, Teacher B directed her students as follows:

Teacher B: When I start the spiral rotating, focus your eye on its center for about 20 seconds. When I say 'Look at me!', then turn your face to me. Let's begin!
Students: [Staring at the center of the exhibit]
Teacher B: Look at me!
Students: Waaoow…
Teacher B: What did you observe?
Student-1: Your face seems so funny.
Student-2: Your face shrinked.
Teacher B: This is a kind of optic illusion. When you stare at a spiral which is rotating outward for a while and then look at a standing object, you see this object as rotating inward.

Above conversation indicated that Teacher B used interpretation as a way to introduce her students to the "Depth Spinner" exhibit, upon their request. That is, although students got the necessary information from the label near the exhibit, the teacher chose to explain it.

4.2.2.2.2. Second field trip to the METU SC

Technically, making an instructional plan for the visit seems a kind of pre-visit strategy. However, following it during the visit could be considered as the issue of during-visit strategy, as stated by Kisiel (2003a). For instance, Teacher B and her students, firstly, participated in stationary presentation about electricity and then they explored exhibits during free time, as stated in Teacher B's instructional plan. Similarly, Teacher B reminded her students to do detailed observation of exhibits related to electricity during free time (Observation record, April 27, 2016).

Since the Teacher B had organized a planned trip this time, it is possible to find examples of structured student engagement strategies during the trip. For instance, presentation of the science center's explainer seemed to fit the "Information receiving activities" because students got information about particular topic (electricity unit) from the explainer and this time, it was intentionally planned together by the teacher and the explainer. During stationary presentation about electricity unit, Teacher B mostly sat and watched like her students and sometimes took photos and videos using her cell phone (Observation record, April 27, 2016).

During free exploration time, students mostly explored whatever they wanted within the science center alone or in small groups. They ran from there to there, in other words, they roamed at the science center. Teacher B just reminded her students to do detailed observation of exhibits related to electricity since they had to write a composition about them when they returned to the school (Observation record, April 27, 2016). Moreover, Teacher B was observed accompanying some students near the "Hand-eye-brain Coordination" exhibit. She pointed out as follows:

> Teacher B: This exhibit is the bigger version of our tabletop version of "Hand-eye-brain Coordination" exhibit in the class.
> Students: Ohh, yeah. They look alike.
> Teacher B: Remember, when you touch metal stick to the pipe…
> Student: Circuit is completed
> Teacher B: Yes.

Above conversation indicated that Teacher B connected students' classroom learning with exhibits in the science center. The summary of the comparison of Teacher B's during-visit strategies for conducting science center visits was shown in the Table 4.9.

Table 4.9.
Comparison of Teacher B's During-visit Strategies for Conducting SC Visits

DURING-VISIT STRATEGIES	Before PD (1st Trip to SC)	After PD (2nd Trip to SC)	Evidence
1. Student Engagement Strategies			
1.1. Structured student engagement			
1.1.1. Information seeking activities (e.g., completing worksheets, notetaking, drawing artifacts, finding and recording information presented through the exhibits)			
1.1.2. Information receiving activities (guided tours or staff presentations or stationary presentation)		✓	***2nd Trip:*** Participating in stationary presentation

Table 4.9. (cont'd)
Comparison of Teacher B's During-visit Strategies for Conducting SC Visits

DURING-VISIT STRATEGIES	Before PD (1st Trip to SC)	After PD (2nd Trip to SC)	Evidence
1.2. Unstructured student engagement			
1.2.1. Interpretation (interpretation of exhibits' meaning based upon teachers' knowledge or exhibit's label to draw students' attention to particular topic or exhibit)	✓		***1st Trip:*** Explaining "Depth Spinner" exhibit
1.2.2. Connecting (helping students correlate some parts of curriculum with exhibits)		✓	***2nd Trip:*** Connecting "Hand-eye-brain Coordination" exhibit with students' classroom learning
1.2.3. Facilitation (asking open-ended questions to help students' meaning-making)			
1.2.4. Label reading			
1.2.4.1. Deliberate label reading (prompting one student to read information on the label out loud to the class and interfere to clarify unfamiliar things)			
1.2.4.2. Complementary label reading (directing students to read and find the answer to a particular question or more about the exhibits)			
1.2.5. Orientation and advance organizers (e.g., maps for introducing exhibit halls)			
1.2.6. Free exploration (allowing students to hang around and explore items/exhibits of interest)	✓	✓	***1st and 2nd Trip:*** Permitting students to roam
2. Supervision Strategies (dividing students into groups, guidance of chaperone, monitor time spent on site, keeping an eye on students, refocusing students about the rules and learning objectives etc.)	✓		***1st Trip:*** Refocussing students' attention on the demonstration of "Vacuum Bell Jar" exhibit
3. Event Documentation (taking photo, videotaping)	✓	✓	***1st and 2nd Trip:*** Documenting the trip using her cell phone
4. Following Instructional Plan		✓	***2nd Trip:*** Following her previously prepared plan

Note. During-visit strategies. Adapted from *Revealing teacher agendas: An examination of teacher motivations and strategies for conducting museum fieldtrips* (pp. 79-80; 119-145), J. F. Kisiel, 2003a, University of Southern California, Los Angeles.

4.2.2.3. After field trip to the METU SC

It is important to note that post-visit activities were not observed - all of them were reported by Teacher B during the interview sessions. The researcher also utilized the instructional plan of Teacher B for analyzing her post-visit strategies.

4.2.2.3.1. First field trip to the METU SC

Teacher B reported that she had requested her students to share their experiences through writing, which was not graded. This could be considered as documentation strategy.

> Teacher B: I requested my students to write a letter about their visits to METU SC. I wanted them to tell me in the letter what they had learned and what they had seen during visit.

4.2.2.3.2. Second field trip to the METU SC

Teacher B reported that they did all post-visit activities written on her instructional plan, which were review and discussion, not graded writing or drawing and making a pano with them.

> Teacher B: In our subsequent lesson, we had a brief review and discussion session about our visit in the class since I wondered whether my students have had misconceptions or what they had learned during visit. I asked my students some questions like "Which activity or exhibit did you like most? Why?", "What was X activity about?", "What was the function of X exhibit?". Moreover, I asked whether everyone observe the "Hand-eye-brain Coordinaton" exhibit. Then, we reiterated that it works with the principle of simple electric circuit. Afterwards, I requested my students to draw or write about their favourite exhibits related to electricity. Finally, we made a pano with their works.

The summary of the comparison of Teacher B's post-visit strategies for conducting science center visits was shown in the Table 4.10.

Table 4.10.
Comparison of Teacher B's Post-visit Strategies for Conducting SC Visits

POST-VISIT STRATEGIES	Before PD (1st Trip to SC)	After PD (2nd Trip to SC)	Evidence
1. Review and Discussion (to talk about what students saw, did, liked and why they like; share experience; relate what they saw to curriculum etc.)		✓	***2nd Trip:*** Having a brief review and discussion session about visit
2. Documentation (not-graded writing or drawing assignment, photo memory board, students' presentations or posters)	✓	✓	***1st Trip:*** Having students write a letter to share their experiences ***2nd Trip:*** Having students write or draw their favourite exhibits related to electricity and making a pano of students' work
3. Assessment (graded descriptive writing assignment or report about students' experiences)			
4. Other Post-visit Activities (activity to correlate special exhibits with classroom unit, integration of tabletop version of exhibits)			

Note. Post-visit strategies. Adapted from *Revealing teacher agendas: An examination of teacher motivations and strategies for conducting museum fieldtrips* (pp. 80-81; 145-148), J. F. Kisiel, 2003a, University of Southern California, Los Angeles.

4.2.3. Case 3: Teacher C

4.2.3.1. Before field trip to the METU SC

It is important to note that Teacher C brought about the same number (±1 or 2 students) of fourth grade students, who are in the same class, on both excursions. Remember that pre-visit activities were not observed - all of them were reported by teacher during the interview sessions. Also, researcher utilized the instructional plan of Teacher C for analyzing her pre-visit strategies.

4.2.3.1.1. First field trip to the METU SC

Teacher C organized a trip to the METU SC for the first time in March 2016. She reported that she had only made a reservation and asked what topic of the presentation would be because she worried about the appropriateness of the topic to her students' grade level. Then, she talked about that she agreed with explainer on that the topic of the stationary presentation would be sound. However, she also mentioned that she did not ask to the explainer for any details about what to do or information about how the process would go on in the science center. Teacher C with her students participated in the typical process of the science center.

Teacher C talked about that she had done water and paper conservation activities in the classroom before the trip. She had not taught something related to sound topic. So, it could be claimed that she did not utilize from content familiarization strategy. Moreover, Teacher C also mentioned about doing some sort of general preparation for the field trip, "I set the day of the trip according to the schedule of the school and got permission from the school administration. I made a reservation from the METU SC and communicated with the explainer to decide on the topic of the trip. I arranged our school's transportation service. Moreover, I asked our classroom teacher to assist me in making sure students focused on task and controlling them during the visit". On the other hand, Teacher C reported that she did not make any planning for either the curriculum, the student gains or things to do during visit. Then, the researcher tried to find out why she did not make any preparations other than general things to do.

> Teacher C: I have too much workload in the school. I want to say that I work both as a teacher and as an administrator. Therefore, I did not have enough time for a more detailed preparation. And also… I thought that it is useful to make a detailed plan for a trip, but how? I think that I do not have enough knowledge to prepare a trip plan integrating with curriculum.

Above responses led the researcher conclude that the workload, not being able to find enough time and not knowing exactly what to do prevented the teacher from doing other preparations.

Furthermore, based on the interview results, it could be said that Teacher C also utilized from some sort of site familiarization: “The day before the trip, I informed the students verbally about what kind of place the science center is and what kind of exhibits to see there. I also said that they could touch and try the exhibits”.

4.2.3.1.2. Second field trip to METU SC

Teacher C could make the second trip to METU Science Center in May 2016. Again, she mentioned general preparation same as the first trip: “ I set the day of the trip according to the schedule of the school and got permission from the school administration and parents. Also, I booked the METU SC visit. I arranged our school's transportation service”. On the other hand, this time, field trip was planned. In other words, an instructional plan was prepared (see Appendix F), and it was determined that what was to be shown in the science center’s presentations and which exhibits were to be addressed during the trip. In this context, Teacher C called the science center to book the visit and communicate with the explainer to plan the trip together.

> Teacher C: First of all, I booked the visit and then communicated with explainer because I want to plan a trip related to electricity unit. I asked whether there is a stationary presentation related to electricity. Also, I demanded from the explainer to send me electricity presentation program, photographs and explanations of the science center exhibits related to electricity (e.g., Van de Graaff Generator, Magnetic Pendulum, Pedal Generator, Wind-powered Generator, etc.). After reviewing the electricity program and exhibits, I called the explainer a second time. And this time, I requested that Copper Pipe activity in the presentation not to be shown because my students’ grade level is junior and science behind the Copper Pipe activity will be complex for my students. I also asked the explainer to assist me in explaining one of the exhibit [Pedal Generator] that I had selected. I mean... I divided my students into three groups and I selected three different exhibits [Pedal Generator, Hand-eye-brain Coordination (simple electric circuit) and Wind-powered Generator] to be respectively discussed together with each student group after the presentation. To be able to actualize this, I needed three people but we were only two teachers, classroom teacher and me. So I needed another person to guide students in one of the groups. Fortunately, the explainer agreed to help us.

As understood from the explanations of Teacher C, pre-visit strategies related to supervision coordination were addressed by dividing students into three groups and getting assistance from the explainer and the classroom teacher. Another pre-visit strategy, procedure familiarization, might be traced on the above explanations of Teacher C. For instance, she became aware of presentation program and different exhibits related to electricity in detail. She also discussed a "plan of action in the science center" with the explainer, including the idea that they would participate in presentation first and then the explanation of three different exhibits as a three-group. With this plan of action, it could be claimed that they minimized chaotic atmosphere and amusement park perception of students during visit. In terms of students, procedure familiarization strategy might also be traced on descriptions of Teacher C's instructional plan as well as the explanations below. She claimed that she had spoken to students about how the visit would go on in the science center.

> It is declared to students that we, first of all, participate in the electricity presentation of the explainer. Then, students are divided into three groups. Students are told that they will examine three pre-determined exhibits as each group in turn and will be able to visit science center freely in the end. (*Excerpt from Teacher C's Instructional Plan*)

> Teacher C: The previous class hour before the trip, I reminded METU SC to my students by browsing the web page of the science center [*site familiarization*]. I told them that the topic of the trip is about electricity and for this reason the explainer will give us a presentation about electricity. I also said that they will have free time after presentation but it will not be long like the last time. That is, after the presentation, I said that they would examine the three different exhibits in three groups in turn, and then they would be able to freely explore in the science center in the end. I also told them that they should take their science notebooks to the science center and take notes in this notebook about the presentations of explainer and exhibits we will discuss together.

Teacher C also mentioned preparation strategy related to content familiarization by providing students prior knowledge before the visit.

> Teacher C: Our trip's topic was "Electrictity in Our Lives". For this purpose, I did an activity in the class about a week ago to prepare my students. First of all, I gave a brief theoretical information about electricity to my students. Then, I divided them into groups. I distributed a simple electric circuit

elements such as battery, battery bed, conductive and insulated wire, light bulb, switch to each group. I wanted them to set up various circuits using the materials in their hands. Afterwards, we discussed each circuit with the questioning strategy. I asked my students such questions: "Why did you use two bulbs?, Is there a change in bulb when used two batteries? Is the bulb lighted by using insulated wire?" As a result, they learnt by experiencing the effects of simple electric circuit elements on the electricity. Thus, I have provided basic level knowledge necessary for students in terms of what we will do in the science center.

Furthermore, based on the interview results, it could be said that Teacher C utilized pre-visit strategy related to supervision, which was behavior clarification.

Teacher C: I reminded my students on the bus that "please carefully observe and take notes all the exhibits that you will explore at the science center. Any time, you can ask me or explainer questions that you wonder about electricity and related exhibits. However, do not ask for interrupting questions other than the subject."

The summary of the comparison of Teacher C's pre-visit strategies for conducting science center visits was shown in the Table 4.11.

Table 4.11.
Comparison of Teacher C's Pre-visit Strategies for Conducting SC Visits

PRE-VISIT STRATEGIES	Before PD (1st Trip to SC)	After PD (2nd Trip to SC)	Evidence
1. Familiarization Strategies			
1.1. Site familiarization (introduction of field trip site)	✓	✓	***1st Trip:*** Informing students verbally about science center and exhibits, in general ***2nd Trip:*** Browsing the web page of METU SC
1.2. Content familiarization (introduction of field trip content)		✓	***2nd Trip:*** Making an activity in which students set up electric circuit
1.3. Procedure familiarization (knowing about or introduction of what will happen on the trip)		✓	***2nd Trip:*** Discussing a plan of action in the science center with the explainer / informing students about how the visit will go on in the science center

Table 4.11. (cont'd)
Comparison of Teacher C's Pre-visit Strategies for Conducting Science Center Visits

PRE-VISIT STRATEGIES	Before PD (1st Trip to SC)	After PD (2nd Trip to SC)	Evidence
2. Supervision Strategies			
2.1. Behavior clarification (discussions with students about expected behaviors and consequences of unexpected ones)		✓	***2nd Trip:*** Reminding careful observation of and taking notes about exhibits / Emphasizing questioning related to topic
2.2. Supervision coordination (finding chaperones and assistants, dividing students into groups)	✓	✓	***1st Trip:*** Asking classrom teacher to assist her during visit ***2nd Trip:*** Asking classrom teacher and explainer to assist her during visit / Dividing students into three groups
3. General Things to Do (organization of transportation, entry costs, booking, getting related permissions, etc.)	✓	✓	***1st and 2nd Trip:*** Setting the day and booking, getting permission from school administration and parents, arranging transportation
4. Instructional Planning (comprehensively defined action plan including the integration of curriculum and visit)		✓	***2nd Trip:*** Preparing an instructional plan
5. Other Pre-visit Activities (preparing worksheet, study guide or activity in which students generate questions related to visit or activity to use during trip)			

Note. Pre-visit strategies. Adapted from *Revealing teacher agendas: An examination of teacher motivations and strategies for conducting museum fieldtrips* (pp. 77-79; 106-118), J. F. Kisiel, 2003a, University of Southern California, Los Angeles.

4.2.3.2. During field trip to the METU SC

It is important to note that during-visit activities were observed and all of them were reported by Teacher C during the interview sessions as well. Also, researcher utilized the instructional plan of Teacher C for analyzing her during-visit strategies.

4.2.3.2.1. First field trip to METU SC

Even if presentation of the science center's explainer seemed to fit the "Information receiving activities", because students got information about particular topic (sound unit) from the explainer, it would not be categorized as "Structured Student Engagement Strategy", since Teacher C did not intentionally plan explainer's presentation before the trip. That is, she agreed with the explainer about the sound topic before the visit but she did not know anything about what would be presented to her students during the presentation program. During stationary presentation about sound unit, Teacher C mostly sat and watched like her students and sometimes took photos and videos using her cell phone (Observation record, March 1, 2016).

During free exploration time offered by the science center, students explored whatever they wanted within the science center alone or in small groups. They ran from there to there, talked each other about what they saw. Some of them pulled their friends to show an interesting or particular exhibit (Observation record, March 1, 2016). Meantime, Teacher C explored some exhibits on her own and took some photos of both students and some exhibits. Sometimes she communicated with her students (Observation record, March 1, 2016). For instance, there was a small student group exploring "vortex" exhibit.

Teacher C: What is happening now?
Students: Water is rotating
Teacher C: What do you expect to happen?
Student-1: Look here!
Student-2: Something is happening.
Student-3: Something like whirlwind.
Teacher C: Yes, but not whirlwind. It is a vortex. Why vortex occurred? I mean… What is happening while water is draining into the hole? What is in the hole?
Students: Air
Teacher C: Yes. While water wants to drain into the hole, the air inside the hole wants to go out. So, vortex occurred.

Above conversation indicated that Teacher C used interpretation strategy since she interpreted the meaning of the exhibit based upon her knowledge.

4.2.3.2.2. Second field trip to METU SC

Technically, making an instructional plan for the visit seems a kind of pre-visit strategy. However, following it during the visit could be considered as the issue of during-visit strategy, as stated by Kisiel (2003a). For instance, Teacher C and her students, firstly, participated in stationary presentation about electricity and then they discussed three different exhibits related to electiricity together with each student group after presentation. Finally, Teacher C gave free exploration time to her students, as stated in her instructional plan. Similarly, Teacher C reminded her students to take notes about exhibits related to electricity. Throughout the visit, students were seen taking on notes about exhibits which were shown in explainer's presentation or discussed during group activity (Observation record, May 9, 2016). This notetaking could be considered as "information seeking activity" since this was planned by the teacher and this strategy kept students engaged during visit.

Since the Teacher C had organized a planned trip this time, it was possible to find examples of structured student engagement strategies during the trip. For instance, presentation of the science center's explainer seemed to fit the "Information receiving activities" because students got information about particular topic (electricity unit) from the explainer and this time, it was intentionally planned together by the teacher and the explainer before the visit. During stationary presentation about electricity unit, Teacher C mostly sat and watched like her students and sometimes took photos and videos using her cell phone. However, it is also important to note that Teacher C sometimes took the floor during presentation to help her students make connection between exhibits and classroom topics (Observation record, May 9, 2016). For instance, when the explainer started to talk about magnets and their poles, Teacher C asked the explainer for permission to speak and then she continued as follows:

> Teacher C: Kids! We did the "Magic Magnets" activity on this subject in our prior classes. Do you remember?
> Students: Yes.
> Teacher C: What we did?
> Student-1: We had colorful magnets.
> Teacher C: What was happenning with the magnets?

Student-2: They attracted and repelled each other.
Student-3: Because they had poles.
Teacher C: If they attract each other [showing two magnets' attraction], their facing poles are…
Students: North and South
Teacher C: And, if they repel each other [showing two magnets' repulsion], their facing poles are…
Students: South and South
Teacher C: Or…
Students: North and North
Teacher C: Yes. Do you remember that we moved the toy car without touching. How could be possible?
Student-4: Using our magnets' attraction force.

Another connection example were mentioned by Teacher C during post-interview: "During the UFO Ball activity, students held hands to complete an electrical circuit. In the meantime, I referred to our previous lesson before the trip by reminding conductivity, insulation and conductivity of human body. In this way, I wanted to make students feel that things in science centers were not much different from what they had learned in the class. Moreover, I tried to help my students make connection between exhibits and classroom topics".

After presentation, Teacher C directed students to the second phase of the visit, which was structured free exploration time. They discussed three different exhibits related to electiricity (Pedal Generator, Hand-eye-brain Coordination and Wind-powered Generator) together with each student group. Teacher C reminded her students to take notes about these exhibits as well since they will talk about them when they return to the class. Teacher C tried to ensure that all students in a group explore exhibits in turn. At the same time, she tried to explain exhibits based on her prior knowledge and information on the exhibit's label as well (Observation record, May 9, 2016). For instance;

Teacher C: This exhibit shows the conversion of wind energy to electrical energy. Let's run it.
Student-1: [Pressed the button]
Teacher C: What do you observe?
Student-2: Propeller is turning.
Student-3: Light is on.

> Teacher C: I want to draw your attention to another part of it. Look at here [Pointing out dynamo]. This is a kind of dynamo. It helps the conversion of wind energy to electrical energy.

Although students could find necessary information on the labels, she preferred to explain it. The reason of Teacher C to prefer the interpretation might be time constraint. During unstructured free exploration time, students mostly explored whatever they interested in the science center alone or in small groups (Observation record, May 9, 2016). Meanwhile, observation of Teacher C revealed a few common supervision strategies, which are keeping track of time and eye on students. The following examples represented direct quotations from Teacher C: "You have fifteen minutes to explore freely", "Each group has six minutes", "Group 3 follow me please", "Did you take notes?", "Where are you going? Please, follow your group members".

The summary of the comparison of Teacher C's during-visit strategies for conducting science center visits was shown in the Table 4.12.

Table 4.12.
Comparison of Teacher C's During-visit Strategies for Conducting SC Visits

DURING-VISIT STRATEGIES	Before PD (1st Trip to SC)	After PD (2nd Trip to SC)	Evidence
1. Student Engagement Strategies			
1.1. Structured student engagement			
1.1.1. Information seeking activities (e.g., completing worksheets, notetaking, drawing artifacts, finding and recording information presented through the exhibits)		✓	***2nd Trip:*** Taking notes about exhibits related to electricity
1.1.2. Information receiving activities (guided tours or staff presentations or stationary presentation)		✓	***2nd Trip:*** Participating in stationary presentation

Table 4.12. (cont'd)
Comparison of Teacher C's During-visit Strategies for Conducting SC Visits

DURING-VISIT STRATEGIES	Before PD (1st Trip to SC)	After PD (2nd Trip to SC)	Evidence
1.2. Unstructured student engagement			
1.2.1. Interpretation (interpretation of exhibits' meaning based upon teachers' knowledge or exhibit's label to draw students' attention to particular topic or exhibit)	✓	✓	***1st Trip:*** Explaining "Vortex" exhibit ***2nd Trip:*** Explaining "Wind-powered generator" exhibit
1.2.2. Connecting (helping students correlate some parts of curriculum with exhibits)		✓	***2nd Trip:*** Connecting "Magnets" and "Ufo Ball" exhibit with students' classroom learning
1.2.3. Facilitation (asking open-ended questions to help students' meaning-making)			
1.2.4. Label reading			
1.2.4.1. Deliberate label reading (prompting one student to read information on the label out loud to the class and interfere to clarify unfamiliar things)			
1.2.4.2. Complementary label reading (directing students to read and find the answer to a particular question or more about the exhibits)			
1.2.5. Orientation and advance organizers (e.g., maps for introducing exhibit halls)			
1.2.6. Free exploration (allowing students to hang around and explore items/exhibits of interest)	✓	✓	***1st and 2nd Trip:*** Permitting students to roam
2. Supervision Strategies (dividing students into groups, guidance of chaperone, monitor time spent on site, keeping an eye on students, refocusing students about the rules and learning objectives etc.)		✓	***2nd Trip:*** Keeping track of time and eye on students
3. Event Documentation (taking photo, videotaping)	✓	✓	***1st and 2nd Trip:*** Documenting the trip using her cell phone
4. Following Instructional Plan		✓	***2nd Trip:*** Following her previously prepared plan

Note. During-visit strategies. Adapted from *Revealing teacher agendas: An examination of teacher motivations and strategies for conducting museum fieldtrips* (pp. 79-80; 119-145), J. F. Kisiel, 2003a, University of Southern California, Los Angeles.

4.2.3.3. After field trip to the METU SC

It is important to note that post-visit activities were not observed - all of them were reported by Teacher C during the interview sessions. The researcher also utilized the instrcutional plan of Teacher C for analyzing her post-visit strategies.

4.2.3.3.1. First field trip to METU SC

Teacher C reported that she did not do anything other than receiving feedback from her students on the bus. This could be considered as review and discussion strategy.

> Teacher C: I asked some general questions like "Are you happy?", "Did you learn something?". They said that they had a lot of fun, wanted to be a METU student and wanted to be a scientist in the future. That's all. Actually, we haven't talked about sound topic yet in the class. However, when I start to teach this topic, I am going to utilize from photos, that I took during visit, to remind students what they had seen.

4.2.3.3.2. Second field trip to METU SC

Teacher C reported that they conducted some sort of review session through students' note about what they saw and liked, as stated in Teacher C's instructional plan.

> Teacher C: In our subsequent lesson, I had my students read their notes to the class. Meanwhile, I asked them some questions like "Which one was your favourite?", "What was the function of X exhibit?". Most of the students told that the most attractive exhibit was Van de Graaff Generator.

On the other hand, Teacher C admitted that she could not carry out other post-visit activities written on the instructional plan, due to her some extra works at school. However, she mentioned that she requested her students to compare their two visits to METU SC through writing assignment, which was not graded.

The summary of the comparison of Teacher C's post-visit strategies for conducting science center visits was shown in the Table 4.13.

Table 4.13.
Comparison of Teacher C's Post-visit Strategies for Conducting SC Visits

POST-VISIT STRATEGIES	Before PD (1st Trip to SC)	After PD (2nd Trip to SC)	Evidence
1. Review and Discussion (to talk about what students saw, did, liked and why they like; share experience; relate what they saw to curriculum etc.)	✓	✓	***1st Trip:*** Reviewing of the day on the bus ***2nd Trip:*** Reviewing students notes about what they saw and liked
2. Documentation (not-graded writing or drawing assignment, photo memory board, students' presentations or posters)		✓	***2nd Trip:*** Having students compare their two visits to METU SC through writing
3. Assessment (graded descriptive writing assignment or report about students' experiences)			
4. Other Post-visit Activities (activity to correlate special exhibits with classroom unit, integration of tabletop version of exhibits)			

Note. Post-visit strategies. Adapted from *Revealing teacher agendas: An examination of teacher motivations and strategies for conducting museum fieldtrips* (pp. 80-81; 145-148), J. F. Kisiel, 2003a, University of Southern California, Los Angeles.

4.2.4. Summary

The commonly reported pre-visit strategies included *site familiarization* and *general things to do* before teachers' participation in the professional development program. On the other hand, teachers' reports after their participation in the professional development program indicated that *instructional planning, content familiarization* (e.g., providing students some prior knowledge about target exhibits) *and procedure familiarization* (e.g., informing students about how the visit will go on in the METU SC) in addition to *general things to do* were common pre-visit strategies. Summary of the all teachers' pre-visit strategies before and after their participation in the professional development program was listed in Table 4.14.

Table 4.14.
Summary of the Teachers' Pre-visit Strategies Before and After PD Program

PRE-VISIT STRATEGIES	***Before PD Program***			***After PD Program***		
	Teacher A	***Teacher B***	***Teacher C***	***Teacher A***	***Teacher B***	***Teacher C***
1. Familiarization Strategies						
1.1. Site familiarization	✓	✓	✓	✓		✓
1.2. Content familiarization				✓	✓	✓
1.3. Procedure familiarization				✓	✓	✓
2. Supervision Strategies						
2.1. Behavior clarification		✓			✓	✓
2.2. Supervision coordination			✓	✓		✓
3. General Things to Do	✓	✓	✓	✓	✓	✓
4. Instructional Planning				✓	✓	✓
5. Other Pre-visit Activities				✓		

The commonly reported during-visit strategies included *unstructured student engagement strategies (e.g., free exploration and interpretation)* and *event documentation* before the professional development program. On the other hand, teachers' report indicated that *structured student engagement strategies (e.g., information receiving activities), following instructional plan* in addition to *event documentation* and *unstructured student engagement strategies* were common during-visit strategies after the professional development program. Summary of the teachers' during-visit strategies before and after the professional development program was listed in Table 4.15.

Table 4.15.
Summary of the Teachers' During-visit Strategies Before and After PD Program

DURING-VISIT STRATEGIES	***Before PD Program***			***After PD Program***		
	Teacher A	***Teacher B***	***Teacher C***	***Teacher A***	***Teacher B***	***Teacher C***
1. Student Engagement Strategies						
1.1. Structured student engagement						
1.1.1. Information seeking activities				✓		✓
1.1.2. Information receiving activities				✓	✓	✓
1.2. Unstructured student engagement						
1.2.1. Interpretation	✓	✓	✓			✓
1.2.2. Connecting					✓	✓
1.2.3. Facilitation						
1.2.4. Label reading						
1.2.4.1. Deliberate label reading						
1.2.4.2. Complementary label reading				✓		
1.2.5. Orientation and advance organizers						
1.2.6. Free exploration	✓	✓	✓	✓	✓	✓
2. Supervision Strategies		✓		✓		✓
3. Event Documentation	✓	✓	✓	✓	✓	✓
4. Following Instructional Plan				✓	✓	✓

The commonly reported post-visit strategies included *review and discussion* before the PD program. On the other hand, teachers' report indicated that *documentation* in addition to *review and discussion* were common post-visit strategies after PD

program. Summary of teachers' post-visit strategies before and after PD program was listed in Table 4.16.

Table 4.16.
Summary of the Teachers' Post-visit Strategies Before and After PD Program

POST-VISIT STRATEGIES	***Before PD (1st Trip to SC)***			***After PD (2nd Trip to SC)***		
	Teacher A	***Teacher B***	***Teacher C***	***Teacher A***	***Teacher B***	***Teacher C***
1. Review and Discussion	✓		✓	✓	✓	✓
2. Documentation		✓			✓	✓
3. Assessment						
4. Other Post-visit Activities				✓		

4.3. Through the Lenses of the Science Teachers: The Characteristics of PD Program Influencing Their Instructional Planning regarding Science Center Visit

The main goal of this section is to better understand the views of teachers on the characteristics of PD program influencing their instructional planning regarding science center visit. But first, the researcher revealed teachers' awareness about the change in their science center visits and then their views on the characteristics of PD program. Accordingly, the researcher examined responses given to interview questions as a main data source. It was also important to note that even though teachers were requested to prepare a plan for their second visits, they were asked during post interviews whether they would prepare a plan when it was not requested. They reported that they would surely prepare plans due to various reasons (e.g., making process monitoring and evaluation easy).

4.3.1. Case 1: Teacher A

During post-interview, the researcher requested Teacher A to compare two visits to METU SC with her students to understand whether she was aware of the changes between these visits. She stated as follows:

> Teacher A: I think there is so much difference between the our first trip and the second trip. Both me and my students did not know what we would experience on the first trip. I did not make any plan for the trip. More specifically, I did not know anything such as "How should I behave children?, At what points should I be involved?, What will the students see?, Are the activities appropriate for student level and our topic?". Similarly, I completely let the students free to explore science center by themselves and so they roamed around during the first trip. But the second was planned and more organized. Both me and my students knew the purpose of the trip and the activities and exhibits to see. Similar to the first trip, students explored science center by themselves, but not completely free, by following the path I had drawn or with a purpose. The greatest contribution of this PD program to me was to teach planning an entire science center visit from beginning to the end. So I developed a trip plan and students are explored again by themselves in accordance with this plan. In addition, since I was aware of the missing points in terms of student gains, I planned post-visit activities to remedy these deficiencies. Thus, I have combined both a lesson and a science center visit together so that my students can reach the relevant gains. Therefore, I can say with peace of mind that the first thing I applied and I received the results immediately after the PD program was efficient trip management. I mean… Planning and implementation of a curriculum integrated trip.

According to above explanations of Teacher A, it might be claimed that she was aware of the changes between the two trips' entire processes and these changes might be the result of the influences of the PD program on her. Correspondingly, curriculum connection, exchange of ideas, teaching techniques and methods, instructional plan and emphasis on communication were found as the characteristics of PD program influencing her instructional planning regarding science center visit through the lenses of Teacher A (see Table 4.17).

Table 4.17.
Teacher A's Views on the Characteristics of PD Program Influencing Her Instructional Planning regarding Science Center Visit

Codes	Evidence	Action
Curriculum connection	"The experts in the project team made a presentation about how to integrate a science center visit into science lessons."	"I purposefully used second visit to METU SC as a means of introducing electricity topic to my students."
Exchange of ideas	"While preparing an instructional plan for a successful science center visit, we as teachers discussed with explainers about what to do during visit (e.g., letting students focus on predetermined exhibits; giving students some choice and control in exhibits' exploration)."	"During free exploration time, I asked my students for selecting one exhibit that interests them to explore painstakingly and present them when we get back to school."
Teaching techniques	"We learned how to use POE technique and KWL chart for science center visits."	"I used KWL chart both before and after the field trip."
Teaching methods	"Different teaching methods as well as teaching techniques were emphasized during PD program."	"I adopted 5E instructional model in my instructional plan regarding our visit."
Emphasis on communication	"Experts emphasized the importance of communication with explainers of science centers during planning a field trip."	"I talked with the explainer to inform him about the purpose of visit and get more information about exhibits related to electricity topic."
Instructional plan	"We were provided with a sample instructional trip plan."	"I adopted the sample instructional trip plan in my own instructional plan."

4.3.2. Case 2: Teacher B

During post-interview, the researcher requested Teacher B to compare two visits to METU SC with her students to understand whether she was aware of the changes between these visits. She stated as follows:

> Teacher B: The biggest difference was that I had planned before, during and after parts of a science center visit, regarding my learnings in the PD program. Apart from that, I can not say that there was a very big difference. I did not know what will happen on the first trip, my students as well. However, for the second visit, I communicated with the explainer before we went to METU SC, while planning during visit program. Besides, I prepared my students

> regarding electricity visit. For instance, I made my students to try a tabletop version of Hand-Eye-Brain Coordination exhibit [a kind of simple electric circuit], which they will observe during visit. As it was before, our visit started with the explainer presentation and then the students freely explored around. We had post-visit activities for both visits. But in the second one, the focus of what we did was electricity topic.

According to above explanations of Teacher B, it might be claimed that she was aware of the changes between the two trips and these changes might be the result of the influences of the PD program on her. Correspondingly, tabletop exhibits, curriculum connection, instructional plan and emphasis on communication were found as the characteristics of PD program influencing her instructional planning regarding science center visit through the lenses of Teacher B (see Table 4.18).

Table 4.18
Teacher B's Views on the Characteristics of PD Program Influencing Her Instructional Planning regarding Science Center Visit

Codes	Evidence	Action
Tabletop exhibits	"We were introduced tabletop exhibits like 'Black box' during the hands-on and minds-on activities of PD program".	"I added a tabletop version of hand-eye-brain coordination exhibit as a pre-visit activity related to electricity topic into my instructional plan."
Curriculum connection	"We also learned that tabletop exhibits could be used to link science center visits with science lessons."	
Emphasis on communication	"Explainers emphasized during their presentations that if we communicate with them, they can better direct us about the planning of during visit activities."	"I communicated with the explainer of METU SC before our second visit. Thus, I was able to be aware of exhibits related to electricity and the inclusion of explainer's presentation."
Instructional plan	"The sample instructional trip plan presented to us in the PD program was very instructive."	"When preparing my instructional plan for the second visit to METU SC, I used mainly the outline of school's plan. However, I made some modifications in my plan like adding pre-, during-, and post-visit sections of the sample plan."

4.3.3. Case 3: Teacher C

During the post-interview, the researcher requested Teacher C to compare two visits to METU SC with her students to understand whether she was aware of the changes between these visits. She stated as follows:

> Teacher C: Conducting a trip before and after the PD program made it possible to notice the differences between them. During our first trip, I felt that something was missing, but I did not know what it was. However, I got the chance to question my deficiencies and learn how to overcome them throughout the PD program. The first thing to do was preparing good plan integrating science lessons into trip. I had not planned for the first trip, but I did it for the second one. For example, I talked with explainer before the trip about what we can do during science center visit. I also asked him for assistance for free time. Moreover, I did not give any information to my students about the topic of first visit before we go. But in the second one, I gave a brief theoretical information to them. Thus, my students were more conscious during the second visit. Similarly, my students roamed around during the first trip's free time but not in the second one. During second one's free time, I had grouped them and they explored three pre-determined exhibits as each group in turn. Besides, as taught in the PD program, I tried to guide my students through questioning technique so that they could find the right answer. In short, compared to the first trip, I can say that our second trip was more efficient in terms of student gains and my process management.

According to above explanations of Teacher C, it might be claimed that she was aware of the changes between the two trips and these changes might be the result of the influences of the professional development program on her. Correspondingly, exchange of ideas, instructional plan and emphasis on communication were found as the characteristics of professional development program influencing her instructional planning regarding science center visit through the lenses of Teacher C (see Table 4.19).

4.3.4. Summary

The results suggested that there were seven different characteristics of the PD program influencing teachers' instructional planning regarding science center visit, which were curriculum connection, exchange of ideas, instructional plan, teaching

Table 4.19
Teacher C's Views on the Characteristics of PD Program Influencing Her Instructional Planning regarding Science Center Visit

Codes	Evidence	Action
Exchange of ideas	"While working as a group, in which teachers and explainers brought together, various ideas regarding visitations were emerged like organizing students into groups, providing each group with exploring predetermined exhibit(s) or designing scavenger hunt activities."	"During our visit, I divided my students into three groups and each group examined three predetermined exhibits in turn."
Emphasis on communication	"The importance of communication with explainers was highlighted in PD program, especially for reviewing our expectations from each other."	"I booked the visit and then communicate with explainer demanding him to send me field trip program, photographs and explanations of exhibits related to electricity. Even I asked explainer whether he will assist me in explaining one of the exhibits called pedal generator during our visitation."
Instructional plan	"After scrutinizing a sample instructional plan, we worked together with explainers in groups for developing our own instructional plans towards a science center visit. Then, each group presented its plan to get feedbacks from other groups for improvement."	"While developing my own instructional plan, I benefited from what I already knew, what I learned and the sample plan presented in PD program. As a result, I adopted the titles of the sample plan in my own plan".

techniques and methods, tabletop exhibits and emphasis on communication. However, instructional plan and emphasis on communication were commonly reported ones by all teachers. Summary of teachers' views on the characteristics of PD program influencing their instructional planning regarding science center visit was listed in Table 4.20.

4.4. Summary of Teachers' All Results

In this section, all the results of the three teachers (Teacher A, B and C) will be summarized respectively. Accordingly, providing field trips to METU SC and Feza Gürsey SC and communication with their explainers in the PD program contributed to Teacher A's awareness about well-known science centers in Ankara.

Table 4.20
Summary of Teachers' Views on the Characteristics of PD Program Influencing Their Instructional Planning regarding Science Center Visit

Codes	Teacher A	Teacher B	Teacher C
Curriculum connection	√	√	
Exchange of ideas	√		√
Instructional plan	√	√	√
Emphasis on communication	√	√	√
Teaching techniques	√		
Teaching methods	√		
Tabletop exhibits		√	

More specifically, she had more information about the Feza Gürsey SC than before and was aware of the differences between METU SC and Feza Gürsey SC after participating in the PD program. Moreover, it was found that presentations of explainers from different science centers in the PD program contributed Teacher A's awareness about science centers in Turkey, science centers' resources and utilization from these resources. That is, she was able to talk about science centers in Turkey including their resources and count planetarium and brochures in addition to exhibits as science center resources after participating in the PD program. Similarly, the findings indicated that she was influenced by the idea of utilization from tabletop exhibits [which were introduced during the PD program] integrating science center resources into the science lessons in addition to her inspiration from the science center activities for her science teaching before. Regarding teachers' ways of conducting field trip to METU SC, some changes in Teacher A's pre-, during-, and post-visit strategies regarding her two field trips to METU SC were revealed through the lenses of the researcher. For instance, while she only used site familiarization and general things to do as pre-visit strategies on her first organized trip, she extended her pre-visit strategies on her second organized trip by adding new ones such as supervision coordination, instructional planning, content and procedure familiarization. Similarly, while she only used event documentation and unstructured strategies during her first organized trip, she utilized from her instructional plan, supervision and structured strategies as well during her second organized trip. Furthermore, it was found that Teacher A did not prepare an instructional plan for her first trip without

being requested. Even though Teacher A was requested to prepare a plan for her second trip, she was asked during post interviews whether she would prepare a plan when it was not requested. She reported that she would surely prepare plan due to various reasons (e.g., making process monitoring and evaluation easy). Moreover, when asked Teacher A during post-interview to compare these two visits to METU SC, she reported some changes in trips' entire processes in a positive way. Regarding Teacher A's views on the characteristics of PD program influencing her instructional planning regarding science center visit, curriculum connection, exchange of ideas, teaching techniques and methods, instructional plan and emphasis on communication were found as the influential characteristics of PD program.

Regarding Teacher B, providing field trip to Feza Gürsey SC in the PD program and METU SC visit in the current study contributed to her awareness about well-known science centers in Ankara. More specifically, she had some additional knowledge about METU SC (e.g, theme-specific presentations, workshop on worms) and about Feza Gürsey SC (e.g., static electricity demonstration). Moreover, it was found that presentations of explainers from different science centers in the PD program contributed Teacher B's awareness about science centers in Turkey, science centers' resources and utilization from these resources. That is, she was able to talk about science centers in Turkey including their resources and count brochures, theme-based tours, and exhibitions in addition to exhibits and planetariums as science center resources after participating in the PD program. Besides, she gained the idea of participating in workhops in science centers as a part of science center visit. Regarding teachers' ways of conducting field trip to METU SC, some changes in Teacher B's pre-, during-, and post-visit strategies regarding her two field trips to METU SC were revealed through the lenses of the researcher. For instance, while she only used site familiarization, behavior clarification, and general things to do as pre-visit strategies on her first organized trip, she extended her pre-visit strategies on her second organized trip by adding new ones such as instructional planning, content and procedure familiarization. Similarly, while she only used event documentation, supervision and unstructured strategies during her first organized trip, she utilized from her instructional plan, and structured strategies as well during her second

organized trip. Besides, Teacher B used the review and discussion strategy in addition to the documentation strategy after the second trip. Furthermore, it was found that Teacher B did not prepare an instructional plan for her first trip without being requested. Even though Teacher B was requested to prepare a plan for her second trip, she was asked during post interviews whether she would prepare a plan when it was not requested. She reported that she would surely prepare plan by stating the following explanation: "I realized during the activities in the program that although science centers filled with so many exhibits which were able to meet the objectives of science teaching, we, being teachers, could not benefit from it properly". Moreover, when asked Teacher B during post-interview to compare these two visits to METU SC, she reported some positive changes in trips' entire processes like making a plan. Regarding Teacher B's views on the characteristics of PD program influencing her instructional planning regarding science center visit, tabletop exhibits, curriculum connection, instructional plan and emphasis on communication were found as the influential characteristics of PD program.

Regarding Teacher C, providing field to Feza Gürsey SC and communication with its explainers in the PD program contributed to her awareness about well-known science center in Ankara. More specifically, she gained knowledge about Feza Gürsey SC and was aware of the differences between METU SC and Feza Gürsey SC after participating in the PD program. Moreover, it was found that presentations of explainers from different science centers in the PD program contributed Teacher C's awareness about science centers in Turkey and science centers' resources. That is, she was able to talk about science centers in Turkey including their resources and count workshops, brochures and planning guides for teachers in addition to exhibits and explainers as science center resources after participating in the PD program. Similarly, the findings indicated that she was influenced by the idea of utilization from tabletop exhibits [which were introduced during the PD program] integrating science center resources into the science lessons in addition to her inspiration from the science center activities for her science teaching before. Regarding teachers' ways of conducting field trip to METU SC, some changes in Teacher C's pre-, during-, and post-visit strategies regarding her two field trips to METU SC were revealed

through the lenses of the researcher. For instance, while she only used site familiarization, supervision coordination, and general things to do as pre-visit strategies on her first organized trip, she extended her pre-visit strategies on her second organized trip by adding new ones such as behavior clarification, instructional planning, content and procedure familiarization. Similarly, while she only used event documentation and unstructured strategies during her first organized trip, she utilized from her instructional plan, supervision and structured strategies as well during her second organized trip. Furthermore, it was found that Teacher C did not prepare an instructional plan for her first trip without being requested. Even though Teacher C was requested to prepare a plan for her second trip, she was asked during post interviews whether she would prepare a plan when it was not requested. She reported that she would surely prepare plan due to various reason (e.g., It is useful to have something written to remember "to do list" or to notice and complete missing points.). Moreover, when asked Teacher C during post-interview to compare these two visits to METU SC, she reported some positive changes in trips' entire processes such as making a good plan, being efficient in terms of students' gains and her process management. Regarding Teacher C's views on the characteristics of PD program influencing her instructional planning regarding science center visit, exchange of ideas, instructional plan and emphasis on communication were found as the influential characteristics of PD program.

CHAPTER 5

DISCUSSION, IMPLICATION, AND RECOMMENDATION

This chapter includes the conclusions and discussions of the findings of the current study, implications of the study and some recommendations for future studies.

5.1. Conclusions and Discussions of the Results

In this part, the results of this study were compared and contrasted with other studies in the literature. Moreover, each discussion of the results was represented under different headings as the influence of the PD program on teachers' awareness about science centers and their resources and as the influence of the PD program on teachers' way of conducting field trip to a science center.

5.1.1. The influence of the PD program on teachers' awareness about science centers and their resources

In the literature, logistic problems, lack of support from school administration and colleagues, lack of personal motivation, and unavailability of resources were depicted as the potential barriers behind the underutilization of informal learning environments like science centers by school groups (Michie, 1998; Şentürk, 2015). However, what if teachers were unaware about science centers and their resources? Or, what if they do not have detailed knowledge about them? From this point of view, teachers' awareness about science centers and their resources was tried to be increased throughout the PD program in the current study.

There is a limited number of research about the effects of professional development programs related to informal learning settings on teachers' awareness about these settings (Chin, 2004; Faria et al., 2012; Melber & Cox-Peterson, 2005; Ogbomo,

2010). In fact, these studies did not directly focus on the awareness issue, but they examined teachers' awareness in addition to other variables such as planning effective field trips, integration of these trips with classroom instruction, etc. In recognition of limited literature that exist, this study extended the related literature about the increase in science teachers' awareness of science centers in Ankara and Turkey as a result of participating in the PD program. More specifically, all teachers in this study knew more than anything about well-known science centers in Ankara before the PD program by means of their education years at METU, childhood field trip memories about Feza Gürsey SC and their first-organized visit to METU SC for this study. On the other hand, teachers were more aware of the well-known science centers in Ankara thanks to adopting collaborative team approach (bringing teachers, explainers, and academicians together) offered by Duran et al. (2010) and conducting science center field trips to explore and examine (as in the studies of Chin, 2004; Duran et al., 2010; Melber & Cox-Peterson, 2005; Ogbomo, 2010) during the PD program. To explain, during field trips to METU SC and Feza Gürsey SC in the PD program, about one-hour free time was given to participants before giving detailed information about the science centers and their resources by the explainers so that they could thoroughly examine science centers. In this way, teachers were able to explore and examine these science centers in detail with their colleagues, explainers and academicians together as well as get more detailed information about activities conducted there from the explainers of these science centers. As a result, teachers built augmented knowledge about them. For instance, two teachers pointed out the differences between METU SC and Feza Gürsey SC during interview session. They said that Feza Gürsey SC had more rich content in the field of biology than METU SC. This result led the researcher to conclude that being aware of the differences between science centers or making comparison of the science centers including resources might help teachers making a proper trip venue choice to maximize their students' gains. Regarding awareness about science centers in Turkey (out of Ankara), two teachers had no idea about them before the PD program. During interview session after the PD program, all of the teachers were able to talk about seven different science centers in Turkey whose explainers participated in the same PD program. More specificially, teachers generally mentioned about what they learnt

from the presentations of explainers of these science centers such as having similar exhibits, organizing science festivals and special workshops for special days (e.g., Mother's Day), etc. Since teachers admitted during post-interviews that they had done no individual research about science centers in Turkey (out of Ankara), presentations of science center explainers could be accepted as their sources of knowledge gain. It was important to note that this was not just an ordinary powerpoint presentation of the explainers, in which teachers just sit back and listen. This was an interactive presentation, in which teachers actively participated in by means of asking questions to the explainers, discussing with each other and the explainers about science centers and their resources. Moreover, as suggested by Fallik, Rosenfeld and Eylon (2013), designing the basis for interaction and cooperation between teachers and explainers throughout the PD program may also have contributed to teachers' acquisition of information about these science centers. Besides, the results indicated that the field trips to science centers and communication with their explainers were so prominent regarding teachers' awareness about science centers in Ankara, while explainer's presentations were so prominent regarding teachers' awareness about science centers in Turkey (out of Ankara). Considering this indication, it could be claimed that teachers might prefer field trips to get information about science centers, which were reachable distance away. Furthermore, Melber (2007) stated that "instruction on how to take scientific notes related to an unknown specimen can be done in any setting – museum or school. Demonstrating effective use of exhibits, visits to a working curatorial lab, or displaying the items available for loan from a local museum cannot" (p.40). Therefore, if teachers' awareness about science centers and their resources are desired to be promoted, field trips to science centers should be organized in PD programs. If science centers are not reachable distance away, at least teachers and science centers' explainers of should be brought together.

Awareness about science centers and their resources can be considered as an inseparable pair. Regarding awareness about science center resources, the teachers were aware of exhibits, explainers, and planetariums as the resources before the PD program. On the other hand, they built augmented knowledge of science center resources as results of explainers' presentations and field trips to well-known science

centers in Ankara (i.e., METU SC and Feza Gürsey SC) in the PD program. These findings supported the conclusions of Ogbomo (2010) who found that teachers built augmented knowledge of resources available to them as a result of participating in museum/science center workshops, including presentations about introduction of activities, a typical visit and a guided tour. Similarly, critical analysis of exhibits with science center educators (Melber & Cox-Peterson, 2005) and specially arranged visits guided by instructors (Chin, 2004) were found to be useful to increase teachers' knowledge about the museums and their resources. On the other hand, Melber and Cox-Peterson (2005) put forward that teachers could make better decisions about their science teaching if they promote their understanding of available museum resources. Regarding awareness about utilization from science center resources, all of the teachers thought that using science centers resources would be useful for their science teaching somehow both before and after participating in the PD program. Before participating in the PD program, they stated that they inspired from science center activities for their science teaching and saw science center visits as effective learning opportunities for their students. On the other hand, after the PD program, two teachers stated that they were influenced by the idea of benefit from tabletop exhibits (introduced during PD program) while integrating them as science center resources into their science lessons. Also, one teacher reported that she realized via explainer's presentation that she can not only explore the exhibits of science centers but also participate in workshops conducted in science centers. These findings may imply that the PD program seems to help teachers adjust their previous teaching schema and use new ways (e.g., integration of science center resources, utilization from tabletop exhibits, etc.) to enhance their science teaching, as claimed by Chin (2004). After all, it might be claimed that if teachers have enough knowledge about science center resources, they could use them in their lessons consciously and decide what and how to use them in their instructional plans regarding science center visit (Melber & Cox-Peterson, 2005). Besides, the results indicated that the explainer's presentation was so prominent regarding teachers' awareness about science centers' resources and utilization from them. Considering this, it could be claimed that teachers might prefer to get information about utilization from science centers' resources and about these resources from the explainers. As a matter of fact,

explainers are generally considered as the most knowledgeable person according to visitors including teachers and students (Gomes da Costa, 2005; Rodari & Xanthoudaki, 2005). Therefore, it may be good to bring teachers and science centers' explainers together in PD programs. Eventually, this study added to the professional development literature in science education because it highlighted the value of integrating science center resources with science classroom practices by raising teachers' awareness about this issue.

To sum up, introduction of science centers both through explainers' presentations and field trips to some of them, communication with explainers, and presenting tabletop exhibits during the PD program have contributed to teachers' awareness about science centers, their resources and educational potentials. However, the common influential factors reported by teachers on their awareness (i.e., science centers in Ankara and Turkey, science center resources and utilization from them) were respectively the explainers' presentations and field trips to science centers in the PD program. The reason why explainers' presentations are so prominent may be due to the nature of the research and interview questions. That is, the nature of research and interview questions based on measuring what and how much teachers know about science centers and their resources. It could be thought that teachers can get information about a science center either by visiting or browsing its web site or science center's explainer or someone who really knows about it. Nonetheless, it was seen that getting information from knowledgeable people (explainers) who actually work in a science center could provide teachers with an extra motivation, which might have had an influence on teachers' awareness of these issues. On the other hand, same gains in teachers' awareness of these issues might not have obtained if some of instructors in the project team of the PD program had informed teachers about science centers and their resources. Put differently, getting information from knowledgeable people (explainers) who actually work in a science center may have given teachers positive emotions that play role in motivation and learning (e.g., enjoyment, arousal and interest), as asserted by Fallik et al. (2013) and Pintrich and Schunk (2002). In a similar approach, Pintrich and Schunk (2002) indicated that the use of interesting presentations, task, texts, and the so on, are more likely to result in generation of and

increased situational interest, which is "the psychological state of being interested in the task or activity" (Pintrich & Schunk, 2002, p.291). In the current study, authentic experiences through field trips to well-known science centers in Ankara and interactive presentations of explainers –seen as most knowledgeable people by visitors- might result in the teachers' generation of and/or increased situational interest and so, their knowledge about science centers. Therefore, the results suggested that explainer's presentations and field trips were important and necessary in the PD programs related to science centers to influence participants' awareness of these issues.

5.1.2. The influence of the PD program on teachers' way of conducting field trip to a science center

In this part, the researcher discussed the influence of the PD program on teachers' way of conducting a field trip to a science center under two perspectives, which were the change in teachers' strategies conducting science center visit through the lenses of the researcher and the characteristics of the PD program influencing teachers' instructional planning regarding science center visits through their lenses.

In the literature, studies related to school field trips generally focused on the identification of teacher's field trip strategies (Kisiel, 2003a) and revealing various suggestions for their pre-visit preparation, during-visit roles and/or post-visit activities (Anderson & Lucas, 1997; Anderson et al., 2000; Behrendt & Franklin, 2014; Şentürk, 2015). However, there was no study in the literature which reveals the change in or improvement of these strategies of teachers as a results of an intervention such as professional development programs, in-service training, and summer school programs, etc. Therefore, the current study extended the related literature by revealing the changes in teachers' strategies for conducting science center visit as a result of participating in a professional development program. Identifying the changes in teachers' strategies in a science center setting as a result of a PD program, it might become easier for educators of science center and science teachers to help teachers

improve particular strategies to maximize their students' field trip learning experiences.

The change in teachers' strategies for conducting science center visit were examined under three parts, as identified in the study of Kisiel (2003a), which were pre-visit, during-visit, and post-visit strategies. Before the PD program, the commonly reported pre-visit strategies included *site familiarization* and *general things to do*. We could make two assumptions about the reasons of why the teachers mostly preferred these two strategies. First of all, teachers might not really know to support class work with science center visit, as mentioned in the literature (Behrendt & Franklin, 2014; Kisiel, 2006). Secondly, they might not see the science center visit as a part of a classroom unit, unlike in Kisiel's study (2003a). In his study, teachers (48%) mostly cited content familiarization strategy and this finding was interpreted as seeing museum visit as a culminating part of a classroom unit. On the other hand, in the current study teachers' report after PD program indicated that *instructional planning, content and procedure familiarization* in addition to *general things to do* were common pre-visit strategies. (Refer Table 4.14 in Chapter 4 for a summary list of pre-visit strategies found in this study). It could be implied that this result indicated the validity of our first assumption. That is, teachers in the current study might not know how to integrate their visit into their class work previously. As a matter of fact, the following quote from Teacher A's response to the one of the interview questions could be presented to validate this assumption:

> ...I did not know anything [about first visit to METU SC with her students] such as 'How I should behave children?, At what points should I be involved?, What will the students see?, Are the activities appropriate for student level and our topic?'...

Participating in the PD program may have enabled them to take advantage of these strategies on their second trip. Put differently, some characteristics of the PD program, which were *curriculum connection, tabletop exhibits* and *emphasis on communication [i.e., special attention to communication with explainers before SC visit or during planning a SC visit]*, seemed to have an influence on teachers' content and procedure familiarization strategies, respectively. For instance, one of the

teachers used a tabletop version of hand-eye-brain coordination exhibit before visit [coded as content familiarization] since she learned in the PD program that tabletop exhibits can be used to link science center visits with science lessons. Similarly, all of the teachers communicated with the explainer of the METU SC before their visit to become familiar with what will happen on the trip [coded as procedure familiarization] and "emphasis on communication with explainers during planning a field trip in the PD program" was found as reason of this action. Likewise, this finding supported the suggestion of Kisiel (2006) who stated that if teachers were informed about the configuration of museum halls by museum staff, they can better prepare their students for museum experience. Moreover, as put forward by Fallik et al. (2013), mutual recognition of informal and formal curricula (e.g., purposes of the educational programmes) by both teachers and explainers might lead them to collaboratively plan beneficial learning experiences. On the other hand, PD program's sessions about learning and preparing an instructional plan regarding science center visit might be helpful in the instructional planning strategies of teachers, as in the study of Chin (2004). Teachers of the current study stated that they utilized from the sample instructional plan, which was presented in the PD program, while preparing their own plans.

Regarding during-visit strategies, the commonly reported ones included *unstructured student engagement strategies (e.g., free exploration, interpretation)* and *event documentation* before the PD program. On the other hand, teachers' report after PD program indicated that *structured student engagement strategies (e.g., information receiving activities), following instructional plan* in addition to *event documentation* and *unstructured student engagement strategies (e.g., free exploration)* were common during-visit strategies. (Refer Table 4.15 in Chapter 4 for a summary list of during-visit strategies found in this study). Although some changes in teachers' unstructured strategies were detected individually, some of these changes were not. That is to say, while one teacher utilized from interpretation and free exploration strategy during her first visit to METU SC, she used connecting and free exploration strategy during her second visit. About these changes, it is hard to directly talk about the influence of the PD program since unstructured strategies are spontanous, based

on what particular situations dictates, and less dependent on particular preparation before visit, as claimed by Kisiel (2003a). In the current study, the identified changes in teachers' unstructured strategies might be due to various reasons such as students' grade level, teachers' approach to particular situations, grouping students during free exploration time, etc. On the other side, the use of event documentation strategy both before and after PD program might be accepted as exclusive strategy to visits to informal learning settings, as in the other studies (Kisiel, 2003a; Şentürk, 2015) since teachers generally took photos to document their visit experience. During their first visit to METU SC, all teachers took the advantage of free exploration time, which was a part of typical visit process at METU SC, since teachers were unprepared and let students to roam. On the other hand, teachers again took the advantage of free exploration time during their second visit, but this time they did it both in a structured and unstructured way. That is, teachers again permitted their students roaming for a while but they wanted them to fulfill some duties like making detailed observation of topic-specific exhibits to prepare their post-visit presentations before roaming. This finding may be an indication of that teachers have learned how to utilize from free exploration time efficiently in the PD program. Put differently, one of the characteristics of the PD program, which is *exchange of ideas*, seemed to have an influence on two teachers' utilization from free exploration time efficiently. The following quote from Teacher A's responses could be shown as an example for this: "*During free exploration time, I asked my students for selecting one exhibit that interests them to explore painstakingly and present them when we get back to school*" [coded as information seeking activity - Structured Student Engagement Strategy –]. She put forward "exchange of ideas with her colleagues and explainers in the PD program about what to do during visit while preparing an instructional plan as a group for a successful visit" as reason of this action. It was also found that teachers did not use structured students engagement strategies during their first visits to METU SC and this may be due to the fact that they did not know how to organize and conduct a planned (structured) visit before the PD program. Likewise, most of the studies reported that teachers (Michie, 1998; Tal & Morag, 2009) or preservice teachers (Kisiel, 2006; Tal, 2004) do not have sufficient pedagogical knowledge and trainings considering field trip planning and preparation or strategies towards how to benefit

from field trip as an informal learning resource (Griffin & Symington, 1997). However, they used some structured student engagement strategies (e.g., making students participate in predetermined stationary presentation, making students take notes about exhibits related to electricity) during second visit after the PD program. This finding may be resulted from general information about effective strategies used in the informal settings presented in the PD program (Chin, 2004), lowering novelty space of teachers by enabling them in the PD program to experience activities that characterize both the school and science center (Fallik et al., 2013) or teachers' experiences during their first visitations to science center. As claimed by Kisiel (2003a), "every teacher comes from a different set of circumstances [e.g., personal experiences, expectations] that shape the school field trip..." (p.210). The following quote from Teacher C's responses could be shown as an example for this:

> During our first trip, I felt that something was missing... my students roamed around... I can not control my students... However, I got the chance to question my deficiencies and learn how to overcome them throughout the PD program. The first thing to do was preparing good plan...

Therefore, it was claimed that if teachers are informed about strategies that can be used in field trips or are exposed to field trip experiences, they are more likely to use the strategies during their subsequent visits.

Regarding post-visit strategies, *review and discussion* strategy was commonly reported by teachers before the PD program. On the other hand, teachers' report after PD program indicated that *documentation* in addition to *review and discussion* were common post-visit strategies. (Refer Table 4.16 in Chapter 4 for a summary list of post-visit strategies found in this study). It seemed that teachers typically conducted post-visit activity in the form of review and discussion. This "unstructured wrap-up" (Kisiel, 2003a, p. 187) might be seen as an easy way to review students' fieldtrip experience. On the other hand, after their second visit to METU SC, teachers extended the post-visit review and discussion into additional activities such as using electrical test circuits [coded as other post-visit activities], writing or drawing, and making a pano of students' work [coded as documentation]. Participating in the PD program may have enabled them to extend their post-visit activities in this direction.

That is to say, during the PD program, teachers were advised of a variety of strategies except formal assessment strategies that could be used after the trip such as completing KWL chart, utilization from tabletop exhibits, writing composition and the like.

Up to the graduation of these teachers, no existence of pre-service teacher education programs in Turkey towards informal learning settings given by either these settings or universities might be the reason behind the use of more general and unstructured strategies in their first visit to METU SC. In a few universities (e.g., Gazi University and Hacettepe University), courses on this subject have more recently begun to be offered. Similarly, Tal et al. (2005) held professional development programs offered by museums responsible as the reasons of teachers' uninvolved role in visit plan since these programs center on informing teachers about museums and their resources, and not on teachers' pedagogies about how to conduct a successful visit. However, in the current study, teachers' strategies for organizing and conducting science center visit has diversified in an extended manner after participating in the PD program. It might be claimed that the reason of this improvement was the PD program, which includes not only actual visits to science centers to inform teachers about them and their resources, but also activities focusing on teachers' and explainers' pedagogies about how to conduct a successful visit that bridge the gap between school and science center, as suggested by Fallik et al. (2013). As a result, all of these might induce a positive influence on teachers' volition, which is defined as "the process of translating intentions into actions" (Pintrich & Schunk, 2002, p. 21), regarding their field trip strategies. Moreover, this is not to say that all teachers, who participated in this PD program, will use these strategies or will change their strategies in these directions. Even in the current study, changes in teachers' strategies differed from each other although they organized and conducted the visit related to same topic (i.e., electricity) and to the same science center. The reason behind this might be due to various other reasons such as difference in students' grade level, type of school, teaching experiences of teachers, etc. Eventually, teachers are the key decision makers for a group of students in the case of field trips (Kisiel, 2003a; Şentürk, 2015).

Moreover, the teachers in the current study pointed out the following characteristics of the PD program influencing their instructional planning with regard to their second visit to METU SC: (1) curriculum connection, (2) exchange of ideas, (3) instructional plan, (4) teaching techniques, (5) teaching methods, (6) tabletop exhibits, and (7) emphasis on communication. However, instructional plan and emphasis on communication were commonly reported ones by all teachers. These results were somehow consistent with findings of limited past research. For instance, at the end of the museum-focused professional development course, Chin (2004) put forward that getting feedback from their peers and reviewing the instructional plans developed by other groups help preservice teachers to refine their own instructional plans. A similar finding was also reported by one of the teachers in the current study: "*after scrutinizing a sample instructional plan, we worked together with explainers in groups for developing our own instructional plans towards a science center visit. Then, each group presented its plan to get feedbacks from other groups for improvement*" and "*While developing my own instructional plan, I benefited from…what I learned and the sample plan in the PD program…*". Unlike from the study of Chin (2004), all of the teachers also mentioned about the sample instructional plan, which had been presented them in the PD program, as an inspirational material for their instructional plan regarding their second visit to METU SC. This result indicated the importance and necessity of presenting a sample instructional plan regarding science center visits in the PD programs related to science centers. On the other hand, Chin (2004) also found that specially arranged science museum visit guided by instructor and several self-visits to science museum increased preservice teachers' in-depth knowledge about museum and its resources and subsequently contributed their ability to integrate science museum resources into their school science plans. In the current study, specially arranged field trips to well-known science centers in Ankara (METU SC and Feza Gürsey SC) were not shown by teachers as an influential factor on their instructional planning. We could make three assumptions about the reasons of why the teachers did not report the specially arranged field trips in the PD program. The first one might be that they conducted a visit to METU SC before the PD program and so they already knew the setting. The second one might be that teachers did not organize and conduct their second visit to

Feza Gürsey SC. That is to say, if they conducted their second visit to there and made an instructional plan for this, then specially arranged field trips in the PD might be shown as an influential factor on their instructional planning. The last one might be that they communicated with the explainer of METU SC before developing instructional plan regarding their second visit to METU SC. In other words, the "emphasis on communication" characteristic of the PD program may be more dominant since it was highlighted in the PD program that teachers' communication with explainers for reviewing their expectations from each other was necessary while planning a science center visit. Thus, specially arranged field trips in the PD program may not have an influence on the instructional plans of the teachers. On the other hand, the "exchange of ideas" characteristic of the PD program might be seen as similar to "the development of learning communities" among teachers and explainers, which is one of the principles of the effective professional development related to education issues. The development of learning communities among teachers and explainers involves sharing of knowledge among each other and collaboration in their learning (Darling-Hammond & McLaughlin, 1995; Loucks-Horsley et al., 1998). Likewise, not only while preparing an instructional plan for a successful science center visit in the PD program, teachers and explainers worked as a group and got a chance to share their knowledge, experience and ideas each other, but also they had this chance in all three days of activities during the PD program. Although Loucks-Horsley and Matsumoto (1999) articulated that teachers do not have chance to establish relations with their colleagues by studying closely together during professional development programs with one-time sessions, the fact that the exchange of ideas is so prominent might be an indication that this can be achieved in this three-day PD program. Apart from that, teachers in the study of Ogbomo (2010) found museum/science center workshops useful since these workshops provided resources and materials aligned to state goals. Based on these finding, Ogbomo (2010) claimed that this would encourage teachers to implement their learnings from the program which were already linked to their curriculum since it facilitated teacher's instructional practices. In line with the Ogbomo (2010), in the reports of two teachers, the PD program's "curriculum connection" characteristic was also found influential on their instructional planning regarding science center visit. Even, one of the

teachers utilized from tabletop exhibits (which were presented in and another characteristics of the PD program) integrating science center visit into her science lesson. Thus, the results also suggested that curriculum connection was important and neccessary in the PD programs, especially related to science centers to influence participants' instructional planning. It was also important to note that the results of the current study showed only three science teachers' views on the characteristics of the PD program influencing their instructional planning regarding science center visit. If more teachers were studied, or if teachers with different background or from different disciplines were studied, other different characteristics of the PD program might be found.

According to one of the characteristics of effective learning experiences for teachers, called as assessment-centered, teachers should be helped to reflect about what they learnt and how to apply what they learnt (Loucks-Horsley & Matsumoto, 1999). Correspondingly, the current study gave teachers opportunity to monitor themselves about what they learnt and their own improvement in organizing and conducting field trips to a science center. In other words, the teachers had a trip experience before the PD program, saw their deficiencies, learnt about them in the PD program and then applied their learning through a second visit.

All in all, it might be claimed that this study adds to research on the PD program's influence on teachers' instructional planning regarding science center visit by the characteristics mentioned above. However, it should be noted that each case related to teacher learning necessitate a unique design combining effective professional development elements in various ways (Loucks-Horsley et al., 1998).

5.2. Implications of the Study

In the lights of the obtained results and discussed points, this study has several implications for pre-service and in-service teacher education, science teacher educators, science centers and similar settings, PD program developers and Ministry of National Education (MoNE).

This study extended the related literature about the increase in science teachers' awareness about science centers as a result of participating in the PD program. By introducing science centers both through explainers' presentations and actual visits, and presenting tabletop versions of some exhibits during the PD program, this study contributed to teacher's awareness about science centers, their resources and educational potentials. In other words, this study exemplified the importance of authentic experiences to increase the awareness of both pre-service teachers and in-service teachers. This led to the idea of conducting professional development programs regarding out-of-school environments in informal settings (e.g., science centers, science museums, planetariums, zoos, aquarium) rather than in a seminar room, or in classrooms. In this regard, science teacher educators may utilize from a science center setting and/or actual visits to them in their teaching method courses to make pre-service teachers aware of educational resources within science centers. Alternatively, these educators may also conduct actual visits to not only science centers but also other informal settings to raise pre-service teachers' awareness about the resources and educational potentials of these settings. Similarly, as for in-service teacher education, PD program developers might consider organizing actual visits to science centers to help teachers built augmented knowledge of resources available to them. More specifically, even if there is no informal learning setting in the province/district where teachers work, PD programs should include actual visits to these settings. During these visits, the teacher would learn a different types of resources that settings have like a virtual tour. Thus, maybe s/he would benefit from this virtual tour in her classes even if s/he couldn't take her students to that setting. Moreover, if conducting actual visits is not possible, explainers from science centers/similar settings and teachers might be brought together to promote teachers' awareness about science centers and their resources. Thus, both pre- and in-service teachers will be more aware of making a proper venue choice for their trip comparing the resources of science centers to maximize students' gains.

On the other hand, this study exemplifies how a purposeful science center visit aligned with school science curriculum could be conducted through identifying the changes in teachers' strategies after participating in the PD program. With that, it

becomes easier for educators of science center and science teacher to help teachers improve particular strategies to maximize their students' field trip learning experiences. In other words, science centers and similar settings, teacher educators and indirectly school administrations might consider how they would better support teachers' strategies used in these kind of visits.

The results also indicated that teachers gave importance to the cooperation between science center's explainers and them regarding exchange of ideas and communication, especially while developing instructional plan related to science center visit. For that reason, if possible, units that provide a one-to-one answer to the questions and requests of teachers can be established in the science centers. If this is not possible, science centers might develop a teacher guide including an expectation list from a visit and teachers, procedures to be followed before and during visit, suggested activities to be used pre-, during- and post-visit, and detailed information about science center's activities and programs – referring to the connection between the exhibits, activities and school curriculum objectives. Separately, explainers of science centers can work with teachers to develop pre-, during-, and post-visit activities (e.g., worksheet, workshop… etc.) that enhance students' gains. Moreover, science centers may sign a protocol with MoNE so that this institution may inform schools about the guide with an official written statement. Thus, teachers will be informed about it and their instructional planning including science center visit will be facilitated regarding their workload at school. Besides, all of the teachers also mentioned about the sample instructional plan, which had been presented them in the PD program, as an inspirational material for their instructional plan regarding their second visit to METU SC. This result indicated the importance and necessity of presenting a sample instructional plan regarding science center visits in the PD programs related to science centers.

Additionally, this PD program serves as valuable characteristics (e.g., providing sample instructional plan, curriculum connection, and emphasis on communication with explainers) for influencing teachers' instructional planning regarding science center visits that can be adopted and contextualized to meet teachers' instructional

needs on this issue by other teacher educators, PD program developers and MoNE. As a matter of fact, the importance given to informal learning environments such as science centers in our country has been increasing day by day. For instance, the informal learning environments (e.g., school gardens, science centers, museums, zoo etc.) have been highlighted in the adopted strategies and methods by MoNE's science curriculum in 2018 (MEB, 2018). Similarly, at the 23rd meeting of the High Council of Science and Technology, it was decided to carry out the studies for the establishment of science centers in all metropolitan cities as of the year 2016 and in all provinces in 2023 in cooperation with local administrations (Çolakoğlu, 2017). At a time when the establishment of science centers in all provinces in Turkey was completed and when these science centers across the country fight to stay open, professional development programs like in the current study might be more significant than ever before to bridge resource gap between informal and formal learning settings – as claimed in the study of Duran et al. (2010). Therefore, similar PD programs might be organized with MoNE partnership on a large scale or offered as in-service training to our teachers within MoNE. More specifically, experienced and qualified teachers can be trained in this field (e.g., internship program conducted at science centers with MoNE partnership for pre-service teachers) by increasing their awareness of science centers and resources, providing the necessary and sample instructional plans for them to benefit from science centers efficiently and teaching them how to do the planning regarding science center visits through this kind of PD programs. Subsequently, these teachers might help to create harmonious learning contexts between schools and informal learning environments like science centers and accommodate the influx of school groups' visitation to the science centers. For instance, teachers, being aware of the science center resources, may design on-site activities integrating field trip experience with school curriculum in many complementary ways. Similarly, these qualified teachers will take this experience back to their schools, becoming reflective practitioners. That is to say, we reached three science teachers in the current study and these three teachers might reach many other teachers in their schools and so they might help the other teachers change in their way of conducting field trips and their field trip frequencies to the science centers.

5.3. Recommendations of the Study

Based on my experiences throughout the current study and the related literature, the following recommendations for future science education research and researchers were suggested:

- A complementary study examining the effects of professional development programs on teachers' field trip strategies and subsequent student outcomes might be useful in identifying which characteristics of the program are more likely to affect teachers' strategies and their subsequent results on students' learning.
- For this study, only three science teachers were examined. However, their characteristics are not similar to whole other science teachers. Similarly, they are not the only teachers to conduct science center visits. Therefore, this study might be a starting point of other studies of other teachers.
- Since each science center settings have particular resources and particular implementation of field trips, teacher strategies might be different from one to another science center. Therefore, studies investigating different science centers having different resources and field trip implementations to determine whether the change in teacher strategies after participating a PD program are completely different or have a lot in common are necessary.
- Similar professional development programs might be offered as in-service training to our teachers within the Ministry of National Education. In addition to this, large scale PD programs can be organized with MoNE partnership.
- Regular reexamination of teachers' fieldtrip strategies is necessary to keep up with the needs of teachers, especially while developing professional development programs.
- Since teachers' pre- and post-visit activities were not observed in the current study, observations of teachers' implementations of pre- and post-visit activities in the classroom environment (if possible) were suggested

for future researchers. Besides, classroom observations of teachers coupled with interviews might further reveal how field trip strategies are enacted in the classroom.

- Studies investigating the effect of PD program on teachers' self-efficacy beliefs related to conducting field trips might be useful in identifying which characteristics of the program are more likely to affect their self-efficacy beliefs. Besides, to assess whether or not these teachers' self-efficacy beliefs sustained over time, follow-up studies would be valuable.

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APPENDICES

A. INSTRUMENTS

ÖĞRETMEN GÖRÜŞME FORMLARI

Ön Söz

Merhaba, adım Semra Tahancalıo. Orta Doğu Teknik Üniversitesi İlköğretim Bölümü Fen Bilgisi Öğretmenliği alanında Doktora öğrencisiyim ve aynı zamanda ODTÜ Toplum ve Bilim Uygulama ve Araştırma Merkezi'nde araştırma görevlisi olarak çalışmaktayım. Daha önce de söylediğim gibi, bilim merkezleri konusunda gerçekleştirilecek mesleki gelişim programına katılacak fen bilgisi öğretmenlerinin bazıları ile bu görüşmeleri yapıyorum. Bu görüşmelerden elde edilecek bilgiler, araştırmacıları, fen bilgisi öğretmenlerini ve Milli Eğitim Bakanlığını bilgilendirmek için kullanılacaktır. Katkılarınız için şimdiden teşekkür ediyorum.

Bana görüşme sürecinde söyleyeceklerinizin tümü gizli olarak kalacaktır. Bu bilgileri araştırmacıların dışında herhangi bir kimsenin görmesi mümkün değildir. Ayrıca, araştırma sonuçlarını yazarken, isimleriniz kesinlikle yer almayacak, bunun yerine takma isimler kullanılacak ya da isimleriniz şifrelenecektir.

- Başlamadan önce, bu söylediklerimle ilgili belirtmek istediğiniz bir düşünce ya da sormak istediğiniz bir soru var mı?
- Görüşmeyi izin verirseniz kaydetmek istiyorum. Bunun sizce bir sakıncası var mı?
- Bu görüşmenin yaklaşık bir saat süreceğini tahmin ediyorum. İzin verirseniz sorulara başlamak istiyorum.

Görüşme Soruları

Bilim merkezleri ve kaynakları ile ilgili sorular

1. Bilim merkezi deyince aklınıza ne geliyor?

2. Ankara'daki bilim merkezleri hakkında bir fikriniz var mı?

'EVET' Cevabı için:

- Nereler olduğunu söyleyebilir misiniz?
- …. Bilim merkezini ne kadar tanımaktasınız? (Çok/Biraz/Hiç)
- …. Bilim merkezinin işleyişi nasıl? Nasıl bir prosedür takip ediliyor?
- …. Bilim merkezinin içerisinde neler var?
- …. Bilim Merkezinde ne tip etkinlikler yapılıyor olabilir? (Sadece atölye çalışmaları mı var? / Sadece deney düzenekleri mi var?)
- …. Bilim Merkezine gezi düzenlemek için neler yapılması gerektiğini (randevu alma ve gezi sürecini) biliyor musunuz? / Siz nasıl bir yol izlerdiniz?

'HAYIR' Cevabı için: Daha önce herhangi bir bilim merkezini ziyaret ettiniz mi?

3. Türkiye'deki (Ankara hariç) bilim merkezleri hakkında bir fikriniz var mı?

4. Bilim merkezi kaynakları hakkında bir fikriniz var mı?

5. Bilim merkezi kaynaklarını (Gezi rehberi, çalışma yaprakları, deney düzenekleri vb.) kullanmanın fen öğretiminize fayda sağlayabileceğini düşünüyor musunuz? Nasıl?

Mesleki gelişim programı ile ilgili sorular

1. Katıldığınız mesleki gelişim programında neler öğrendiniz? Kısaca bahsedebilir misiniz?

- Öğrendikleriniz arasında sizin için en önemli olan şey neydi? Niçin böyle düşünüyorsunuz?

2. Mesleki gelişim programına katılımınızın, fen öğretiminize bir katkısı olduğunu/olacağını düşünüyor musunuz?

- Cevabınız 'Evet' ise, lütfen ne tür bir katkı yaratacağını kısaca bahsediniz. Sizce fen öğretiminiz önceden nasıldı? Şimdi nasıl?

a. Fen bilgisi alan bilginize

b. Pedagojik alan bilginize
c. Fen öğretim yöntemlerinize

- Cevabınız ‘Hayır’ ise neden böyle düşünüyorsunuz?

3. Mesleki gelişim programına katılımınızın, fen öğretiminizde bilim merkezlerinden ve kaynaklarından yararlanmanıza bir katkısı olduğunu/olacağını düşünüyor musunuz?

- Cevabınız ‘Evet’ ise, lütfen ne tür bir katkı yaratacağını kısaca bahsediniz.
- Cevabınız ‘Hayır’ ise neden böyle düşünüyorsunuz?

4. Katıldığınız mesleki gelişim programı, bir bilim merkezine yönelik sınıf gezisi düzenleme yöntemlerinizi nasıl etkiledi?

- Sizce önceden nasıldı? Şimdi nasıl?

5. Mesleki gelişim programında yer alan konulardan en çok hangisini fen öğretiminize entegre etmek istersiniz?

- Nasıl entegre ederdiniz? / Neden bunu entegre ederdiniz?

6. Mesleki gelişim programında yer alan aktivitelerden en çok hangisini fen öğretiminize entegre etmek istersiniz?

- Nasıl entegre ederdiniz? / Neden bunu entegre ederdiniz?

7. Mesleki gelişim programında yer alan materyallerden en çok hangisini fen öğretiminize entegre etmek istersiniz?

- Nasıl entegre ederdiniz? / Neden bunu entegre ederdiniz?

Bilim merkezi gezileri ile ilgili sorular

Gezi öncesi yapılanlarla ile ilgili;

1.Gezi öncesi herhangi bir hazırlık yaptınız mı?

‘EVET’ Cevabı için:

- Geziden ne kadar önce ve neler yaptığınızı anlatır mısınız? (örneğin; gidilecek bilim merkezi ile ilgili oryantasyon sunumu). Neden bunları yaptınız?
  a. öğretim programı (müfredat – bilimsel içerik ile ilgili)
  b. öğrenci kazanımları (BSB, FTTÇ, Tutum ve Değer Kazanımları)
  c. izin/servis/ randevu vb.
  d. diğer

‘HAYIR’ Cevabı için:

- Neden bir hazırlık yapmadığınızı öğrenebilir miyim?
- Sizin yap(a)mamanızın önündeki engeller nelerdi?
- Ne olsaydı, yapardınız?

2. Gezi öncesi yaptığınız etkinliklerin size ya da öğrencilerinize bir faydası olduğunu düşünüyor musunuz?

‘EVET’ Cevabı için:

- Ne gibi fayda sağladı? Örneklendirebilir misiniz?

‘HAYIR’ Cevabı için:

- Neden böyle düşünüyorsunuz? Ne olmasını isterdiniz?

3. Bilim merkezi kaynakları ile okul derslerini ilişkilendirmek için herhangi bir ders planı geliştirdiniz mi? Mümkünse bir kopyasını benimle paylaşabilir misiniz?

- Sizden talep edilmeseydi de bir plan hazırlar mıydınız? Neden? [Yalnızca son görüşmede]

‘EVET’ Cevabı için:

- Ders planı geliştirirken en çok hangi kısımlara/nelere dikkat ettiniz?

‘HAYIR’ Cevabı için:

- Ders planı geliştirmeme sebebinizi öğrenebilir miyim?

Gezi boyunca yapılanlarla ilgili;

1. Bir fen bilimleri öğretmeni olarak, geziniz sırasındaki rolünüzle ilgili neler söylemek istersiniz?

- Neden bu rolü benimsediniz?

2. Geziniz sırasında neler yaptınız? Biraz bahsedebilir misiniz?

- ilk girişte neler yaptınız?
- rehber sunumu sırasında neler yaptınız?
- serbest zamanda neler yaptınız?

3. Öğrencileriniz bilim merkezindeki düzenekleri nasıl gezdiler? (tek başına yada sizin rehberliğinizde)

- Niçin böyle gezdiler? Siz mi onları bu şekilde yönlendirdiniz?

4. Geziniz sırasında, öğrencilerinizle aranızdaki iletişimden biraz bahsedebilir misiniz?
5. Gezi öncesi yaptığınız etkinliklerin, sınıf gezisi esnasında yaptıklarınıza bir etkisi oldu mu? Yani bu etkinliği yapmasaydınız, sınıf gezisi esnasında yaptıklarınızda bir değişiklik olacak mıydı?

Gezi sonrası yapılanlarla ilgili;

1. Gezi sonrası, öğrencilerinizle birlikte gezinizle ilgili herhangi bir aktivite yaptınız mı?
'EVET' Cevabı için:

- Geziden ne kadar sonra bir aktivite yaptınız?
- Gezi sonrası neler yaptığınızı anlatır mısınız?
- Sınıf içi uygulamalarda gezideki deneyimlerden yararlanıyor musunuz? Bunu nasıl yapıyorsunuz? Neden yapıyorsunuz?

'HAYIR' Cevabı için: Neden bir aktivite yapmadığınızı öğrenebilir miyim? Sizin yap(a)mamanızın önündeki engeller nelerdi?
2. Gezi öncesi, boyunca ve sonrasında yaptığınız aktiviteleri nasıl birbiri ile ilişkilendirdiniz?
3. Gezi sonrası işlediğiniz ilk fen dersinde neler yaptınız?

Genel sorular;

1. Bilim merkezine gezi öncesi-boyunca-sonrasında hazırlanırken sizin için en önemli şeyler nelerdi? Diğer bir deyişle, en çok nelere dikkat edersiniz?

- Niçin bunların önemli olduğunu düşünüyorsunuz?

2. Bu geziyi düzenleme amaçlarınızdan bahsedebilir misiniz?
3. Gezinizin başarılı olup olmadığına nasıl karar verirsiniz?
4. Öğrencilerinizin bu geziden herhangi bir kazanım elde ettiğini düşünüyor musunuz?
'EVET' Cevabı için:

- Ne tip kazanımlar elde ettiklerini düşünüyorsunuz? Örneklendirebilir misiniz?

- Sizce, bu kazanımları elde etmelerindeki neden ne olabilir?

‘HAYIR’ Cevabı için: Neden böyle düşünüyorsunuz? Kazanım elde edebilmeleri için ne olması gerekirdi?

5. Öğrencilerinizin geziden maksimum düzeyde deneyim kazanması için neler yapılması gerektiğini düşünüyorsunuz?

6. Düzenlediğiniz sınıf gezisi nasıl olsaydı daha iyi olabilirdi?

7. Düzenlediğiniz iki gezi arasındaki benzerlik ve farklılıkları söyleyebilir misiniz?

- Değişen bir şey var mıydı? Neler? Örnek verebilir misiniz?
- Bu değişimlerin ardında yatan sebep ne olabilir? (Mesleki gelişim programı mı, deneyim kazanmak mı ya da diğer etkenler mi?)

Bilim Merkezi Gezisi Esnasındaki Gözlem Formu

Tarih:
Okul Türü: Özel ya da Devlet
Sınıf Seviyesi:
Sınıf Mevcudu:

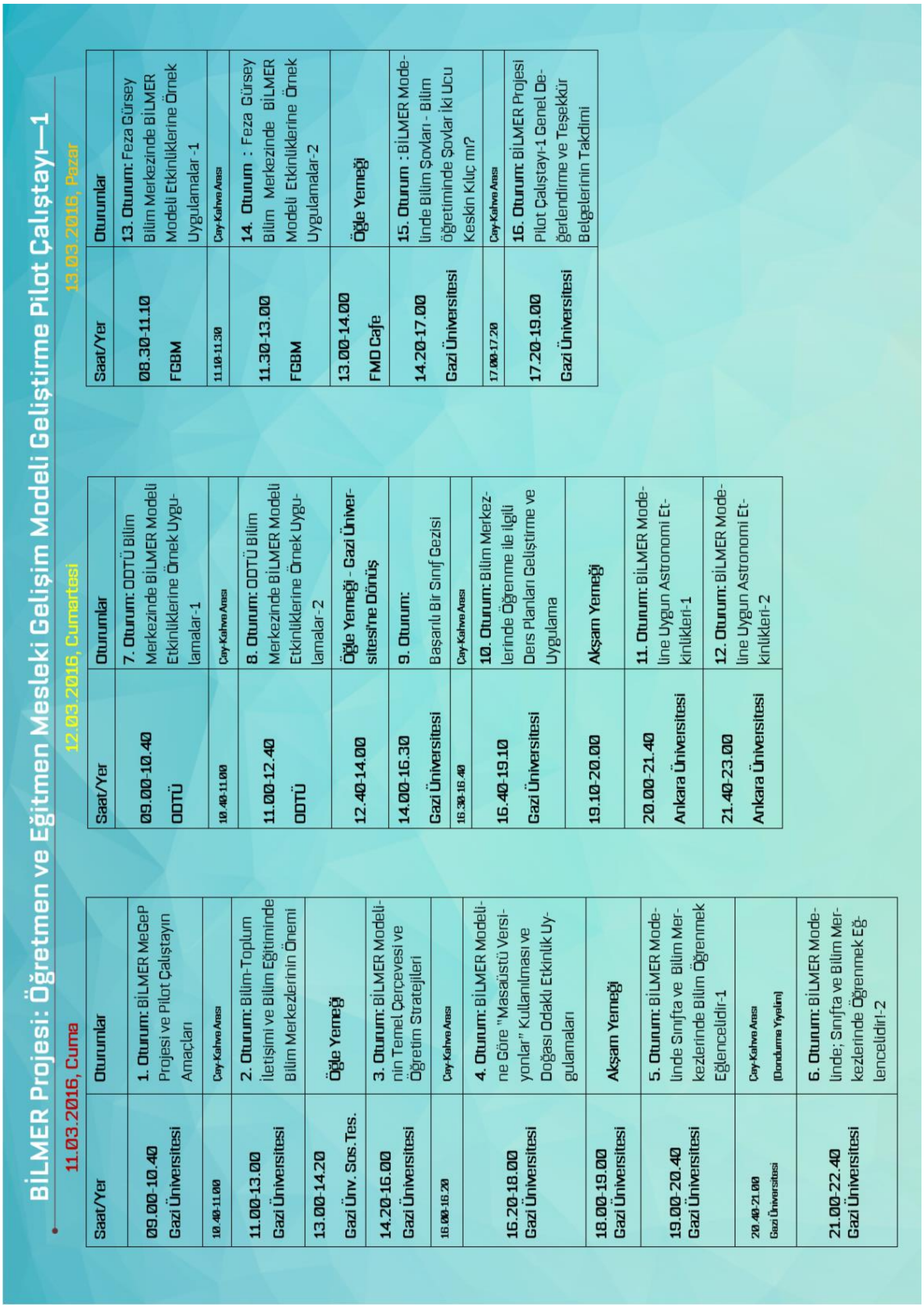
Aşağıdaki seçeneklerden her biri için, öğretmen/öğrenci belirtilen davranışları yaptığında EVET, yapmadığında HAYIR kısmına "/" işareti yazınız. Ayrıca, aşağıdaki seçeneklerle ilgili ekstra not almak istediğinizde ilgili seçeneğin notlar bölümüne yazınız.

	EVET	**HAYIR**	**Notlar**
Öğrencilere gezi için zaman çizelgesi dağıtılmıştı.			
Öğrencileri bilim merkezine giriş ve çıkışlarda komut vererek yönlendirdi. *(Örneğim; Sıraya geç!, arkadaşlarını takip et!, şuraya otur!)*			
Öğretmen, öğrencileri soru sormaya teşvik etti.			
Öğrencilerin ön bilgi ve deneyimlerini, bilim merkezindeki deneyimleri ile ilişkilendirmelerine yardımcı oldu. *(Soru sorarak, öğrenci sorularına cevap vererek, geri dönütler sağlayarak vb.)*			
Öğretmen gezi içeriğini fen müfredatı/dersi ile ilişkilendirdi. *(Soru sorarak, açıklama yaparak, hatırlatarak) (Örneğin; Hatırlarsanız, geçen ders sesin titreşimlerden oluştuğunu bahsetmiştik. Ya da, sunumu dikkatli dinleyin önümüzdeki ders sesin çukur ayna konusuna başlayacağız.)*			
Öğretmen gezi sırasında bilimsel kavramlara ilişkin açıklamalar yaptı. *(Rehberin söylediklerini tekrar ederek/özetleyerek, açıklama panolarını okuyarak… vb.)*			
Öğretmen bu tür ortamlarda nasıl davranılacağına ilişkin öğrencilerine rol model oldu *(Örneğin; açıklama panolarında yazan uyarıları dikkate alarak deney düzeneklerini çalıştırdı. Rehber, 'telefonların sesi kapatılsın' dediğinde önce kendi telefonunun sesini kapattı)*			
Öğrencilere, deney düzenekleri/sergileri gezmede yönlendirme ve yapılandırılmış görevler içeren kısıtlı seçme ve kontrol hakkı tanıdı.			

	EVET	**HAYIR**	**Notlar**
Öğrencileri ile birlikte bütün sergileri/deney düzeneklerini gezmek yerine, dersi ile ilgili/önceden belirlediği düzenekleri gezdi.			
Öğrencilere, deney düzenekleri/sergileri gezmede seçme ve kontrol hakkı tanıdı.			
Öğretmen, öğrencileri deney düzeneklerini denemeye teşvik etti. *(Örneğin; Hadi çocuğum sende yapabilirsin!)*			
Öğrenciler arasında sosyal iletişimi teşvik etti. (Örneğin; '*Hadi arkadaşınla birlikte dene!*' diyerek.)			
Öğrencilerin ikili ya da küçük gruplar halinde çalışmasını/gezmesini sağladı.			
Öğretmen, gezi boyunca fotoğraf ve video çekti.			
Öğretmen, kendi kendine deney düzeneklerini gezdi.			
Rehber tarafından öğrencilere yöneltilen soruları öğretmen cevapladı.			
Öğretmen rehbere deney düzenekleri, bilimsel açıklamalar ya da gezi ile ilgili sorular sordu.			
Öğretmen, öğrencilerin ne tür davranışlar sergilediğinden habersizdi.			
Gezi esnasında öğrenciler çalışma kağıdı doldurdu.			
Gezi esnasında öğrenciler defterlerine not aldı.			
Öğrenciler kendi başına gezdi.			
Öğrenciler fotoğraf ve video çekti.			

Diğer:……
……..
……..
……..
……..
……..

B. PROFESSIONAL DEVELOPMENT PROGRAM BROCHURE



BİLMER Projesi: Öğretmen ve Eğitmen Mesleki Gelişim Modeli Geliştirme Pilot Çalıştayı—1

11.03.2016, Cuma

Saat/Yer	Oturumlar
09.00-10.40 Gazi Üniversitesi	1. Oturum: BİLMER MeGeP Projesi ve Pilot Çalıştayın Amaçları
10.40-11.00	Çay-Kahve Arası
11.00-13.00 Gazi Üniversitesi	2. Oturum: Bilim-Toplum İletişimi ve Bilim Eğitiminde Bilim Merkezlerinin Önemi
13.00-14.20 Gazi Ünv. Sos.Tes.	Öğle Yemeği
14.20-16.00 Gazi Üniversitesi	3. Oturum: BİLMER Modeli-nin Temel Çerçevesi ve Öğretim Stratejileri
16.00-16.20	Çay-Kahve Arası
16.20-18.00 Gazi Üniversitesi	4. Oturum: BİLMER Modeli-ne Göre "Masaüstü Versi-yonlar" Kullanılması ve Doğası Odaklı Etkinlik Uy-gulamaları
18.00-19.00 Gazi Üniversitesi	Akşam Yemeği
19.00-20.40 Gazi Üniversitesi	5. Oturum: BİLMER Mode-linde Sınıfta ve Bilim Mer-kezlerinde Bilim Öğrenmek Eğlencelidir-1
20.40-21.00 Gazi Üniversitesi	Çay-Kahve Arası (Dondurma Yiyelim)
21.00-22.40 Gazi Üniversitesi	6. Oturum: BİLMER Mode-linde; Sınıfta ve Bilim Mer-kezlerinde Öğrenmek Eğ-lencelidirI-2

12.03.2016, Cumartesi

Saat/Yer	Oturumlar
09.00-10.40 ODTÜ	7. Oturum: ODTÜ Bilim Merkezinde BİLMER Modeli Etkinliklerine Örnek Uygu-lamalar-1
10.40-11.00	Çay-Kahve Arası
11.00-12.40 ODTÜ	8. Oturum: ODTÜ Bilim Merkezinde BİLMER Modeli Etkinliklerine Örnek Uygu-lamalar-2
12.40-14.00	Öğle Yemeği - Gazi Üniver-sitesi'ne Dönüş
14.00-16.30 Gazi Üniversitesi	9. Oturum: Başarılı Bir Sınıf Gezisi
16.30-16.40	Çay-Kahve Arası
16.40-19.10 Gazi Üniversitesi	10. Oturum: Bilim Merkez-lerinde Öğrenme ile ilgili Ders Planları Geliştirme ve Uygulama
19.10-20.00	Akşam Yemeği
20.00-21.40 Ankara Üniversitesi	11. Oturum: BİLMER Mode-line Uygun Astronomi Et-kinlikleri-1
21.40-23.00 Ankara Üniversitesi	12. Oturum: BİLMER Mode-line Uygun Astronomi Et-kinlikleri-2

13.03.2016, Pazar

Saat/Yer	Oturumlar
08.30-11.10 FGBM	13. Oturum: Feza Gürsey Bilim Merkezinde BİLMER Modeli Etkinliklerine Örnek Uygulamalar -1
11.10-11.30	Çay-Kahve Arası
11.30-13.00 FGBM	14. Oturum : Feza Gürsey Bilim Merkezinde BİLMER Modeli Etkinliklerine Örnek Uygulamalar-2
13.00-14.00 FMD Cafe	Öğle Yemeği
14.20-17.00 Gazi Üniversitesi	15. Oturum : BİLMER Mode-linde Bilim Şovları - Bilim öğretiminde Şovlar İki Ucu Keskin Kılıç mı?
17.00-17.20	Çay-Kahve Arası
17.20-19.00 Gazi Üniversitesi	16. Oturum: BİLMER Projesi Pilot Çalıştayı-1 Genel De-ğerlendirme ve Teşekkür Belgelerinin Takdimi

C. INFORMATION FROM PRESENTATIONS AND DISTRIBUTED BOOKLET/BROCHURE OF SCIENCE CENTERS

Table C.
Information from Presentations and Distributed Booklet/Brochure of Science Centers

	İTÜ SC	Sancaktepe SC	Gaziantep SC
Web address	http://www.bilimmerkezi.itu.edu.tr	http://www.sabidem.org	http://www.gezegenevi27.com.tr
Tour program	Reservation is necessary for groups for science center tour, workshop programs and science shows. Every 20 students are assigned one explainer and they are visiting the science center in the presence of these explainers.	Reservation is necessary for groups. Individual visitors are hosted weekend.	Incoming school groups are divided into groups of fifteen people. First, the 'Robot Theater' is watched for about ten minutes. There are two robots that inform students about the science center and how to take a tour. Later, the groups are briefly taken a tour accompanied by explainers. Then, students are given free time to explore.
Planetarium	-	There is a planetarium having a capacity of 52 visitors	There is a planetarium having a capacity of 77 visitors. Films: 'Muhteşem Teleskop', 'Zula Patrol'.. etc.
Exhibition Gallery	-	-	'Bilim Adamları Sergisi'
Hands-/Minds-on Exhibit(s)	There are various exhibits about such as sound, optics, mechanic, space topics.	There are 39 different exhibits. E.g., Bernoulli Blower, Pulley, Kaleidoscope, Archimedan Screw	'Archimedes Principle', 'Solar System & Planets', 'Constellations'
Workshop(s)	'Yaz/Kış Okulu', 'Haftasonu Bilim Atölyesi', 'Model Uçak Atölyesi'	'Yaz/Kış Okulu'	'Robot Atölyesi', 'Yaz/Kış Okulu', 'Enerji Atölyesi'
Activity/Project/ Show	'TÜBİTAK Bilim Okulları ve Doğa Eğitimi Projeleri', 'Avrupa Birliği Projeleri (Irresistable, Researchers' Night)', 'ISTKA', 'Galileo Öğretmen Eğitimi Programı'	'TÜBİTAK Bilim Genç Robotik Projesi', 'Yıldızlı Geceler'	'23 Nisan Bilim Şenliği', 'Bi' Dünya Bilim Gösterisi', 'Robot Tiyatrosu'
Material(s)	Brochure	Brochure	Teacher Guide, Visitor Booklet

Table C. (cont'd)
Information from Presentations and Distributed Booklet/Brochure of Science Centers

	Bursa SC	**Kocaeli SC**
Web address	http://bursabilimmerkezi.org	http://www.kocaelibilimmerkezi.com
Tour program	Reservation is necessary for groups. Tour program lasted in about 2 hours. In the program, presentation of exhibits regarding grade level is carried out by the explainers. Then, school groups are led to watch 'Science Show'. After that, they take a tour on 'Mars Exhibition' accompanied by explainer. Finally, there is free time for their own exploration. If anyone wishes, s/he can take advantage of paid events like simulators or planetarium shows during this time.	Reservation is necessary for groups. First of all, students are informed about the science center and how to take a tour for about five minutes when they arrive to the science center. In the "Perception and Reality Gallery" primary school students are accompanied by a guide, secondary school and high school students take a tour by themselves to freely explore. Then, some exhibits are explained them by explainers. In the "Dynamic World Gallery", students are allowed to walk around freely. Explainers help out on issues they do not understand. Besides, there is an information panel next to each exhibit.
Planetarium	There is a planetarium building, which operates on a fee basis.	-
Exhibition Gallery	'Mars Sergisi', 'Altınçağ'da Bilim Sergisi'	'Bilimin Sultanları'
Hands-/Minds-on Exhibit(s)	E.g., Newton's Cradle, Downhill Race, Magdeburg Spheres, Green-screen TV studio	"Perception and Reality Gallery" has different exhibits in the field, such as optics, light, vision and sound. "Dynamic World Gallery" has differents exhibitions about our World, Solar System and Universe.
Workshop(s)	'Model Uçak Yapma', 'Minik Mucitler'	In different fields such as robotics, physics, chemistry and biology, workshops are being carried out free of charge four days a week. E.g., 'Organik Bakım Atölyes (for women's day)', 'Annemle Bilim (for Mother's Day)', 'Öğretmenime En Güzel Hediye (for Teacher's Day)'
Activity/Project/Show	'Bursa Bilim Şenliği', 'AstroFest', 'Bilimsel Geceleme Etkinliği', 'Max Flight', '7D & 9D Simulators'	'Bilim Sahnesi (Van de Graaff Jenerator, liquid nitrogen etc.)', 'Kocaeli Matematik Dehalarını Arıyor', 'Müslüman Bilginleri Tanıyalım (Ramazan Ayı)',
Material(s)	Brochure, 3rd – 4th Grade Exhibit Areas Booklet	There is a library including 1500 scientific publications and intelligence games. Moreover, teachers can utilize from the lab and workshop areas in the science center to do the lessons.

Table C. (cont'd)
Information from Presentations and Distributed Booklet/Brochure of Science Centers

	Eskişehir SC	Bornova SC
Web address	http://www.eskisehirbilimdeneymerkezi.com	http://mtbm.bornova.bel.tr
Tour program	Reservation is necessary for groups. There are five different tour programs, which lasted in about one hour. 1) School Tour: School groups are taken an explainer-led tour based on groups' grade level. 2) Free Tour: Visitors freely and individually explore SC based on their interest. 3) Dynamic Tour: Five different exhibits are explained by explainer. Then, free time is given to groups for their own exploration. 4) Thematic Tour: Presentation exhibits determined by teachers based on their topic is carried out by the explainer. 5) Geography Tour: Explainers conduct presentations about geography at both SC through geography-related exhibits and planetarium buildings.	Reservation is necessary for workshops.
Planetarium	It has a capacity of 96 visitors. 40-minute presentations are made regarding age groups. Each presentation consists of 2 sections. In the first part, special planetarium film (e.g., Zula Patrol, Dawn of the Space Age) is watched, in the second part, the real images of universe are shown.	-
Exhibition Gallery	-	-
Hands-/Minds-on Exhibit(s)	Mostly based on physics-theme such as Bernoulli Blower, Van de Graaff, Pipes of Pan	-
Workshop(s)	18 different workshops were held at different times	Workshops in seven different areas such as Astronomy, Physics, Chemistry and Biology is done. An educational period consists of twelve weeks. Science and philosophy education is given for 2 weeks. Workshops on topics selected by students are also being held for 10 weeks.
Activity/Project/Show	'Robot Bilim Projesi', '7'den 77'ye Gökbilim Semineri', 'Science-based Birthday Celebration'	-
Material(s)	Brochure	Brochure

Table C. (cont'd)
Information from Presentations and Distributed Booklet/Brochure of Science Centers

	Feza Gürsey SC	METU SC
Web address	http://www.fezagurseybilimmerkezi.com	http://www.tbm.metu.edu.tr
Tour program	Reservation is necessary for groups. Tour program lasted in about 1 hour. In the first 20 minutes of one session, liquid nitrogen or Van de Graaff Jenerator show is presented. In the second 20-minute section, 4-5 exhibits are explained by the explainers to the students. Students are given free time to explore in the last 20 minutes. A total of 6 sessions are performed in one day.	Reservation is necessary for groups. Three sessions (9.30am, 11am and 2pm) are held on weekdays to school groups for that monthly activity program. One and half hour time slots are reserved for each group. In the tour program, school groups are greeted at the entrance and requested to seat in theater seating arrangement in the seating area to participate in explainers' presentation. This presentation consists of the explanation about three or four exhibits related to that months' topic, which is usually structured by the explainers in parallel to the school curriculum. Then, free time is given to students to explore other exhibits attracting their attention.
Planetarium	-	There is a planetarium having a capacity of 40 visitors. Films: 'Oasis in Space', 'Muhteşem Teleskope', 'We are Astronomers'.. etc.
Exhibition Gallery	'Dinazor Dünyası Sergisi'	-
Hands-/Minds-on Exhibit(s)	There are various exhibits such as 'Reaction time', 'Van de Graaff Jenerator', 'Black Hole Model', 'Colored Shadows', 'Human Body Model'	There are about 80 different exhibits including 'Weight Simulator', 'Everyone is You and Me', 'Hand Battery', 'Center of Gravity' .. etc.
Workshop(s)	'Su Deneyleri Atölyesi', 'TÜBİTAK Robot Etkinlik Atölyesi'	-
Activity/Project/ Show	'Liquid Nitrogen or Van de Graaff Jenerator Show', 'Science Theatre', '7D Cinema', ' Science-based Birthday Celebrations', ' Observation with Solar Telescope', ' Science Festivals in Shopping Centers'	Scientific Research Projects, 'TÜBİTAK Bilimin Beşiği Sallasın Sizi Projesi', 'Researchers' Night-2016 & 2017',
Material(s)	-	Gezi Rehberi

D. PROGRAM DETAILS AT THE SCIENCE CENTER AND FIELD TRIP GUIDELINE FOR SCIENCE CENTER EXPLAINER

ODTÜ Toplum ve Bilim Uygulama ve Araştırma Merkezi

2015-2016 Eğitim Öğretim Yılı Bahar Dönemi

Bu çalışma kapsamında, bilim merkezinde gösterim yapacak eğitmen aşağıdaki yönerge doğrultusunda bilgilendirildi.

Sevgili Bilim Merkezi Eğitmenim,

Bu çalışma kapsamında Bilim Merkezine gelen okul gruplarına yapılacak sunum hizmetinin standartlaştırılması için ODTÜ Bilim Merkezi araştırma görevlileri tarafından oluşturulan ve bu çalışma için araştırmacı tarafından yeniden düzenlenen yönergeyi ilerleyen sayfalarda inceleyebilirsiniz. Yönergede sunulan anlatımları, gelecek katılımcı öğretmenlerin öğrencilerine uygulayarak çalışmama destek olduğunuz için teşekkür ediyorum.

Saygılarımla.
Semra Tahancalıo

Sınıf Gezisi Esnasında…

1. Temel amacımız bütün öğrencileri güdülemek olduğu için öğrenci cevaplarına "Aferin", "Doğru söyledin", "Üzgünüm, yanlış cevap verdin" gibi tepkiler vermeyelim. Aksine, "Arkadaşınızın söylediğine katılıyor musunuz?", "Başka fikri olan var mı?" gibi sorularla öğrencileri kendi aralarında yönlendirerek doğru cevaba ulaşmalarını sağlayalım.
2. Yapacağınız açıklamaları öğrencilerin sınıf seviyesine göre ayarlayabilirsiniz. Öğrenci sınıf seviyelerine göre dikkat etmeniz gereken kavram yanılgısı, kavram kullanımı, müfredat ilişkisi vb. konulara aşağıda yer alan düzenek açıklamaları bölümünde değinilmiştir.
3. Sunumunuz sırasında, öğrencileri en iyi tanıyan kişiler olan öğretmenleri sürece dâhil edebilirsiniz. Bunun için, sunumun başlangıcında veya sunum sırasında ara ara öğretmene "Eklemek istediğiniz başka bir şey var mı?" gibi soru yöneltip, göz teması kurabilirsiniz.
4. Sunum sırasında, Tahmin Et-Gözle-Açıkla yöntemine yer vermeye çalışalım. Böylelikle, öğrencileri sürece katıp, onların da fikir üretmelerini sağlayalım.
5. Gruba serbest zaman verildiğinde, tek bir noktada sabit bir şekilde beklemeyin. Öğrencilerin aralarında dolaşarak, çeşitli sergi düzeneklerini denemeleri için onları teşvik edin. Sizden yardım talep etmedikleri takdirde, herhangi bir açıklama veya müdahalede bulunmayın. Size düzeneklerle ilgili bir soru sorduklarında direkt cevap vermek yerine, düzeneği birlikte deneyerek gözlemlenen olayın neden olmuş olabileceğine yönelik tartışın veya açıklama panolarını okumaları için yönlendirin.

Grubu Karşılama Esnasında…

Grubu güler yüzle karşılayın. Bilim merkezi kapısından girerken öğrencilere minderlere basmadan merdivenlerden inerek, ön sıradan itibaren oturmaya başlamalarını isteyin. Öğrenciler oturduktan sonra kendinizi tanıtabilirsiniz. Örneğin;

Merhaba Arkadaşlar,

Hepiniz hoşgeldiniz! Bugün sizlere ben yardımcı olmaya çalışacağım. İsmim Semra. Toplum ve Bilim Merkezinde araştırma görevlisi olarak çalışıyorum. Aynı zamanda, ilköğretim fen bilgisi öğretmenliğinde doktora yapıyorum.

Bugün hep birlikte …. konusunu irdeleyeceğiz. Öncelikle sizlere … adet sergi düzeneğini göstereceğim ve ardından gözlemlediğimiz olayların neden olmuş olabileceğini tartışacağız. Bunun için sizlerden sunumlara çekinmeden katılmanızı ve fikirlerinizi paylaşmanızı rica ediyorum. Daha sonra ise, sizleri serbest bırakacağım ve böylece istediğiniz / merak ettiğiniz sergi düzeneklerini deneyebileceksiniz. Yardıma ihtiyaç duyarsanız, seve seve sizlere yardımcı olacağım. Hadi başlayalım!

ŞUBAT - MART 2016: SES VE DALGALAR

Aşağıda, ilk gezi sırasında anlatılacak sergi düzenekleri ile ilgili hazırlanmış yönergeyi inceleyebilirsiniz.

1. GÜRÜLTÜ DAVULU [Ses nedir ve nasıl oluşur?]

İlköğretim kademesindeki öğrencilerin ellerini birbirine vurarak, tempo tutmasını sağlayabilirsiniz. Ahenkli bir ses duymak için her öğrencinin aynı anda ellerini birbirine vurması gerektiğinden, siz de tempo tutun. 5-6 saniye tempo tuttuktan sonra öğrencileri durdurun ve duyduklarının ne olduğunu sorun. SES diyeceklerdir. "Nasıl oluşmuş olabilir?" sorusunu sorarak çeşitli fikirler üretmelerini isteyin. Gelebilecek fikirler:

a. Ellerimizi birbirine vurunca [Böyle bir cevap gelirse şöyle devam edelim: "Doğru fakat ellerimizi birbirine vurunca ne olmuş olabilir?"],
b. Ellerimizin arasındaki havayı sıkıştırdık,
c. Ellerimizi titreştirdik vb.

Olabildiğince fikrini söylemek isteyen öğrencilerden fikirlerini aldıktan sonra, "Gelin sesin nasıl oluşmuş olabileceği ile ilgili bir deneme yapalım" diyerek gürültü davulunu elinize alın ve öğrencilere göstererek elinizde ağzı açık bir davul olduğunu, incelediğimizde de davulun alt kısmında bir yay, yayın bağlı olduğu bir kâğıt parçası

olduğunu söyleyin. “Acaba yayı sallasak, ne olur?” Yine öğrenci fikirlerini alın. Yayı sallayın ve muazzam sesi öğrencilerin duymasını sağlayın. Ne olmuş olabilir sorusu ile devam edebilirsiniz. “Yayı tek başına sallasaydık, yine böyle bir ses duyar mıydık? Davulun altındaki kâğıdın bir amacı var mı?, Yayı salladığımızda kağıda ne oluyor olabilir?” vb. soruları sorabilir; fikirleri toplayarak ve deneyerek hep birlikte cevap arayabilirsiniz.

İşte, ellerimizin birbirine çarpması, yayı sallamamız sırasında [Gürültü Davulu] bu cisimleri oluşturan atomları titreştiriyoruz. Ellerimizi birbirine çarptık, ellerimizi oluşturan atomları titreştirdik; yayı salladık, önce yayı sonra davulun altındaki kâğıdı titreştirdik. Bir enerji formu olan ses de herhangi bir kaynakta meydana gelen titreşimler sonucu oluşuyor diyebilirsiniz.

“Yayı sallamış ve kâğıdın titreşmesini sağlayarak ses üretmiştik. Peki, tam tersini yapsak? Davulun içerisine doğru konuşsak, bu sırada bir elimizle yayı tutsak; bir şey hisseder miyiz?” diyerek öğrenci fikirlerini alabilir; haydi deneyelim diyerek, tek tek öğrencilere denetebilirsiniz. Davulun içerisine doğru konuşulurken, yaydaki titreşimleri öğrencilerin hissetmesini arzu ediyoruz [Sesin titreşimler sonucu oluştuğunu 5. Sınıf itibari ile öğrendikleri için, titreşimleri öğrencilere hissettirmek önemli.].

Özetlersek, enerji formu olan ses herhangi bir kaynakta meydana gelen titreşimler sonucu oluşuyor diyebiliriz. Peki, bu titreşimlerin kulağımıza ulaşabilmesi için hava gibi gaz, su gibi sıvı ya da tahta gibi katı bir ortama ihtiyacı var mı? Haydi deneyelim!

2. VAKUMDA ZİL [Sesin yayılması için bir ortama ihtiyaç var mıdır?]

Öğrencilere “Vakumda Zil” sergi düzeneğini tanıtmakla başlayabilirsiniz.

- Gördüğünüz gibi düzeneğin üzerinde plastik bir kapak ve içerisinde bir kapı zili var. İçeride başka ne olabilir? sorusunu sorun ve öğrencilerin fikirlerini alın. Hava diyen bir öğrenci olursa, arkadaşınıza katılıyor musunuz diyerek diğer öğrencilerin fikirlerini alın.

- Düzeneğin üzerinde de bazı düğmeler var. Sağdaki düğmeye bastığımızda zil çalışıyor. [Düğmeye basın ve zilin çalmasını sağlayın]. Herkes zilin sesini duyabiliyor mu? [Tüm öğrencilerin zilin sesini duyduğundan emin olun].
- Düzenek üzerinde bir vana ve bir düğme daha var. İçeriye hava girişi ya da içeriden hava çıkışı olmasın diye önce vanayı kapatıyorum. Sonra da düzeneğin sol kısmındaki düğmeye basarak, içerideki havanın alt kısımdaki pompa yardımıyla dışarı çıkmasını sağlıyorum. Tıpkı evlerimizde kullandığımız elektrik süpürgesi gibi. İçerideki havayı olabildiğince dışarı çıkartıyorum. Şimdi sizden dikkatlice gözlem yapmanızı rica ediyorum. İçerideki hava azaldıkça, duyulan ses nasıl değişiyor? Artıyor mu? Azalıyor mu?" [Soldaki düğmeye basarak vakum sürecini başlatın].
- Bu gözlemimizden nasıl bir sonuç çıkarabiliriz? [Öğrencilerin fikirlerini paylaşmasını rica edin. İçerideki hava miktarı azaldıkça, duyulan sesin [şiddetinin – ses şiddetini 3. sınıf itibari ile öğrendiler.] azaldığı çıkarımını yapmış olmalarını bekliyoruz. Eğer bu çıkarım yapılamıyorsa, tekrar deneyin].
- O zaman zil içeride çalmaya devam ederken içerideki tüm havayı alırsak, ne olmasını bekliyorsunuz? [Öğrencilerin 'Hiç ses duymayacaktık' cevabını vermelerini bekliyoruz].
- Ses kaynakta meydana gelen titreşimler sonucu oluşuyordu. [Kapı zilinin titreşmesi]. O zaman yayılmak için neye ihtiyaç duyuyor olabilir? [Hava gibi bir ortama çıkarımını yapmalarını bekliyoruz.]
- Özetleyecek olursak değerli arkadaşlar, sesin yayılabilmesi için kaynakta meydana gelen titreşimlerin aktarılması gerekiyor. Kaynaktaki titreşimlerin aktarılması için de tanecikli bir ortam gerekiyor. Bu ortam su gibi sıvı, tahta, duvar gibi katı ya da hava gibi gaz olabilir. [Normalde maddenin plazma halinde de ses yayılabiliyor. Fakat öğretim programında olmadığı için değinmiyoruz]. Eğer herhangi bir ortam olmaz ise, ses yayılamıyor. Bu yüzden sesin boşlukta yayılamayacağı çıkarımını yapıyoruz. İyi ki de ses boşlukta yayılamıyor. Boşlukta yayılabildiğini bir düşünsenize… Güneş'teki patlamaların hepsinin dünyamıza ulaştığını…

Enerji formu olan ses, kaynakta meydana gelen titreşimler sonucu oluşuyor. Yayılmak için de tanecikli bir ortama ihtiyaç duyuyor. Yayılırken de dalgalar

şeklinde yayılıyor. Eğer su dolu bir kovaya üstünden bir damla su bırakırsanız, suyun nasıl ilerlediğini görebilirsiniz. Ses de su dalgaları gibi küresel bir şekilde her yöne doğru yayılıyor. Fakat biz dalgaları biraz yakından incelemek istiyoruz. Haydi deneyelim! [Heliks düzeneğine geçiniz].

3. HELİKS [Ses dalgalar halinde yayılır.]

Yine sergi düzeneğini tanıtmakla başlayabiliriz.

- Düzenek üzerinde uçlarında bilyeler olan çelik çubuklar olduğunu ve bu çubukların bir plastik üzerine tutturulduğunu görüyoruz. Birazdan düzeneği çalıştıracağım. Düzeneği gözlemenizi rica ediyorum. [Düzeneği çalıştıralım].
- Düzenek çalıştığında ilk başta aşağıdan yukarı doğru bir dalga oluştuğunu gözlemleyeceğiz. Öğrencilere çelik çubukların uçlarında bulunan bilyelerin yukarıdan aşağıya ya da aşağıdan yukarıya gidip gitmediğini sorun. [Bilyelerin dikey yönde yer değişikliği yapmadığını fark etmelerini arzu ediyoruz].
- Bilyelerin yeri değişmemesine rağmen ilerleyen bir dalga oluştuğunu gözlemliyoruz. O zaman bu dalganın ilerlemesini/yayılmasını ne sağlıyor olabilir? [Öğrencilerden bilyelerin hareket enerjilerini birbirlerine aktarmaları sonucu dalganın ilerlediği sonucuna ulaşmalarını bekliyoruz].

Özetleyecek olursak, dalgaların yayılması sırasında taneciklerin yeri değişmiyor. Bunun yerine birbirlerine hareket enerjilerini aktarıyorlar. [Tıpkı, denizin ortasındaki bir su molekülünün dalga ile sahile gelmesi gibi.].

4. İNCE/KALIN SESLER

Gün boyu birçok farklı ses duyuyoruz. Fark etmişsinizdir her şeyin sesi birbirinden farklı. Bir kuşun, bir arabanın ya da rüzgârda yaprakların çıkardığı ses. Bu ses çeşitliliğin ardında yatan ne olabilir diye plastik boruyu önce yavaş sonra hızlı döndürerek sallamaya başlayalım. Öğrencilerin, borudan çıkan seslerin yavaş sallandığında kalın, hızlı sallandığında ince olduğunu fark etmelerini sağlayalım.

Ardından, hızlı ve yavaş sallamanın çıkan seslere nasıl bir katkı sağlamış olabileceğini soralım. Öğrencilerden gelen cevapları aldıktan sonra, bu çeşitliliği ses kaynağındaki bir saniyedeki titreşim sayısının sağladığı söyleyelim. Kaynakta birim zamanda (1saniyede) meydana gelen titreşim sayısı ne kadar fazla ise o kadar tiz/ince bir ses; kaynakta birim zamanda (1saniyede) meydana gelen titreşim sayısı ne kadar az ise o kadar bas/kalın ses duyuyoruz [8. sınıfa kadar Frekans kavramına girilmez].

"Ben de sesimi değiştirmek istiyorum. Ne yapmamı önerirsiniz?" sorusu ile öğrenci fikirlerini alın. Genellikle taklit fikri ortaya atılıyor. "Başka ne yapabilirim?" sorusu ile fikir toplamaya devam edin. Helyum çekerim vb. öneriler gelebilir. Gelirse deneyin; gelmez ise sorularla öğrencileri yönlendirmeye çalışalım. Örn. Şuan itibari ile içime ne çekiyorum? Hava. Hava dışında farklı bir gaz karışımı çeksem ya da sadece belirli bir gazı çeksem benden aynı ses çıkar mı? vb. Helyum (He) ve Kükürt Hekzaflorür (SF_6) gazlarını ciğerlerinize gitmeyecek, ağzınızda birikecek şekilde çekin ve konuşun [Sadece deneyimli, bu konuda eğitim almış, ve alerjik bünyeye sahip olmayan personel yapabilir, ziyaretçilere kesinlikle denettirmeyiniz. Önemli Not: Kesinlikle evde denemeyiniz.]. Öğrencilerin havadan yaklaşık 6 kat hafif Helyum gazını çekerek konuştuğunuzda sesinizin inceldiğini; havadan yaklaşık 6 kat ağır Kükürt Hekzaflorür (SF_6) gazını çekerek konuştuğunuzda sesinizin kalınlaştığını fark etmelerini, açıklamasının yapılıp yapılmamasına kendinizin karar vermesini arzu ediyoruz. Cisimler ne kadar ağırsa onları hareket ettirmek o kadar zor olacaktır. Nitekim biz de yaklaşık havadan 6 kat ağır Kükürt Hekzaflorür (SF_6) gazını çekerek konuştuğumuzda sesimizin kalınlaştığını fark ettik. Bunun sebebi ses tellerimizin havadan yaklaşık 6 kat ağır olan Kükürt Hekzaflorür (SF_6) gaz moleküllerini havaya göre daha zor titreştirebilmesidir. Helyum gazı havadan yaklaşık 6 kat hafif olduğu için ise ses tellerimiz Helyum gaz moleküllerini havaya göre çok daha kolay titreştirebilmektedir. [Gaz çekimlerinden sonra mutlaka saf oksijen gazı ile lütfen en az 1 dakika normal teneffüs yapın. Detaylı güvenlik önlemleri ve açıklama için bakınız: https://www.stevespanglerscience.com/lab/experiments/heavy-gas-sulfur-hexafluoride-sf6/]

NİSAN-MAYIS 2016 – ELEKTRİK VE MANYETİZMA

Aşağıda, ikinci gezi sırasında anlatılacak sergi düzenekleri ile ilgili hazırlanmış yönergeyi inceleyebilirsiniz.

1. ELEKTRİKLENİYORUZ! - VAN DE GRAAFF JENERATÖRÜ

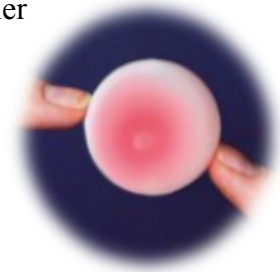
Bildiğiniz üzere her şey atom ve moleküllerden oluşuyor ve bunlarda yükler var. Hangi yükler olduğunu hatırlıyor musunuz? Protonlar (+); Elektronlar (-) ve nötronlar (yüksüz). Eğer aynı iki yükü birbirine yaklaştırırsak, birbirlerini ittiğini görürüz. Farklı yüklerin ise birbirini çektiğini… Çoğumuz, kazağımızı çıkarırken çıtır çıtır sesleri en az bir kere duymuşuzdur ya da kapı kolunu tam tutacak iken en az bir kere çarpılmışızdır. Bu durumların hepsini elektriklenme çeşitleri ile açıklayabiliriz. Gelin sürtünme ile elektriklenmeyi inceleyelim.

Bir balonu bir kazağa ya da saçımıza sürtersek, başlangıçta nötr (- ile + yüklerin eşit dağılımı) olan balonumuz, kazaktaki (–) yükleri toplayarak, (-) yükle yüklenecektir. Eğer balonumuzu (nötr) kağıt parçalarına yaklaştırırsak parçaları çektiğini görürüz ya da (nötr) duvara tutarsak balonun duvara yapıştığını görürüz. Eğer başka bir balonu da aynı şekilde kazak ya da saçımıza sürtüp asarsak ve başlangıçtaki balonumuzu yaklaştırırsak, birbirlerini ittiklerini görürüz. Buradan, aynı yüklerin birbirini ittiği, farklı yüklerin birbirlerini çektiği sonucuna ulaşabilir miyiz?

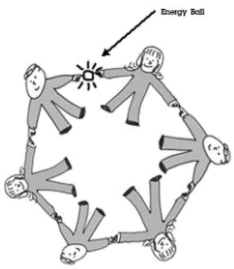
Yüklerin birbiriyle etkileşmesine aslında aşinayız. Bir yıldırım, şimşeğin oluşmasında da temelde yüklerin etkileşmesi söz konusudur. Gelin birlikte yıldırım oluşturalım. Van de Graaff jeneratörü aletini tanıtalım. Sistemi çalıştırdığımzda kürenin içerisindeki kayış dönmektedir. Dönen lastik, sistem içerisinde bulunan fırçalara sürtündüğünde eksi yükler topraklanmaktadır. Geriye kalan artı yükler kürede toplanmaktadır. Aletimizde iki şey deneyebiliriz [Hatırlatma: sahneye davet edeceğiniz öğrencilere güvenlik önlemi açısından herhangi bir sağlık probleminin olup olmadığını, üzerinde kalp pili, işitme cihazı vb. aletlerin olup

olmadığını mutlaka sorunuz. Eğer bu tip durumla karşılaşırsanız, sahneye başka bir öğrenci davet ediniz]: (1) bir kız öğrenciyi alıp, küre kapalı konumdayken elini küreye dokundurun. Sonra sistemi çalıştırın. Saçlarını sallamasını isteyin. Saç tellerinin birbirinden ayrıldığını gözlemlemeliyiz [‘+’ yükler birbirini ittiği için]. (2) Şimdi de iki erkek öğrenci alalım. Öğrencilerden biri küreye dokunsun; diğeri yanında dursun. Sistemi çalıştırdığımızda küreye dokunan öğrencimizin yükünü nötr den (+)’ya döndüreceğiz. Yanında duran öğrencimizin yükü ise hala nötr; eğer işaret parmaklarını birbirlerine yaklaştırırlarsa, bir yıldırım oluştuğunu görebiliriz. (+) yükler, (-) yükleri çekti ve öyle bir an geldi ki (–) yükler (+) yükün olduğu yere göç etti (yük boşalması). Böylece, yüklerin etkileşmesini görmüş olduk ve sürtünme ile elektriklenme ile bir kıvılcım oluşturmuş olduk. Aslında şuan zararsız gibi gözüküyor; fakat yanıcı maddelerin bulunduğu bir yerde bu olayın gerçekleştiğini düşünün. Bir felaketle sonuçlanabilir. Bu yüzden, ameliyathanelerin zeminleri iletken bir madde ile kaplanmaktadır, böylelikle yükler topraklanmaktadır. [Etil alkol, eter gibi yanıcı maddelerin yanmasını engellemek için]. Roket yapılan bir fabrika düşünün. Ufak bir kıvılcım, hayati tehlike yaratabilir. Bu yüzden, burada çalışanların ayakkabıları antistatik yani sürtünme ile elektriklenmeyen malzemeden yapılmış olmalıdır.

2. BEN BİR GARİP KABLOYUM! – ENERJİ TOPU



Peki, basit bir elektrik devresi yapacak olsak, içerisinde neler olurdu? Kablo, güç kaynağı, ampül, anahtar. Elimizde bir pinpon topu var. Bu topun içerisinde aslında basit bir elektrik devresi var. Güç kaynağı (pil), lamba, ses çıkaran bir alet, bağlantı kabloları. Fakat kabloları birleştirmek yerine, uçlarını açıkta bıraktık. Eğer, elimizde bir iletken tel olursa ve uçları birleştirebilirsek devremiz tamamlanacak ve topumuz hem ses çıkarak hem de içindeki lamba yanacaktır. “Aramızda iletken teli olan var mı?” diye sorabiliriz. Öğrencilerin “kendimizi kullanabiliriz” demesini bekliyoruz. İnsan vücudunun elektriği ilettiğini buldurmaya çalışmalıyız. Sonra da



istediğiniz kadar öğrenciyi sahneye alıp, bir yuvarlak oluşturarak devreyi tamamlayabilir ve insan vücudunun elektriği ilettiğini yani bir iletken madde olduğunu öğrencilere gösterebilirsiniz.

Devremizde lamba bir dirençti. Nedir bu direnç? "Maddelerin elektrik enerjisinin iletimine karşı gösterdikleri zorluk", direnç olarak tanımlanabilir. Bir iletkenin direnci nelere bağlıdır? Formül verilmeden, direcin *iletkenin boyuna, kesit alanına* ve *cinsine* bağlı olduğunu görebilirsiniz. Uzunluk arttıkça, direncin büyüklüğü artıyor; kesit alan arttığında ise direncin büyüklüğü azalıyor. Cinsi de etkiliydi. Nikel-Krom telin direnç büyüklüğü, bakır telden daha büyüktür.

3. MIKNATISLAR DÜNYASINA YOLCULUK

Elektrik yüklerinde farklı yüklerin birbirini çektiğini, aynı yüklerin birbirini ittiğini gördük. Acaba mıknatıslarda durum ne? Mıktanıslarda da elektrik yüklerinde olduğu gibi birbirini iten ve çeken bir şeyler var mı? Deneyelim. Mıknatısları öğrencilere dağıtın. Yanyana oturan öğrencilerden mıknatısları birbirlerine yaklaştırmalarını, sonra da bir öğrencinin elindeki mıknatısı ters çevirerek tekrar yaklaştırmasını isteyin. Bir durumda çektiklerini, bir durumda ittiklerini fark edecekler. İten, çeken şeyin ne olduğunu buldurmamız gerekiyor. "Kutuplar". Mıknatıslarda da kuzey ve güney kutup olduğunu dünyadan yola çıkarak buldurabiliriz. Yön bulmaya yarayan aleti sorun? Pusula diyeceklerdir. Pusulanın nasıl yön bulmamızı yardımcı olduğunu soralım. Dünyanın manyetik alanı sayesinde. Dünyamızda iki kutup var, değil mi? Kuzey ve Güney. Mıknatıslarda da durum böyle. Bir mıknatısda hem kuzey hem güney kutup bulunuyor ve mıknatısların çevresinde görmediğimiz manyetik alan kuvvet çizgilerinin yönünün mıknatısın kuzey kutbundan güney kutbuna doğru olduğunu biliyoruz. Pusula bir mıknatıstı; o zaman manyetik alan kuvvet çizgilerinin yönü mıknatısın kuzey kutbundan güney kutbuna doğru. Ama pusula bize yön olarak güneyi değil, kuzeyi gösteriyor? Acaba neden? Hatırlatalım: mıknatısların kutupları ile dünyanın coğrafik kutupları terstir. Yani, kuzey manyetik kutup, güney coğrafik kutupta; güney manyetik kutup ise coğrafik kuzey kutbunda bulunmaktadır. Aklımıza şu gelebilir: "Mıknatısın kutuplarını nasıl belirleyeceğiz?" Elimizdeki mıknatıslarla

basit bir deney yapalım. Mıknatısın bir yönünü pusulaya yaklaştırdığımızda, eğer kuzey kısım (kırmızı ok) mıknatısa doğru yaklaşıyorsa, mıknatısın o tarafı güney kutbu, mıknatısın diğer tarafı kuzey kutbu olacaktır. Buradan aynı kutupların birbirlerini ittiklerini, farklı kutupların da birbirlerini çektiklerini görmüş oluyoruz. Hatırlatma: Elimizde var olan mıknatıslarda hem kuzey hem güney kutup olduğunu unutmayalım. İstediğiniz kadar küçük parçalara ayırsanızda her bir parçada hem kuzey hem güney kutup olacaktır.

4. GİZEMLİ AKIM: EDDY

Bakır boru ve Neodmiyum mıknatıs etkinliğini gerçekleştirmeden önce 'Elimde tuttuğum Neodmiyum mıknatısı yere bıraksam düşer mi?' diye soralım. Öğrenciler, 'Yer çekiminden dolayı düşer' gibi cevaplar verebilir. Ardından, elimizdeki mıknatısı serbest bırakarak yere düşmesini sağlayalım. Daha sonra 'Aynı mıknatısı elimde gördüğünüz bakır borudan bıraksam yere düşer mi?' diye soru yöneltip, öğrencilerin fikirlerini toplayalım. Öğrenciler, 'Düşer', 'Düşmez, içine yapışır' gibi çeşitli fikirler belirtecektir. Hadi hep birlikte görelim diyerek mıknatısı bakır borunun içinden bırakalım. Sonuçta, öğrenciler mıknatısın düştüğünü fakat bir önceki duruma göre daha yavaş düştüğünü gözlemleyeceklerdir. Acaba bu durumun neden olmuş olabileceğini sorarak etkinliği tamamlayalım. Böylece, öğrencileri merak içerisinde bırakacak ve bu soru onları araştırma yapmaya yöneltecektir. Bu etkinliğin nedenini merak edip, serbest zamanda gelip eğitmene soracak olurlarsa, aşağıda eğitmen için kısa bir detaylı açıklama yer almaktır.

Bir mıknatısı, bir iletken telin çevresinde hızlıca hareket ettirsek akım oluşturabilir miyiz? [*Faraday, manyetizmadaki değişimin akım oluşturduğunu (indüksiyon akımı – indükleme olayı) buldu.]*. Mıknatısın kendine ait bir manyetik alanı var. Mıknatıs bakır boru içerisinde düşerken, bakır borudaki elektronların hareket etmesine, yani elektrik akımı oluşmasına neden olmaktadır. Bu akımlar «İndüksiyon Akımları» «Eddy Currents» olarak bilinmektedir. Tıpkı suda oluşan anaforlar (girdap) gibi. İlginç olan, akım bakır boruda ilerlerken manyetik alan yaratıyor. Lenz Kanununa göre de yeni yaratılan manyetik alanın, kendisini yaratanla zıttır. Bu yüzden, iki

manyetik alanın birbirini itmesi ile mıknatıs serbest düşme yerine, yavaşça düşmektedir.

E. SAMPLE INSTRUCTIONAL PLAN

Sınıf Gezisi Ders Planı Örneği *(TÜBİTAK 1001, BİLMER Project, Project No: 114K646)*

<table>
<tr><td>Dersin Adı</td><td>Fizik</td><td>Sınıf Seviyesi</td><td>11</td></tr>
<tr><td>Ünite Adı/Konusu</td><td>Kuvvet ve Hareket</td><td>Önerilen Süre</td><td>Gezi öncesi – 40dk
Gezi süreci – 150dk
Gezi sonrası – 40dk</td></tr>
<tr><td>İlgili Kavramlar</td><td>Denge, ağırlık merkezi</td><td>İlgili Deney Düzenekleri:</td><td>Tırmanan koni,
Denge kartalı</td></tr>
<tr><td>Kavram Yanılgıları (varsa)</td><td colspan="3">Ağırlık ve kütle kavramları birbirinin yerine kullanılmamalıdır.</td></tr>
<tr><td>Gezinin Amacı:</td><td colspan="3">● Bilime yönelik olumlu tutum geliştirmek,
● Bilime, özellikle müfredat konularına yönelik ilgiyi artırmak,
• Denge ve ağırlık merkezi konularını gerçek bilimsel alet /modellerle test etmek</td></tr>
<tr><td colspan="2">Öğretim Yöntem ve Teknikleri:
Bilimsel sorgulayıcı-araştırma öğretim yaklaşımı: 5E Modeli, Tahmin et-Gözle-Açıkla (TGA) öğretim tekniği ve Bildiklerim-Merak Ettiklerim-Öğrendiklerim (BMÖ) tekniği</td><td colspan="2">Ünite Kazanımları:
11.1.9.1. Cisimlerin denge durumunu analiz eder.
11.1.9.2. Kuvvetlerin dengesi ile ilgili günlük hayattan problem durumları ortaya koyar ve çözüm yolları üretir.
11.1.9.3. Cisimlerin kütle ve ağırlık merkezlerinin yerini
karşılaştırır.</td></tr>
<tr><td colspan="2">Problem Çözme Becerileri (varsa):</td><td colspan="2">Tutum ve Değer Kazanımları (varsa):
1.a. İlgili, meraklı, içten, dürüst, açık fikirli ve girişimcidir/yaratıcıdır.
1.k. Bireysel olarak ve(ya) diğerleri ile iş birliği içerisinde çalışır.</td></tr>
<tr><td colspan="4">Bilişim ve İletişim Becerileri (varsa):
2. Amacına uygun bilgi geliştirir.
4. İletişim becerileri geliştirir.</td></tr>
<tr><td colspan="4">Fizik-Teknoloji-Toplum-Çevre Kazanımları (varsa):
1.h. Anahtar fizik kavramlarının farkına varır.</td></tr>
<tr><td colspan="4">Bilimin Doğası Kavramları (varsa):
……
……
……</td></tr>
</table>

GEZİ ÖNCESİ YAPILACAKLAR:

BÜROKRATİK İŞLEMLER SÜRECİ:

Gezi öncesi ODTÜ TBM'den randevu alınmalıdır. Randevu alabilmek için;

1. **0 312 210 6043**'ü arayarak randevu tarihinizi ve saatinizi görevliyle birlikte kararlaştırıp onaylatmanız,
2. "http://www.tbm.metu.edu.tr/iletisim.aspx" adresinde var olan "Bilim Gösterisi" randevu formunu **eksiksiz doldurarak** **0 312 210 6044**'e faks çekmeniz,
3. 0 312 210 6043 nolu telefonu arayarak faksınızın ulaşıp ulaşmadığını ve ziyaret tarih ve seans saatinizin doğruluğunu teyit ettirmeniz gerekmektedir.

Gezinin düzenlenebilmesi için okul idaresi ve velilerden gerekli izinleri almayı unutmayınız.

Öğrencilerinizi getirmeden önce merkezi ziyaret ederek binaları ve sunduğu imkanları incelemeli, lavabolar, yeme-içme, acil çıkış yerlerini ve öğrencileriniz için uygun bir yer olup olmadığını belirlemelisiniz.

EĞİTİMSEL HAZIRLIK SÜRECİ:

Öğrencilerinizi geziye hazırlamak için "http://www.tbm.metu.edu.tr" adresinde var olan TBM tanıtım sunumlarını kullanarak YA DA **EK-1**'deki gibi bir Gezi Broşürü hazırlayarak, gezi günü yapılacakları ve öğrencilerinizi neyin beklediğini paylaşabilirsiniz. Böylece öğrencileriniz merkez ve sizin tarafınızdan sunulacak etkinliklere daha iyi bir katılım sergileyecektir.

[DİKKAT ÇEKME AŞAMASI] Gezi öncesi, öğrencilerinizin denge ve ağırlık merkezi konularında ön bilgilerini belirlemede ve ne öğreniyor olduklarını daha iyi anlamalarına yardımcı olmada BMÖ çizelgesini kullanabilirsiniz. Bunun için öğrencilerinize **EK-2**'deki çizelge formunu dağıtınız. Geziden bir önceki dersinizde, 'Bildiklerim (B)' kısmı doldurularak öğrencilerin denge ve ağırlık merkezi konularında ön bilgileri ve alternatif kavramlarını belirleyebilir, 'Merak Ettiklerim (M)' kısmı ile de öğrencilerin amaçlanan kavram grubu ile ile ilgili merak ettiği noktaları tespit edebilir, gezinizin işleyişini ona göre yönlendirebilirsiniz. Bu sayede, öğrencilerinizin zihinsel olarak konuya odaklanmalarını sağlayabilirsiniz. B ve M

sütunları doldurulan çizelgeleri, geziden sonra tekrar öğrencilere verilmek üzere toplayınız. Bununla birlikte, konunun işleniş aşamasında TGA öğretim tekniğinden yararlanılacağı için öğrencilerinizin gözlem becerilerini geliştirmelerine yardımcı olmak iyi olabilir. Bu nedenle, geziniz öncesinde **EK-3**'teki Gözlem Etkinliğini yapmanızı tavsiye ediyoruz.

GEZİ ESNASINDA YAPILACAKLAR

TBM'deki eğitmenlerin yaklaşık 20 dakika süren gösterisinden sonra öğrencilerinizi 2 gruba ayırınız. Bir grup öğrenci eğitmenin (ve varsa diğer öğretmenin/velinin) gözcülüğünde kendi ilgi ve gereksinimleri doğrultusunda serbestçe merkezi gezerken, diğer grup öğrenci de sizin rehberliğinizde gezinizin odağında olan aşağıda belirtilen fizik etkinliklerine katılabilir.

[ARAŞTIRMA AŞAMASI] Tırmanan Koni sergi ünitesinin başında "Bir cismi bırakırsak düşer değil mi?" sorusu sorularak etkinliğe başlayabilirsiniz. Öğrencileriniz büyük ihtimalle "Tabi ki, yer çekimi var." diyecek, tam bu esnada tırmanan koni sergi ünitesini gösterebilirsiniz. Öğrencilerinizden, aşağı doğru itilecek koninin hareketini tahmin etmelerini isteyiniz *(Tahmin Et Aşaması)*.

Aşağı doğru itilmesine rağmen koninin kendi kendine yukarı çıktığını öğrencileriniz gözlemleyecektir *(Gözle Aşaması)*. "Böyle bir şey nasıl olabilir?" denerek, tartışma başlatabilirsiniz. Tartışmayı başlattıktan sonra, öğrencilerinize fikirler üretmeleri ve bunları test etmeleri için zaman veriniz. Öğrencileriniz çeşitli tahminler ve hipotezler öne sürecektir: (1) "İçinde mıknatıs var.", "Arada görünmez ip olabilir mi?", "Kesin şeklinden dolayı böyle oluyor?" gibi. Bu tip bir durumda, öğrencilerine yönlendirici sorular sorabilirsiniz: "Şeklinden mi diyorsun, o zaman bu şekil cismin hareketine nasıl bir fayda sağlamış olabilir?". Aynı zamanda, öğrencilerinizin öne sürdüğü fikirler doğru ya da yanlış olsun onlara, bunları deneyip arkadaşları ile test etme imkanı sunmalısınız. Örneğin; tırmanan koninin tekrar yukarı çıkmasının nedeninin içerisinde bulunan mıknatıstan kaynaklanabileceğini öneren bir öğrenci olursa,

bunun bir metal (saç tokası vb.) ile test edilmesini ve bundan kaynaklanmadığının gösterilmesini sağlayınız.

[AÇIKLAMA AŞAMASI] Buradaki temel yaklaşım yine sorunun cevabını yine öğrencilere buldurma olmalıdır. Öğrencilerinizi yönlendirerek onları doğru cevaba yaklaştırabilirsiniz. Örneğin; Bir cismin düşmesini sağlayan şey nedir? [Yer çekimi]

> Yer çekimi cisimlerin neresine etki ediyordu? [Ağırlık merkezine]
>
> Bana tırmanan koninin ağırlık merkezinin nerede olduğunu gösterebilecek olan var mı? [Öğrenci denemeleri ve sizin yönlendirmeleriniz]

Sonunda, tırmanan koninin aşağı doğru itilirken aslında ağırlık merkezinin yerden yüksekliğinin arttırıldığının, böylelikle yer çekiminin tekrar ağırlık merkezini düşürerek başlangıç konumuna tırmanan koniyi getirdiğinin, bu esnada da sanki koni yukarı doğru çıkıyor gibi algılandığı açıklaması yapılarak etkinlik tamamlanmalıdır.

GEZİ SONRASINDA YAPILACAKLAR

[DERİNLEŞTİRME AŞAMASI] Bu aşamada öğrencilerinize, gezi esnasında geliştirdikleri kavram, açıklama ve becerileri başka bağlamlara uygulama fırsatı vermelisiniz. Böylece, öğrencileriniz yeni geliştirdikleri kavramlar üzerinde düşünme ve derinlemesine anlama imkanına sahip olacaklar.

Tırmanan koni düzeneğinde öğrendikleri ağırlık merkezi konusunu bir de aşağıdaki etkinlikler yardımı ile pekiştirme imkanı sağlayabilirsiniz.

Etkinlik-1: Düzgün Olmayan Cisimlerin Ağırlık Merkezi

Gerekli Malzemeler: Karton, makas, delgeç zımba, ip, cetvel

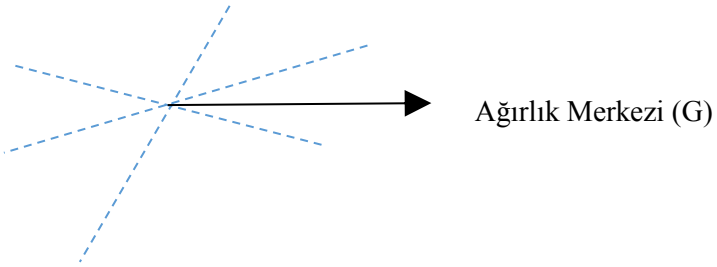
Ön Hazırlık: Aşağıdaki şekile benzer karton parçaları hazırlayınız.

Şekil-1. Karton parçası

Öğrencilerinizi gruplara ayırıp, her bir gruba şekli düzgün olmayan karton parçaları, delgeç zımba, cetvel, ip ve makas veriniz. Ardından, ellerindeki malzemeleri kullanarak, verdiğiniz karton parçalarının ağırlık merkezlerini bulmalarını isteyiniz.

İşlem Basamakları:

1. Elinizdeki kartonun dört bir yanına delgeç zımba yardımı ile delikler açınız.
2. Açtığınız deliklere ip bağlayarak, dikey doğrultuda kartonu tutunuz. Bu sırada, ipin doğrultusunu bir cetvel yardımıyla karton üzerinde işaretleyiniz.
3. Bu işlemi sırayla açtığınız tüm delikler için gerçekleştiriniz.
4. Karton üzerinde işaretlediğiniz doğrultuların kesiştiği nokta size kartonunuzun ağırlık merkezini verecektir.
5. Ağırlık merkezinin yerini doğru bulup bulmadığınızı test etmek için, kartonu o noktadan parmağınızın üzerinde dengede tutmaya çalışınız. Karton dengede duruyor ise, ağırlık merkezinin yerini doğru buldunuz, tebrikler!



Etkinlik-2: Cetvelin Ağırlık Merkezi

Gerekli Malzemeler: 30 cm, 50 cm ve 100 cm uzunluğunda cetveller

Öğrencilerinizi gruplara ayırıp, her bir gruba farklı uzunluklarda cetvel vererek, bu cetvellerin ağırlık merkezlerini ellerini kullanarak bulmalarını isteyiniz.

İşlem basamakları:

http://www.exploratorium.edu/snacks/center-gravity, Alınma tarihi: 01.03.2016.

1. Resimde gösterildiği gibi uzun bir cetveli işaret parmaklarınız üzerinde tutunuz.
2. İşaret parmaklarınız orta yerde buluşuncaya kadar parmaklarınızı kaydırınız. Parmaklarınız cismin ağırlık merkezinin altında bir araya gelecektir.
3. Cetvelin herhangi bir ucuna ağırlık ya da oyun hamuru yapıştırarak ağırlık ekleyiniz.
4. Yine resimde görüldüğü gibi cetveli işaret parmaklarınız üzerinde tutunuz.
5. İşaret parmaklarınız yeni ağırlık merkezinin altında buluşuncaya kadar birbirine yaklaştırınız.
6. Ekleyeceğiniz ağırlıkların cetvel üzerindeki yerlerini değiştirerek, deneyi tekrarlayınız. Her defasında parmaklarınızın cetvelin yeni ağırlık merkezinin altında buluştuğunu fark ettiniz mi?

Neler Oluyor?

Cetvelin ağırlık merkezi tek parmağınızla cetveli dengede tutabildiğiniz yerdir. Cetveli uçlarından iki işaret parmağınızla desteklediğinizde, ağırlık merkezine yakın olan işaret parmağınız diğer parmağınızdan biraz daha fazla cetvelin ağırlığını taşımaktadır. Parmaklarınızı birbirlerine yaklaştırmaya çalıştığınızda, daha az ağırlık taşıyan parmağınız daha kolay hareket edecektir (Daha fazla ağırlık taşıyan parmağınıza daha fazla sürtünme kuvveti etki ettiği için -- Fs = k.N). Bu parmağınız cetvelin ağırlık merkezine diğer parmağınızdan daha yakın olana kadar hareket edecektir. Bu parmağınız diğer parmağınızdan ağırlık merkezine daha yakın

olduğunda ise, diğer parmağınız hareket etmeye başlayacaktır. Sağ ve sol işaret parmağınız basitçe cetvelin ağırlığını aynı miktarda taşıdıkları cetvelin ağırlık merkezinin altında buluşuncaya kadar hareket edecektir. **Dikkat!:** Eğer her iki parmağınızı aynı şekilde, aynı kuvvetle hareket ettirebilirseniz, her ikisi aynı anda ağırlık merkezinin altında buluşuyor. [Cismin yüzeyinin aynı sürtünme katsayısına sahip olduğunu varsayıyoruz.]

[DEĞERLENDİRME AŞAMASI]

Geziden döndükten sonraki ilk dersinizde derinleştirme aşamasından sonra, BMÖ çizelge formlarını öğrencilerinize tekrar dağıtınız ve konu ile ilgili öğrendiklerini çizelgedeki "Öğrendiklerim (Ö)" kısmına kaydetmelerini isteyiniz. Daha sonra, öğrencilerin düşüncelerini tahtada tek bir çizelgede birleştirip, sınıfça B-M-Ö kısımlarında yazılanları tartışıp değerlendirebilirsiniz.

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Şimşek, C. L. (Ed.) (2011). *Fen Öğretiminde Okul Dışı Öğrenme Ortamları*. Ankara: Pegem Akademi.

http://www.exploratorium.edu/snacks/center-gravity, Alınma tarihi: 01.03.2016.

http://www.tbm.metu.edu.tr, Alınma tarihi: 01.03.2016.

EK.1 GEZİ BROŞÜRÜ

Gezi Yönergesi

Sevgili Öğrenciler,

Geziniz esnasında dikkat etmenizi istediğimiz bazı noktalar konusunda sizleri bilgilendirmek istiyorum:

- Eğitmen ve öğretmenlerinizin uyarı ve yönlendirmelerini lütfen dikkate alınız.
- Size verilen serbest zaman diliminde ilgi ve gereksinimleriniz doğrultusunda düzenekleri geziniz.
- Sergi düzeneklerine dokunmaktan ve onları denemekten çekinmeyiniz!
- Merak ettiklerinizle ilgili eğitmen ya da öğretmenlerinize soru sormaktan çekinmeyiniz!
- Dilerseniz gezinizle ilgili küçük notlar alabilirsiniz (Örn; en çok hoşunuza giden sergi düzeneği vb.).
- Foto/video çekimlerinizi lütfen size verilen serbest zaman dilimlerinde gerçekleştiriniz.
- Lütfen kişisel eşyalarınızı kontrol ederek, gezinizi tamamlayınız.

Zaman Çizelgesi

9.00-9.30	Okul-BM* Transferi
9.30-9.50	Eğitmen Sunumu
9.50-10.05	I. Grup serbest zaman / II. Grup Öğretmen Etkinliği
10.05-10.20	II. Grup serbest zaman / I. Grup Öğretmen Etkinliği
10.20-10.30	Ulaşım Tarihi Sergisi
10.30-11.00	Bilim ve Teknoloji Tarihi Sergisi
11.00-11.30	BM-Okul Transferi

*BM: Bilim Merkezi

Adres: Orta Doğu Teknik Üniversitesi, Toplum ve Bilim Uygulama ve Araştırma Merkezi, 06800, Çankaya/Ankara/TÜRKİYE

Tel: 0(312) 210 6053
Faks: 0(312) 210 7939
E-posta: tbm@metu.edu.tr
İnternet adresi: www.tbm.metu.edu.tr

Gezi Broşürü

ODTÜ TOPLUM VE BİLİM UYGULAMA VE ARAŞTIRMA MERKEZİ

Gezi Amaçları

- Bilime yönelik olumlu tutum geliştirmek,
- Bilime, özellikle müfredat konularına yönelik ilgiyi artırmak,
- Denge ve ağırlık merkezi konularını gerçek bilimsel alet /modellerle test etmek

İYİ EĞLENCELER, İYİ GÖZLEMLER...

Gezi Broşürü

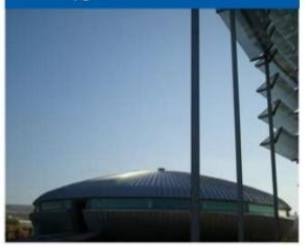
Sevgili öğrenciler,

Bu broşürde, 2006'da kurulmuş Türkiye'nin ilk toplum ve bilim merkezi olan ODTÜ Toplum ve Bilim Merkezi (TBM) hakkında bilgi verilmiştir. **Geziye gelmeden önce lütfen dikkatlice okuyunuz**. Gezi öncesinde, esnasında ve sonrasında öğretmenlerinizin ve TBM eğitmenlerinin uyarı ve yönlendirmelerini dikkate alınız.

Açık Hava Sergisi

ODTÜ TBM'ye bağlı faaliyet gösteren Bilim ve Teknoloji Koleksiyonu Sergi Alanı 3 binadan ve açık hava sergisinden oluşmaktadır. Açık hava parkında uçaklar, tren ve otomobiller yer alıyor.

Uygulamalı Bilim Merkezi



Uygulamalı Bilim Merkezi'nde karmaşık bilimsel konular, anlaşılabilir ve eğlenceli bir şekilde anlatılıyor. Bu binada, "Bilime Dokunun!" ilkesiyle tasarlanan deney ve düzenekler, öğrenmekte olduğunuz fizik ilkelerini ve doğa olaylarını günlük hayat ile ilişkilendirmenize yardımcı olacaktır.

Bilim ve Teknoloji Tarihi Sergisi

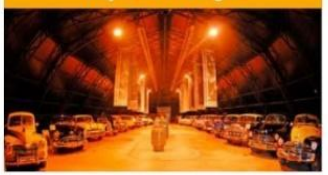
M.Ö. 9000'den günümüze bilim ve teknoloji tarihini anlatmaya yönelik sergilerde Tunç Çağı tablet fırını, cam ve seramik fırınlar, bakırcı ve demirci işlikleri gibi eserler yer alıyor.

DENEY DÜZENEKLERİ

BU İŞTE BİR TERSLİK VAR!
Cisimlere etkiyen yer çekimi kuvvetinin uygulama noktasına ağırlık merkezi dendiğini kavrayacağız.

DENGEYİ BULMA!
Cisimlerin ağırlık merkezlerinden asıldığında dengede duracaklarını keşfedeceğiz.

Ulaşım Tarihi Sergisi



Özel otomobil koleksiyonu ile zaman içinde bir yolculuğa çıkacaksınız!

EK-2. B.M.Ö Çizelgesi

Öğrencinin Adı-Soyadı:

Gezinin Amacı:

Bildiklerim	**Merak Ettiklerim**	**Öğrendiklerim**
1.	1.	1.
2.	2.	2.
3.	3.	3.
4.	4.	4.
5.	5.	5.

EK. 3 GÖZLEM ETKİNLİĞİ

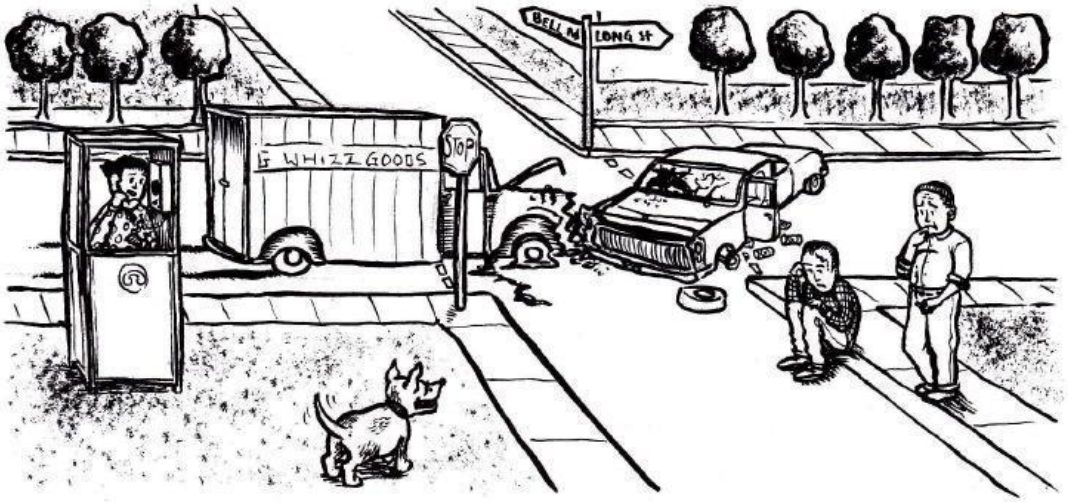
Dikkatli gözlem yapma becerisi bilim insanlarının araştırmalarının vazgeçilmez bir basamağıdır. Bazen bir şeyleri detaylı inceleme, onlar hakkında daha fazla merak etmemize neden olabilir. Bilimsel araştırmanın temeli de budur! Bunun yanı sıra, bilim insanları diğer bilim insanlarının yaptığı deneyleri tekrarlamaya ihtiyaç duymaktadır. Bu dikkatli gözlem yapmayı ve gözlemleri uygun bir şekilde kayıt altına almayı gerektirir.

Gözlem, duyu organlarımız veya araçlar (mikroskop, teleskop, büyüteç vb.) yardımı ile bir durumu tanımlamaktır. Şeker hastalığının keşfinin basit bir gözlemle başladığını biliyor muydun? Hastalığın bilinmediği yıllarda, iki köpeğin idrarından birine sinekler üşüşürken, diğerinden uzak dururlar. Bu dikkat çekici farkın araştırılması sonucunda şeker hastalığı bulunur. Newton'un evrensel çekim kanununu bulması basit bir gözlemle başlar. Arşimet'in suyun kaldırma kuvvetini bulması da…

Çıkarımlarımız, gözlem sonuçlarımıza dayanan zihinsel kararlarımızdır. Düşünmek gerektirir. Örneğin, sabah kalktığınızda havada siyah bulutlar gördüğünüzü, havanın serin olduğunu hissettiğinizi, yolun ıslak olduğunu gördüğünüzü varsayalım. Bu gözlemlerinize dayanarak şu çıkarımı yapabilirsiniz: "Yakın bir zamanda yağmur yağmış olabilir". Fakat yağmurun yağdığını görmediniz. Fakat gözlemlerinize dayanarak bu çıkarımı yaptınız.

Gözlem mi, Çıkarım Mı?

Alttaki resmi, projeksiyon yardımıyla öğrencilerinize gösteriniz ve bu resim ile ilgili gözlemlerini paylaşmalarını talep edin. Öğrencilerinizin gözlemlerini tahtanın bir köşesine not ediniz.



(http://fillpot.pbworks.com/w/file/fetch/110511133/Observation%20Inference%20(1).pdf)

Resimle ilgili gözlemler:

1. Örneğin, resimde 1 köpek var.
2. ..
3. ..

"Benzer ya da farklı şeyleri fark eden var mı?" gibi sorular sorarak öğrencilerinizin katılımlarını sağlayınız. Verilen cevaplarda gerçek gözlem ve çıkarım arasındaki farka vurgu yapmayı unutmayınız.

Örneğin;

Eğer 2 araç kaza yapmış, biri telefonla görüşüyor, kaza yapan insanlar düşünceli vb. öneriler sunduysan; bunların hiçbirinin gözleminiz olamayacağını söyleyebiliriz. Bunların hepsi çıkarımdır. Araçların kaza yapma anını gözlemlemedik. Kulağına sadece telefon ahizesini tutan bir adam görüyoruz ya da yolun kenarında biri ayakta biri oturan iki adam…

F. INSTRUCTIONAL PLANS OF TEACHERS

INSTRUCTIONAL PLAN OF TEACHER-A

<table>
<tr><td>Dersin Adı</td><td>Fen Bilimleri</td><td>Sınıf Seviyesi</td><td>6</td></tr>
<tr><td>Ünite Adı/Konu</td><td>Elektriğin İletimi</td><td>Önerilen Süre</td><td>Gezi öncesi: 40’
Gezi süreci: 150’
Gezi sonrası: 40’</td></tr>
<tr><td>İlgili Kavramlar</td><td>İletken ve Yalıtkan Maddeler</td><td>İlgili Deney Düzenekleri</td><td>Elektrikleniyoruz (Van de graaff jeneratörü)
Ben bir garip kabloyum
Mıknatıslar dünyasına yolculuk
Gizemli akım: eddy</td></tr>
<tr><td>Kavram Yanılgıları (varsa)</td><td colspan="3"></td></tr>
<tr><td>Gezinin Amacı</td><td colspan="3">• Bilime yönelik tutum geliştirme
• Bilime, özellikle müfredat konularına yönelik ilgiyi artırmak
• Elektriğin iletimi konusunu gerçek bilimsel alet/ modellerle test etmek</td></tr>
<tr><td colspan="2">Öğretim Yöntem ve Teknikleri:
5E Modeli, TGA ve BMÖ teknikleri</td><td colspan="2">Ünite Kazanımları:
• 6.7.1.1. Tasarladığı elektrik devresini kullanarak maddeleri, elektriği iletme durumlarına göre sınıflandırır.
• 6.7.1.2. Maddelerin elektriksel iletkenlik ve yalıtkanlık özelliklerinin hangi amaçlar için kullanıldığını günlük yaşamdan örneklerle açıklar.</td></tr>
<tr><td>Problem Çözme Becerileri</td><td></td><td>Tutum ve Değer Kazanımları</td><td></td></tr>
<tr><td colspan="2">Bilişim ve İletişim Becerileri</td><td colspan="2"></td></tr>
<tr><td colspan="2">Fen- Teknoloji- Toplum- Çevre Kazanımları</td><td colspan="2"></td></tr>
<tr><td colspan="2">Bilimin Doğası Kavramları</td><td colspan="2"></td></tr>
</table>

GEZİ ÖNCESİ YAPILACAK İŞLEMLER:

Eğitimsel Hazırlık Süreci

[Dikkat Çekme Aşaması]

- Gezi broşürü (Ek1) öğrencilere dağıtılarak ön bilgilendirme yapılacak.
- Geziden bir önceki derste BMÖ tekniğindeki çalışma kâğıdının (Ek2) B (Bildiklerim) ve M (Merak ettiklerim) bölümlerinin öğrenciler tarafından doldurulması istenecek. Bu yolla öğrencilerin alt sınıftan gelen bilgileri kontrol edilerek varsa kavram yanılgıları giderilecek. Aynı zamanda öğrencilerden bildiklerim kısmında yazılanların diğer öğrencilerle de paylaşmaları istenecek. Bu yolla alt sınıflarda öğrendikleri temel bilgilerin hatırlanması sağlanacak. Merak ettiklerim kısmında ise öğrencilerin konuyla ilgili düşünmeleri sağlanacak ve ilgilerinin bu yolla arttırılacaktır.
- Çalışma kâğıtları öğrencilerden gezi sonrası dağıtılmak üzere toplanacak.
- Öğrenciler gezi esnasında yapılacak grup çalışması için 4 kişilik gruplara ayrılacaklar.

GEZİ ESNASINDA YAPILACAKLAR:

[Araştırma Aşaması]

- Öğrenciler ilk olarak bilim merkezi eğitmenleri tarafından hazırlanan ve müfredat kazanımları kapsamındaki gösteriye alınacaklar.

Öğrencilerden bilim merkezi etkinlikleri esnasında gözlem yoluyla merak ettiklerine cevap aramaları istenecektir. Etkinlikler esnasında sorularına cevap bulamamaları halinde bilim merkezi eğitmenine sorularını yöneltmeleri istenecektir. Bu aşamada bilim merkezi eğitmeni tarafından düzenekler tanıtılacak ve öğrencilerin düzeneklerin çalışmalarına ait bilimsel prensipleri kavramaları sağlanacaktır.

[Açıklama Aşaması]

Düzeneklere ait prensipler öğrencileri de yönlendirerek açıklanacaktır. Bu aşamanın sonunda öğrencilerden BMÖ çalışma kâğıtlarında bulunan Ö (Öğrendiklerim) kısmını doldurmaları istenecektir.

- Gösterinin ardından öğrenciler serbest gezi etkinliğine alınacaklar.
- Daha önce gruplandırılan öğrenciler diğer gruplardan farklı olarak serbest etkinlik gezisinde bulunan düzeneklerden herhangi biri hakkında detaylı gözlem ve araştırma yapacaklar.

GEZİ SONRASINDA YAPILACAKLAR:

[Derinleştirme Aşaması]

- Bu aşama geziden sonraki ilk derste okulda gerçekleştirilecektir. Serbest etkinlik esnasında grup çalışması yapan öğrenciler ilgili deney düzeneği hakkında kısa sunumlar yapacaklar.
- Öğrencilerden ders kitaplarında bulunan TGA çalışmasının T (Tahmin ettiklerim) kısmını doldurmaları istenecektir. Bu yolla öğrenciler maddelerin elektrik iletkenliği durumunu tahmin edeceklerdir. Daha sonra öğrencilerden bir test devresi kurmaları istenecek ve daha önce belirledikleri malzemelerin elektrik iletme durumunu gözlemleyerek G (Gözlemlediklerim) kısmını doldurmaları istenecek. Daha sonra A (Açıklama) kısmına ise tahmin ve gözlem arasındaki uyumu belirlemeleri istenecektir.

[Değerlendirme Aşaması]

BMÖ çalışma kâğıtları değerlendirme aşaması için toplanacak. Öğrencilerden maddelerin iletkenliği hakkında genelleme yapmaları istenecektir. Örneğin; plastikler elektrik yalıtkanıdır ve metaller elektrik iletkenidir.

EK 1. TANITIM BROŞÜRÜ

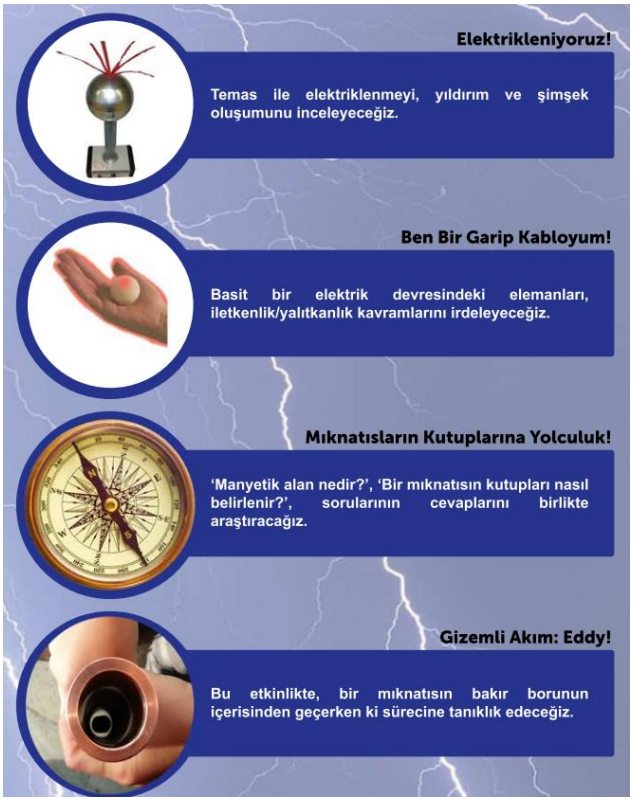
EĞLENEREK ÖĞRENMEYE GİDİYORUZ!

Gezi Sahası: ODTÜ Toplum Bilim Uygulama ve Araştırma Merkezi

Gezi Tarihi: 4 Mayıs 2016

Gezi Saati: 15:30-17:00

Gezi İçeriği



ODTÜ Toplum Bilim Uygulama ve Araştırma Merkezi gezimiz iki bölümden oluşacaktır. Birinci bölümde bilim merkezinde bulunan eğitmenler size elektrik konusunda deney düzenekleri ile bilim şovu yapacaklar. Bu şov sırasında "Elektrikleniyoruz (Van de graaff jeneratörü), ben bir garip kabloyum, mıknatıslar dünyasına yolculuk, gizemli akım: eddy'' isimli deney düzenekleri ile tanışacaksınız. İkinci bölüm ise serbest gezi etkinlikleri şeklinde olacak. Merkezde bulunan diğer düzenekleri kendiniz test ederek ve inceleyerek keşfedebilirsiniz. Gezimizin bu bölümünde düzeneklerin hemen yanında bulunan açıklamaları okumayı unutmayın. Bu tablolardan bilimin gizemli kapılarını aralayan yeni bilgiler edinebilirsiniz.

Öğrencinin Adı-Soyadı:

- 5. sınıfta iken ‘Yaşamımızdaki Elektrik’ isimli ünitede elektrik hakkında bilgiler edinmiştiniz. Bu bilgilerden hatırladıklarınızı aşağıdaki tabloda bulunan ‘Bildiklerim’ sütununa yazınız.
- Elektrik konusunda öğrenmek istediklerinizi ya da aklınıza takılanları ise ‘Merak ettiklerim’ sütununa yazınız. Bu bölümdeki ifadelere gezimizin elektrik şovları bölümündeki düzenekleri gözlemleyerek ya da bilim merkezindeki görevli eğitmenlere sorarak ulaşmaya çalışınız.
- Gezi öncesinde bu çalışma kâğıdını öğretmeninize teslim ediniz. Elektrik şovundan sonra ise ‘Öğrendiklerim’ sütununu doldurmak için öğretmeninizden isteyiniz.

BİLDİKLERİM	**MERAK ETTİKLERİM**	**ÖĞRENDİKLERİM**

INSTRUCTIONAL PLAN OF TEACHER-B

DERS: Fen Bilimleri **SINIF SEVİYESİ:** 5

KONU/KAZANIM: Yaşamımızın vazgeçilmezi elektrik

SÜRE: 35 + 35 + (gezi) + 35

<table>
<tr><td>ÖĞRENME KAZANIMI</td><td colspan="3"><u>Dersin Kazanımları:</u>
5.6.2.1. Bir elektrik devresindeki elemanları sembolleriyle gösterir. Devre şemalarının ortak bilimsel dil açısından önemi belirtilir.
5.6.2.2. Bir elektrik devresi şeması çizer, çizdiği devreyi kurar ve çalıştırır.

<u>Bağımsız Çalışmayı Tanımla:</u> Dersimizde öncelikle devre elemanları ve devre elemanlarının görevlerini hatırlayıp, yüzük oyununu oynayıp ardından bize verilen devrelerin neden çalışmadığını tespit edeceğiz.</td></tr>
<tr><td>ÖNCEKİ BİLGİLERİN HAREKETE GEÇİRİLMESİ</td><td colspan="3"><u>Genel Yaşantı Deneyim:</u>
Evde ne gibi elektrikli eşyalar kullanıyorsun?
Evde lamba yanmıyorsa bunun sebepleri neler olabilir?

<u>Alt Becerilerin Gözden Geçirilmesi:</u>
Basit bir elektrik devresinde neler bulunur?
Devre elemanlarının görevleri nelerdir?

Anlamayı kontrol etme: Bilimsel deneylerde değişken kavramını açıklayınız. Her devre elemanının sembolünü çiziniz.</td></tr>
<tr><td>DERSİN ÖNEMİ</td><td><u>Kişisel Önem:</u>
Bazı durumlarda lambaların daha çok ışık vermesini ve daha parlak yanmasını, bazı durumlarda ise daha az ışık vermesini isteriz. Bunu kendi kendine kontrol edebilirsin.</td><td><u>Akademik Önem:</u>
Elektrik ünitesi fiziğin bir parçasıdır, parlaklıkların nasıl değişeceğini öğrenmek, sembolleri ve devre şemalarını okumak seni daha başarılı yapacaktır.</td><td><u>Gerçek Yaşam Önemi:</u>
Günlük hayatta şemayı inceleyerek devreyi kurmadan bir devrenin çalışıp çalışmayacağını anlayabiliriz.</td></tr>
<tr><td>İÇERİĞİN SUNUMU</td><td colspan="3">Dikkat çekme aşaması:
• Basit elektrik devresini verilen malzemelerle kuran öğrenciler yüzük oyununu oynamaya hak kazanırlar.
• Öğrencilere sorular sorarak bir önceki dersin özetlemesi yapılır.
• Devre elemanları ve sembolleri hatırlatılır.

GEZİ ÖNCESİNDE;

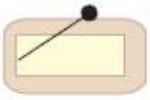
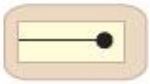
TBM’ye daha önce geldikleri için ek olarak bir tanıtım yapılmaz. Öğrencilere elektrik konusunda bir sunum dinleyecekleri ifade edilir. TBM’nin broşüründeki elektrik konulu sayfa üzerinden elektrik sunumu öğrencilere kısaca anlatılır. Öğrencilerin hazır bulunuşluğu sağlanır.</td></tr>
</table>

	Elektrik konusu ile ilgili ekteki çalışma kâğıdındaki sorular çözülür. Çalışma kâğıdının son sayfası ödev verilir. **Anlamayı kontrol etme:** • Devrede sembolleri olan ve olmayan elemanlar var mıdır? • Semboller ne işe yarar? • Lamba, pil, kablo ve anahtarın sembollerini çizer misin? • 3 lamba 2 pil ve bir açık anahtardan oluşan devreyi sembollerle çizer misin? Çalışma kâğıdı bittikten sonra, sınıfta ya da laboratuvarda çeşitli devreler hazırlayarak öğrencilerden devre şemasını çizmeleri istenir. Ayrıca devre şeması çizildikten sonra öğrencilerden 3-4 kişilik gruplar oluşturarak kendilerine verilen devreleri çalıştırmaları beklenir. Devresini tamamlayan öğrenciler yüzük oyununun masaüstü versiyonunu oynamaya hak kazanırlar. Derste yüzük oyununun etrafında sırayla oyunu oynarlar. Yüzük oyununu bitiren öğrenciler bozuk bir devre alarak devrenin neden çalışmadığı hakkında fikir yürütüp devreyi çalışır hale getirmeye uğraşırlar. **GEZİ SIRASINDA;** Öğrenciler elektrik konusunda yapılan sunumu dinlerler. 46 kişiden oluşan grup ikiye bölünerek ayrılır ve alanda düzenekleri serbetçe kullanır. Gezi boyunca öğretmen öğrencilerine eşlik eder ve öğrencilerine en beğendikleri 3 tane elektrik konusuyla ilgili düzenek belirlemelerini ve okula döndüklerinde yazıp vermelerini ister. NOT: Derste masaüstü versiyonu kullanılan yüzük oyunu oynandığı için, bilim merkezi öğrenciler yüzük oyunu büyük versiyonda [EL BECERİSİ] gözlemlenir. **GEZİ SONRASINDA;** Öğrencilerle gezinin nasıl geçtiği soru cevap yöntemiyle tartışılır. Öğrencilerden en beğendikleri 3 tane elektrik konulu düzeneği anlatmaları ve yazmaları istenir, isterlerse resim yapıp boyama da yapabilirler. Öğrencilerden alının çalışmalarla bir pano oluşturulur.
BİRLİKTE YAPALIM	Devre kurma çalışmaları, öğretmen tarafından yürütülür. Yüzük oyunu bireysel oynanır.
PEKİŞTİRME-DÜZELTME ÖZETLEME	Bu derste devre elemanı sembollerini ve bir devrenin neden çalışmadığı hakkında fikir yürütme becerisi kazanmış olduk.

DERS İÇİ DEĞERLENDİRME	• **Hatırlama**: Bilimsel deneylerde kaç tür değişken vardır? • **Anlama**: Bağımsız değişken nedir? • **Uygulama**: Pil sayısını sabit tutarak deney devreleri oluştur. • **Analiz**: Lamba sayısını sabit tutarak devreler kuracak olsan değişkenlerin neler olabilirdi? • **Değerlendirme**: Lamba parlaklığını değiştiren bir faktörün de lamba sayısı olduğunu ispatla. • **Yaratma**: Kendi isteğine göre sembollerden oluşan devreler tasarla
ÖDEV: Çalışma kâğıdı son sayfa ödev.	

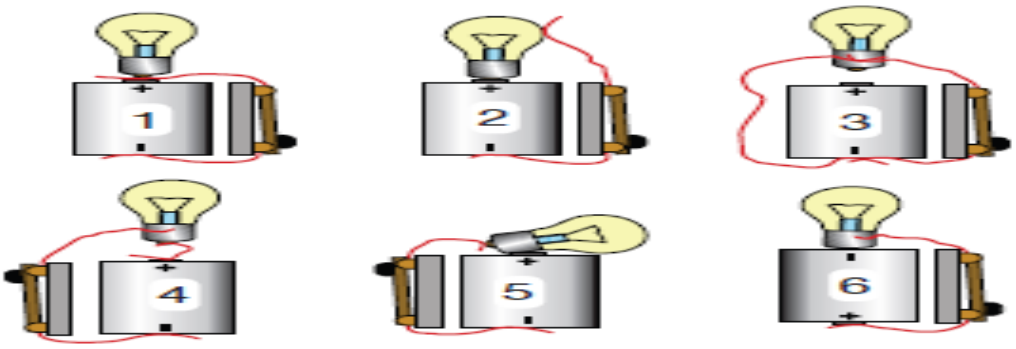
EK 1. Çalışma Kağıdı

Aşağıda verilen tabloyu öğretmenimizin rehberliğinde dolduralım.

Devre elemanı	Devre elemanının resmi	Devre elemanının sembolü
Lamba		
Pil		
Bağlantı kablosu		
Anahtar		
		

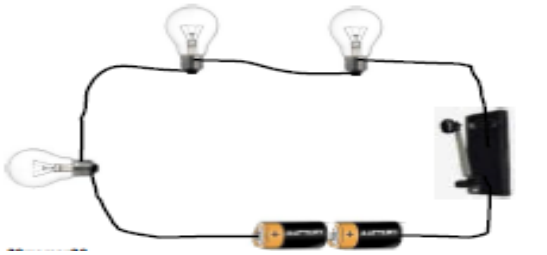
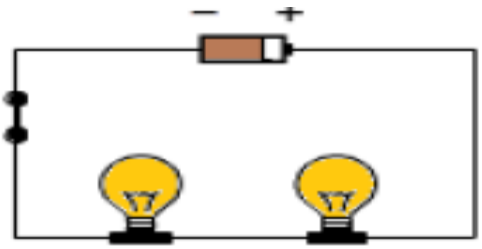
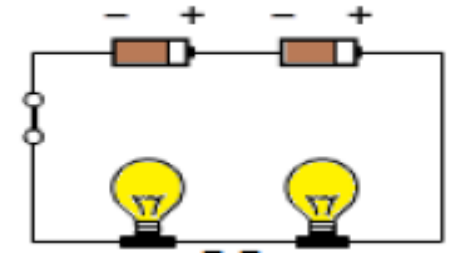
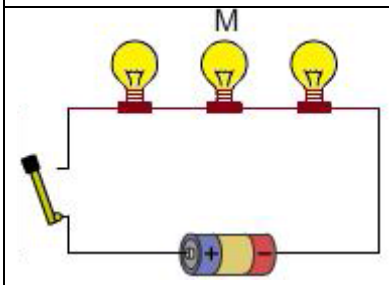
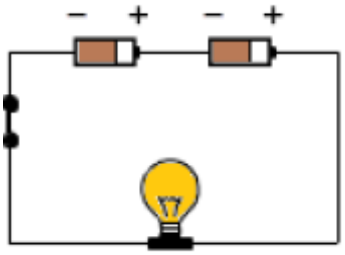
Sembolleri kullanarak aşağıya bir devre çizelim.

Aşağıdaki devrelerde lambanın ışık verip vermediğini sebebiyle yazalım.



Devre numarası	Işık verir / Işık vermez	Sebebi
1		
2		
3		
4		
5		
6		

Aşağıdaki devreleri sembollerle gösterelim.

ÖDEV - DOĞRU YANLIŞ ETKİNLİĞİ YAPALIM

Aşağıda verilen ifadeleri okuyarak, başlarında bulunan parantez işaretlerinin içine ifade de anlatılmak istenen doğru ise "D", yanlış ise "Y" yazınız.

1. ( )Bir elektrik devresinde art arda bağlı özdeş ampullerin sayısı arttıkça parlaklıkları artar.
2. ( )Birden fazla değer alabilen her şey değişkendir.
3. ( ) Bağımsız değişkene bağlı olarak değişen değişkene bağımlı değişken denir.
4. ( )Basit elektrik devresindeki piller birbirine belli bir düzene göre bağlanır.
5. ( )Tüm elektrikli aletlerde aynı özellikli devre elemanları kullanılır.
6. ( ) Elektrik devresinde anahtar devreyi kontrol etmeyi sağlar.
7. ( ) Elektrik düğmeleri devredeki anahtar görevini üstlenir.
8. ( ) Devredeki elemanları çizmek zaman alacağından, elemanların şekil ve özellikleri farklı olabileceğinden her bir eleman sembolle gösterilir.
9. ( ) Basit elektrik devrelerinde devreye bağlanan her bir pil ampulün parlaklığının artmasına neden olur.
10. ( ) Elektrikle çalışan her aletin içinde bir elektrik devresi bulunur.
11. ( ) Kapalı devrede anahtar kapalıdır ve devre ışık verir.
12. ( ) Bir devrede ampul ışık vermiyorsa piller ters bağlanmış olabilir.

INSTRUCTIONAL PLAN OF TEACHER-C

Ders Adı: Fen Bilimleri **Sınıf Seviyesi:** İlkokul 4

Ünite Adı/Konusu: Yaşamımızdaki Elektrik/ Basit Elektrik Devreleri

Süre: Gezi Öncesi: 40 dk Gezi Süreci: 150 dk

Gezi Sonrası: 80 dk

Gezinin Amacı:

- ✓ Bilime yönelik olumlu tutum geliştirmek.
- ✓ Müfredat konularının daha iyi anlaşılmasını sağlamak.
- ✓ Bilime ilgiyi arttırmak.
- ✓ Basit bir elektrik devresindeki elemanları ile iletkenlik ve yalıtkanlık kavramlarının pekiştirilmesidir.

İlgili Kavramlar: Devre elemanları, basit elektrik devresi kurulumu

Kazanım(lar): 4.6.1.1. Basit elektrik devresini oluşturan devre elemanlarını işlevleriyle tanır ve çalışan bir devre kurar.

Öğrenme Öğretme Yöntem ve Teknikleri: Anlatım, tüme varım, tümden gelim, grup tartışması, gezi gözlem, gösteri, soru yanıt, beyin fırtınası, grup çalışmaları, gösterim, keşfetme

Tutum ve Değer Kazanımları:

TD-1.

• Kendini vererek dinler.

• Çevresinde olayları/etkinlikleri takip eder.

• Öğrenmeye ve anlamaya isteklidir.

• Açık fikirlidir.

Bilimin Doğası Kavramları: Deney, Gözlem ve Çıkarım Yapma

Gezi Öncesi Yapılacaklar

Bürokratik İşlemler Süreci:

- Okul idaresi ve velilerden gerekli izinler alınır.
- Gezi öncesi ODTÜ TBM'den randevu alınır.
- Öğrencileri götürmeden önce merkez ziyaret edilerek veya telefonla aranarak, binaları ve sunduğu imkânları incelemeli, lavabolar, yeme-içme, acil çıkış yerleri belirlenir.

Eğitimsel Hazırlık Süreci:

ODTÜ Bilim Merkezi eğitmenleri ile irtibata geçilerek, öğrencilerin yaş gruplarına uygun yapılabilecek etkinlikler ve kullanılacak düzenekler hakkında konuşulur. Bilim Merkezi'nin Gezi Rehberindeki elektrik sunum programı incelenir ve öğrencilerin yaşlarına uygun olan etkinlikler seçilir. Daha sonrasında, eğitmenden sunum sonrası bir düzeneği anlatma konusunda yardım istenir.

Gezi konusu olan 'Yaşamımızdaki Elektrik' hakkında öğrencilere ön bilgi verilir. Bu bağlamda, öğrenciler gruplara ayrılır ve her bir gruba pil, pil yatağı, ampul, anahtar, iletken/yalıtkan kablo dağıtılır. Ardından, ellerindeki malzemeleri kullanarak çeşitli elektrik devreleri oluşturmaları istenir. Daha sonrasında, gruplarla yaptıkları devreler üzerine konuşulur. "Neden iki ampul kullandın? İki pil kullandığında ampulde bir değişiklik oldu mu? Yalıtkan tel ile lamba yakılır mı?" gibi çeşitli sorularla öğrencilerin düşünmesi sağlanır.

Geziye gitmeden önce, öğrenciler gezi günü yapılacaklar ile ilgili bilgilendirilir. İnternet sitesi ile Bilim Merkezi hatırlatılır. Bilim Merkezi'nden beklentileri hakkında konuşulur. Bununla birlikte öncelikle eğitmenin sunumuna katılacağımız belirtilir. Ardından öğrenciler üç gruba ayrılır. Önceden belirlenen üç değişik düzeneği her bir grubun sırasıyla inceleyeceği ve en son bilim merkezini serbestçe gezebilecekleri öğrencilere söylenir. Öğrencilerden Uygulamalı Fen Bilimleri Dersi'nde kullandıkları Bilim Günlükleri'nin bilim merkezine götürülüp, eğitmen tarafından gösterilecek etkinliklerle birlikte, orada kullanılacak ilgili düzeneklerle de ilgili not almaları gerektiği belirtilir.

Gezi Sırasında Yapılacaklar

Öğrencilerin gezi kurallarına uygun olarak düzenli bir şekilde Bilim Merkezi'ne girmeleri sağlanır. Tüm öğrenciler eğitmen tarafından yapılacak etkinlikleri dinlemek üzere uygun alana oturtulur. Elektrikleniyoruz ve Ben Bir Garip Kabloyum, Mıknatısların Kutuplarına Yolculuk etkinlikleri eğitmen tarafından öğrencilerin seviyelerine uygun olarak yapılır. Eğitmenin yaptığı etkinlikler sırasında öğrenciler soru-cevap yöntemi ile konu ve etkinliklerle ilgili merak ettikleri soruları yöneltirler. Öğrenciler sunum sırasında, eğitmenin programı dâhilinde yapılan etkinlikleri deneyimler ya da gözlemleri sonucunda çıkarımlarını paylaşırlar.

Eğitmen sunumu bittikten sonra öğrenciler 3 gruba ayrılır ve önceden öğretmen tarafından konuya uygun olarak belirlenmiş her 3 düzenek her grubun başında bir öğretmen olacak şekilde gezilir. (Bilim merkezi eğitmeni, sınıf öğretmeni, fen bilimleri öğretmeni) Gezi sırasında da öğrencilerin düzeneklerle ilgili not almaları gerekliliği öğretmen tarafından tekrar hatırlatılır. Her 3 grup da ilgili düzenekleri gezdikten sonra öğrencilere 15 dk serbest gezme süresi verilir.

Gezi Sonrasında Yapılacaklar

Öğrencilerle gezi değerlendirmesi yapılır. En çok hangi etkinlik ve düzeneğin dikkat çektiği, nedenler konuşulur. Öğrenciler tarafından alınan notlar sınıfta paylaşılır. Gezi sırasında oluşturulan gruplara, bilim merkezinde konuyla ilgili belirlenen düzeneklerden ya da eğitmenin gösterdiği deney ve düzeneklerden herhangi bir tanesi araştırma ödevi olarak verilir. Poster ya da sunumlarının bir sonraki derste sunulması istenir.

G. PROTOCOLS FOR CODING

PROTOCOL FOR CODING TEACHERS' AWARENESS

Table G.1.
Protocol for Coding Teachers' Awareness about Science Centers and Their Resources

Codes	Explanation
Explainer's presentation	Code if any mention of presenting or introducing of detailed information about resources and activities carried out in the science centers (e.g., workshops, festivals and exhibits, etc.) by the explainers of these science centers in the PD program
Communication with explainers	Code if any mention of getting information about science center's resources and activities carried out in the science centers (e.g., workshops, festivals and exhibits, etc.) from the explainers of them during field trips to these science centers in the PD program
Field trip to SC	Code if any mention of conducted visits to some science centers in Ankara in the PD program to explore and examine these science centers.
METU SC visit	Code if any mention of organizing and/or conducting a visit to METU SC for the current study
Website	Code if any mention of getting information from and/or of learning something from the website of any science center
Tabletop exhibit	Code if any mention of utilizing from tabletop exhibits to integrate science center resources into the science classes *Note.* Tabletop exhibit is a portable exhibit that can be used to extend students' learning in the classroom (or to introduce related science concepts to the trip before the visitation). It can be a small size of science center exhibits such as "Newton's Cradle". Also, it can be an exhibit be used to extend the same science concept(s) related to science center exhibit(s) such as vacuum bag [tabletop exhibit] for "Magdeburg Spheres" [science center exhibit].

PROTOCOL FOR CODING TEACHERS' STRATEGIES

Table G.2.
Protocol For Coding Teachers' Strategies for Conducting Science Center Visit

PRE-VISIT STRATEGIES	
1. Familiarization Strategies: were related to the arragement of some sort of background knowledge for teacher and/or students.	
a) Site familiarization	is about the field trip site's general introduction. These strategies might be [*for students*] (1) discussion of what they will see at the site (e.g., exhibits, halls, objects…etc.) on a museum map or browsing the website of the museum, (2) sharing their previous museum experience (if any); [*for teachers*] (3) finding out the location of the site browsing the Internet map, (4) the field trip site visitation before the trip, (5) participating an exhibit preview (if any), (6) obtaining information about ongoing events
b) Content familiarization	involves providing prior information about the topics of museum's displays or science center's exhibits to help students familiarize with them. Teacher might also need to familiarize themselves with them if the trip will be unguided tour.
c) Procedure familiarization	refers to get familiar with what will be going on the trip. These strategies might be [*for students*] (1) the introduction of the detailed trip schedule, planned activities, trip's goals and what is expected of them do during the trip; [*for teachers*] (2) information about visitor rules and regulations such as admission, food & drink, security, guidance, demonstrations, film/video recording etc.
2. Supervision Strategies: involves student behavior clarification and supervision coordination.	
a) Behavior clarification	refers to the discussion of which behaviors are expected of students as well as possible consequences of inappropriate behavior.
b) Supervision coordination	refers to arranging parent chaperones and dividing students into small groups.
3. General Things To Do: refers to the general works to do such as organization of transportation, entry costs, booking, getting related permissions	
4. Instructional Planning: is comprehensively defined action plan including the integration of curriculum and visit for every part of the visit. It is used to determine whether teachers prepare an instructional plan for their trips or not.	

Table G.2. (cont'd)
Protocol For Coding Teachers' Strategies For Conducting Science Center Visit

5. Activity Development (Other Pre-visit Activities): is used as a way to motivate students to learn or bring up their questions or incorporating their prior knowledge into the new concepts in the setting by means of discussions, assignments before going.	
DURING-VISIT STRATEGIES	
1. Student Engagement Strategies: can be divided as structured and unstructured student engagement activities based on the structure level of activities like questioning, taking notes, exploring, completing scavenger hunts and guided tours, etc.	
a) Structured student engagement	refers to similar classrom learning activities like worksheets or explanation of guide.
i. Information seeking activities	refer to such activities as completing worksheets, note-taking or exploring and recording information presented through the exhibits are used to help students engaged in activities and keep up proper behavior
ii. Information receiving activities	refer to such activities as guided tours or expert presentations about particular topics, which require students' listening to or observation.
b) Unstructured student engagement	refers to less formal activities, that is more spontaneous and less dependent on specific pre-visit preparation. E.g., discussing, sharing, asking or answering questions, pointing out items of interest, reflecting, facilitating, and guiding.
i. Interpretation	interpretation of exhibits' meaning based upon teachers' knowledge or exhibit's label to draw students' attention to particular topic or exhibit
ii. Connecting	helping students correlate some parts of curriculum with the exhibits
iii. Facilitation	asking open-ended questions to help students' meaning-making
iv. Free exploration	allowing students to hang around and explore items/exhibits of interest
v. Label reading	• *Deliberate label reading*: prompting one student to read information on the label out loud to the class and interfere to clarify unfamiliar things • *Complementary label reading: directing students to read and find the answer to a particular question or more about the exhibits*
vi. Orientation and advance organizers	e.g, maps for introducing exhibit halls

Table G.2. (cont'd)
Protocol For Coding Teachers' Strategies For Conducting Science Center Visit

2. Supervision Strategies: refer to the chaperone guidance, monitor time spent on site, keeping an eye on students, refocusing students about the rules and learning objectives etc.	
3. Event Documentation: includes taking photos or videotaping during the trip.	
4. Following Instructional Plan: is used to determine whether teachers follow their instructional plan or not.	
POST-VISIT STRATEGIES	
1. Review and Discussion	talking about what students saw, did, liked and why they like; sharing experiences; relating what they saw to curriculum
2. Documentation	not-graded writing or drawing assignment, photo memory board, students' presentations or posters
3. Other Post-visit Activities	activities other than writing or discussion to correlate special exhibits or the day with classroom unit. E.g., create classroom wordbanks and organizational visual maps, etc.
4. Assessment	graded descriptive writing assignment or report about students' experiences.

Note. Strategies to make field trip successful. Adapted from *Revealing teacher agendas: An examination of teacher motivations and strategies for conducting museum fieldtrips* (pp. 77-81; 106-148), J. F. Kisiel, 2003a, University of Southern California, Los Angeles.

PROTOCOL FOR CODING TEACHERS' VIEWS ON THE CHARACTERISTICS OF PD PROGRAM

Table G.3.
Protocol for Coding Teachers' Views on the Characteristics of PD Program Influencing Their Instructional Planning regarding Science Center Visit

Codes	Explanation
Curriculum connection	Code if any mention of integrating a science center visit into science lessons.
Exchange of ideas	Code if any mention of emerging various ideas regarding science center visit followed by a discussion among teachers and explainers and/or followed by a collaborative work of teachers and explainers
Instructional plan	Code if any mention of developing instructional plan and/or being introduced to a sample instructional plan and/or getting feedback on instructional plan
Emphasis on communication	Code if any mention of special attention to communication with explainers before science center visit or during planning a science center visit
Teaching techniques	Code if any mention of being introduced to any teaching techniques that can be used for a science center visit such as POE, KWL chart, argumentation, demonstration and hands-on activities
Teaching methods	Code if any mention of being introduced to any teaching methods that can be used for a science center visit such as inquiry, 3E and 5E learning model, discussion method
Tabletop exhibits	Code if any mention of tabletop exhibits, which is a portable exhibit that can be used to extend students' learning in the classroom (or to introduce related science concepts to the trip before the visitation). It can be a small size of science center exhibits such as "Newton's Cradle". Also, it can be an exhibit be used to extend the same science concept(s) related to science center exhibit(s) such as vacuum bag [tabletop exhibit] for "Magdeburg Spheres" [science center exhibit].

H. HUMAN SUBJECTS ETHICS COMMITTEE APPROVAL FORM

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
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09 ŞUBAT 2016

Gönderilen: Prof.Dr. Jale ÇAKIROĞLU
Eğitim Fakültesi

Gönderen: Prof. Dr. Canan SÜMER
İnsan Araştırmaları Komisyonu Başkanı

İlgi: Etik Onayı

Sayın Prof.Dr.Jale ÇAKIROĞLU'nun danışmanlığını yaptığı doktora öğrencisi Semra TAHANCALIO'nun "A study on informal science professional development: A case study of science teacher's way of science teaching in conjuction with science center / Informal ortamlarda mesleki gelişim üzerine bir çalışma: Fen bilgisi öğretmeninin bilim merkezleri ile bağlantılı fen öğretim yolları üzerine bir durum çalışması" başlıklı araştırması İnsan Araştırmaları Komisyonu tarafından uygun görülerek gerekli onay **2016-EGT-017** protokol numarası ile **22.02.2016-27.02.2016** tarihleri arasında geçerli olmak üzere verilmiştir.

Bilgilerinize saygılarımla sunarım.

Prof. Dr. Canan SÜMER
Uygulamalı Etik Araştırma Merkezi
İnsan Araştırmaları Komisyonu Başkanı

Prof. Dr. Meliha ALTUNIŞIK
İnsan Araştırmaları Komisyonu
Üyesi

(İZİNCİ)
Prof. Dr. Aydan BALAMİR
İnsan Araştırmaları Komisyonu
Üyesi

Prof. Dr. Mehmet UTKU
İnsan Araştırmaları Komisyonu
Üyesi

Prof. Dr. Ayhan SOL
İnsan Araştırmaları Komisyonu
Üyesi

I. CURRICULUM VITAE

PERSONAL INFORMATION

Surname, Name: Tahancalıo, Semra

Nationality: Turkish (TC)

Date and Place of Birth: 9 June 1987, Tekirdağ

Marital Status: Married

E-mail: e148924@metu.edu.tr

EDUCATION

Degree	Institution	Year of Graduation
Ph. D.	METU, Elementary Education	2019
MS	METU, Elementary Science and Mathematics Education	2013
BS (Major)	METU, Elementary Science Education	2010
BS (Minor)	METU, Chemistry	2010
High School	Hayrabolu Anadolu Lisesi, Tekirdağ	2005

WORK EXPERIENCE

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FOREIGN LANGUAGES

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PUBLICATIONS

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J. TURKISH SUMMARY / TÜRKÇE ÖZET

BİLİM MERKEZLERİNE YÖNELİK MESLEKİ GELİŞİM ÜZERİNE BİR ÇALIŞMA: FEN ÖĞRETMENLERİNİN BİLİM MERKEZLERİ HAKKINDAKİ FARKINDALIKLARINDAKİ VE BİLİM MERKEZLERİNE GEZİ DÜZENLEME YOLLARINDAKİ DEĞİŞİM

1. Giriş

Birçok gelişmiş ülkede, kariyer tercihi olarak fen alanını seçecek öğrenci sayılarındaki düşüş büyük bir sıkıntı olarak görülmektedir (Braund ve Reiss, 2006b). Okullardaki mevcut fen derslerinin genellikle günlük yaşamla ilgili olmaması, soyut, sıkıcı, modası geçmiş ve yalnızca gelecek bilim insanlarını eğitmek için tasarlanmış olması (Braund ve Reiss, 2006b; Laçin Şimşek, 2011) bunun nedeni olarak gösterilebilir. Halbuki, alanyazında öğrencilerin fene olan ilgilerini artırmada ve sürdürmede önemli olan birbiri ile uyumlu bir öğrenme ortamı oluşturmak amacıyla müzeler ve okulların birbirlerine ihtiyaç duyduklarına dikkat çekilmektedir (Jolly, Campbell, ve Perlman, 2004). Ellenbogen ve Stevens (2005), okul gibi resmi bir ortamda başarılı olamayan bazı çocukların informal ortamlarda daha etkili bir şekilde öğrenebileceklerini belirtmiştir. Benzer şekilde, Ulusal Fen Öğretmenleri Birliği (NSTA, 1998, s.30) "informal fen eğitiminin, sınıftaki fen dersi çalışmalarını tamamladığını, desteklediğini, derinleştirdiğini ve geliştirdiğini" belirtmiştir. Her ne kadar sınıf müfredatının ve formal eğitim çalışmalarının iyileştirilmesi için informal eğitimi formal eğitim sürecine, özellikle fen eğitimine, dahil etmek etkili bir strateji olsa da (Duran, Ballone-Duran ve Haney, 2010), bilim merkezlerine ve müzelere yapılan sınıf gezileri öğrenmeyi artıracak şekilde düzenlenmemektedir (DeWitt ve Osborne, 2007). Bunun nedeni olarak, (1) öğretmen yetiştirme programlarında fen öğretmen adaylarının bir sınıf gezisini nasıl planlayacakları ve organize edecekleri konusunda yeterli bir şekilde eğitilmemeleri (Behrendt ve Franklin, 2014), (2) öğretmen adaylarının, bilim merkezlerinin olanaklarından haberdar olmadan mezun

olmaları (Taşdemir, Kartal ve Özdemir, 2006), (3) öğretmenlerin sınıf içeriğini müze ziyareti ile nasıl bütünleştireceğini bilmemeleri (Kisiel, 2006) gösterilebilir.

Öğretmenler hala kendilerine informal ortamlara yapılan sınıf gezileri hakkında şu tür sorular sormaktalar: "Öğrencilerimin bilimsel bilgi ve bilimi anlama açısından kazançları ne olacak?" (Braund ve Reiss, 2006a, s.1377). Rennie ve McClafferty'nin (1996; akt. Braund ve Reiss, 2006b, s.220) belirttiği gibi, "asıl soru: 'insanlar bir bilim merkezi ziyaretinden bilimi öğreniyor mu?' olmamalı. Bilim merkezleri insanların bilim ile daha olumlu bir ilişki kurmasına yardımcı oluyor mu?" (s.83) olmalıdır. İşte bu noktada öğretmenler, gerek öğrencilerin bilime olan ilgisini harekete geçirme ve çekmede, gerekse bilimsel bilgi ve bilimi anlama açısından kazançları için öğrencilerin önceki bilgileri ile bilim merkezi içerikleri arasında bağlantı kurmalarına yardımcı olmada önemli bir rol oynamaktadır (Cox-Petersen ve Pfaffinger, 1998). Ancak, bu tür etkinliklerin öğretmenler açısından planlama ve organizasyon gibi bazı gereksinimleri vardır (Behrendt ve Franklin, 2014). İlgili alanyazında, ziyaret öncesi informal öğrenim kurumunu ziyaret etmek, öğrencileri ziyarete hazırlamak, gezi sırasında kullanılmak üzere çalışma kağıdı hazırlamak gibi öğretmenlere çeşitli tavsiyeler sunulmaktadır (Griffin, 1999). Ama yine de, öğretmenlerin ziyaret için öğrencilerini yeterince hazırlayamadıkları; ziyaret için herhangi bir özel amaç benimsemedikleri; ve ziyaret edilen yerdeki öğrenme stratejilerini bilmedikleri görülmüştür (Anderson, Kisiel ve Storksdieck, 2006; Griffin, 1994; Griffin ve Symington, 1997; Jarvis ve Pell, 2005; Kisiel, 2005; Orion ve Hofstein, 1994; Storksdieck, 2001). Bu nedenle, öğretmenlerin öğrencilerinin informal öğrenme ortamlarında öğrenmelerine nasıl yardımcı olacakları ya da informal öğrenme ortamlarına başarılı bir sınıf gezisini nasıl yapacakları konusunda eğitilmeleri gerekmektedir. Sonuç olarak, öğretmenlerin bilim merkezleri gibi informal ortamlara yönelik sınıf gezileriyle ilgili bilgi, strateji ve öğretim planlamasını iyileştirmede etkili olmak için tutarlı ve kapsamlı bir mesleki gelişim programı gereklidir.

1.1. Araştırmanın Amacı

Yukarıda belirtilen konuları ele alarak, Türkiye Bilimsel ve Teknolojik Araştırma Kurumu'na (TÜBİTAK) BİLMER projesi adıyla bir mesleki gelişim programı (MGP) önerilmiştir. BİLMER projesinin amacı ("BİLMER Projesi: Bilim Merkezlerinin Bilim-Toplum İletişiminde ve Bilim Eğitiminde Etkinliğini Arttırmaya Yönelik Bir Öğretmen ve Eğitmen Mesleki Gelişim Modeli" - Proje Numarası: 114K646) öğretmen adaylarının, öğretmenlerin ve bilim merkezi eğitmenlerinin bilim merkezleri hakkındaki farkındalıklarını artırmak, bilim merkezlerini eğitsel amaçlı kullanımlarını geliştirmek ve onların bu alandaki yeterliklerini artırmaktır. Ayrıca, BİLMER projesi tarafından geliştirilen mesleki gelişim programının fen bilimleri öğretmenlerine uygulanması durumunda, bilim merkezlerine yapılan gezilerde öğrencilerinin öğrenmelerini en üst düzeye çıkarmak için bu öğretmenlerin bilim merkezlerindeki öğrenme fırsatlarını daha iyi kullanabileceği varsayılmaktadır. Bu çalışmanın temel amacı, "BİLMER Projesi: Bilim Merkezlerinin Bilim-Toplum İletişiminde ve Bilim Eğitiminde Etkinliğini Arttırmaya Yönelik Bir Öğretmen ve Eğitmen Mesleki Gelişim Modeli" tarafından geliştirilen mesleki gelişim programının fen bilimleri öğretmenlerinin bilim merkezleri hakkındaki farkındalıklarını ve bilim merkezine gezi düzenleme yollarını nasıl etkilediğini ortaya koymaktır. Bu amaçlar doğrultusunda, araştırma soruları aşağıdaki gibidir:

1. Mesleki gelişim programı fen öğretmenlerinin bilim merkezleri ve kaynakları hakkındaki farkındalığını nasıl etkilemiştir?
2. Mesleki gelişim programı, fen öğretmenlerinin bilim merkezlerine gezi düzenleme yollarını nasıl etkilemiştir?
    a) Araştırmacının gözünden, fen öğretmenlerinin bilim merkezi ziyaretini baştan sona gerçekleştirme stratejilerindeki değişiklikler nelerdir?
    b) Öğretmenlerin gözünden, mesleki gelişim programının ne tür özellikleri öğretmenlerin bilim merkezi ile ilgili öğretim planlarına katkıda bulunmuştur?

1.2. Araştırmanın Önemi

Türkiye'de altmış iki farklı şehirde altmış dokuz eğitim fakültesinde fen bilgisi öğretmenliği bölümü bulunmaktadır (CoHE, t.b.). Her şehrin etnografik ve arkeolojik materyaller içeren en az bir müzesi olmasına rağmen (Taşdemir ve diğ., 2014), ülkemizde on farklı ilde on sekiz farklı bilim merkezi bulunmaktadır (TÜBİTAK, t.b.). Bazı şehirlerde (örneğin, Ankara'da Feza Gürsey Bilim Merkezi, Polatlı Bilim Merkezi ve ODTÜ Bilim Merkezi) birden fazla bilim merkezi olduğu göz önüne alındığında, bilim merkezlerinin sayısı ve şehirlerarası dağılımı, eğitim fakülteleri sayısına göre oldukça düşüktür. Ayrıca, Taşdemir ve diğ. (2014), yirmi ildeki eğitim fakültesinde okuyan öğretmen adaylarının yüzde yirmisinin doğrudan bilim merkezlerinden yararlanabildiğini belirtmiştir. Bu oldukça düşük olan oran, öğretmen adaylarının çoğunun, bilim merkezlerinin olanaklarından haberdar olmadan mezun olduklarını göstermektedir. Buna bağlı olarak da öğretmenler bilim merkezleri gibi informal ortamlara başarılı bir gezi düzenlemeyi ve fen öğretimini bu gezilere nasıl entegre edeceklerini bilememektedir (Kisiel, 2003a; Taşdemir ve diğerleri, 2014). Ancak ülkemizdeki bilim merkezleri gibi informal öğrenme ortamlarına verilen önem gün geçtikçe artmaktadır. Örneğin, Bilim ve Teknoloji Yüksek Kurulu'nun 23. toplantısında, 2016 yılı itibariyle tüm büyük şehirlerde ve 2023'te tüm illerde yerel idarelerle işbirliği içinde bilim merkezlerinin kurulmasına yönelik çalışmaların yapılması kararlaştırılmıştır. (Çolakoğlu, 2017). Benzer şekilde, Milli Eğitim Bakanlığı'nın 2018 yılında yayımladığı fen bilimleri dersi öğretim programında benimsenen strateji ve yöntemler bölümünde okul dışı öğrenme ortamları vurgulanmıştır: "Öğrencilerin bilgiyi anlamlı ve kalıcı olarak öğrenebilmeleri için sınıf/okul içi ve okul dışı öğrenme ortamları, araştırma-sorgulamaya dayalı öğrenme stratejisine göre tasarlanır. Bu bağlamda informal öğrenme ortamlarından da (okul bahçesi, bilim merkezleri, müzeler, planetaryumlar, hayvanat bahçeleri, botanik bahçeleri, doğal ortamlar vb.) faydalanılır." (s. 11).

Günümüzde öğretmenlerin bilim merkezlerinden öğretim için yeterince yararlanamadıkları görülmektedir (Griffin ve Symington, 1997; Ramey-Gassert, Walberg ve Walberg, 1994; Tal, Bamberger ve Morag, 2005). Bu da, öğretmenleri

okul dışı öğrenme ortamından nasıl faydalanabileceği konusunda eğitecek bir mesleki gelişim programı olmaması nedeniyle olabilir (Melber ve Cox-Petersen, 2005). Bununla birlikte, alanyazında sınıf gezileri ile ilgili yapılan çalışmalar genellikle (1) öğretmenlerin gezi düzenleme stratejilerinin belirlenmesine (Kisiel, 2003a) ve (2) ziyaret öncesi hazırlık, ziyaret sırasındaki rolleri ve / veya ziyaret sonrası etkinlikleri için çeşitli önerileri ortaya koymaya odaklanmıştır (Anderson ve Lucas, 1997; Anderson, Lucas, Ginns, ve Dierking, 2000; Behrendt ve Franklin, 2014; Şentürk, 2015). Bu bağlamda, fen bilimleri öğretmeninin bir MGP'ye katılması sonucunda bir bilim merkezi ziyareti düzenleme yollarındaki değişimin araştırılması faydalı olacaktır. Bu çalışma, ilgili alanyazını genişleterek ve mesleki gelişim programının yukarıda bahsedilen konulardaki etkisine dair daha ayrıntılı bir tablo çizerek öğretmen eğitimcilerine, Milli Eğitim Bakanlığı'na (MEB), mesleki gelişim programı geliştiricilerine ve bilim merkezlerine çeşitli önerilerle katkı sağlayacaktır.

2. Yöntem

Çalışmada nitel araştırma yöntemlerinden biri olan durum çalışması deseni kullanılmıştır. Durum çalışmasında, BİLMER projesi kapsamında düzenlenen üç günlük mesleki gelişim programına katılan ve bu çalışmanın amacı doğrultusunda ODTÜ Bilim Merkezi'ne MGP öncesi ve sonrası olmak üzere iki kez gezi düzenleyen üç fen bilimleri öğretmeni durum olarak seçilmiştir. MGP'nin seçilen bu üç öğretmenin bilim merkezleri hakkındaki farkındalıklarına ve bilim merkezine gezi düzenleme yollarına etkisi açısından incelenmiştir.

2.1. Katılımcılar

Katılımcılar gönüllülük esasına dayalı, tipik örnekleme yaklaşımıyla araştırmanın amacına yönelik seçilmiştir. Katılımcıların seçiminde öğretmenlikte en az bir yıl deneyimli olmak, bilim merkezi gibi okul dışı öğrenme ortamlarına ilgi duymak, daha önce bilim merkezleri ile alakalı bir mesleki gelişim programına katılmamış olmak, çalışma için istekli olmak gibi kriterler göz önüne alınmıştır.

2.2. Veri Kaynakları

Veriler yarı yapılandırılmış görüşmeler, gözlem ve öğretim planı ile toplanmıştır. Buna göre, yarı yapılandırılmış görüşmelerin amacı, mesleki gelişim programının fen öğretmenlerinin bilim merkezleri hakkındaki farkındalıklarını ve bilim merkezine gezi düzenleme yollarını nasıl etkilediğini ortaya koymaktır. Bu görüşmeler MGP'den önce ve sonra olmak üzere ön görüşme ve son görüşme şeklinde düzenlenmiş olup, tüm görüşmeler ses kaydedici ile kayıt altına alınmıştır. Gözlem ise, araştırmacının gözünden öğretmenlerin bilim merkezi ziyaretini gerçekleştirmedeki stratejilerindeki değişikliği tespit amacıyla öğretmenlerin MGP'den önce ve sonra düzenlediği geziler sırasında yapılmıştır. Gözlemler sırasında araştırmacı katılımcı olmayan dışarıdan gözlemci (nonparticipant) rolünü benimsemiştir. Öğretim planının bir veri toplama aracı olarak kullanılmasının amacı, görüşmeler ve gözlemlerden elde edilen verileri çeşitlemektir (triangulation). Başka bir deyişle, araştırmacı, öğretmenlerin ziyaretleri hakkındaki görüşme sorularına verdiği cevapların ve ziyaretleri sırasında gözlemlenen eylemlerinin, öğretim planlarında yazılanlarla eşleşip eşleşmediğini belirlemek için öğretim planlarını kullanmıştır.

2.3. Verilerin Analizi

Öğretmenlerin bilim merkezi farkındalığı ve ODTÜ Bilim Merkezi ziyareti düzenlemedeki stratejileri ile ilgili toplanan verileri analiz etmek için hem betimsel hem de içerik analizi kullanılmıştır. Daha spesifik olarak, öğretmenlerin bilim merkezi farkındalığı, görüşme sorularına dayanarak takip eden çerçevelerde açıklayıcı (betimsel) bir şekilde sunulmuştur: Ankara ve Türkiye'deki bilim merkezleri hakkında farkındalık, bilim merkezi kaynakları hakkında farkındalık ve bu kaynaklardan yararlanma hakkındaki farkındalık. Ayrıca, öğretmenlerin bilim merkezi farkındalığı hakkındaki görüşleri 'verilerden elde edilen kavramlara göre' kodlanarak içerik analizine tabi tutulmuştur. Benzer şekilde, öğretmenlerin ODTÜ Bilim Merkezi ziyareti düzenlemedeki stratejileri, ilgili alanyazına dayanarak takip eden çerçeveler altında açıklayıcı bir şekilde sunulmuştur: gezi öncesi, sırası ve

sonrası stratejileri. Bununla birlikte, öğretmenlerin ODTÜ Bilim Merkezi ziyareti düzenlemedeki stratejilerine ilişkin veriler 'önceden tanımlanmış kavramlara göre' kodlanarak içerik analizine tabi tutulmuştur.

2.4. Çalışmanın Geçerliği ve Güvenirliği

Çalışmanın geçerliği ve güvenirliğini sağlamak amacıyla verilerin inandırıcılığı, tutarlılığı ve aktarılabilirliği açısından çeşitli yöntemler kullanılmıştır. Bu yöntemler, takip eden başlıklar altında sunulmuştur.

2.4.1. Verilerin inandırıcılığı

Çalışmada elde edilen verilerin inandırıcılığı için bazı yöntemler kullanılmıştır. Bu yöntemler, çeşitleme, akran değerlendirmesi (peer review) ve araştırmacının güvenirliği ve rolüdür (Merriam, 2009). Çeşitleme yönteminde araştırmacı, farklı yöntemlerle (görüşme, gözlem ve öğretim planı) elde edilen verileri birbirini teyit etmek amacıyla kullanmıştır. Akran değerlendirmesinde elde edilen bulguların güvenilir olup olmadığının incelenmesi için araştırmacı, hem fizik eğitiminde doktora derecesine sahip bir meslektaşından hem de fen eğitiminde bir uzmandan destek almıştır. Araştırmacının "eğitimi, deneyimi, bir işi yapabileceğini gösteren geçmiş tecrübeleri, statüsü ve kendisini takdimi" (Patton, 2002, s. 552) gibi çeşitli faktörlerin sunulması da araştırmacıların, dolayısıyla çalışmalarının güvenilirliğini arttırdığı bilinmektedir. Bu bağlamda bu çalışmanın araştırmacısı olarak, ODTÜ Bilim Merkezi'nde 2011-2019 yılları arasında hem eğitmen hem de araştırmacı olarak çalıştım. Her yıl farklı sınıf seviyelerinde bilim merkezini ziyarete gelen yaklaşık bin öğrenciye hizmet verdim. Ayrıca, ODTÜ Bilim Merkezi'nin (örneğin, TÜBİTAK, H2020-MSCA-NIGHT) yürüttüğü birçok araştırma projesinin tasarlanmasından, yazımına ve raporlanmasına kadar çeşitli aşamalarında görev aldım. Bu nedenle, uygun tasarımın seçilmesi, verilerin toplanması ve analiz edilmesi gibi çeşitli araştırma metodolojilerinde kendimi geliştirdim. Araştırmacının rolü açısından, (1) araştırmacının gözlemsel rolünün araştırılan ortamda ne ölçüde olacağına karar verme (Patton, 2002; Merriam, 2009), (2) katılımcıların gözlemleri ve çalışmanın

amacı hakkında ne ölçüde bilgilendirileceğine karar verme (Patton, 2002) ve (3) araştırmacının katılımcılar ve çalışma ortamında harcadığı zaman miktarı (Patton, 2002) gibi değişkenlerle çalışmanın inandırıcılığı için detay sunulmalıdır. Bu bağlamda, gözlemler sırasında araştırmacı katılımcı olmayan dışarıdan gözlemci (nonparticipant) rolünü benimsemiştir. Çalışmanın başlangıcında katılımcılara gönüllü katılım formu imzalatılarak, çalışmanın amacı, katılımcılardan beklentiler ve verilerin gizliliği gibi konular hakkında bilgi verilmiştir. Ayrıca, verilerin geçerliliğinin daha yüksek olmasında etkili olan katılımcı ve araştırmacı arasındaki etkileşim, telefon görüşmeleri, okul ziyaretleri ve mesleki gelişim programında birlikte geçirilen zaman ile sağlanmıştır.

2.4.2. Verilerin tutarlılığı

Nicel araştırmalardaki bulguların tekrar edilebilirliği, nitel araştırmalarda mümkün değildir, çünkü insan davranışları asla durağan değildir (Merriam, 2009). Veri kaynaklarının tutarlılığı ve değerlendiriciler (puanlayıcılar) arası güvenilirlik olmak üzere tutarlılığı sağlamanın iki yolu vardır. Bu çalışmada, öğretim planları, görüşmeler ve gözlemler dahil olmak üzere çeşitli veri kaynakları kullanılmış ve tüm bu veri kaynakları içsel olarak birbirleriyle tutarlıdır. Ayrıca, öğretmenlerin bilim merkezleri hakkındaki farkındalıkları ve bilim merkezi ziyaretini düzenleme stratejileri ile ilgili elde edilen kodlar nitel araştırmada, eğitim alanında ve bilim merkezleri ile buralara yapılan ziyaretler alanında uzman bir kişi tarafından kontrol edilmiştir. Değerlendiriciler arası güvenilirlik, Miles ve Huberman (1994) tarafından önerilen formül kullanılarak, öğretmenlerin bilim merkezleri farkındalığı için %89, bilim merkezine gezi düzenlemedeki stratejileri için %97 olarak hesaplanmıştır. Öğretmenlerin bilim merkezi ziyaretine ilişkin öğretim planlamasını etkileyen MGP özelliklerine ilişkin görüşleri ile ilgili elde edilen kodlar nitel araştırma ve eğitim alanında uzman olan iki farklı araştırmacı tarafından kontrol edilmiştir. Bu kodların puanlayıcılar arası güvenilirlik hesabı için Kappa analizi yapılmıştır. Buna göre, tüm puanlayıcılarda ortalama Kappa değeri ($p < .0005$ anlamlılığı ile) .88 olarak bulunmuştur.

2.4.3. Verilerin aktarılabilirliği

Bir çalışmanın aktarılabilirliği, sonuçların diğer durumlara genelleştirilmesi ile ilgilidir (Merriam, 2009). Araştırmanın aktarılabilirliğini sağlamak için bir araştırmacı ayrıntılı betimleme yapmalıdır. Bu nedenle, araştırmacı araştırmanın geçtiği ortamları, mesleki gelişim programını, katılımcıları ve bulguları (yer yer ayrıntılı alıntılar ile) detaylı olarak tanımlamıştır. Ayrıca, bu çalışma Ankara'da yaşayan ve araştırmanın amacına yönelik seçilen fen bilimleri öğretmenlerini incelemektedir. Bu açıdan da, bu çalışmanın aktarılabilirliğinin sınırlı olduğu söylenebilir. Bu çalışmanın genelleştirilebilirliği, özellikleri ve geçmişleri mevcut çalışmanın örneklemine benzeyen fen öğretmenleri için kabul edilebilir olacaktır. Ayrıca, öğretmenlerin gözlemleri ve bilim merkezi gezi organizasyonu belirli bir ortamda (ODTÜ Bilim Merkezi) gerçekleşmiştir. Bu nedenle, diğer bilim merkezlerine genellenebilirlik sınırlı olabilir.

2.5. Çalışmanın Sınırlılıkları

- Bu çalışmada, fen bilimleri öğretmenlerinin 4., 5., ve 6. sınıf öğrencileri ile düzenlediği sınıf gezisi deneyimleri incelenmiştir. Bu nedenle, çalışmanın bulguları diğer sınıf öğretmenleri için geçerli olmayabilir.
- Sınıf gezisi deneyimi yalnızca belirli bir bilim merkezinde (ODTÜ Bilim Merkezi) gerçekleştiğinden, çalışmanın bulguları benzer ortamlar için geçerli olabilir.
- Öğretmenlerin gezi öncesi ve sonrası gerçekleştirdiği etkinlikler gözlemlenmemiştir. Bu nedenle, öğretmenlerin gezi öncesi ve sonrası stratejileri ile ilgili veriler görüşmelerde öğretmenlerden elde edilen cevaplara dayanarak raporlanmıştır.
- Bilim merkezine düzenlenen ikinci gezi sırasındaki öğretmenlerin davranışı, sadece mesleki gelişim programındaki deneyimlerden değil, ODTÜ Bilim Merkezi'ne ilk ziyaret sırasında edinilen deneyimlerden de etkilenmiş olabilir.

2.6. Mesleki Gelişim Programı

Bu çalışmadaki mesleki gelişim programı 11-13 Mart 2016 tarihlerinde Gazi Üniversitesi Eğitim Fakültesi'nde gerçekleştirilmiştir. Onaltı oturum ve toplam otuzaltı saatten oluşan mesleki gelişim programında ODTÜ ve Feza Gürsey Bilim Merkezlerine, Ankara Üniversitesi Kreiken Rasathanesine geziler düzenlenmiştir. Programa, Türkiye'nin farklı illerindeki bilim merkezlerinden toplam 13 bilim merkezi eğitmeni ile farklı okullardan ve branşlardan (Fen, Fizik, Kimya, Biyoloji) toplam 25 öğretmen katılmıştır. Katılıcımlar, gönüllülük esasına ve bazı kriterlere (örneğin, daha önce MEB ve(ya) TÜBİTAK tarafından düzenlenen etkinliklere katılma durumuna) göre seçilmiştir. Programın içeriği ile ilgili detaylar Tablo J.'de özet olarak sunulmuştur.

Tablo J.
Mesleki Gelişim Programı İçerik Özeti

Oturumlar	**İçerik**
1. Oturum	• BİLMER Projesi ve MGP tanıtımı • Bilim merkezi eğitmenlerinin bilim merkezlerini etkileşimli tanıtımla sunmaları
2. Oturum	• "Bilim-Toplum İletişimi ve Bilim Eğitiminde Bilim Merkezlerinin Önemi" konulu etkileşimli uzman sunumu • "Ses Konusu Öğretim Dizini" video gösterimi – Bilim merkezlerinin okul müfredatlarına alternatif değil, tamamlayıcı ortamlar olarak kullanılabileceğini göstermek • "Yerçekimine Meydan Okumak" Etkinliği – Sorgulamaya dayalı öğretim stratejilerinin bir bilim gösterisine nasıl uygulanacağını göstermek • "Soğuk, Daha Soğuk" Etkinliği – Bir bilim gösterisinin Tahmin Et-Gözle-Açıkla (TGA) tekniği kullanılarak nasıl sunulabileceğini göstermek
3. Oturum	• "Daphnia Kalbi" Etkinliği – Bilim merkezi ziyaretine entegre bir etkinliğin nasıl verimli bir şekilde yürütüleceğini göstermek • "Zebra Balığı" Sergisi – Bilimsel çalışmaların anlaşılır ve basit bir dilde nasıl sunulacağını göstermek
4. Oturum	• "Sihirli Kutu" Etkinliği – Bilimin doğasına hizmet eden ve bilim merkezlerindeki sergi düzeneklerinin masa üstü bir versiyonunu sunmak • "Plastinasyon" konulu uzman sunumu – Hem okullarda hem de bilim merkezlerinde eğitim materyali olarak kullanılabilecek yeni teknolojiler/uygulamalar tanıtmak

Tablo J. (devamı)
Mesleki Gelişim Programı İçerik Özeti

Oturumlar	**İçerik**
5. Oturum	• "Allah Raydan Çıkarmasın" Etkinliği – Bilim merkezi sergi düzeneklerinden yararlanarak TGA tekniği ile nasıl bir ders yapılacağını göstermek
6. Oturum	• "Bakmak Görmek Değildir" Etkinliği – Bilimin doğasını vurgulamak • "Sıvı Azotla Dondurma" Etkinliği – Hem öğretmenlerin hem de eğitmenlerin bilim gösterilerinin vazgeçilmez bir parçası olan 'sıvı azot' konusunda farkındalıklarını artırmak
7. ve 8. Oturum	• ODTÜ Bilim Merkezi Gezisi; o Keşif için serbest zaman o "Tırmanan Koni" Gösterimi – Bir sergi düzeneğini öğrencilere nasıl daha iyi açıklayabileceğimizi göstermek o "Magdeburg Küreleri Öğretim Dizini" Gösterimi – Bilim merkezi ziyaretinin okul müfredatına tamamlayıcı olarak nasıl kullanılabileceğini göstermek o Bir dizi Kimya etkinlikleri - Magnesium flaşı, Hydrojen Balonu Patlatma, sabun Yapımı, Limon Pili vb. o "Göremediğimiz Canavarlar" Etkinliği – Bilim merkezlerinde ve okullarda yapılabilecek bir biyoloji etkinliği tanıtımı
9. Oturum	• "Başarılı Bir Sınıf Gezisi" konulu etkileşimli uzman sunumu
10. Oturum	• "Bilim Merkezlerinde Öğrenme ile İlgili Ders Planları Geliştirme" Etkinliği
11. ve 12. Oturum	• "Ankara Üniversitesi Kreiken Rasathanesi" Gezisi – Türkiye'deki ve Dünyadaki gözlemevleri ve teleskoplar, astronomi etkinlikleri hakkında bilgi edinmek
13. ve 14. Oturum	• Feza Gürsey Bilim Merkezi Gezisi o Keşif için serbest zaman o "Durgun Elektrik (Van De Graaff Jeneratörü)" Gösterimi o Feza Gürsey Bilim Merkezindeki gezi süreçleri hakkında tanıtıcı sunum o "Balık Pullarındaki Sırlar" Etkinliği - Bilim merkezi ziyaretine entegre bir etkinliğin nasıl verimli bir şekilde yürütüleceğini göstermek o "İddiaya Giren Var mı?" Etkinliği – Bilim merkezi gezisinden önce veya sonar kullanılabilecek bir sınıf içi etkinlik örneği vermek o "Döndürmek Gerçekten Kolay mı?" Etkinliği - Bilim merkezi gezisinden önce veya sonar kullanılabilecek bir sınıf içi etkinlik örneği vermek
15. Oturum	• "Fillerin Diş Macunu" Demonstration – Bir bilim gösterisinin nasıl yapılması gerektiğini göstermek
16. Oturum	• MGP genel değerlendirme ve teşekkür belgelerinin takdimi

3. Bulgular ve Tartışma

Araştırmanın sonuçları, mesleki gelişim programında (1) bilim merkezlerinin hem eğitmenlerin sunumları, hem de bazı bilim merkezlerine düzenlenen gezi yoluyla tanıtılmasının, (2) bilim merkezi eğitmenleri ile iletişimin sağlanmasının ve (3) bazı sergi düzeneklerinin masa üstü versiyonlarının sunulmasının öğretmenlerin bilim merkezleri ve kaynakları hakkındaki farkındalıklarına katkıda bulunduğunu ortaya koymuştur. Bu arada, eğitmen sunumlarının öğretmenlerin arkasına yaslanıp dinlediği sıradan bir "powerpoint" sunumu olmayıp, öğretmenlerin bilim merkezleri ve kaynakları hakkında eğitmenlere sorular sorduğu, birbirleri ve eğitmenlerle tartıştığı aktif katılımlı ve etkileşimli sunumlardı. Ayrıca, Fallik, Rosenfeld ve Eylon (2013) tarafından önerildiği gibi mesleki gelişim programı boyunca öğretmenler ve eğitmenler arasında etkileşim ve işbirliği sağlayan altyapıların oluşturulması da öğretmenlerin bilim merkezleri hakkında bilgi edinmelerine katkıda bulunmuş olabilir. Öte yandan, sonuçlar öğretmenlerin Ankara'daki bilim merkezleri hakkındaki farkındalığı konusunda "bilim merkezi gezileri" ve "eğitmenler ile iletişimin sağlanması"nın ön plana çıktığını; öğretmenlerin Türkiye'deki (Ankara hariç) bilim merkezleri hakkındaki farkındalığı konusunda ise eğitmen sunumlarının ön plana çıktığını göstermiştir. Bu bulgu dikkate alındığında, öğretmenlerin ulaşılabilir uzaklıktaki bilim merkezleri hakkında bilgi edinmek için gezileri tercih ediyor olabilecekleri söylenebilir. Nitekim, Melber'in (2007, s.40) de dediği gibi: "bilinmeyen bir örnekle ilgili nasıl bilimsel notların alınacağına ilişkin öğretim herhangi bir ortamda (müze veya okul) yapılabilirken, sergi düzeneklerinin etkin kullanımına, çalışan bir küratör laboratuvar ziyaretine, yerel bir müzeden ödünç alınan nesnelerin sergilenmesine yönelik öğretim yapılamaz". Bu nedenle, eğer öğretmenlerin bilim merkezleri ve kaynakları hakkındaki farkındalıklarının arttırılması isteniyorsa, mesleki gelişim programlarında bilim merkezi gezileri düzenlenmelidir. Eğer bilim merkezleri ulaşılabilir uzaklıkta değilse, en azından öğretmenler ve bilim merkezlerinin eğitmenleri mesleki gelişim programlarında bir araya getirilmelidir.

Mesleki gelişim programından önce öğretmenlerin bilim merkezi kaynakları hakkındaki farkındalıkları incelendiğinde, sergi düzeneklerini, eğitmenleri ve gökevlerini (planetarium) bilim merkezi kaynakları olarak gördükleri tespit edilmiştir. Öte yandan, mesleki gelişim programında eğitmenlerin sunumu ve Ankara'daki tanınmış bilim merkezlerine (ODTÜ ve Feza Gürsey Bilim Merkezleri) düzenlenen geziler aracılığıyla, öğretmenlerin MGP sonrası bilim merkezi kaynakları hakkında daha genişlemiş bir bilgi yelpazesine sahip olduğu görülmüştür. Bu bulgular, etkinliklerin tanıtımı, tipik bir gezi ve rehberli [eğitmenli] turları içeren müze/bilim merkezi atölyelerine katılımın bir sonucu olarak öğretmenlerin bilim merkezleri hakkındaki farkındalığının arttığını bulan Ogbomo'nun (2010) sonuçlarını destekler niteliktedir. Bununla birlikte, öğretmenlerin bilim merkezi kaynakları ve bunların eğitsel amaçlı kullanımı hakkındaki farkındalığı konusunda "eğitmen sunum"larının ön plana çıktığı görülmüştür. Bu sonuç doğrultusunda, öğretmenlerin bu konular hakkında bilim merkezi eğitmenlerinden bilgi almayı tercih ettiği söylenebilir. Nitekim, bilim merkezi eğitmenleri, öğretmen ve öğrenci gibi ziyaretçiler tarafından bilim merkezlerindeki en bilgili kişi olarak kabul edilmektedir (Gomes da Costa, 2005; Rodari ve Xanthoudaki, 2005). Bu nedenle, bir mesleki gelişim programı hazırlanırken öğretmen ve eğitmenleri bir araya getirmenin faydalı olacağı söylenebilir.

Öğretmenlerin bilim merkezleri ve kaynakları hakkındaki farkındalıklarını etkileyen faktör olarak eğitmen sunumlarının bu kadar ön plana çıkmasının bir başka nedeni araştırmanın ve görüşme sorularının yapısı olabilir. Diğer bir deyişle, araştırmanın ve görüşme sorularının yapısının öğretmenlerin bilim merkezleri ve kaynakları hakkında ne ve ne kadar bildiklerini ölçmeye yönelik olmasıdır. Örneğin; "Türkiye'deki bilim merkezleri hakkında bir fikriniz var mı? ... Bilim Merkezi ile ilgili neler söyleyebilirsiniz? Bilim merkezi kaynakları hakkında bir fikriniz var mı? Varsa, neler?" gibi. Öğretmenler bir bilim merkezi hakkındaki bilgiye, bilim merkezini ziyaret ederek, internet sitesini inceleyerek, bilim merkezi eğitmeninden ya da bilim merkezini iyi bilen birinden bilgi alarak ulaşabilir. Ama yine de, bir bilim merkezinde çalışan bilgili kişilerden (eğitmenlerden) bilgi almanın, öğretmenlerin bu konu hakkındaki farkındalığını artırmada ekstra bir motivasyon kaynağı olabileceği iddia

edilebilir. Eğer öğretmenler bilim merkezleri ve kaynakları hakkında eğitmenler tarafından değil de mesleki gelişim programı ekibindeki uzmanlar tarafından bilgilendirilmiş olsalardı, bu konulardaki farkındalıklarında aynı kazanımlar elde edilemeyebilirdi. Başka bir deyişle, bilim merkezinde çalışan ve bilgili kişiler olarak görülen eğitmenlerden bilgi almak öğretmenlere, motivasyon ve öğrenmelerinde önemli rol oynayan olumlu duygular (örneğin, ilgi duymak, keyif almak) sağlamış olabilir (Fallik ve diğ., 2013; Pintrich ve Schunk, 2002). Benzer şekilde, Pintrich ve Schunk (2002) ilginç sunumların, görevlerin ve metinlerin kullanımının kişilerde "durumsal ilginin (situational interest)" oluşmasına ve artmasına neden olabileceğini ileri sürmüştür. Bu çalışmada ise, Ankara'daki tanınmış bilim merkezlerine yapılan geziler ile gerçek deneyimler ve eğitmenlerin etkileşimli sunumları, öğretmenlerde durumsal ilgi yaratma ve(ya) durumsal ilginin artmasına, dolayısıyla da onların bilim merkezleri ve kaynakları hakkındaki farkındalıklarının artmasına neden olmuş olabilir. Bu nedenle, öğretmenlerin bu konulardaki farkındalıklarının artırılmasında, mesleki gelişim programlarında bilim merkezi gezilerinin düzenlenmesinin ve eğitmen sunumlarının önemli ve gerekli olduğunu göstermektedir.

Bu çalışmanın bir diğer önemli bulgusu ise, öğretmenlerin bilim merkezi ziyaretini gerçekleştirirken kullandıkları stratejilerinin mesleki gelişim programına katıldıktan sonra geniş bir şekilde çeşitlenmesidir. Örneğin, mesleki gelişim programından önce, bütün öğretmenler tarafından raporlanan ortak gezi-öncesi-stratejileri: "mekan aşinalığı (site familiarization)" ve "yapılacak genel şeyler (general things to do)"di. Öğretmenlerin en çok bu iki stratejiyi tercih etmelerinin nedenleri hakkında iki varsayımda bulunabiliriz: 1. öğretmenler alanyazında belirtildiği gibi, sınıf çalışmalarını bilim merkezi ziyaretleri ile nasıl destekleyeceğini bilmiyor olabilirler (Behrendt ve Franklin, 2014; Kisiel, 2006), 2. Kisiel'in (2003a) çalışmasından farklı olarak, öğretmenler bilim merkezi ziyaretini sınıf çalışmalarının bir parçası olarak görmüyor olabilir. Öte yandan, daha önce de bütün öğretmenler tarafından raporlanan "mekan aşinalığı" ve "yapılacak genel şeyler" stratejilerine ek olarak öğretmenlerin mesleki gelişim programından sonraki ortak gezi-öncesi-stratejileri: "Öğretim planı hazırlama (instructional planning)", "içerik aşinalığı (content familiarization)" ve "prosedür aşinalığı (procedure familiarization)"dır. Bu bulgular, ilk varsayımın

geçerliliğini göstermektedir. Yani, mesleki gelişim programından önce, öğretmenler bilim merkezi ziyaretlerini sınıf çalışmaları ile nasıl entegre edeceklerini bilmiyor olabilir. Nitekim, Öğretmen A'nın görüşme sorularına verdiği yanıtlardan biri bu varsayımı doğrular niteliktedir: *"[ODTÜ Bilim Merkezi'ne öğrencileriyle ilk ziyareti hakkında] ...hiç birşey bilmiyordum: 'Öğrencilere nasıl davranmalıyım?', 'Hangi noktalarda yer almalıyım?', 'Öğrencilerim ne görecek?', 'Etkinlikler öğrencilerin seviyesi ve konumuz için uygun mu?'..."*. Öğretmenlerin ikinci gezilerinde farklı gezi-öncesi-stratejilerinden yararlanmalarına mesleki gelişim programına katılmaları neden olmuş olabilir. Başka bir deyişle, (1) "müfredat bağlantısı (curriculum connection)", (2) "masa üstü sergi düzenekleri (tabletop exhibits)" ve (3) "iletişime vurgu (emphasis on communication) –bilim merkezi ziyaretinden önce veya ziyaretin planlanması sırasında eğitmenlerde iletişime geçilmesine özellikle dikkat çekilmesi-" gibi MGP'nin bazı özelliklerinin öğretmenlerin sırasıyla "içerik aşinalığı" ve "prosedür aşinalığı" stratejilerinde etkili olduğu görülmüştür. Örneğin, öğretmenlerden biri gezi öncesi dersinde el-göz-beyin koordinasyon sergi düzeneğinin masaüstü versiyonunu kullanmıştır. Mesleki gelişim programında masa üstü versiyonların fen derslerini bilim merkezi ziyaretleri ile ilişkilendirmede kullanılabileceği çeşitli etkinliklerle anlatılmıştı. Benzer şekilde, öğretmenler ikinci gezilerinde neler olacağını öğrenmek için gezi öncesinde bilim merkezi ile iletişim kurmuşlardır.

Mesleki gelişim programından önce öğretmenler gezi-sırası-stratejileri olarak "yapılandırılmamış öğrenci katılım (unstructured student engagement)" ve "etkinlik dokümantasyonu (event documentation)" stratejilerini yaygın olarakbelirtmişlerdir.. Öte yandan, daha önce de bütün öğretmenler tarafından raporlanan "yapılandırılmamış öğrenci katılım" ve "etkinlik dokümantasyonu" stratejilerine ek olarak öğretmenlerin mesleki gelişim programından sonraki ortak gezi-sırası-stratejileri: "yapılandırılmış öğrenci katılım (structured student engament)" ve "öğretim planına uygun hareket etme (following instructional plan)"dir. MGP'den önce ve sonra "etkinlik dokümantasyonu" stratejisinin kullanılması diğer çalışmalarda olduğu gibi (Kisiel, 2003a; Şentürk, 2015) öğretmenlerin ziyaret deneyimlerini belgelemek için fotoğraf ve video çektiği informal ortamlara yapılan

ziyaretlere özgü özel bir strateji olarak düşünülebilir. Diğer yandan, "yapılandırılmamış öğrenci katılım" strateji türlerindeki değişimlerle ilgili olarak, MGP'nin etkisinden doğrudan söz etmek zor olacaktır. Çünkü yapılandırılmamış stratejiler, Kisiel'in (2003a) de iddia ettiği gibi, kendiliğinden, koşullara bağlı olarak gelişen, ziyaret öncesinde belirli hazırlıklara daha az bağımlı olan stratejilerdir. Bu çalışmada, öğretmenlerin "yapılandırılmamış öğrenci katılım" strateji türlerindeki değişimler, öğrencilerin sınıf düzeyleri, serbest zamanda öğrencilerin gruplandırılması, öğretmenlerin belirli durumlara yaklaşımı gibi çeşitli nedenlerden kaynaklanmış olabilir. Ayrıca, öğretmenlerin ilk gezilerinden farklı olarak, ikinci gezilerinde bazı "yapılandırılmış öğrenci katılım" stratejilerini (örneğin, öğrencilerin önceden belirlenmiş sunumlara katılmaları, elektrikle ilgili sergi düzenekleri hakkında notlar almalarının sağlanması) kullanmalarında mesleki gelişim programının etkileri olabilir. Şöyleki, mesleki gelişim programında (1) öğretmenlere bilim merkezi gibi informal öğrenme ortamlarında kullanılacak etkili stratejiler hakkında genel bilgilendirme yapılması (Chin, 2004), (2) öğretmenlerin hem okul hem de bilim merkezini karakterize eden etkinliklere maruz bırakılarak yenilik alanlarının (novelty space) azaltılması gibi çeşitli faktörler onların yapılandırılmış stratejiler kullanmalarında etkili olmuş olabilir. Ayrıca, öğretmenlerin öğrencileri ile bilim merkezini ilk ziyaretlerinde elde ettiği deneyimleri de göz ardı etmemek gerekir. Kisiel (2003a, s.210) tarafından iddia edildiği gibi: "her öğretmen sınıf gezisini şekillendiren farklı koşullardan [örneğin, kişisel deneyimler, beklentiler] gelir". Nitekim, Öğretmen C'nin görüşme sorularına verdiği yanıtlardan biri bu duruma örnek olarak gösterilebilir: *"İlk gezimiz sırasında birşeylerin eksik olduğunu hissettim... Öğrencilerim etrafta başıboş dolaştı...Öğrencilerimi kontrol edemedim... Ancak mesleki gelişim programı boyunca eksikliklerimi sorgulama ve onların üstesinden nasıl gelebileceğime dair öğrenme fırsatım oldu. Yapılacak ilk şey iyi bir plan hazırlamaktı..."*. Dolayısıyla, öğretmenler sınıf gezilerinde kullabilecekleri stratejiler hakkında bilgilendirilirse veya sınıf gezisi deneyimlerine maruz bırakılırsa, bu yaşantılarını bir sonraki gezilerinde yansıtmalarının daha olası olduğu iddia edilebilir.

Öğretmenlerin gezi-sonrası-stratejileri olarak mesleki gelişim programından önce ve sonra "gözden geçirme ve tartışma (review and discussion)" stratejisini kullandığı tespit edilmiştir. Aslında, "yapılandırılmamış tamamlama (unstructured wrap-up)" olarak da görülen (Kisiel, 2003a, s.187) bu strateji, öğretmenler tarafından öğrencilerin gezi deneyimlerini gözden geçirmenin kolay yolu görülüyor olabilir. Öte yandan, ODTÜ Bilim Merkezi'ne yapılan ikinci ziyaretten sonra "gözden geçirme ve tartışma" stratejisine ek olarak öğretmenlerin elektrik test devrelerinin kullanılması ["diğer gezi-sonrası etkinlikler (other post-visit activities)" olarak kodlanmış], yazma-çizme veya öğrenci çalışmalarından pano yapılması ["belgeleme (documentation)" olarak kodlanmış] gibi ilave stratejilerde kullandığı bulunmuştur. Öğretmenlerin mesleki gelişim programına katılması, onların gezi-sonrası stratejilerini bu yönde genişletmelerini sağlamış olabilir. Diğer bir deyişle, mesleki gelişim programında öğretmenlere Bildiklerim-Merak ettiklerim-Öğrendiklerim (BMÖ) çizelgesini tamamlama, sergi düzeneklerinin masa üstü versiyonlarından yararlanma, kompozisyon yazma gibi çeşitli gezi-sonrası stratejileri önerilmişti.

Sonuç olarak, bu öğretmenlerin mezuniyetine kadar gerek informal ortamlar tarafından, gerekse üniversiteler tarafından verilen informal öğrenme ortamlarına yönelik bir eğitimin olmaması, öğretmenlerin ODTÜ Bilim Merkezi'ne ilk ziyaretlerinde daha genel ve yapılandırılmamış stratejiler kullanmamalarının nedeni olabilir. Nitekim, birkaç üniversitede (örneğin, Gazi Üni. ve Hacettepe Üni.) bu konudaki dersler yakın zamanda sunulmaya başlandı. Benzer şekilde, Tal ve arkadaşları (2005) da, öğretmenlerin gezi planındaki katılımcı olmayan rollerinin sebebi olarak müzeler tarafından sunulan mesleki gelişim programlarını işaret etmektedir. Çünkü, bu programlar öğretmenlerin başarılı bir gezinin nasıl yapılacağına dair öğretmen pedagojilerine değil, müzeler ve kaynakları hakkında bilgilendirmeye odaklanmaktadır (Tal ve diğ., 2005). Bununla birlikte, bu çalışmada öğretmenlerin bilim merkezi ziyaretini gerçekleştirirken kullandıkları stratejilerinin mesleki gelişim programına katıldıktan sonra geniş bir şekilde çeşitlendiği tespit edilmiştir. Bu gelişmenin sebebi, öğretmenleri (1) sadece bilim merkezleri ve kaynakları hakkında bilgilendiren gezileri içeren değil, aynı zamanda (2) okul ve bilim merkezi arasındaki boşluğu doldurmaya yönelik başarılı bir gezinin nasıl

gerçekleştirileceğine ilişkin öğretmenlerin ve eğitmenlerin pedagojilerine odaklanan etkinlikleri içeren (Fallik ve diğ. 2013) mesleki gelişim programı olduğu iddia edilebilir. Sonuç olarak, bunların tümü öğretmenlerin niyetlerini eyleme dönüştürme süreci olan tanımlanan iradelerinin ["volition"] (Pintrich ve Schunk, 2002, s.21) üzerinde olumlu bir etki yaratmış olabilir. Ayrıca, bu çalışmadaki mesleki gelişim programına katılan tüm öğretmenlerin bu stratejileri kullanacaklarını veya stratejilerini bu yönlerde değiştireceklerini söylemek doğru olmayacaktır. Mevcut çalışmada bile, öğretmenlerin stratejilerindeki değişimler aynı konuya ve aynı bilim merkezine ilişkin geziyi gerçekleştirmelerine rağmen birbirlerinden farklıydı. Bunun nedeni, öğrencilerin sınıf seviyesindeki farklılık, okul türü, öğretmenlik deneyimleri gibi çeşitli sebepler olabilir. Nihayetinde, öğretmenler sınıf gezilerinde öğrencileri için kilit kararları veren kişilerdir (Kisiel, 2003a; Şentürk, 2015).

Bu çalışmadaki diğer önemli bir bulgu ise, mesleki gelişim programının öğretmenlerin bilim merkezi ziyareti ile ilgili öğretim planlamasını etkileyen, müfredat bağlantısı, fikir alışverişi, öğretim planı, öğretim teknikleri ve yöntemleri, masa üstü sergiler ve iletişime vurgu gibi yedi farklı özelliğidir. Bununla birlikte, "öğretim planı" ve "iletişime vurgu" tüm öğretmenler tarafından ortak olarak rapor edilenlerdir. Bu sonuçlar, sınırlı sayıdaki geçmiş araştırmaların bulgularıyla bir şekilde tutarlıdır. Örneğin, müze odaklı mesleki gelişim programının sonunda Chin (2004) öğretmenlerin meslektaşlarından geri bildirim almalarının ve diğer gruplar tarafından geliştirilen öğretim planlarını gözden geçirmelerinin onların kendi öğretim planlarını iyileştirmede etkili olduğunu ileri sürmüştür. Bu çalışmadaki öğretmenlerden biri tarafından da benzer bir bulgu bildirilmiştir: *"örnek bir öğretim planını detaylıca inceledikten sonra, eğitmenlerle birlikte grup olarak bir bilim merkezi gezisine yönelik kendi öğretim planımızı geliştirdik. Ardından, her grup kendi planını sunarak diğer gruplardan geri bildirim aldı"*, *"kendi öğretim planımı geliştirirken MGP'de öğrendiklerimden ve örnek öğretim planınından yararlandım"*. Chin'in (2004) çalışmasından farklı olarak, bu çalışmadaki öğretmenlerin tümü ODTÜ Bilim Merkezi'ne ikinci ziyaretlerine ilişkin öğretim planlarına ilham kaynağı olarak MGP'de sunulan örnek öğretim planından bahsetmiştir. Bu sonuç, bilim merkezleri ile ilgili mesleki gelişim programlarında örnek öğretim planlarının

sunulmasının önemini ve gerekliliğini göstermiştir. Bunun dışında, Ogbomo'nun (2010) çalışmasındaki öğretmenler müze/bilim merkezi atölye çalışmalarını okul müfredatlarına uygun materyal ve kaynak sağladıkları için yararlı bulmuşlardır. Nitekim, Ogbomo (2010) bu durumun öğretmenleri programdan öğrendiklerini uygulamaya teşvik edeceğini iddia etmiştir. Ogbomo'nun (2010) iddiasına paralel olarak, iki öğretmen MGP'nin "müfredat bağlantısı" özelliğinin, bilim merkezi ziyaretleriyle ilgili öğretim planlarında etkili olduğunu belirtmişlerdir. Buradan hareketle, "müfredat bağlantısı"nın mesleki gelişim programlarında önemli ve gerekli bir özellik olduğu söylenebilir. Unutulmamalıdır ki, bu çalışmada sadece üç fen bilimleri öğretmeninin bilim merkezi gezileriyle ilgili öğretim planlarını etkileyen MGP özelliklerine dair görüşleri sunulmuştur. Daha fazla öğretmenle çalışılsaydı ve(ya) farklı geçmişe veya farklı disiplinlerden öğretmenlerle çalışılsaydı, mesleki gelişim programının diğer farklı özellikleri tespit edilebilirdi.

4. Öneriler

Bu çalışmadan elde edilen sonuçların ve yukarıda tartışılan noktaların ışığında, fen öğretmen eğitimcilerine, hizmet öncesi ve hizmet içi eğitimine, bilim merkezleri ve benzeri informal ortamlara, mesleki gelişim programı geliştiricilerine ve Milli Eğitim Bakanlığı'na (MEB) bazı önerilerde bulunulmuştur. Daha açık ifade etmek gerekirse, bu çalışma, fen öğretmenlerinin bilim merkezleri hakkındaki farkındalığını mesleki gelişim programına katılarak geliştirdiğini göstererek ilgili alanyazına katkıda bulunmuştur. Araştırmanın sonuçları, mesleki gelişim programında (1) bilim merkezlerinin hem eğitmenlerin sunumları, hem de bazı bilim merkezlerine düzenlenen gezi yoluyla tanıtılmasının, (2) bilim merkezi eğitmenleri ile iletişimin sağlanmasının ve (3) bazı sergi düzeneklerinin masa üstü versiyonlarının sunulmasının öğretmenlerin bilim merkezleri ve kaynakları hakkındaki farkındalıklarına katkıda bulunduğunu ortaya koymuştur. Diğer bir deyişle, bu araştırma hem öğretmen adaylarının hem de öğretmenlerin bilim merkezleri farkındalığını artırmada gerçek deneyimlerin önemli olduğunu göstermiştir. Bu da, okul dışı ortamlarla ilgili mesleki gelişim programlarının bir seminer odasında veya dersliklerde değil de, informal ortamlarda (örneğin, bilim merkezleri, bilim müzeleri,

hayvanat bahçeleri vb.) yapılması fikrine yol açmıştır. Bu bağlamda, fen öğretmen eğitimcileri bilim merkezleri ve kaynaklarından öğretmen adaylarını haberdar etmek için derslerinde bu merkezleri kullanabilir veya buralara gerçek geziler düzenleyebilir. Alternatif olarak, öğretmen eğitimcileri, yalnızca bilim merkezlerine değil diğer informal öğrenme ortamlarına da gezi düzenleyerek öğretmen adaylarının bu ortamlar hakkındaki farkındalıklarını da artırabilir. Benzer şekilde, hizmet içi öğretmen eğitimi olarak mesleki gelişim programı geliştiricileri de öğretmenlerin bilim merkezleri hakkındaki farkındalıklarını artırmak için programlarında gerçek bilim merkezi gezileri düzenlemeyi göz önünde bulundurabilirler. Daha açık ifade etmek gerekirse, öğretmenlerin çalıştığı il/ilçede informal öğrenme ortamı olmasa bile, mesleki gelişim programları bu ortamlara yönelik gezileri içermelidir. Bu geziler sırasında, öğretmenler informal ortamların sahip olduğu "sanal tur" gibi farklı özellik ve kaynaklar hakkında detaylı bilgiye ulaşabilirler. Böylece, öğretmenler öğrencilerini bu gibi ortamlara götüremeseler bile, kendi derslerinde bu sanal turdan faydalanabilirler. Eğer programda gerçek ziyaretlerin yapılması mümkün değilse, bilim merkezlerinden/benzer ortamlardan eğitmenler ve öğretmenler bir araya getirilerek, öğretmenlerin bilim merkezleri ve kaynakları hakkındaki farkındalığını artırmaya katkıda bulunulabilir. Bu sayede, hem öğretmen adayları hem de öğretmenler öğrencilerin gezilerden kazanımını üst seviyeye çıkarmak için bilim merkezlerinin kaynaklarını karşılaştırarak, gezileri için en uygun informal ortamı seçme konusunda daha bilinçli olacaklardır.

Sonuçlar ayrıca, öğretmenlerin özellikle bilim merkezi ziyaretiyle ilgili öğretim planı geliştirirken, bilim merkezinin eğitmenleri ile fikir alışverişi ve iletişim konusundaki işbirliğine önem verdiğini göstermiştir. Bu nedenle, mümkünse, bilim merkezlerinde öğretmenlerin soru ve isteklerine bire bir cevap veren birimler kurulabilir. Bu mümkün değilse, bilim merkezleri bir öğretmen rehberi geliştirebilir. Bu öğretmen rehberi: (1) bir ziyaretten ve öğretmenlerden beklentilerin listesini, (2) gezi öncesi, sırası ve sonrasında takip edilmesi gereken prosedürleri, (3) gezi öncesi, sırası ve sonrasında kullanılabilecek etkinlik önerilerini ve (4) bilim merkezinin etkinlik ve programları hakkında detaylı bilgiyi (sergi düzenekleri, etkinlikler ve okul müfredatı arasındaki ilişkiye atıfta bulunarak) içerebilir. Ayrıca, bilim merkezi eğitmenleri ve

öğretmenler, öğrenci kazanımlarını artırmaya yarayacak gezi öncesi, sırası ve sonrası etkinliklerini (örneğin, çalışma kağıdı, atölyeler vb.) geliştirmek için birlikte çalışabilirler. Hatta, bilim merkezleri MEB ile bir protokol imzalayarak, öğretmen rehberleri hakkında okulları resmi bir yazılı açıklama ile bilgilendirebilirler. Böylece, öğretmenler de rehber hakkında bilgilendirilecek ve onların bilim merkezi gezilerine ilişkin öğretim planı hazırlamaları kolaylaşacaktır. Bunun dışında, bu çalışmadaki tüm öğretmenler ODTÜ Bilim Merkezi'ne ikinci ziyaretlerine ilişkin öğretim planlarına ilham kaynağı olarak MGP'de sunulan örnek öğretim planından bahsetti. Bu sonuç da, bilim merkezleri ile ilgili mesleki gelişim programlarında örnek öğretim planlarının sunulmasının önemini ve gerekliliğini göstermiştir.

Ayrıca, bu çalışmadaki mesleki gelişim programı ile öğretmenlerin bilim merkezi gezilerine ilişkin öğretim planlarını etkileyen değerli özellikler sunmuştur. Bu özellikler, öğretmen eğitimcileri, MEB ve mesleki gelişim programı geliştiricileri tarafından benimsenebilir ve bağlamsallaştırılabilir. Nitekim, ülkemizde bilim merkezleri gibi informal öğrenme ortamlarına verilen önem gün geçtikçe artmaktadır. Örneğin, MEB'in 2018 yılında yayımladığı fen bilimleri dersi öğretim programının benimsenen strateji ve yöntemler bölümünde okul dışı öğrenme ortamları (okul bahçesi, bilim merkezleri, müzeler, planetaryumlar, hayvanat bahçeleri, botanik bahçeleri, doğal ortamlar vb.) vurgulanmıştır. Benzer şekilde, Bilim ve Teknoloji Yüksek Kurulu'nun 23. toplantısında, 2016 yılı itibariyle tüm büyük şehirlerde ve 2023'te tüm illerde yerel idarelerle işbirliği içinde bilim merkezlerinin kurulmasına yönelik çalışmaların yapılması kararlaştırılmıştır. (Çolakoğlu, 2017). Duran ve arkadaşlarının (2010) çalışmasında iddia edildiği gibi, Türkiye'deki tüm illerde bilim merkezlerinin kurulmasının tamamlandığı ve ülkedeki bu bilim merkezlerinin açık kalmak için mücadele ettiği bir zamanda, informal ve formal öğrenme ortamları arasındaki kaynak açığını kapatmak ve köprü oluşturmak için bu çalışmadaki gibi mesleki gelişim programları daha önce hiç olmadığı kadar önem kazanacaktır. Bu nedenle, MEB ortaklığı ile büyük ölçekte benzer mesleki gelişim programları sunulabilir veya bu programlar MEB kapsamında öğretmenlerimize hizmet içi eğitim olarak sunulabilir. Hatta, öğretmen adayları için MEB ortaklığı ile okullarda yapılan stajlara ek olarak bilim merkezleri gibi informal ortamlarda yapılan stajlar

düzenlenebilir. Dolayısıyla, bu alanda deneyimli ve kalifiye öğretmenler yetiştirilebilir. Daha sonra, bu öğretmenler okullar ile bilim merkezleri gibi informal öğrenme ortamları arasında uyumlu öğrenme bağlamları oluşturmaya yardımcı olabilir ve okul gruplarının bilim merkezlerine ziyaretinin akışını düzenleyebilirler. Örneğin, öğretmenler -bilim merkezi kaynaklarının farkında olarak- sınıf gezisi deneyimini okul müfredatıyla birçok tamamlayıcı şekilde bütünleştiren yerinde etkinlikler tasarlayabilirler. Benzer şekilde, bu nitelikli öğretmenler bu deneyimlerini okullarına geri götürecek ve bu konuda okullarında yansıtıcı uygulayıcılar olacaklardır. Diğer bir deyişle, bu çalışmaya katılan üç fen bilimleri öğretmeni okullarındaki diğer birçok öğretmene ulaşabilir. Böylece, okullarındaki diğer öğretmenlerin bilim merkezlerine sınıf gezisi düzenlemelerine ve gezi sıklıklarını değiştirmelerine yardımcı olabilirler.

Bu çalışma ile, yukarıda belirtilen öneriler dışında gelecek çalışmalar için de bazı tavsiyelerde bulunulabilir. Örneğin, bu çalışmada sadece üç fen bilimleri öğretmeni incelenmiştir. Ancak, diğer tüm fen bilimleri öğretmenleri ile bu çalışmadaki öğretmenlerin özellikleri benzer olmayacağı gibi bu çalışmadaki fen bilimleri öğretmenleri bilim merkezi gezisi düzenleyen tek öğretmen değillerdir. Bu nedenle, bu çalışma diğer öğretmenlerin diğer çalışmaları için başlangıç noktası olabilir. Benzer şekilde, her bilim merkezi ortamının belirli kaynakları ve özel gezi uygulamaları olduğundan, öğretmen stratejileri bir bilim merkezinden diğerine farklılık gösterebilir. Bu nedenle, bir MGP'ye katıldıktan sonra öğretmen stratejilerindeki değişimin tamamen farklı olup olmadığını veya ortak bir çok noktaya sahip olup olmadıklarını belirlemek için farklı kaynaklara ve farklı gezi uygulamalarına sahip farklı bilim merkezlerini araştıran çalışmalar yapılabilir. Öte yandan, mesleki gelişim programının öğretmenlerin gezi düzenleme stratejileri üzerindeki etkileri ile bunun öğrenci kazanımları üzerindeki etkisini inceleyen tamamlayıcı bir çalışma yapılabilir. Böylece programın hangi özelliklerinin öğretmenlerin stratejilerini ve dolayısıyla öğrencilerinin kazanımlarını etkilediği tespit edilebilir.

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